4.0 INDUSTRY DESCRIPTION

This section presents the following information about the ICDC industry:

- An overview of the industry (Section 4.1);
- Cleaning and reconditioning processes in the industry (Section 4.2);
- Cargo types cleaned by ICDC facilities (Section 4.3);
- Chemical cleaning solutions used by the industry (Section 4.4); and
- References for this section (Section 4.5).

Information presented in this section is based on data collected from the Reusable Industrial Packaging Association (RIPA), EPA site visits and sampling episodes, and other non-EPA data sources (see Section 3.0). Figures appear at the end of the section.

4.1 ICDC Industry Overview

The ICDC industry includes facilities that clean and recondition metal and plastic drums and intermediate bulk containers (IBCs) for resale, reuse, or disposal. ICDC facilities can be further classified as facilities that either burn open-head steel drums or wash plastic or tight-head steel drums and/or IBCs. ICDC facilities may also clean and recondition other types of containers, such as fiber drums, cloth (i.e., flexible) IBCs, bottles, cans, and/or pails or transportation equipment, such as tank trucks; however, this study focuses only on metal and plastic drums and IBCs.

4.1.1 Size of the Industry and Geographical Location

EPA obtained several sources that identify potential drum and IBC reconditioning facilities. These sources include the Hazardous Cargo Bulletin Drum & IBC Guide, membership listings from RIPA, industry-related Web sites, the Transportation Equipment Cleaning (TEC) Point Source Category rulemaking record, and other sources discussed in Section 3.0. Based on these sources, EPA prepared two estimates, the sum of which represents the total population of the ICDC industry. These two estimates include the number of ICDC facilities that also clean transportation equipment and the number that do not.

Using these sources, EPA initially identified 152 potential ICDC facilities that do not clean transportation equipment. Of these 152 facilities, 94 were confirmed by RIPA as drum or container reconditioning facilities. EPA then contacted 9 of the unconfirmed facilities to determine whether they perform ICDC operations. Based on information obtained from the telephone contacts for both the listed facilities and for other facilities within the same corporate structure, EPA identified 100 confirmed ICDC facilities that do not clean transportation equipment. This represents the total confirmed industry population. However, based on these limited industry contacts, EPA believes that 50% of the unconfirmed ICDC facilities should be included in the industry population estimate. Applying this percentage to the remaining 36 unconfirmed facilities results in a total estimated population of 118 ICDC facilities that do not clean transportation equipment. (References 1 and 2 describe EPA's industry population estimates in greater detail.) The majority of these ICDC facilities are located in California, Illinois, Ohio, and Texas.

Based on the TEC rulemaking record, EPA estimates that 173 TEC facilities (predominantly tank truck cleaning facilities) reconditioned at least one IBC in 1994. (EPA is aware of only one TEC facility that cleaned a small number of drums in 1993.) Comments submitted on the proposed TEC rule and the TEC Notice of Availability overwhelmingly indicate that IBC use and reconditioning have grown significantly since 1994. Literature sources, such as Hazardous Cargo Bulletin's "The Future of the IBC Market," verify the growth of the IBC market (3). Therefore, EPA's total estimated population of 173 ICDC facilities that also clean transportation equipment includes a low bias that EPA has not quantified. TEC facilities that clean tank trucks are distributed primarily within the industrial portions of the United States, with relatively high concentrations in the area between Houston and New Orleans and within specific urban areas such as Los Angeles, Chicago, and St. Louis.

In summary, EPA estimates a total ICDC industry population of 291 facilities.

Based on recent (non-statistical) membership surveys, RIPA estimates the following numbers of drums and containers are reconditioned by their members (4)(5)(6). Note that RIPA believes their survey data overestimates total industry production (6). For comparison, the table below also presents Department of Commerce data for new drum manufacturing for 1998.

Production at Drum Reconditioning Facilities

Container Type	Number Produced/Year	Number Reconditioned/Year
Plastic Drums	15 million	8.3 million
Steel Drums	27.6 million	31.2 million
IBCs	Unknown	275,000

Modern Bulk Transporter, an industry trade journal, estimates that currently at least 500,000 IBCs are cleaned annually (7). Based on this estimate, EPA believes at least 225,000 IBCs are cleaned by TEC facilities (500,000 minus 275,000 cleaned by drum reconditioners). Therefore, the table below presents EPA's estimates of the current total production by the ICDC industry.

Total Production by the ICDC Industry

Container Type	Number Reconditioned/Year
Plastic Drums	8.3 million
Steel Drums	31.2 million
IBCs	500,000

EPA has no data on the number of drums and containers that are cleaned by shippers and end users, which are generally not considered ICDC facilities because they perform other industrial and commercial operations. Shippers and end users are not included in EPA's industry population estimates of ICDC facilities. Drum and container manufacturers generally perform manufacturing and drum and container reconditioning at separate facilities, and, therefore, are considered ICDC facilities. EPA believes its ICDC industry population estimate captures most of these facilities. Finally, EPA has no data on the number of drums and containers that are cleaned by fill/distribution centers, which may be considered ICDC facilities depending on other industrial and commercial operations performed at these centers. EPA did not include fill/distribution centers in its industry population estimates of ICDC facilities.

4.1.2 Types of ICDC Facilities

ICDC facilities often report under 1987 Standard Industrial Classification (SIC) code 7699 (Repair Shops and Related Services, Not Elsewhere Classified). Most ICDC facilities purchase used drums or containers that they clean and recondition for resale. Some ICDC facilities commercially clean containers they do not own. Other ICDC facilities lease new or reconditioned drums or containers to clients and then clean and recondition the drums and containers when they are returned by the end user. Many new drum or container manufacturers accept used drums and containers as part of product stewardship programs, and may clean and recondition drums and containers themselves or broker used drums and containers to other reconditioners.

RIPA estimates that approximately 60% of their member ICDC facilities (i.e., ICDC facilities that do not clean transportation equipment) are classified as small businesses (size cutoff unknown). Only a few companies have multiple plants because the industry has only recently begun consolidation. In contrast, EPA estimates 30% of TEC facilities (which include at least 173 ICDC facilities) are small businesses (annual revenues less than $5,000,000) and many companies have multiple plants.

ICDC facilities are also classified as follows by the types of cleaning operations performed: washing facilities, burning facilities, and washing and burning facilities. (Washing and burning operations are described in detail in Section 4.2.) Although statistically-reliable data are not available, several industry surveys provide anecdotal information regarding the distribution of ICDC facilities by cleaning operation. For example, the National Barrel and Drum Association (NABADA, now RIPA) conducted a membership survey in 1980 (8). The association sent surveys to 119 drum reconditioner members, and received 49 survey responses.

Among these respondents, 39% were washing only facilities, 18% were burning only facilities, and 43% were both washing and burning facilities. For the 2000 RIPA survey (6), the association sent surveys to 98 drum reconditioner members, and received 36 survey responses. Among these respondents, 56% were washing only facilities, 19% were burning only facilities, and 25% are both washing and burning facilities. All TEC facilities that also clean IBCs are washing-only facilities.

4.2 Cleaning/Reconditioning Process

Drums and IBCs are used to transport thousands of different cargos. The interiors and exteriors of these containers are cleaned and reconditioned to prevent contamination of materials from one cargo shipment to the next and to ensure the integrity of the containers. The following processes are described in greater detail below: drum washing, drum burning, and IBC cleaning/reconditioning. The table below summarizes the number of drums and IBCs cleaned and reconditioned using these processes (5)(6). Note that RIPA believes their survey data overestimates total industry production and also skews steel drum production toward open-head drums (6).

Process	Number of Drums/IBCs Cleaned
Drum Washing	11.0 million steel tight-head 7.6 million plastic tight-head 664,000 plastic open-head
Drum Burning	20.2 million steel open-head
IBC Cleaning/Reconditioning	500,000 plastic and steel IBCs

4.2.1 Drum Washing

Drum washing includes cleaning and reconditioning tight-head, or bung-type, steel or plastic drums and open-head plastic drums for resale, reuse, or disposal. In 2000, EPA observed steel drum washing at two facilities and plastic drum washing (tight-head and open-head) at one facility. The following discussion of the drum washing process is based on EPA's observations at these facilities. The Agency also included supplemental information where noted based on observations during visits to 15 steel drum washing facilities in the mid-1980s.

Figure 4-1 illustrates the general drum washing process. Upon receipt of a drum shipment, the washing facility inspects the drums and returns damaged drums, drums that are not empty, or drums that contain unacceptable materials to the shipper. One facility visited in 2000 presteams drums prior washing. Presteaming entails steaming the drum interior to enhance residual material (heel) removal. The steam condensate, which contains heel, is transported to a fuels blending facility as a hazardous waste. Another facility visited in 2000 preflushes open-head plastic drums with water prior to washing. Preflush wastewater is routed to wastewater treatment.

Drums are washed by spraying the drum interior and exterior with hot caustic solution. Drums are typically turned upside down and loaded onto a conveyor, which transports the drums through an automatic drum cleaning machine in an assembly-line style. Alternatively, drums may be washed manually using hand-held spray nozzles. After caustic washing, drums undergo single or multiple rinses, depending on facility preference. Next, drums are inspected for rust (steel drums) and cleanliness. Rusty drums are washed with a hydrochloric acid solution in the same manner as caustic washing described above, followed by one or more rinses. Emissions from the acid washer go through a packed column scrubber, which uses fresh water or dilute caustic solution.

When the contents of a steel drum are difficult to remove using only hot caustic, the facility may use a process called chaining, in which chains are inserted into the drum, along with caustic, and the drum is tumbled to remove remaining materials. (Chaining is not applicable to plastic drum washing.) Drums may require a second chaining cycle. One steel drum washing facility visited in 2000 does not perform chaining, but instead processes drums twice through the caustic washer. If a steel drum cannot be cleaned, it is either sent for conversion to an open-head drum for burning or crushed for recycling. Plastic drums that cannot be cleaned are not burned, but are instead shredded and typically sold to a plastics recycler.

Both steel drum washing facilities visited by EPA in 2000 follow drum washing and initial rinsing with a final rinse step, which includes a corrosion inhibitor additive (sodium nitrite).

After rinsing, plastic drums are dried using vacuum siphons or hot air, and pressure tested using air. Plastic drums are then inspected and the final bungs and fittings are attached. Drums may also be labeled at this step. Steel drums are dried using vacuum siphons, hot air or flame treating; dedented; rechimed; and placed into a submerger to check for leaks. Steel drums are then shot blasted to prepare the surface for painting. Shot-blast emissions are controlled by dust bags with shot-blast dust either recycled with scrap steel or disposed. After painting, the drums are oven cured. As a final step, the drums have bungs and fittings attached and are inspected.

Drum washing processing steps can vary considerably between ICDC facilities. First, not all facilities perform all operations or perform these operations in the sequence described. Second, facilities vary processing steps by drum type, condition, or cargo. The following examples demonstrate these differences:

- Several operations (e.g., chaining, dedenting, chiming, painting/baking) are not applicable to plastic drum washing. Dedenting and other mechanical reconditioning steps are performed on steel drums only when needed.

- Not all steel drum washing facilities perform presteaming or chaining. In general, only steel drums that are difficult to clean are chained.

- In general, only steel drums that contain rust are acid washed.

- One steel drum washing facility caustic washes drum exteriors as a component of the automatic drum washing process. Another steel drum washing facility conducts exterior caustic washing as the first drum washing processing step, which takes place in a separate washing machine.

- One steel drum washing facility removes labels following the final rinse. The other steel drum washing facility removes labels prior to shot blasting.

- One steel drum washing facility returns drums that are acid washed to the caustic washer for additional processing.

EPA also compared the steel drum washing operations observed in 2000 to those observed in the mid-1980s (observations documented in site visit reports, which are included in the ICDC record). Note that the focus of site visit reports from the mid-1980s was to document the selection of facilities and sampling points for subsequent sampling rather than thoroughly describing process operations. This comparison revealed the following observations:

- Processing steps and their sequence were similar.
- Variations in processing steps and sequence were similar at facilities visited in the mid-1980s and those visited in 2000. For example, not all facilities performed chaining. Some facilities performed chaining before or after caustic washing or without prior or subsequent caustic washing.
- Six facilities visited in the mid-1980s drained heels prior to processing. (None of the facilities visited in 2000 drain heels.) The heel was drained primarily from drums that last contained petroleum products.
- Five facilities visited in the mid-1980s presteamed drums prior to processing. (One facility visited in 2000 presteams drums.) Primarily drums that last contained petroleum products were presteamed.
- Four facilities visited in the mid-1980s preflushed drums with either hot water, caustic, or kerosene to enhance heel removal prior to processing. Primarily drums that last contained petroleum products were preflushed. (One facility visited in 2000 preflushes open-head plastic drums which predominantly last contained dyes.)
- Limited available data suggest that most washing facilities visited in the mid-1980s operated an alternative caustic washing process in which drums are submerged in a hot caustic bath. Drums were set on their sides with bungs removed and rotated as they proceeded through the bath.

RIPA provided EPA a summary of the results of a membership survey from 2000 that included data for certain process operations (6). The association sent surveys to 98 RIPA members who reprocess steel and plastic drums, as well as IBCs, and received 36 survey responses. Below are relevant observations from the (nonstatistical) survey summary:

- Twenty-nine respondents reported performing caustic cleaning process operations, while only eight respondents reported performing acid cleaning process operations. Assuming all drum washing facilities perform caustic cleaning, these responses suggest that approximately 28% of drum washing facilities perform acid washing.
- One respondent reported performing a solvent rinse. RIPA indicated that solvent rinsing is rarely performed due to the cost of solvent (9). No additional information is available regarding this process.
- Sixteen respondents reported performing chaining, suggesting that approximately 55% of drum washing facilities perform chaining while 45% do not.
- The percentage of drums reportedly scrapped and/or recycled are as follows: 14% of steel tight-head drums, 20% of plastic tight-head drums, and 24% of plastic open-head drums.
- Eight respondents reported using wet (acid) or dry scrubber air pollution controls.
- Four respondents reported generating hazardous paint waste, four respondents reported generating hazardous oil or oily water, and three respondents reported generating hazardous spent solvents. These responses suggest that some facilities continue to remove heels or perform prerinsing or presteaming to enhance heel removal.

Data provided by RIPA and EPA observations suggest that steel drum washing processes have not changed significantly in the last 13 years. EPA has no data on whether or how plastic drum washing processes have changed in the last 13 years. As discussed in Section 10.1, very few plastic drums were manufactured or reconditioned in the mid-1980s. Since then, plastic drums have since gained significant market share from steel drums.

4.2.2 Drum Burning

Drum burning includes cleaning and reconditioning open-head steel drums for resale, reuse, or disposal. EPA observed steel drum burning at one facility in 2000 that also washes steel drums. The following discussion of the drum burning process is based on EPA's observations at this facility. The Agency also included supplemental information where noted based on observations during visits in the mid-1980s to five drum burning facilities that also wash drums, and one drum-burning-only facility.

Figure 4-2 illustrates the general drum burning process. Upon receipt of a drum shipment, the burning facility inspects the drums and returns those that are damaged or not considered empty to the shipper. The drum burning facility visited by EPA in 2000 does not pour or otherwise remove heels prior to burning. In fact, small amounts of heel with high BTU value may be beneficial to offset furnace energy requirements.

Open-head drums are burned in tunnel-type continuous furnaces. The furnace operated by the drum burning facility visited by EPA in 2000 was considered by facility personnel to be state of the art in the industry. The furnace includes a primary furnace that operates at 1,100°F, an afterburner that operates at 1,850°F to 1,900°F to control emissions, automatic controls, and continuous emissions monitoring for carbon monoxide and temperature. Drums travel through the furnace upside down on a moving chain; drum lids are placed on top of the drums. Drums exiting the furnace are cooled by a steam curtain, which also removes ash from drums. The furnace chain is quenched with water at the end of the furnace.

After burning, the drums are rinsed with fresh water and 1% sodium nitrite, a rust inhibitor. The drums are then shot blasted (inside and out) to remove any remaining paint. Shot-blast emissions are controlled by dust bags with shot-blast dust either recycled with scrap steel or disposed. Next, drums are mechanically dedented by curling, expanding, and body rolling, and the bottom chime is sealed on a chime roller (rechimed). Drums are then leak tested in a submerger and inspected. Finally, drums are dried, painted, and oven cured; often, the inside of the drum receives an interior coating. The drum lids and rings are then replaced to complete the process.

EPA also compared the steel drum burning operations observed in 2000 to those observed in the mid-1980s (observations documented in site visit reports, which are included in the ICDC record). (Note that the focus of site visit reports from the mid-1980s was to document the selection of facilities and sampling points for subsequent sampling, rather than thoroughly describing process operations.) This comparison revealed the following observations:

- Processing steps and their sequence were similar.
- Similar to the facility visited in 2000, none of the burning facilities visited by EPA in the mid-1980s reported removing heels prior to burning (i.e., heel removal is not discussed in the site visit reports).
- Only one of the five drum burning facilities visited in the mid-1980s operated an afterburner to control emissions (i.e., use of an afterburner is specifically discussed in the site visit report).
- Most furnaces had water sprays, a steam curtain, and/or physical barriers at the inlet opening to prevent flashbacks.
- Three facilities visited in the mid-1980s reported quenching drums with water to cool the drum, remove ash, and extinguish any burning residue. The remaining three facilities reported cooling drums by air. (EPA has no data on the current use of water quenches by the industry, or whether their use has changed since the mid-1980s.)
- Two facilities visited in the mid-1980s reported rinsing drums to prepare them for painting, while the remaining three facilities did not report rinsing drums.

Relevant observations from RIPA’s 2000 survey (6) are provided below:

- Sixteen respondents reported using a drum furnace. Sixteen respondents also reported using a thermal oxidizer (i.e., afterburner), and two respondents also reported using a baghouse.

- As discussed in Section 4.2.1, survey responses suggest that some facilities currently remove heels or perform prerinsing or presteaming to enhance heel removal. Data available to EPA are inadequate to determine whether any of these responses came from drum burning facilities.

- The percentage of steel open-head drums reportedly scrapped and/or recycled is 6.1 percent.

- Eight respondents reported monitoring stack emissions. Pollutants monitored by one or more respondents include carbon monoxide, metals, particulates, volatile organic compounds, and opacity.

- Fourteen respondents reported testing furnace ash, typically once per year. Four respondents reported generating hazardous furnace ash.

Data provided by RIPA and EPA observations suggest that steel drum burning processes have not changed significantly in the last 13 years.

As part of a program to reduce levels of toxic pollution in the atmosphere, the California Environmental Protection Agency, Air Resources Board, assessed combustion sources that emit polychlorinated dioxins and furans (dioxins and furans), polycyclic aromatic hydrocarbons (PAHs), and other toxic compounds (10). The assessment included sampling and analysis of dioxins and furans, PAHs, and heavy metals in emissions from two drum reconditioners and two waste oil burners. Furnaces that were sampled included afterburners operated at 1,700°F. Test results indicated that the drum reconditioning facilities emitted significantly higher levels of dioxins and comparable levels of metals than did the waste oil burners. Dioxin and metals emissions from the drum reconditioning facilities were comparable to levels from previous cement kiln emissions tests. PAH emissions from both drum reconditioning and waste oil burners were essentially zero.

4.2.3 IBC Cleaning/Reconditioning

IBC cleaning/reconditioning includes cleaning and reconditioning plastic or metal IBCs for resale, reuse, or disposal. Plastic IBCs are either blow-molded, which makes them sturdier, or rotationally molded. Rotationally molded IBCs are plastic bottles in steel cages and are referred to as composite IBCs. EPA observed plastic IBC cleaning and reconditioning at one facility in 2000 that also cleans and reconditions plastic drums. EPA also observed plastic and metal IBC cleaning and reconditioning at two facilities in 1999 that also clean tank trucks. The following discussion of the IBC washing process is based on EPA's observations at these facilities. EPA did not observe IBC washing at any facilities visited in the mid-1980s.

Figure 4-3 shows the general IBC cleaning process. IBC cleaning and reconditioning, regardless of type, typically involves the following steps:

- Identify the cargo last contained in the container and determine an appropriate cleaning process;
- Wash the container interior using one or more cleaning methods and solutions;
- Clean fittings and valves and replace gaskets;
- Rinse the container interior;
- Wash the container exterior;
- Dry the container;
- Perform leak test and final inspection.

Determining the material last contained in the container allows the cleaning facility to: (1) assess its ability to clean the container efficiently; (2) determine the appropriate cleaning sequence and cleaning solutions; (3) evaluate whether the residue cleaned from the container will be compatible with the facility's wastewater treatment system; and (4) establish an appropriate level of health and safety protection for the employees who will clean the container. The facility may decide to reject a container based on any of these four determinations.

Once it accepts a container for cleaning, the facility then checks the volume of heel in the container to determine appropriate heel management and/or disposal. Containers with excess heel are returned to the shipper. Water-soluble heels compatible with the facility's treatment system and the conditions of the facility's wastewater discharge permit are usually combined with other wastewaters for treatment at the facility and discharge. Incompatible heels are segregated into drums or tanks for disposal by alternative means, which may include sale to a reclamation facility, landfilling, and incineration. The facility may reuse heels comprising soaps, detergents, solvents, acids, or alkalis as cleaning solutions. The container may be preflushed to enhance heel removal, with preflush wastewater generally segregated for disposal.

Cleaning processes vary between facilities depending on available cleaning equipment and cargos last contained in the IBCs to be cleaned. Certain residual materials (such as ink or food products) may require only a hot water wash, while other residual materials (such as latexes or resins) may need to be washed with a detergent or strong caustic solution followed by a final water rinse. The cleaning processes used also depend on the state of the product. For example, hardened, caked-on products, or hard-to-clean products may require an extended processing time, chemical cleaning solutions, or manual cleaning.

Containers are typically washed and rinsed using one or both of the following methods: (1) spinner nozzles or (2) hand-held wands and nozzles. Spinner nozzles are inserted through the main hatch; they rotate about both their vertical and horizontal axes, which creates an overlapping spray pattern that cleans the entire interior of the container. Manual washing with hand-held wands and nozzles is similar to washing with spinner nozzles, but involves manually directing the spray across the interior surface of the container. Operating cycles range from rinse or wash bursts of a few seconds to recirculating detergent or caustic washes of several minutes or longer for caked or crystallized residues.

Cleaning personnel inspect all containers and perform additional manual cleaning as required. Valves and fittings are removed and cleaned by hand, and gaskets are replaced. Container exteriors are cleaned using hand-held wands either simultaneously with or subsequent to interior washing. Leak tests are performed by partially filling the IBC with water to a level above the valve. After cleaning, containers are dried with ambient or heated air from a blower. The IBC cage is repaired as necessary or applicable. A final inspection completes the process.

Section 7.2.3 discusses the similarities and differences in IBC cleaning processes at facilities that also clean drums versus facilities that also clean tank trucks.

Responses to the 2000 RIPA survey (6) do not distinguish between drum washing processes (performed by 29 respondents) and IBC washing processes (performed by 17 respondents); therefore, observations described in Section 4.2.1 regarding drum washing operations based on RIPA responses may or may not apply to IBC washing operations. The percentage of IBCs reportedly scrapped and/or recycled by RIPA members is 10 percent. In contrast, one TEC facility visited by EPA in 1999 indicated that it cleans and returns to service 60% of rotationally molded IBCs, while it cleans the remaining 40% for disposal or recycle.

4.3 Cargo Types Cleaned

Drums and IBCs are used to transport thousands of different cargos. The following table provides general information regarding cargos last contained in drums cleaned by drum reconditioners. The source of these data is the 1980 NABADA membership survey (8). EPA has no additional information for extrapolation or comparison of these data to current operations.

Cargos Last Contained in Drums (1980)

Cargo Type	Percentage
Oil and petroleum	36.2
Industrial chemicals	15.6
Paint and ink	14.8
Cleaning solvents	8.8
Resins	8.8
Adhesives	6.8
Food	6.8
Other	1.7

Cargo Type	Percentage
Pesticides	0.5
TOTAL	**100**

The 2000 RIPA survey does not address cargos last contained in drums, but does provide limited data on users of reconditioned packagings (6). EPA is not presenting these data in this report because users of reconditioning packagings may differ significantly from sources of used drums for reconditioning.

Literature data, as well as data from drum reconditioners that EPA visited in 2000 and in the mid-1980s, indicate that steel drums typically last contained oil, solvents, paint, resins, chemicals, lacquers and varnishes, adhesives, cleaners, and food. Literature data, as well as data from one ICDC facility that EPA visited in 2000, indicate that plastic drums typically last contained pharmaceutical products, chemical products, food products, dyes, paint, and paint components. Open-head drums are better suited than tight-head drums to transport viscous liquids, powders, or slurries.

The following table presents available information regarding cargos transported in IBCs. The source of these data is a Hazardous Cargo Bulletin Report on the future of the IBC market (3). The report does not provide any additional reference to the basis or source of the cargo information.

Cargos Last Contained in IBCs (2000)

Cargo Type	Percent
Oil and petroleum	20
Chemicals	70
Food	10
TOTAL	**100**

Literature data, as well as data from IBC cleaning facilities that EPA visited in 1999 and 2000, indicate that IBCs typically last contained paints, resins, dyes, wastewater treatment chemicals, food, and other industrial chemicals.

4.4 Chemical Cleaning Solutions

ICDC facilities use various types of chemical cleaning solutions throughout the cleaning process, including caustic, acid, and detergent solutions. Caustic solutions typically comprise sodium hydroxide and water. Acid solutions typically comprise hydrochloric acid and water. Detergent solutions may be off-the-shelf brands of detergents or consist of sodium metasilicate and phosphate-based surfactants. ICDC facilities may also use a corrosion inhibitor rinsing solution during the cleaning process (typically sodium nitrite and water).

The choice of chemical cleaning solutions is primarily determined by wastewater treatment compatibility, POTW limitations, and/or facility preference; however, all steel drum washing facilities use caustic and many also use acid. Plastic drum and IBC washing processes commonly use detergents. Chemical cleaning solutions are generally reused until cleaning personnel determine they are no longer effective. Make-up solution is periodically added to replace solution lost in the final rinse or to boost efficacy. A significant amount of water in chemical cleaning solutions typically evaporates. Make-up water is commonly supplied by recirculated rinse water. Spent cleaning solutions may be hauled off site for disposal or discharged to the on-site wastewater treatment system, if compatible. Some facilities use cleaning solutions indefinitely (with periodic make-up and treatment); they are never discharged or disposed of.

4.5 References

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4. Reusable Industrial Packaging Association. http://www.reusablepackaging.org/Stats.html (DCN D00164).

5. Reusable Industrial Packaging Association. http://www.reusablepackaging.org/whatsnew.html (DCN D00165).

6. Reusable Industrial Packaging Association. "RIPA Reconditioners Survey - Presentation of Business, Technical, and Regulatory Data." September 16, 2000 (DCN D00167).

7. Wilson, C. "IBCs Grow in Popularity," Modern Bulk Transporter. August 1999 (DCN D00043).

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9. Personal communication with C. L. Pettit, Reusable Industrial Packaging Association, March 16, 2001 (DCN D00171).

10. State of California, Air Resources Board, Research Division. Assessment of Combustion Sources That Emit Polychlorinated Dioxins and Furans, Polycyclic Aromatic Hydrocarbons, and Other Toxic Compounds. January 1992 (DCN D00146).

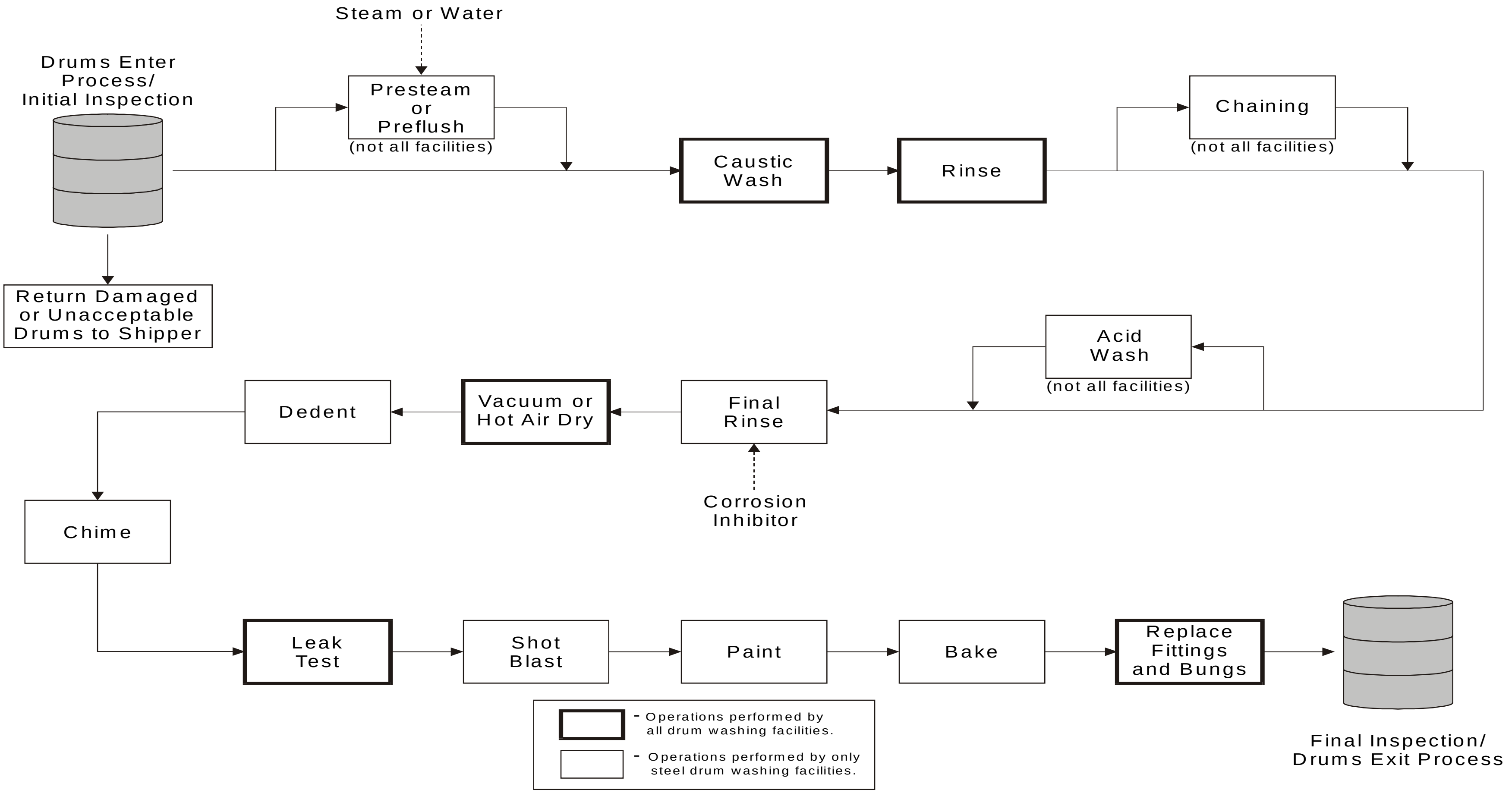

Figure 4-1. General Drum Washing Process Diagram

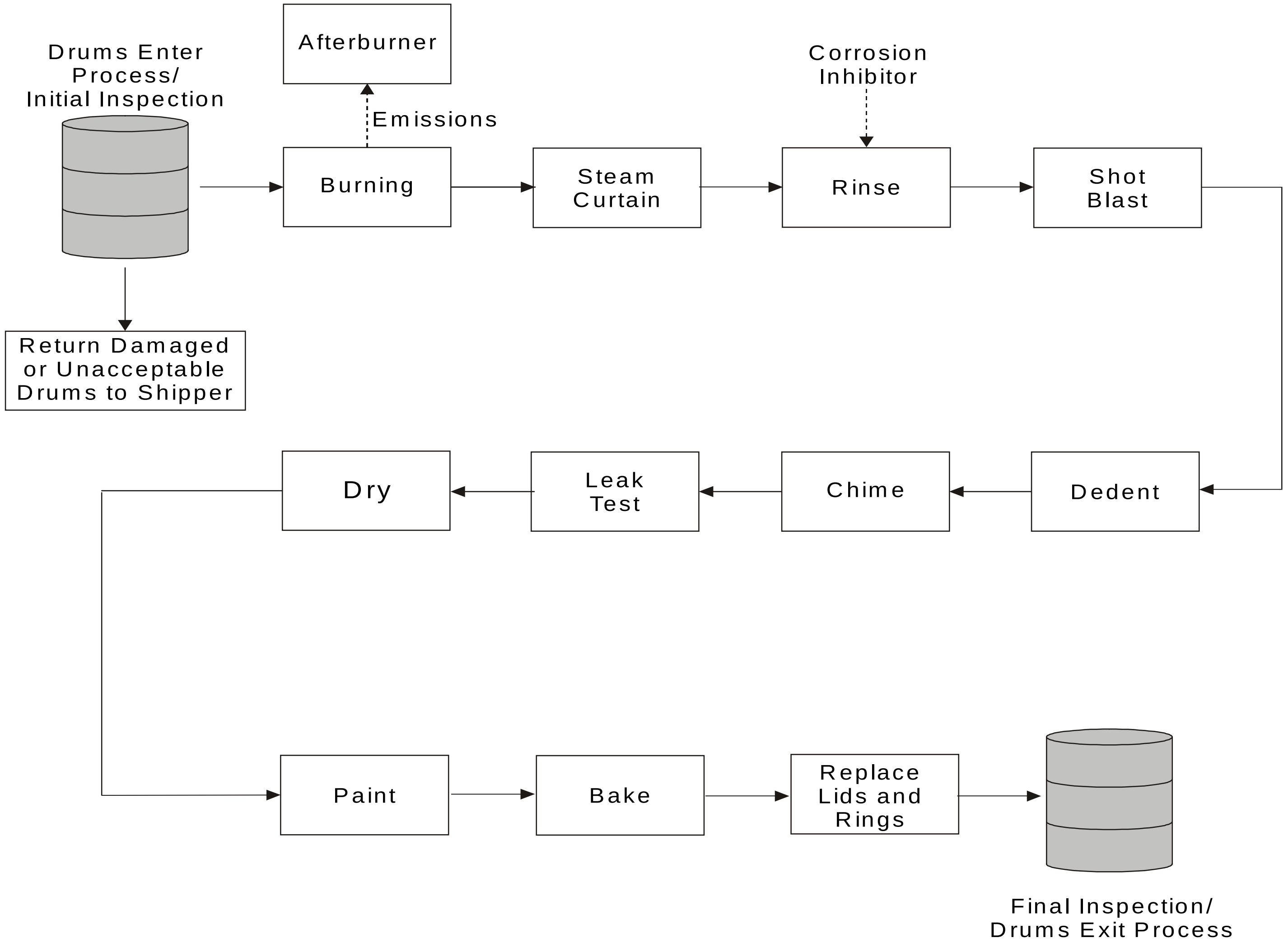

Figure 4-2. General Drum Burning Process Diagram

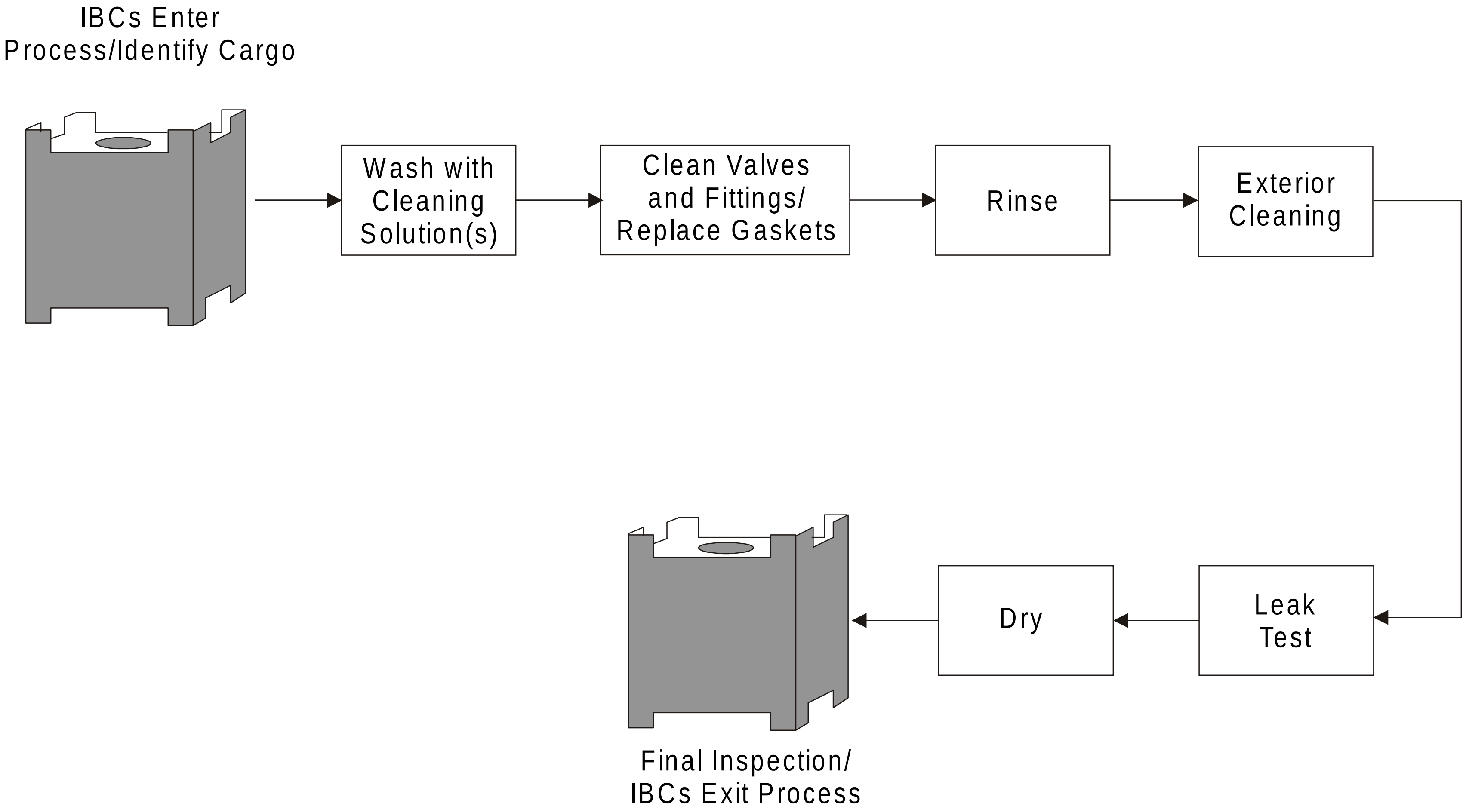

Figure 4-3. General IBC Cleaning Process Diagram

5.0 WATER USE AND WASTEWATER CHARACTERIZATION

As part of the characterization of the ICDC industry, EPA determined water use and wastewater generation practices associated with ICDC operations and assessed what constituents may be present in ICDC wastewater. The following topics are discussed in this section:

- Section 5.1: An overview of water use and sources of wastewater in the ICDC industry;
- Section 5.2: A discussion of the wastewater discharge practices within the ICDC industry;
- Section 5.3: An overview of water use and recycling in the ICDC industry;
- Section 5.4: Wastewater characterization data collected during EPA's sampling programs; and
- Section 5.5: References used in this section.

Most of the information presented in this section is based on observations and information collected during EPA's site visits and sampling episodes in 2000 and in the mid-1980s. Tables and figures appear at the end of the section.

5.1 Water Use and Sources of Wastewater

This section describes water use and sources of wastewater at discharging ICDC facilities which use water or water-based cleaning solutions to clean or rinse drum and container interiors. The amount of water required to clean each drum and container depends upon the cleaning process, as well as the type of cargo last transported. As a result, the amount of wastewater generated from drum and container cleaning is highly variable based on drum or container type and size, the cargo cleaned, cleaning method, and the presence of caked, solidified, or crystallized residues.

Process wastewater may be contaminated with a variety of pollutants including the cargos last contained in the drums or containers, spent cleaning solutions, and exterior surface dirt, spills, and coatings. Process wastewater generally has high concentrations of waste constituents that require substantial treatment for removal or reduction such as oxygen demanding substances, oil and grease, suspended and dissolved solids, and some metals.

Water use and wastewater generation characteristics specific to drum washing, drum burning, and IBC cleaning/reconditioning are described below.

5.1.1 Drum Washing

Water is used throughout the drum washing process. The most significant uses of water associated with drum washing operations include:

- Drum interior preflush, prior to washing;
- Drum interior cleaning hot water washes and/or rinses;
- Drum exterior washing; and
- Formulation of cleaning solutions.

Drum washing facilities perform hot water washes (at some facilities) and rinses to clean drum interiors. Substantial volumes of water can also be used to clean drum exteriors. Since cleaning solutions are often received in concentrated form, water is used to formulate the cleaning solutions to appropriate concentrations. Water is also used to “make up” cleaning solutions, due to loss by evaporation and solution carry-over into subsequent rinse wastewater.

Wastewater is generated primarily through drum washes and rinses. Caustic wash wastewater is generated by preflushing, chaining, and caustic flushing. Rinse water is generated by preflushing, rinsing, and re-rinsing. Acid wash and corrosion inhibition wastewater are sometimes discharged with rinse water. Drum exterior cleaning wastewater includes water and cleaning solutions generated by exterior cleaning operations. Other wastewater sources include leak testing, siphon drying, air pollution scrubber wastewater, paint booth water curtain wastewater, boiler blowdown, compressor condensate, cooling water, sanitary wastewater, and stormwater runoff. Contaminated stormwater runoff could especially be a problem if drums are stored outside where the water comes into contact with exterior surface dirt, spills, and coatings.

Many drum washing facilities use extensive wastewater recycle systems, which greatly reduce the volume of wastewater discharged. According to data collected from 10 steel drum reconditioning facilities in 1987, water use from drum washing averaged 10 gallons per drum. Since approximately 15% of water used at drum washing plants is lost to evaporation, approximately 9 gallons of wastewater are generated and discharged per drum washed (1).

One plastic drum washing facility visited by EPA in 2000 generates about 9 to 10 gallons of wastewater per drum washed. Two steel drum washing facilities visited by EPA in 2000 generate about 3 gallons of wastewater per drum washed, and 4 to 4.5 gallons of wastewater per drum washed, respectively. These data may suggest a possible trend in reduced water use by steel drum washing facilities over the past 13 years.

5.1.2 Drum Burning

Water is used mainly in the quenching stage of the drum burning process; therefore, the primary source of wastewater from drum burning operations is drum quenching, and most quench water is lost to evaporation. Some drum burning facilities rinse drums prior to painting; at these facilities, rinse water is the predominant water use and source of wastewater. Other sources of wastewater include air pollution scrubber wastewater, paint booth water curtain wastewater, leak testing, boiler blowdown, cooling water, sanitary wastewater, and stormwater runoff. According to data collected from 2 drum reconditioning facilities in 1987, water use at drum burning operations averaged 10.6 gallons per drum burned. Since most of the water used for quenching is lost to evaporation, wastewater generation volumes averaged 3 gallons per drum burned (1).

EPA visited one drum burning facility in 2000. Although this facility combines wastewater from washing and burning operations, EPA estimates that drum burning operations generate about 1 to 1.5 gallons of wastewater per drum burned. Note that this facility does not perform drum quenching; wastewater sources include drum rinsing prior to painting. EPA believes these data are too limited to suggest any trends in water use or wastewater generation at drum burning facilities.

5.1.3 IBC Cleaning/Reconditioning

Water is used in the IBC cleaning process for interior cleaning, exterior cleaning, and leak testing. Wastewater is generated by IBC washing and rinsing operations. Cleaning solutions are generally reused with make-up solution periodically added to replace solution lost in the final rinse. Spent cleaning solution may be hauled off site for disposal or discharged to the on-site wastewater treatment system. Rinse water is generated by prerinses and final rinses. Other wastewater sources include IBC exterior cleaning, boiler blowdown, IBC hydrotesting, and safety equipment cleaning.

EPA believes that the volume of wastewater generated by IBC cleaning is highly variable depending on the type of IBC, cargo transported, and degree of cleanliness required. One plastic drum and IBC washing facility visited by EPA in 2000 reportedly generates 5 gallons of wastewater per IBC cleaned. One tank truck and IBC cleaning facility visited by EPA in 1999 estimated generating 150 to 300 gallons of wastewater per IBC cleaned, depending on the type of IBC and degree of cleanliness required. Another tank truck and IBC cleaning facility also visited by EPA in 1999 estimated generating 200 to 250 gallons of wastewater per IBC cleaned.

As noted in the Transportation Equipment Cleaning Notice of Availability (64 FR 38863), EPA believes approximately 100 gallons of wastewater are generated per IBC cleaned. However, RIPA commented on the Notice of Availability and stated that according to member data, approximately 45 gallons of wastewater are generated per IBC cleaned (2).

5.2 Wastewater Discharge Practices

EPA believes that most ICDC facilities discharge ICDC wastewater and that all or almost all of these facilities discharge indirectly to a POTW. EPA has not identified any facilities that discharge directly to surface waters. EPA also believes that some portion of the industry generates ICDC wastewater but does not discharge wastewater directly to surface waters or indirectly to POTWs. Many of these facilities achieve zero discharge of ICDC wastewater by hauling the wastewater to a centralized waste treatment facility, or disposing of the wastewater by land application or evaporation. However, EPA also believes that some ICDC facilities achieve zero discharge by recycling or reusing 100% of ICDC wastewater.

Section 4.1.1 describes EPA's estimate of the total ICDC industry population of 291 facilities, including 118 ICDC facilities that do not clean transportation equipment and 173 ICDC facilities that also clean transportation equipment. Of the 118 ICDC facilities that do not clean transportation equipment, EPA is aware of 11 facilities that do not discharge ICDC wastewater:

- Six facilities identified by RIPA achieve zero discharge of ICDC wastewater via 100% recycle of treated effluent in ICDC processes (3)(4)(5);
- Four drum reconditioning facilities visited by EPA in the mid-1980s, not included on the RIPA list, recycle 100% of treated wastewater effluent in ICDC processes, resulting in zero discharge (see Section 6.2.5); and
- One ICDC facility identified by EPA achieves zero discharge of ICDC wastewater by hauling wastewater to a centralized waste treatment facility (6).

EPA believes many more facilities than the 11 facilities discussed above do not discharge ICDC wastewater, particularly ICDC facilities that only burn drums, but available data are insufficient to better estimate the total number of zero discharge facilities.

Of the 173 ICDC facilities that also clean transportation equipment, EPA estimates that 80 facilities discharge wastewaters indirectly to POTWs and 93 facilities do not discharge ICDC wastewater. Of these 93 facilities, approximately 86 facilities contract haul ICDC wastewater to a centralized waste treatment facility; the remaining 7 facilities recycle 100% of treated effluent in ICDC (and TEC) processes (7).

In summary, based on available data, EPA estimates the discharge status of the ICDC industry as follows:

Facility Type	Number of Direct Dischargers	Number of Indirect Dischargers	Number of Zero Dischargers	Total
ICDC Facilities	0	<187	>104	291

EPA estimates that the total annual volume of wastewater generated by the ICDC industry is 295 million gallons:

- 200 million gallons of wastewater from drum washing (assuming 9 gallons of wastewater generated per drum washed);
- 45 million gallons of wastewater from drum burning (assuming 2.8 gallons of wastewater generated per drum burned); and
- 50 million gallons of wastewater from IBC cleaning (assuming 100 gallons of wastewater generated per IBC washed).

As previously mentioned, the vast majority of this wastewater is discharged indirectly; negligible amounts are believed to be discharged directly. The amount of wastewater that is contract hauled (zero discharge) is unknown, but likely less than 5% (assuming 46% of TEC facilities that clean IBCs are zero discharge, and 50% of IBCs cleaned are cleaned at TEC facilities).

5.3 Water Reuse and Recycling

Water reuse and recycling activities commonly performed by discharging and zero discharge facilities include:

- Recirculation of cleaning solutions, including chemical solutions and water washes;
- Reuse of drum burning quench water;
- Reuse of final rinse wastewater as initial rinse water;
- Reuse of treated ICDC wastewater as source water for ICDC operations;
- Reuse of leak testing wastewater as source water for ICDC operations; and
- Reuse of final rinse wastewater as cleaning solution “make-up” water.

EPA believes that most ICDC facilities reuse or recycle cleaning solutions and/or rinse water. Figure 5-1 illustrates common wastewater recycle and reuse practices for ICDC operations. Additional information concerning water conservation and water recycle and reuse technologies applicable to the ICDC industry is included in Section 6.2.

5.4 Wastewater Characterization

As discussed in Section 3.0, EPA conducted three sampling episodes at three facilities between August and September 2000 representative of the types of facilities in the ICDC industry. As part of this sampling program, EPA analyzed wastewater samples for volatile organics, semivolatile organics, pesticides and herbicides, dioxins and furans, metals, and classical pollutants using standard EPA methods. All data and information collected during these sampling episodes are documented in site-specific sampling episode reports included in the ICDC record. Note that several pesticides and herbicides were tentatively identified, but not confirmed, in wastewater samples as described in the sampling episode reports. Data for tentatively identified analytes are not considered in this analysis, or listed in the data summary tables in this section.

EPA also compiled available ICDC wastewater characterization data from the *Preliminary Data Summary for the Drum Reconditioning Industry* (PDS). Data from the PDS consist of 10 raw wastewater samples collected at four drum reconditioning facilities (Plants A, B, C, and D). Data include 9 steel drum washing samples and 1 steel drum burning sample (furnace quench). EPA analyzed all 10 samples for volatile organics, semivolatile organics, metals, and classical pollutants. EPA also analyzed two drum washing samples for pesticides and herbicides at Plant D (a facility known to wash drums that last contained pesticides and herbicides), and one furnace quench sample for dioxins and furans at Plant D.

5.4.1 Steel Drum Washing

Table 5-1 presents a comparison of raw wastewater characterization data for drum washing samples collected in the 1980s and in 2000 (nine data points from four facilities from the mid-1980s and two data points from two facilities from 2000). This table includes the mean concentration values for each pollutant or parameter detected at least once in either data set. For samples in which individual pollutants were not detected, the sample detection limit was used in calculating the mean concentration. The methodology used to calculate the mean concentration involved first calculating a mean concentration for each facility characterized, and then calculating a mean concentration for the two data sets using applicable mean facility concentrations. Also listed in these tables are the range of pollutant concentrations (including detection limits as appropriate) and the number of times each pollutant or parameter was analyzed and detected in raw wastewater samples.

Cargos last contained in drums washed by the sampled facilities are comparable as shown in the table below.

Data Set	Facility	Cargos
1980s	Facility A	Petroleum and solvents
	Facility B	Lacquers, finishers, varnishes, paints, and solvents
	Facility C	Petroleum
	Facility D	Petroleum, chemicals, and resins
2000	Facility 1	Solvents, paint resins, and petroleum
	Facility 2	Petroleum and solvents

Review of the data sets presented in Table 5-1 reveals the following observations:

- Similar types and numbers of pollutants were detected in the two data sets.
- Average pollutant concentrations for the 1980s data set are generally greater than the average pollutant concentrations for the 2000 data set. However, average concentrations for the 1980s data set are elevated by significantly higher concentrations in wastewater from one facility that recycles 100% of treated effluent in ICDC processes. Exclusion of this facility results in average pollutant concentrations for the 1980s data set that are generally less than the average pollutant concentrations for the 2000 data set.
- The range of pollutant concentrations for the 1980s data set is generally much broader than that for the 2000 data set; however, the ranges of pollutant concentrations in the two data sets generally overlap. Differences are likely because the 2000 data set is significantly smaller than the 1980s data set, and because of elevated wastewater pollutant concentrations at the one facility described above.
- Pollutants detected in a majority of samples from the 1980s were also detected in one or both samples from 2000, with the exception of 1,1,1-trichloroethane, which was not detected in samples collected in 2000. Similarly, pollutants that were detected in both samples from 2000 were generally detected in multiple samples from the 1980s.

The two data sets are too limited to demonstrate whether or not the data sets are comparable. However, available information regarding steel drum washing processes provided in Section 4.2.1 suggests that steel drum washing processes have not changed significantly in the last 13 years. Therefore, the observations listed above, coupled with RIPA and EPA observations regarding steel drum washing processes, suggest that steel drum washing wastewater characteristics have not changed significantly in the last 13 years.

EPA commonly identifies pollutants of interest for a point source category using the following criteria:

(1) The frequency of detection in wastewater characterization samples; and

(2) Raw wastewater pollutant concentrations.

Criteria (1) ensures that the pollutant is representative of the industry, rather than an isolated occurrence. Criteria (2) ensures that the pollutant is present at treatable levels. Table 5-1 lists data for 119 pollutants, the majority of which may be considered to be pollutants of interest for the ICDC industry. At this point, EPA is not selecting specific pollutants of interest for the ICDC industry. However, for the purpose of this study, the following discussion focuses on pollutants that were detected in at least 50% of the samples and/or at an average raw wastewater concentration of 1 mg/L or greater.

The volatile organics that were detected in at least half of the samples in both data sets include acetone, ethylbenzene, methyl ethyl ketone, and toluene. 1,1,1-Trichloroethane was detected in more than half of the samples in the 1980s, but was not detected in the 2000 samples; methyl isobutyl ketone was detected in both 2000 samples, but was not detected in the 1980s samples. The above-mentioned six volatile organic pollutants were also detected at the highest concentrations. Ethylbenzene, toluene, and 1,1,1-trichloroethane are priority pollutants as designated by EPA in 40 CFR Part 423, Appendix A. Treatment technologies commonly employed by the ICDC industry (see Section 6.3) are estimated to volatilize these pollutants by 50% or greater.

The semivolatile organics that were detected in at least half of the samples in both data sets include bis (2-ethylhexyl) phthalate, naphthalene, and styrene. Bis (2-ethylhexyl) phthalate and naphthalene are priority pollutants, while styrene is not. In general, more semivolatile organics were detected in a greater percentage of 2000 samples than in the 1980s samples. The five pollutants detected at the highest mean concentrations in the 1980s samples are benzoic acid, bis (2-ethylhexyl) phthalate (a priority pollutant), styrene, n-decane, and isophorone (a priority pollutant). The five pollutants detected at the highest mean concentrations in the 2000 samples are benzoic acid, hexanoic acid, benzyl alcohol, phenol (a priority pollutant), and n-nitrosomorpholine.

Almost all of the analyzed metals, including 10 priority pollutants, were detected in all eleven samples. Chromium, lead, and zinc are the priority pollutants detected in both the 1980s and the 2000 samples at the highest concentrations.

All of the analyzed classical pollutants were detected in all samples. Raw wastewater exhibited a high pH (10 to 13 standard units) due to the caustic cleaning solutions used in the drum washing process. For the 1980s data set, the mean BOD_5 concentration is 3,700 mg/L; COD is 17,000 mg/L; TSS is 4,700 mg/L; and oil and grease is 13,000 mg/L. For the 2000 data set, the mean BOD_5 concentration is 3,500 mg/L; COD is 10,000 mg/L; TSS is 1,400 mg/L; and HEM is 310 mg/L. These concentrations are significantly greater than those in strong domestic wastewater, which is characterized as follows: BOD_5 is 400 mg/L; COD is 1,000 mg/L; TSS is 350 mg/L; and oil and grease is 150 mg/L (8).

A few dioxins and furans were detected at concentrations typical of those found in oily wastewater. Specifically, hepta- and octa-substituted dioxins and furans ranged in concentration from 50 to 1,400 pg/L.

Ten pesticides and herbicides were detected in 1980s samples collected at a facility known to clean drums that last contained pesticides and herbicides. Pesticides and herbicides were not positively identified in the 2000 samples. Neither of the facilities sampled in 2000 is known to clean drums that last contained pesticides and herbicides.

5.4.2 Plastic Drum and IBC Washing

Table 5-2 presents raw wastewater characterization data from a plastic drum and IBC washing facility sampled in 2000. Cargos last contained in drums and IBCs washed at the sampled facility include dyes and water-based paint components (acrylics and latexes). A total of 27 priority pollutants were detected: 3 volatile organics, 5 semivolatile organics, 8 metals, and 1 classical. (This table includes only those pollutants that were detected in the raw wastewater.)

Relatively few volatile and semivolatile organics were detected in plastic drum and IBC washing wastewater as compared to the number of organics detected in steel drum washing wastewater; however, this may be because only one plastic drum and IBC washing wastewater sample was analyzed. All of these pollutants, with the exception of chloroform, were detected at significantly lower concentrations than the levels in the steel drum washing wastewater.

Three times as many dioxins and furans were detected in plastic drum and IBC washing wastewater as compared to the steel drum washing wastewater and at relatively high concentrations. Specifically, hepta-, hexa-, and octa-substituted dioxins and furans ranged in concentration from 51 to 12,000 pg/L. Although EPA did not investigate the source of dioxins and furans in the facility’s wastewater, facility personnel indicated that small amounts of bleach are used in the drum and container cleaning process. Therefore, one possible source is a chemical reaction of bleach with dioxin and furan precursors in the drum and container washing wastewater.

Two pesticides and herbicides were detected in plastic drum and IBC washing wastewater. The source of these pollutants is unknown because the sampled facility reportedly does not clean drums or IBCs that last contained pesticides or herbicides.

All of the analyzed metals were detected with the exceptions of antimony, beryllium, silver, thallium, and yttrium. The metals in the plastic drum and IBC washing wastewater were detected at significantly lower concentrations than in the steel drum washing wastewater with the exceptions of calcium, aluminum, magnesium, mercury, and molybdenum.

The mean BOD_5 concentration is 440 mg/L; COD is 2,400 mg/L; TSS is 1,500 mg/L; and HEM is 21 mg/L. Again, these levels are much lower than those in the steel drum washing wastewater, and are more comparable to strong domestic wastewater.

5.4.3 Steel Drum Burning

Table 5-3 presents raw wastewater characterization data from a steel drum burning facility sampled in the mid-1980s. Cargos last contained in drums burned at the sampled facility include petroleum, chemicals, and resins. A total of 22 priority pollutants were detected in the raw wastewater: 4 volatile organics, 3 semivolatile organics, 13 metals, and 2 classicals. (This table also includes only those pollutants that were detected in the raw wastewater.)

Relatively few volatile and semivolatile organics were detected in steel drum burning wastewater as compared to steel drum washing wastewater; however, this may be because only one steel drum burning wastewater sample was analyzed. Steel drum burning wastewater pollutant levels are similar to those of the steel drum washing wastewater. One exception, methylene chloride (a priority pollutant), was detected at a much higher concentration of 100,000 μg/L as compared to 1,300 μg/L.

Dioxins and furans were detected in lower levels than those in steel drum washing and plastic drum and IBC washing wastewaters.

All of the analyzed metals were detected and generally present at levels comparable to or less than concentrations in steel drum washing wastewater. Notable exceptions include chromium and zinc, which were detected in drum burning wastewater at significantly greater concentrations than those in steel drum washing wastewater.

The mean BOD_5 concentration is 2,600 mg/L; COD is 52,000 mg/L; TSS is 9,500 mg/L; and oil and grease is 5,300 mg/L. These concentrations are significantly greater than those in steel drum washing wastewater, as well as those in strong domestic wastewater.

5.5 References

1. U.S. EPA, Office of Water Regulations and Standards, Preliminary Data Summary for the Drum Reconditioning Industry, EPA 440/1-89/101, September 1989 (DCN D00001).

2. Reusable Industrial Packaging Association (RIPA), Comments on the Transportation Equipment Cleaning Notice of Availability. Letter from Paul Rankin, RIPA to John Tinger, EPA/EAD, September 20, 1999 (DCN D00023).

3. Personal communication from Dana Worcester, Reusable Industrial Packaging Association, August 13, 1999 (DCN D00083).

4. Personal communication from Dana Worcester, Reusable Industrial Packaging Association, August 31, 1999 (DCN D00076).

5. Personal communication from Dana Worcester, Reusable Industrial Packaging Association, September 14, 1999 (DCN D00077).

6. Personal communication from Rich Crowley, Evans Industries, Inc., January 18, 2001 (DCN D00160).

7. U.S. EPA Office of Water, 1994 Detailed Questionnaire for the Transportation Equipment Cleaning Industry - Part A: Technical Information, April 1995.

8. Metcalf and Eddy, Inc. Wastewater Engineering: Treatment, Disposal, Reuse, Third Edition. McGraw-Hill, Inc., 1991, p. 109.

Table 5-1

Comparison of Steel Drum Washing Raw Wastewater Characterization Data

Priority Pollutant Code	Analyte	Units	1980s Data			2000 Data		
			Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?	Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?
Volatile Organics								
	Acetone	μg/L	170,000	50 - 2,000,000	4/9	22,000	210 - 43,000	2/2
P004	Benzene	μg/L	ND			36	10 - 63	1/2
P007	Chlorobenzene	μg/L	ND			15	10 - 21	1/2
P023	Chloroform	μg/L	ND			630	10 - 1,300	1/2
P010	1,2-Dichloroethane	μg/L	160	10 - 1,000	1/9	ND		
P029	1,1-Dichloroethene	μg/L	1,400	10 - 25,000	1/9	ND		
P038	Ethylbenzene	μg/L	17,000	100 - 190,000	7/9	2,700	10 - 5,400	1/2
	Isobutyl Alcohol	μg/L	560	10 - 3,500	1/9	ND		
	m+p-Xylene	μg/L	ND			6,700	10 - 13,000	1/2
P044	Methylene Chloride	μg/L	1,900	10 - 15,000	2/9	ND		
	Methyl Ethyl Ketone	μg/L	290,000	50 -1,400,000	5/9	43,000	320 - 85,000	2/2
	Methyl Isobutyl Ketone	μg/L	ND			75,000	230 - 150,000	2/2
	o-Xylene	μg/L	ND			2,000	10 - 3,900	1/2
P085	Tetrachloroethene	μg/L	4,500	10 - 86,000	1/9	22	10 - 35	1/2
P086	Toluene	μg/L	18,000	25 - 110,000	8/9	26,000	10 - 51,000	2/2
P030	Trans-1,2-Dichloroethene	μg/L	160	10 - 1,000	1/9	ND		
P011	1,1,1-Trichloroethane	μg/L	7,400	10 - 72,000	5/9	ND		
P087	Trichloroethene	μg/L	650	10 - 4,600	4/9	ND		
Semivolatile Organics								
	Acetophenone	μg/L	ND			21	15 - 27	1/2
	Alpha-Terpineol	μg/L	1,300	10 - 4,700	1/9	ND		

Table 5-1 (Continued)

Priority Pollutant Code	Analyte	Units	1980s Data			2000 Data		
			Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?	Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?
	Benzoic Acid	μg/L	12,000	50 - 95,000	2/9	89,000	21,000 - 160,000	2/2
	Benzyl Alcohol	μg/L	1,000	10 - 9,800	3/9	3,300	690 - 6,000	2/2
	Biphenyl	μg/L	190	10 - 1,400	4/9	ND		
P066	Bis (2-Ethylhexyl) Phthalate	μg/L	5,400	10 - 44,000	5/9	270	76 - 470	2/2
P067	Butyl Benzyl Phthalate	μg/L	210	10 - 3,300	1/9	260	16 - 510	1/2
P020	2-Chloronaphthalene	μg/L	1,200	10 - 4,600	3/9	ND		
P068	Di-N-Butyl Phthalate	μg/L	1,100	10 - 14,000	3/9	100	16 - 190	1/2
P059	2,4-Dinitrophenol	μg/L	ND			1,000	76 - 2,000	1/2
P035	2,4-Dinitrotoluene	μg/L	100	10 - 1,000	1/9	ND		
	Diphenyl Ether	μg/L	170	10 - 2,500	1/9	ND		
P080	Fluorene	μg/L	100	10 - 1,000	1/9	ND		
	Hexanoic Acid	μg/L	370	10 - 1,200	2/9	59,000	2,000 - 120,000	2/2
P054	Isophorone	μg/L	2,800	10 - 25,000	4/9	200	67 - 330	2/2
P060	2-Methyl-4,6-Dinitrophenol	μg/L	ND			640	30 - 1,200	1/2
	2-Methylnaphthalene	μg/L	80	10 - 1,000	1/9	140	16 - 270	1/2
	n-Decane	μg/L	3,000	10 - 12,000	1/9	1,100	16 - 2,200	1/2
	n-Docosane	μg/L	880	10 - 12,000	2/9	220	18 - 430	2/2
	n-Dodecane	μg/L	1,800	10 - 7,000	1/9	770	16 - 1,500	1/2
	n-Eicosane	μg/L	ND			410	40 - 790	2/2
	n-Hexacosane	μg/L	ND			1,200	50 - 2,300	2/2
	n-Hexadecane	μg/L	400	10 - 1,200	2/9	290	23 - 560	2/2
	n-Nitrosomorpholine	μg/L	ND			2,400	16 - 4,800	1/2
	n-Octacosane	μg/L	1,500	10 - 28,000	1/9	160	16 - 300	1/2
	n-Octadecane	μg/L	910	10 - 13,000	2/9	320	57 - 580	2/2
	n-Tetracosane	μg/L	ND			450	16 - 890	1/2

Table 5-1 (Continued)

Priority Pollutant Code	Analyte	Units	1980s Data			2000 Data		
			Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?	Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?
	n-Tetradecane	μg/L	2,600	10 - 44,000	2/9	ND		
P055	Naphthalene	μg/L	1,900	10 - 18,000	6/9	230	16 - 450	1/2
P056	Nitrobenzene	μg/L	100	10 - 1,000	2/9	ND		
P057	2-Nitrophenol	μg/L	770	20 - 3,300	3/9	1,800	1,100 - 2,400	2/2
P058	4-Nitrophenol	μg/L	ND			2,400	1,500 - 3,200	2/2
	o-Cresol	μg/L	100	10 - 1,000	2/9	180	15 - 350	1/2
	p-Cresol	μg/L	ND			200	15 - 380	1/2
	p-Cymene	μg/L	160	10 - 2,000	4/9	90	16 - 160	1/2
P081	Phenanthrene	μg/L	670	10 - 12,000	1/9	ND		
P065	Phenol	μg/L	140	10 - 1,000	1/9	3,200	3,200 (b)	1/1 (b)
	Styrene	μg/L	4,500	10 - 35,000	6/9	50	15 - 85	1/2
	Thioxanthone	μg/L	190	20 - 2,000	1/9	ND		
	Tripropyleneglycol Methyl Ether	μg/L	ND			2,300	270 - 4,400	2/2
Dioxins and Furans								
	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/L	NA			160	90 - 220	2/2
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/L	NA			100	50 - 160	1/2
	Octachlorodibenzo-p-dioxin	pg/L	NA			1,300	1,200 - 1,400	2/2
	Octachlorodibenzofuran	pg/L	NA			270	220 - 330	2/2
Pesticides and Herbicides (c)								
	Azinphos Ethyl	μg/L	2,100	ND - 4,300	1/2	ND		
	Azinphos Methyl	μg/L	5,400	4,700 - 6,200	2/2	ND		
	Diazinon	μg/L	520	ND - 1,000	1/2	ND		
	Dimethoate	μg/L	750	ND - 1,500	1/2	ND		

Table 5-1 (Continued)

			1980s Data			2000 Data		
Priority Pollutant Code	**Analyte**	**Units**	**Mean Concentration (a)**	**Range of Individual Data Points**	**Detected in How Many Samples?**	**Mean Concentration (a)**	**Range of Individual Data Points**	**Detected in How Many Samples?**
P095	Endosulfan I	µg/L	150	ND - 300	1/2	ND		
P097	Endosulfan Sulfate	µg/L	260	ND - 530	1/2	ND		
	Etridazone	µg/L	130	ND - 250	1/2	ND		
	Fensulfothion	µg/L	6,800	5,800 - 7,900	2/2	ND		
P100	Heptachlor	µg/L	140	ND - 280	1/2	ND		
	Leptophos	µg/L	2,000	ND - 4,000	1/2	ND		
Metals								
	Aluminum	µg/L	20,000	3,100 - 91,000	9/9	16,000	11,000 - 21,000	2/2
P114	Antimony	µg/L	3,500	15 - 34,000	9/9	320	280 - 360	2/2
P115	Arsenic	µg/L	54	16 - 500	9/9	38	28 - 48	2/2
	Barium	µg/L	2,000	89 - 7,500	9/9	2,200	980 - 3,400	2/2
P117	Beryllium	µg/L	15	1 - 50	3/9	0.38	0.19 - 0.57	2/2
	Boron	µg/L	2,100	13 - 7,700	9/9	16,000	2,500 - 29,000	2/2
P118	Cadmium	µg/L	410	6 - 4,700	9/9	19	2.9 - 36	1/2
	Calcium	µg/L	39,000	9,200 - 120,000	9/9	28,000	19,000 - 38,000	2/2
P119	Chromium	µg/L	3,200	630 - 6,700	9/9	1,000	210 - 1,900	2/2
	Cobalt	µg/L	400	68 - 1,700	9/9	570	560 - 580	2/2
P120	Copper	µg/L	1,600	250 - 5,900	9/9	710	670 - 760	2/2
	Iron	µg/L	110,000	9,000 - 690,000	9/9	170,000	160,000 - 180,000	2/2
P122	Lead	µg/L	14,000	2,400 - 38,000	9/9	3,200	1,600 - 4,800	2/2
	Magnesium	µg/L	12,000	3,900 - 40,000	9/9	9,600	7,000 - 12,000	2/2
	Manganese	µg/L	1,700	63 - 6,900	9/9	700	700 - 710	2/2
P123	Mercury	µg/L	5.9	0.2 - 41	8/9	0.57	0.20 - 0.93	1/2
	Molybdenum	µg/L	560	100 - 2,200	9/9	930	770 - 1,100	2/2

Table 5-1 (Continued)

Priority Pollutant Code	Analyte	Units	1980s Data			2000 Data		
			Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?	Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?
P124	Nickel	μg/L	200	16 - 1,000	9/9	210	180 - 250	2/2
P125	Selenium	μg/L	14	5.0 - 50	4/9	ND		
P126	Silver	μg/L	2.8	1.0 - 18	4/9	7.5	3.5 - 11	1/2
	Sodium	mg/L	5,200	1,500 - 9,500	9/9	4,300	4,200 - 4,400	2/2
P127	Thallium	μg/L	19	10 - 100	2/9	ND		
	Tin	μg/L	1,500	120 - 6,400	9/9	400	240 - 560	2/2
	Titanium	μg/L	470	24 - 2,600	9/9	230	160 - 300	2/2
	Vanadium	μg/L	35	2.0 - 95	5/9	71	41 - 100	2/2
	Yttrium	μg/L	ND			1.6	1.3 - 1.8	2/2
P128	Zinc	μg/L	25,000	3,300 - 110,000	9/9	18,000	13,000 - 24,000	2/2
Classicals								
	Ammonia	mg/L	9.3	0.1 - 23	9/9	42	31 - 53	2/2
	BOD_5, Dissolved	mg/L	2,500	480 - 9,000	9/9	NA		
	BOD_5, Total	mg/L	3,700	420 - 17,000	9/9	3,500	1,600 - 5,400	2/2
	Chloride	mg/L	1,400	50 - 5,100	9/9	1,400	1,100 - 1,800	2/2
	COD, Dissolved	mg/L	8,500	800 - 46,000	9/9	NA		
	COD, Total	mg/L	17,000	1,300 - 100,000	9/9	10,000	4,600 - 16,000	2/2
	Dissolved Solids	mg/L	15,000	5,700 - 30,000	9/9	NA		
	Fluoride	mg/L	34	15 - 90	9/9	NA		
	Nitrate/Nitrite	mg/L	NA			360	230 - 480	2/2
	Oil & Grease/HEM	mg/L	13,000	2,500 - 34,000	9/9	310	130 - 490	2/2
	pH	Standard Units		10 - 13	9/9		12 - 13	2/2
P065	Phenol	mg/L	35	1.5 - 170	9/9	NA		
	SGT-HEM	mg/L	NA			140	61 - 220	2/2
	Suspended Solids	mg/L	4,700	20 - 22,000	9/9	1,400	930 - 1,900	2/2

Table 5-1 (Continued)

Priority Pollutant Code	Analyte	Units	1980s Data			2000 Data		
			Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?	Mean Concentration (a)	Range of Individual Data Points	Detected in How Many Samples?
	Suspended Volatile Solids	mg/L	2,400	8.0 - 16,000	9/9	NA		
	TKN	mg/L	71	1.6 - 430	9/9	NA		
P121	Total Cyanide	mg/L	4.2	0.05 - 8.3	9/9	1.4	1.3 - 1.5	2/2
	Total Organic Carbon	mg/L	3,200	210 - 19,000	9/9	2,000	920 - 3,100	2/2
	Total Phosphorus	mg/L	NA			17	9.5 - 25	2/2
	Total Volatile Solids	mg/L	6,000	390 - 30,000	9/9	NA		

(a) For samples in which individual pollutants were not detected, the sample detection limit was used in calculating the mean concentration. For pesticide and herbicide analytes, the sample detection limit was not reported; therefore, a value of zero was used for nondetected results in calculating the mean concentration for these analytes.
(b) One data point was excluded.
(c) Pesticides and herbicides were detected in samples collected at a facility known to clean drums that last contained pesticides and herbicides.
ND - Pollutant was not detected.
NA - Pollutant was not analyzed.

Table 5-2

Summary of Raw Wastewater Characterization Data for Plastic Drum and IBC Washing

Priority Pollutant Code	Analyte	Units	Concentration
Volatile Organics			
	Acetone	μg/L	240
P048	Bromodichloromethane	μg/L	91
P007	Chlorobenzene	μg/L	12
P023	Chloroform	μg/L	4,000
	Methyl Ethyl Ketone	μg/L	120
Semivolatile Organics			
	Acetophenone	μg/L	11
	Benzoic Acid	μg/L	350
P066	Bis (2-Ethylhexyl) Phthalate	μg/L	16
	Hexanoic Acid	μg/L	69
	2-Methylnaphthalene	μg/L	50
	n-Decane	μg/L	120
	n-Eicosane	μg/L	23
	n-Hexacosane	μg/L	18
	n-Hexadecane	μg/L	21
	n-Octadecane	μg/L	22
	n-Tetracosane	μg/L	27
P055	Naphthalene	μg/L	13
P065	Phenol	μg/L	180
P084	Pyrene	μg/L	10
P021	2,4,6-Trichlorophenol	μg/L	44
	Tripropyleneglycol Methyl Ether	μg/L	3,900
Dioxins and Furans			
	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/L	2,100
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/L	610
	1,2,3,4,7,8,9-Heptachlorodibenzofuran	pg/L	310
	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	pg/L	1,400
	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	pg/L	230
	1,2,3,4,7,8-Hexachlorodibenzofuran	pg/L	97
	1,2,3,6,7,8-Hexachlorodibenzofuran	pg/L	51
	2,3,4,6,7,8-Hexachlorodibenzofuran	pg/L	420
	Octachlorodibenzo-p-dioxin	pg/L	12,000
	Octachlorodibenzofuran	pg/L	6,600

Table 5-2 (Continued)

Priority Pollutant Code	Analyte	Units	Concentration
Pesticides and Herbicides			
	Dalapon	μg/L	210
	MCPA	μg/L	2,300
Metals			
	Aluminum	μg/L	39,000
	Barium	μg/L	57
	Boron	μg/L	78
P118	Cadmium	μg/L	7.0
	Calcium	μg/L	68,000
P119	Chromium	μg/L	84
	Cobalt	μg/L	14
P120	Copper	μg/L	360
	Iron	μg/L	2,300
P122	Lead	μg/L	61
	Magnesium	μg/L	14,000
	Manganese	μg/L	54
P123	Mercury	μg/L	63
	Molybdenum	μg/L	1,700
P124	Nickel	μg/L	30
P125	Selenium	μg/L	5.1
	Sodium	μg/L	2,000,000
	Tin	μg/L	700
	Titanium	μg/L	44
	Vanadium	μg/L	44
P128	Zinc	μg/L	3,200
Classicals			
	Ammonia	mg/L	21
	BOD_5, Total	mg/L	440
	Chloride	mg/L	2,200
	COD, Total	mg/L	2,400
	Nitrate/Nitrite	mg/L	5.3
	Oil & Grease/HEM	mg/L	21
	Suspended Solids	mg/L	1,500
P121	Total Cyanide	mg/L	0.78
	Total Organic Carbon	mg/L	1,300
	Total Phosphorus	mg/L	20

Table 5-3

Summary of Raw Wastewater Characterization Data for Steel Drum Burning

Priority Pollutant Code	Analyte	Units	Concentration
Volatile Organics			
	Acetone	μg/L	16,000
P038	Ethylbenzene	μg/L	12,000
P044	Methylene Chloride	μg/L	100,000
	Methyl Ethyl Ketone	μg/L	68,000
	Methyl Isobutyl Ketone	μg/L	18,000
P011	1,1,1-Trichloroethane	μg/L	17,000
P086	Toluene	μg/L	17,000
Semivolatile Organics			
	Benzyl Alcohol	μg/L	4,600
P066	Bis (2-Ethylhexyl) Phthalate	μg/L	880
P054	Isophorone	μg/L	14,000
P055	Naphthalene	μg/L	5,300
	o-Cresol	μg/L	2,600
	p-Cymene	μg/L	1,000
	Styrene	μg/L	13,000
Dioxins and Furans			
	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/L	15
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/L	2.0
	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	pg/L	0.37
	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	pg/L	0.36
	1,2,3,4,7,8-Hexachlorodibenzofuran	pg/L	0.55
	2,3,7,8-Tetrachlorodibenzofuran	pg/L	0.21
	Octachlorodibenzo-p-dioxin	pg/L	200
	Octachlorodibenzofuran	pg/L	10
Metals			
	Aluminum	μg/L	47,000
P114	Antimony	μg/L	600
P115	Arsenic	μg/L	10
	Barium	μg/L	5,700
P117	Beryllium	μg/L	5.0
	Boron	μg/L	7,300
P118	Cadmium	μg/L	730
	Calcium	μg/L	170,000
P119	Chromium	μg/L	12,000

Table 5-3 (Continued)

Priority Pollutant Code	Analyte	Units	Concentration
	Cobalt	μg/L	3,500
P120	Copper	μg/L	1,200
	Iron	μg/L	47,000
P122	Lead	μg/L	11,000
	Magnesium	μg/L	30,000
	Manganese	μg/L	1,500
P123	Mercury	μg/L	0.80
	Molybdenum	μg/L	790
P124	Nickel	μg/L	1,200
P125	Selenium	μg/L	25
P126	Silver	μg/L	1.0
	Sodium	μg/L	770,000
P127	Thallium	μg/L	50
	Tin	μg/L	350
	Titanium	μg/L	780
	Vanadium	μg/L	50
	Yttrium	μg/L	50
P128	Zinc	μg/L	110,000
Classicals			
	Ammonia	mg/L	33
	BOD_5, Dissolved	mg/L	1,500
	BOD_5, Total	mg/L	2,600
	Chloride	mg/L	330
	COD, Dissolved	mg/L	18,000
	COD, Total	mg/L	52,000
	Dissolved Solids	mg/L	6,200
	Fluoride	mg/L	11
	Oil & Grease/HEM	mg/L	5,300
	pH	mg/L	8.2
P065	Phenol	mg/L	39
	Suspended Solids	mg/L	9,500
	Suspended Vol. Solids	mg/L	14,000
	TKN	mg/L	560
P121	Total Cyanide	mg/L	0.28
	Total Organic Carbon	mg/L	4,000
	Total Volatile Solids	mg/L	19,000

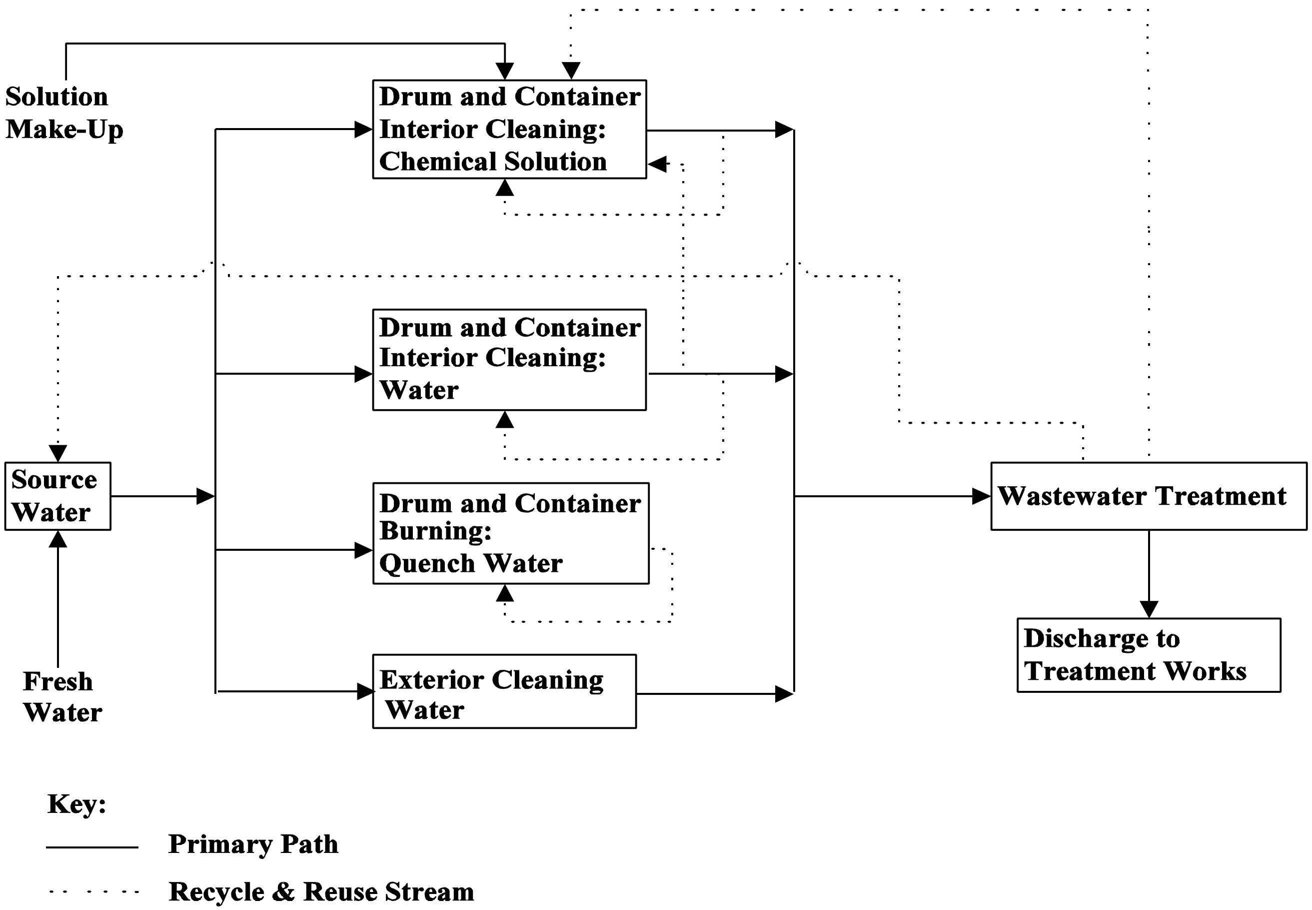

Figure 5-1. Water Use in ICDC Operations

6.0 POLLUTION PREVENTION AND WASTEWATER TREATMENT TECHNOLOGIES

This section describes technologies that are used by the Industrial Container and Drum Cleaning (ICDC) industry to prevent the generation of wastewater pollutants or reduce the discharge of wastewater pollutants. Three major approaches are used by the ICDC industry to improve effluent quality: (1) cleaning process technology changes and controls to prevent or reduce the generation of wastewater pollutants; (2) flow reduction technologies to decrease wastewater generation and increase pollutant concentrations, thereby improving the efficiency of treatment system pollutant removals; and (3) end-of-pipe wastewater treatment technologies to remove pollutants from ICDC wastewater prior to discharge. Most facilities use various combinations of these approaches to control pollutant discharges.

These approaches are discussed in the following sections:

- Section 6.1: Pollution prevention controls used by the ICDC industry;
- Section 6.2: Flow reduction technologies used by the ICDC industry;
- Section 6.3: End-of-pipe wastewater treatment technologies used by the ICDC industry;
- Section 6.4: Wastewater treatment performance data collected from the ICDC industry; and
- Section 6.5: References.

Most of the information presented in this section is based on observations and information collected during EPA site visits and sampling episodes, data collected from the Reusable Industrial Packaging Association (RIPA), and other non-EPA data sources (see Section 3.0). Tables appear at the end of the section.

6.1 Pollution Prevention Controls

EPA has defined pollution prevention as source reduction and other practices that reduce or eliminate pollution at the source. Source reduction includes any practices that reduce the amount of any hazardous substance or pollutant entering any waste stream or otherwise released into the environment, or any practice that reduces the hazards to public health and the environment associated with the release of such pollutants. Pollution prevention controls used by the ICDC industry include heel reduction, heel removal, reduction in the amount and toxicity of chemical cleaning solutions, and good housekeeping practices.

6.1.1 Heel Reduction

Heel is the residual cargo remaining in a container or drum after emptying and is the primary source of pollutants in ICDC wastewater. The Resource Conservation and Recovery Act (RCRA) mandates a comprehensive system to identify hazardous wastes and to track and control their movement from generation through transport, treatment, storage, and ultimate disposal. Any hazardous waste remaining in either an empty container or an inner liner removed from an empty container is not subject to regulation under RCRA. Empty is defined in 40 CFR Part 261.7 paragraph (b), which is provided in Attachment A of this report. In general, the definition specifies that (1) containers must be emptied by pouring, pumping, or aspirating, and (2) any residual must be less than or equal to volume cutoffs determined based on container volume and cargo (e.g., one inch for 55-gallon drums that contained non-hazardous material). Drums and containers received by ICDC facilities are “empty” as defined by RCRA. All facilities visited by EPA in 2000 return to the shipper any hazardous and non-hazardous waste drums and containers that are not empty.

Excess heels are also an important economic consideration for drum and container end users. For example, many cargos are valuable, and any product waste represents a significant loss. In an article in *Chemical Week* dated March 5, 1986, Vincent Buonanno of the National Barrel and Drum Association (now RIPA) referred to the 1 inch of product remaining in empty drums as "the $1 billion inch" (1). Therefore, both the ICDC industry and the end user have strong incentives to minimize heels.

Heel generation occurs during the emptying of a drum or container. Since drum and container emptying typically does not occur at the ICDC facility, the end user has more direct control over heel generation than the ICDC facility that ultimately cleans the drum or container and disposes or discharges the heel. However, ICDC facilities can develop a heel minimization program that identifies the sources of heels and institutes practices that discourage heel generation by the end user. Successful heel minimization programs commonly include education on heel minimization and return of drums and containers that are not empty. Many ICDC facilities also require signed certification by the shipper that the drums or containers were properly emptied.

Education programs focus on instructing the end user on RCRA's definition of empty. For example, a common misconception by end users is that empty means 1 inch (or less) of product in a drum, with no other requirements such as pouring, pumping, or aspirating. In fact, the "1 inch rule" applies only to very viscous products; RIPA promotes the term "drip-dry" to indicate that all product that can be removed has been removed. Mitchell Container Services, Inc. provides the following guidance on their website (2):

> "If more material may be poured out of the drum, then it is not empty. If everything is poured out, but more than 2.5 centimeters (1 inch) remain on the bottom, the drum is not empty. If the residual material is listed by EPA in 40 CFR 261.33(E) as a "P-listed" acute hazardous waste, the drum is not deemed empty unless it has been triple-rinsed using an effective solvent, or has been cleaned by method shown to achieve equivalent removal."

EPA visited one ICDC facility in 2000 that requests shippers to rinse all IBCs and triple rinse all plastic drums, regardless of cargo. Facility personnel estimate that approximately 60% of their clients comply with their request.

As a corollary to an education program, ICDC facilities must rigorously enforce RCRA's definition of empty. In fact, most ICDC facilities cannot legally accept drums or containers that are not empty because they do not hold RCRA permits as treatment, storage, or disposal facilities (TSDFs). For drums or containers that contain non-hazardous heels, facilities may charge an extra fee, beyond that required to either return the drum or container to the shipper or to dispose of the heel, as an incentive to minimize heel.

Empty drum or container certification programs are intended to encourage the emptier to implement procedures and systems to ensure that drums and containers are properly emptied. (Certification is not required by any federal or state agency.) The certification should be signed by the supervisor where the drum or container was last used to confirm that the drum or container was properly emptied. Some ICDC facilities incorporate certification within the drum or container reconditioning contract; other ICDC facilities require certification with each shipment of drums or containers. The empty drum certification form required by Mitchell Container Services, Inc. requires the shipper to agree to the following (2):

> "1. This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the DEPARTMENT OF TRANSPORTATION. (49 CFR 173.204)
>
> 2. It is further certified that all containers are empty: that all plugs, lids and rings are securely in place. (49 CFR 173.29)
>
> 3. It is further certified that all containers are properly classified, described and offered for shipment according to the applicable regulations of the ENVIRONMENTAL PROTECTION AGENCY (40 CFR Parts 260-263), and that they are EMPTY as defined in 40 CFR 261.7, and have not contained "acutely hazardous waste," as listed in 40 CFR 261.33 (e), and that all "RQ" markings apply only to the original, filled containers and not to these empty containers."

6.1.2 Heel Removal

Heel removal techniques used by ICDC facilities include heel pouring or draining, presteaming, and preflushing. None of the facilities visited by EPA in 2000 pour or drain heels from drums prior to washing or burning (any drums that are not empty are returned to the shipper). Based on site visits to washing facilities in the mid-1980s, only drums that last contained oil and other petroleum products were poured or drained prior to washing, and the heels were sold to oil recyclers. None of the burning facilities visited by EPA in the mid-1980s reported pouring or draining heels (i.e., heel pouring or draining is not documented in available site visit reports). EPA visited two transportation equipment cleaning (TEC) facilities in 1999 that also clean IBCs; both facilities drain heels from IBCs prior to washing. EPA also visited one IBC washing facility in 2000 that does not clean transportation equipment. This facility does not drain heels from IBCs; however, the facility requests that shippers rinse IBCs prior to shipment.

Presteaming includes steaming the drum or container interior to enhance heel removal. Steaming also lowers heel viscosity to facilitate draining. EPA found the following presteaming trends based on site visits:

- One drum washing facility visited by EPA in 2000 presteams drums. This facility transports steam condensate, which contains product residual, as a hazardous waste to a fuels blending facility. The remaining two drum washing facilities visited by EPA in 2000 do not presteam drums or IBCs.

- Approximately one third of drum washing facilities visited by EPA in the mid-1980s presteamed some or all drums. For example, several of these facilities presteamed all drums; one facility presteamed only drums that last contained viscous cargos; and one facility presteamed only drums that last contained oil or sticky cargos. Information regarding steam condensate management at these drum washing facilities is not available.

- None of the burning facilities visited by EPA in 2000 and in the mid-1980s presteamed drums prior to burning.

- The two TEC facilities that EPA visited in 1999 prestream IBCs prior to washing depending on the cargo last transported. The steam condensate is

> disposed of as a hazardous waste. The IBC washing facility that does not clean transportation equipment that EPA visited in 2000 does not perform presteaming; however, the facility requests that shippers rinse IBCs prior to shipment.

Preflushing includes spraying the drum or container interior with either water or cleaning solutions to enhance heel removal. One drum washing facility visited by EPA in 2000 preflushes open-head plastic drums with water. One drum washing facility visited by EPA in the mid-1980s preflushed drums that last contained petroleum with kerosene. This kerosene, with product residue, was sold to an oil rerefiner. None of the remaining drum reconditioning facilities visited by EPA in the mid-1980s preflushed drums. The TEC facilities visited by EPA preflush IBCs with either detergent, water, or a pyrrolidine-based solution prior to washing depending on the cargo last transported. Oily preflush waste is sent to an oil reprocessor, while other preflush waste is disposed of as a hazardous waste. The IBC washing facility visited by EPA in 2000 that does not clean transportation equipment does not perform preflushing; however, the facility requests that shippers rinse IBCs prior to shipment.

6.1.3 Reduction in the Amount and Toxicity of Chemical Cleaning Solutions

All drum and IBC washing facilities visited by EPA use one or more chemical cleaning solutions in the washing process. (None of the drum burning facilities visited by EPA in 2000 and the mid-1980s use chemical cleaning solutions.) In addition to the contaminants contained in the heel removed by chemical cleaning solutions, the chemicals used in the solutions may themselves be toxic. By reducing the amount and toxicity of chemical cleaning solutions used in the drum and container washing process, ICDC facilities can reduce the contribution of cleaning solutions to the total wastewater pollutant concentrations. These pollution prevention procedures include recirculating and reusing cleaning solutions, disposing cleaning solutions separately from drum and container washing wastewater, and using less toxic cleaning solutions.

Recycle and reuse is usually achieved through the use of automated cleaning systems with cleaning solution recirculation loops that allow reuse of cleaning solutions until their efficacy diminishes below acceptable levels. This reduces the amount of additional chemical cleaning solution required for each drum or container cleaned; instead, small amounts of make-up solution are periodically added to replace solution lost in carryover to rinses or to boost efficacy. Presteaming and preflushing may extend the useful life of a chemical cleaning solution, thereby reducing the total amount of chemical cleaning solution needed for drum and container washing.

In general, chemical cleaning solutions that are discharged to POTWs include those that are not reused or that are reused for relatively short periods, such as one week to three months. However, some ICDC facilities reuse cleaning solutions for very long periods of time, such as three months, six months, or indefinitely. At these facilities, cleaning solutions are periodically treated using a variety of technologies to remove contaminants, such as solids and oil. For example, one facility visited in 2000 uses “shakers” which remove solids via screens and a clarifier to remove oil. Other facilities visited in 2000 and in the mid-1980s use dissolved air flotation, sedimentation, or clarification to treat cleaning solutions. When (or if) these solutions are ultimately determined to be spent, they are typically hauled off site for treatment at a centralized treatment facility which is frequently better equipped to treat these wastes.

Available data indicate that relatively toxic cleaning solutions such as petroleum-based solvents (e.g., kerosene or diesel fuel) are seldom used by ICDC facilities. Only one drum washing facility visited by EPA in the mid-1980s used kerosene to preflush drums that last contained petroleum; the preflush waste was sold to an oil rerefiner.

Use of these procedures by the three drum washing facilities visited in 2000 and the two TEC facilities visited in 1999 that clean IBCs is summarized below:

Procedure	Number of Facilities
Recirculation and reuse of cleaning solutions	4
Disposal of cleaning solutions	2
Use of less toxic cleaning solutions	5

Available information from site visits conducted in the mid-1980s suggest similar cleaning solution management practices at that time. Note that the focus of site visit reports from the mid-1980s was to document the selection of facilities and sampling points for subsequent sampling, rather than thorough documentation of process operations.

RIPA provided EPA a summary of the results of a membership survey from 2000 which included data from certain process operations (3). The association sent surveys to 98 RIPA members who reprocess steel and plastic drums, as well as IBCs, and received 36 survey responses. Eleven respondents reported cleaning and reusing wash solutions, while eight respondents reported treating and discharging these solutions. One respondent reported performing a solvent rinse. Note that survey responses are not statistically based and may not accurately represent industry operations.

6.1.4 Good Housekeeping Practices

Good housekeeping practices are simple, straightforward operating practices that can significantly reduce wastes. Good housekeeping practices applicable to the ICDC industry include mopping up and managing spills rather than rinsing to floor drains, and periodically cleaning floor drains to remove possible heel accumulation and debris.

Good housekeeping practices also include proper management of drum storage to minimize the potential for spills and leaks and for stormwater contamination. Many facilities have drum storage that is warehoused or under roof; however, many facilities continue to operate open drum storage yards. Good housekeeping practices for open storage yards include:

- Storing all drums with bungs in place, and rings and lids on the drums;
- Wiping or cleaning spills from drum exteriors;
- Constructing berms and dikes around storage areas to contain any contaminated stormwater and to minimize the amount of stormwater coming into contact with the drums;

- Paving storage areas to prevent infiltration of potentially contaminated stormwater; and

- Managing drum inventory to prevent or minimize drum deterioration.

Responses to RIPA's 2000 survey indicated that the daily number of drums stored onsite ranges from 1,000 to 100,000 and averages 22,250. Drum storage was reported as follows (3):

- Storage on concrete or blacktop pads (10 respondents);
- Storage in buildings or covered structures (9 respondents);
- Storage on soil (10 respondents); and
- Storage in trailers (28 respondents).

In addition, four respondents reported collecting and discharging stormwater runoff.

During site visits conducted in 2000, EPA observed all of the drum storage practices listed above. Two of the three facilities visited stored drums in trailers and/or in buildings. The third facility stored drums using all of the practices listed above.

6.2 Flow Reduction Technologies

This section describes technologies that can reduce the volume of wastewater discharged from ICDC facilities. Flow reduction offers the following benefits: (1) increased pollutant concentrations which increase the efficiency of the wastewater treatment system; (2) decreased wastewater treatment equipment sizes, resulting in reduced treatment system capital and operating and maintenance costs; and (3) decreased water and energy usage. Flow reduction technologies applicable to the ICDC industry serve to reduce the amount of fresh water required for drum and container washing and drum burning through process modifications and/or recycling and reusing process wastewater in ICDC or other operations. These flow reduction technologies are discussed in the following subsections.

6.2.1 Process Modifications

One of the most effective tools for reducing water use in the drum washing process is increased process automation. Modern turn-key reconditioning systems include presteam, washing, and rinsing stations with reuse of all solutions and rinses until spent. Final rinse wastewater is reused in wash and preflush solutions to replace water lost to evaporation; excess spent rinse wastewater is discharged to wastewater treatment. Manual cleaning operations, if any, include efficient use of hand-held, high-pressure, low-volume wands. Both steel drum washing facilities visited by EPA in 2000 operated automated cleaning processes. The plastic drum and IBC washing facility visited by EPA in 2000 operated an automated cleaning process for open-head drums and semi-automated cleaning processes for closed-head drums and IBCs.

Unlike drums, IBCs are manufactured in a variety of configurations including different top opening sizes, container volumes and dimensions, and materials of construction. Consequently, it is difficult to design a fully automated IBC reconditioning system for facilities that wash a variety of IBC types. Custom-designed automated IBC washing systems are best suited for IBC leasers and chemical manufacturers that can control the types of IBCs cleaned; however, semi-automated systems may be feasible for other facilities. Regardless of the technique employed (automated, semi-automated, or manual), cleaning solutions and rinses can be collected and reused in subsequent cleaning operations. For example, during site visits in 1999, EPA observed IBC wash lines at TEC facilities where cleaning solutions and rinse water were collected in troughs under the rack and were returned to cleaning solution and rinse water storage tanks for reuse.

Mechanical or thermal techniques can substitute for water-intensive techniques, particularly for cleaning metal drums and containers. For example, during site visits, EPA observed a variety of drum and IBC label removal operations including hand-held pressure wands, mechanical buffing, shot blasting, thermal removal, and manual scraping. See also the discussion of cryogenic cleaning in Section 6.2.2.

Drum burning processes use and generate significantly less water and wastewater than drum washing processes. *(Note: EPA is not suggesting or recommending conversion of drum washing operations to drum burning operations.)* Flow reduction technologies applicable to drum burning include reuse of drum quench, chain quench, and conveyor washing water. In general, these wastewater streams are never discharged, but require periodic fresh water make-up to replace losses to evaporation. Wastewater from leak testing and drum rinses (if any) can be reused until spent. EPA visited only one ICDC facility that only burns drums (i.e., does not also wash drums); this facility (visited in the mid-1980s) does not discharge any process wastewater because all process wastewater is reused. This facility sandblasts but does not rinse drums prior to painting. EPA has no data on the percentage of ICDC facilities that only burn drums and that achieve 100% reuse of process wastewater.

6.2.2 Cleaning Without the Use of Water

Literature searches reveiled two drum and IBC cleaning processes that do not use water - solvent washing and cryogenics.

Hoyer built a new IBC cleaning facility in Antwerp, Belgium to clean water-insoluble cargos such as varnishes, paints, and lacquers via solvent cleaning. The facility began cleaning operations in September 1999. Solvent cleaning is performed in a multi-stage process and is designed for maximum recovery of solvent. The facility also operates a hermetically sealed solvent washing cabinet to clean heavily soiled IBCs. Solvent emissions are incinerated on site, along with heels and residues from solvent recovery (4)(5). EPA has no data on the solvent used or potential air pollution problems. EPA is not aware of any ICDC facilities in the United States that perform solvent washing. *(Note: Discussion of this technology does not constitute or imply an endorsement, recommendation, or warranty by the U.S. Environmental Protection Agency.)*

At least two manufacturers in the United States (W.S.I. Industrial Services and Drumbeaters of America) market cryogenic systems to clean plastic or metal drums, pails, and cans. In the cryogenic system, the drum, pail, or can is placed in a chamber where it is cooled using liquid nitrogen to solidify any liquid residue. Solid residue is removed by inverting and hitting or vibrating the container, and the residue and container (metal) may be reused. According to the manufacturers, the system removes residues, such as paints, mastics, glue, asphalts, cementatious materials, greases, oils, and glycol (6)(7). Similar systems may be available for cleaning IBCs; however, one IBC manufacturer that investigated cryogenic cleaning several years ago (Fabricated Metals) had serious concerns about potential adverse effects of low temperatures on some metals used in the construction of IBCs (8)(9). EPA has not identified any ICDC facilities in the United States that use cryogenic drum or container cleaning processes. *(Note: Discussion of this technology does not constitute or imply an endorsement, recommendation, or warranty by the U.S. Environmental Protection Agency.)*

6.2.3 Cascade Rinsing

Rinse water is the largest source of wastewater generated by ICDC operations, both for washing facilities and for burning facilities that rinse drums. One technique used by some ICDC facilities to significantly reduce the volume of rinse water discharged is referred to as "cascade rinsing." In this process, the most contaminated ICDC rinse water is used in the beginning of the process for drum and container preflushing or initial rinsing, with preflush or initial rinse wastewater routed to wastewater treatment or disposal. Final rinse water from the end of the process is reused as initial drum or container rinse water when cleaning subsequent drums or containers. Fresh water is only used at the end of the process for final rinses. Through this process, rinse water is used at least twice prior to discharge or disposal.

Make-up water to replace water lost to evaporation may also be cascaded. For example, the most contaminated ICDC rinse water is used to make-up chemical cleaning solutions or preflush solutions, final rinse water is used as make-up for initial rinse water, and fresh water is used to make-up final rinse water. One facility visited by EPA in the mid-1980s treated rinse wastewater by sedimentation and clarification prior to reuse as make-up for chemical cleaning solutions.

EPA observed cascade rinsing at two of the three drum washing facilities visited in 2000 (one facility also washes IBCs). At the first facility, open-head plastic drums undergo the following washing cycle: exterior rinse, interior preflush, two interior washing steps, and final rinse. Final rinse wastewater is reused in the preflush step. The second facility operates the following caustic washing process: presteaming, two caustic washing steps, two rinsing steps, and vacuuming. Fresh water is added as make-up to the final rinse step, and first rinse water is added as make-up to the caustic cleaning solutions. Cascade rinsing is also used in this facility's acid washing process. At the third facility, rinse water is routed to wastewater treatment without reuse. Fresh cleaning solution make-up is added to replace solution lost to evaporation and carryover into the rinses.

Cascade rinsing is not performed by the three IBC washing facilities visited in 2000 and 1999.

Available information from site visits conducted in the mid-1980s suggest that as many as two-thirds of facilities visited practiced cascade rinsing.

6.2.4 Recirculated Rinse Water

Another technique used by some ICDC facilities to significantly reduce the volume of rinse water discharged is the use of recirculation loops on rinse steps to allow reuse of rinse water until contamination exceeds acceptable levels. Recirculation reduces the amount of fresh rinse water required for each drum or container cleaned, and small amounts of fresh make-up water are periodically added to replace water lost to evaporation or carryover. Typically, rinse water is recirculated for up to one day and then discharged; however, one facility visited by EPA in the mid-1980s recirculates rinse water for up to one week prior to discharge. Several ICDC facilities visited by EPA in 2000 and in the mid-1980s both recirculate rinse water and cascade rinse water to replace water lost to evaporation.

EPA observed rinse water recirculation at one of the three drum washing facilities visited in 2000. At this facility, caustic and acid rinse tanks are filled with fresh water each morning. The rinses are reused throughout the day and then discharged to wastewater treatment each night. At the remaining two facilities visited, rinse water is either routed to wastewater treatment without reuse, or a portion is reused in other process steps as described in Section 6.2.3. Rinse water recirculation is not practiced by the three IBC washing facilities visited in 2000 and 1999.

Available information from site visited conducted in the mid-1980s suggest that approximately 25% of facilities visited practice rinse water recirculation.

Respondents to RIPA's 2000 survey provided information regarding management of spent rinsing solutions. Six respondents reported cleaning and reusing solutions, while 12 respondents reported treating and discharging solutions (3). EPA has no additional information regarding rinse water "cleaning" or rinse water reuse (e.g., cascade rinsing or rinse water recirculation).

6.2.5 Treated Wastewater Recycle and Reuse

Four ICDC facilities visited by EPA in the mid-1980s recycle 100% of treated wastewater effluent in ICDC processes, resulting in zero discharge of ICDC process wastewater. Wastewater recycling at these facilities is summarized below:

Facility	Recycle Wastewater as...	After the following treatment...
1	Caustic solution make-up and furnace quench	Equalization, screening, chemical precipitation, and air flotation
2	Rinse water and furnace quench	Clarification
3	Caustic solution make-up and initial caustic rinse water	Chemical precipitation and air flotation
4	Furnace quench	Sedimentation

EPA is also aware of two drum washing facilities that are evaluating 100% reuse of final treated wastewater. Finally, two additional facilities visited by EPA in the mid-1980s reuse some but not all treated wastewater in ICDC processes, with the remainder discharged to POTWs.

Several facilities visited by EPA in 2000 and in the mid-1980s reuse leak test water for one day or up to one week. Paint booth water curtain water can also be reused for up to one week. One facility visited in the mid-1980s uses compressor condensate and boiler blowdown as make-up for drum rinses. One potential source of large volumes of wastewater is floor washing. Floor washing wastewater can be significantly reduced by using mechanical scrubbers which continually recirculate cleaning water while increasing the cleaning effectiveness, and by mopping up leaks and spills rather than flushing to floor drains using hoses or hand-held spray wands.

6.3 End-of-Pipe Wastewater Treatment Technologies

End-of-pipe wastewater treatment technologies used by the ICDC industry include physical and chemical processes that remove pollutants from ICDC wastewater prior to reuse in ICDC processes or discharge to a POTW or receiving stream. End-of-pipe treatment technologies commonly used by ICDC facilities visited by EPA in 2000 and in the mid-1980s include the following pretreatment and primary treatment technologies:

- Equalization;
- pH adjustment;
- Gravity settling;
- Oil/water separation;
- Chemical precipitation;
- Clarification;
- Air flotation; and
- Sludge dewatering.

EPA is not aware of any ICDC facilities that operate secondary biological treatment. However, two facilities visited by EPA in 2000 treat wastewater with sodium hypochlorite (bleach) for organics and cyanide destruction. EPA is aware of only one ICDC facility that uses advanced treatment (activated carbon); this facility also cleans transportation equipment.

Twenty of the 36 respondents to RIPA's 2000 survey reported having on-site wastewater treatment (3). The survey responses did not provide specific treatment technologies used by these facilities.

6.3.1 Equalization

Equalization involves homogenizing variable wastewater over time to control fluctuations in flow and pollutant characteristics, thereby improving the efficiency of subsequent treatment units and reducing the probability of treatment system upsets. Equalization also allows downstream treatment units to be sized and operated on a continuous-flow basis and optimized for a narrower range of influent wastewater characteristics. Equalization units include tanks which are often equipped with agitators (e.g., impeller mixers and air spargers) to mix the wastewater and to prevent solids from settling at the bottom of the unit. Chemicals may also be added to the equalization unit to adjust pH, as necessary, for further treatment. The amount of residence time required by an equalization unit to achieve optimum effects is dependent upon the specific characteristics and daily flow patterns of the wastewater.

6.3.2 pH Adjustment

pH adjustment is a process in which chemicals are added to wastewater to make it acidic or basic or to neutralize acidic or basic wastewater. A pH adjustment system normally consists of a small tank in which the wastewater pH is adjusted by mixing and addition of either caustic or acidic chemicals under the control of a pH meter. Because many treatment technologies are sensitive to pH fluctuations, pH adjustment may be required as part of an effective treatment system. Some treatment technologies require a high pH, while others require a neutral pH. In addition, the pH of the final effluent from these technologies must often be adjusted prior to discharge to meet permit conditions for wastewater discharge.

6.3.3 Gravity Settling

Gravity settling, or sedimentation, removes suspended solids from wastewater by maintaining wastewater in a quiescent state so that contaminants can separate by density. During gravity settling, wastewater is typically collected in a tank or catch basin, where it is detained for a period of time, allowing solids with a specific gravity higher than water to settle to the bottom of the tank and solids with a specific gravity lower than water to float to the surface. The sedimentation unit may be periodically shut down and the solids removed manually. Alternatively, the solids that settle out or float to the surface may be removed from the unit continuously using automatic scrapers or skimmers. The effectiveness of gravity separation depends upon the characteristics of the wastewater and the length of time the wastewater is held in the treatment unit. Properly designed and operated gravity separation units are capable of achieving significant reductions of suspended solids and biochemical oxygen demand for many ICDC wastewaters.

6.3.4 Oil/Water Separation

Oil/water separators use the difference in specific gravity between oil and water to remove free or floating oil from wastewater. The most common mechanism for oil removal is an oil skimmer. Some skimming devices work by continuously contacting the oil with a material, such as a belt or rope, onto which the oil readily adheres. As the material passes through the floating oil layer, the oil coats the surface of the material. The oil-coated material then passes through a mechanism that scrapes the oil from the material into an oil collection unit. Another common type of skimming device uses overflow and underflow baffles to skim the floating oil layer from the surface of the wastewater. An underflow baffle allows the oil layer to flow over into a trough for disposal or reuse while most of the water flows underneath the baffle. This is followed by an overflow baffle, which is set at a height relative to the first baffle such that only the oil-bearing portion will flow over the first baffle during normal operation.

Other, more complex, oil/water separators include American Petroleum Institute (API) separators and coalescing (corrugated plate or tube) separators. EPA is not aware of any ICDC facilities using these types of separators.

Due to the complex nature of ICDC wastewater and the presence of high-pH chemicals, oils may form a stable emulsion which does not separate well in a gravity separator. Stable emulsions require pH adjustment, the addition of chemicals, and/or heat to break the emulsion. EPA has no data to indicate whether stable emulsions are common in ICDC wastewater.

6.3.5 Chemical Precipitation

Chemical precipitation is a separation technology in which insoluble solid precipitates are formed from the organic or inorganic compounds in the wastewater through the addition of chemicals during treatment. Common treatment chemicals used by the ICDC industry include coagulants such as aluminum or ferric chloride or sulfate, and flocculants, which include a variety of polymers. Coagulation and flocculation are processes that cause suspended solids in wastewater to coalesce. The coalesced particles tend to settle out of the wastewater more quickly than particles that have not undergone coagulation and flocculation. All three drum washing facilities visited in 2000, and one of the two TEC facilities visited in 1999 that clean IBCs, use chemical precipitation for wastewater treatment. Four of the 16 drum reconditioning facilities visited by EPA in the mid-1980s used chemical precipitation for wastewater treatment.

Coagulation consists of the addition and rapid mixing of a “coagulant,” the destabilization of colloidal and fine suspended solids, and the initial aggregation of those particles. After rapid mixing, coagulant aids, such as polyelectrolytes, may be added to reduce the repulsive forces between the charged particles. Flocculation is the slow stirring to complete aggregation of those particles and form a floc which will in turn settle by gravity (10). Flocculation may also be accomplished by adding such materials as lime or sodium silicate to form loose agglomerates that carry the fine particles down with them. These settled solids form a sludge; therefore, coagulation/flocculation is typically followed by clarification or dissolved air flotation to remove solids.

Chemical precipitation may be performed on a continuous basis using a series of chemical addition and mix tanks (followed by clarification or dissolved air flotation), or on a batch basis using a single chemical treatment tank, which also serves as a clarifier.

6.3.6 Clarification

Clarification involves holding wastewater in a quiescent state so that contaminants can separate by density. Clarification uses the same principles for treatment as gravity settling but differs from gravity settling in that it is typically used after chemical precipitation and/or biological treatment. Approximately half of ICDC facilities visited by EPA that use chemical precipitation treatment also use clarification.

Clarification can be used as either a pre- or post-treatment step for various operations to aid in removing settleable solids, free oil and grease, and other floating material. Clarifiers are often referred to as primary or secondary sedimentation tanks. Primary clarification is used to remove settleable solids from raw wastewater or wastewater treated by chemical precipitation. ICDC facilities visited by EPA use clarifiers for both of these purposes. Secondary clarification is normally used in activated sludge systems to remove biomass. A portion of the sludge biomass is often recycled from the secondary clarifier back to the activated sludge biological oxidation unit. None of the ICDC facilities visited by EPA use secondary biological treatment.

Clarifiers consist of settling tanks and are commonly equipped with a sludge scraper mounted on the floor of the clarifier to rake sludge into a sump for removal. Sludge may also be removal manually. The bottom of the clarifier may be sloped to facilitate sludge removal.

6.3.7 Air Flotation

Air flotation is the process of influencing suspended particles to rise to the wastewater surface using air where they can be collected and removed. Approximately half of ICDC facilities visited by EPA that use chemical precipitation treatment also use air flotation.

During flotation, gas bubbles introduced into the wastewater attach themselves to suspended particles, thereby reducing their specific gravity and causing them to float. Flotation processes are used because they can remove suspended solids that have a specific gravity slightly greater then 1.0 more quickly than settling (e.g., clarification). Several flotation techniques are used for wastewater treatment to extract free and dispersed oil and grease, suspended solids, and some dissolved pollutants from process wastewater. In air flotation, air is injected at the bottom of a clarifier, dispersing air bubbles into the wastewater. In dissolved air flotation (DAF), air is dissolved in the pressurized wastewater stream. When the wastewater enters the flotation vessel, the pressure is reduced, causing fine bubbles to be released. With DAF, two modes of operation may be employed to pressurize wastewater. In recycle pressurization, air is injected into a portion of recycled, clarified effluent and dissolved into a wastewater stream in an enclosed tank or pipe, pressurizing the wastewater. In full flow pressurization, all of the influent wastewater is injected with air in a surge tank and is pumped to a retention tank under pressure to dissolve the air into the wastewater.

Air bubbles make contact with the suspended particles by two separate mechanisms. The first mechanism involves the use of a flocculant (see Section 6.3.5), which causes rising air bubbles to be trapped inside flocculated masses as they increase in size. The second mechanism involves the intermolecular attraction between the solid particle and the air bubble, which causes the solid to adhere to the bubble. In both mechanisms, the low density of the air bubble causes it to rise to the surface of the flotation tank with the flocculated or adhered solids attached.

Flotation units are equipped with rakes that scrape the floc from the surface and into a sludge collection vessel, where it is subsequently pumped to a dewatering unit and later disposed. A sludge auger may be included in the flotation unit to remove solids that have settled to the bottom of the tank. Units are typically operated on a continuous basis and incorporate chemical mix tanks (if flocculants are used), a flotation vessel, and a sludge collection tank in a single enclosed unit.

6.3.8 Sludge Dewatering

Sludge dewatering reduces sludge volume by decreasing its water content. The decrease in sludge volume achieved through sludge dewatering substantially reduces the cost for sludge disposal and allows for easier sludge handling. Various methods can be used for sludge dewatering; however, ICDC facilities visited by EPA use filter presses and rotary vacuum filters.

The most widely used filter press is referred to as the plate-and-frame filter press. A filter press uses positive pressure provided by a mechanical device, such as a hydraulic ram, to drive water contained in the sludge through a filter medium. This type of unit comprises a series of recessed plates that are affixed with a filter medium (e.g., filter cloth) and are stacked together on a horizontal shaft. The plates form a series of spaces separated by the filter media and are otherwise sealed to withstand the internal pressures created during the filtration cycle. As the sludge is forced through the system, the water passes through the filter medium and is discharged through the filtrate port while the solids become trapped within the spaces, forming a dewatered cake against the filter medium.

When the cycle is over, the plates are separated, and the dewatered cake is released from the spaces into a collection bin. Removing the cake from the filter media is often performed manually by an operator. The filter press filtrate that results from the dewatering is usually piped back to the beginning of the treatment system.

A rotary vacuum filter consists of a cylindrical drum with a filter medium, such as cloth or wire mesh, around its perimeter. The drum is horizontally suspended within a vessel and is partially submerged in the sludge. The drum is rotated and the filter surface contacts the sludge within the vessel while a vacuum is drawn from within the drum. This draws the water through the filter medium toward the axis of rotation and discharges it through a filtrate port. The solids become trapped against the filter medium, forming a dewatered cake around the outside of the drum. The dewatered cake is continuously scraped from the drum into a collection bin.

Thirteen respondents to RIPA's 2000 survey reported testing wastewater treatment sludges or filter cakes, typically once per year. Five respondents reported generating hazardous sludge or filter cake (3).

6.4 Wastewater Treatment Performance Data

EPA conducted sampling at four ICDC facilities in 1986-1987 to characterize the performance of wastewater treatment at ICDC facilities. Wastewater treatment systems at these facilities are summarized below:

Facility	Wastewater Treatment System
A	Oil/water separation
B	Chemical precipitation followed by air flotation
C	Chemical precipitation followed by clarification
D	Chemical precipitation followed by air flotation

The results of this sampling are presented below, with the exception of Facility C for which paired influent and effluent samples from the wastewater treatment system were not collected. EPA has no additional treatment performance data for the ICDC industry.

6.4.1 Oil/Water Separation

Facility A is a medium-sized drum washing facility that reconditions 900 drums per day that last contained petroleum (60% of drums), solvent (30% of drums) and other cargos. Drums are drained before being flushed with caustic, and then are washed with caustic and rinsed with water. Caustic wash solution and rinse wastewater are not recycled. Wastewater consists of caustic flush, caustic wash water, and rinse water, and is treated by oil/water separation. The oil/water separator consists of a three-chamber tank from which oil is removed weekly. The tank provides an average detention time of 2.4 hours over an 8-hour operating shift.

Table 6-1 presents treatment performance data for the oil/water separator. Oil and grease was removed by 76%, and suspended solids were removed by 62%. The system did not provide significant removals for metals or volatile and semivolatile organics.

6.4.2 Chemical Precipitation Followed by Air Flotation

EPA characterized treatment performance of chemical precipitation followed by air flotation at two facilities. Facility B is a small washing facility that reconditions 200 drums per day that last contained paint (95%) and other cargos. Drum interiors and exteriors are washed with caustic, and then drum interiors are chained with caustic. Finally, drums are rinsed with water. Caustic wash solutions are reused, but rinse wastewater is not reused. Wastewater influent to the wastewater treatment system consists of rinse wastewater only. The wastewater treatment unit characterized consists of 2 mix tanks and an air flotation vessel. Aluminum sulfate and sulfuric acid are added in the first mix tank; polymer is added in the second mix tank. The air flotation vessel consists of a 1,500-gallon clarifier which is injected with 60 psig air. The average surface loading rate is 375 gallons per day per square foot over a 38 square foot area.

Facility D is a large facility that washes 3,000 drums per day and burns 3,000 drums per day. Drums that are washed last contained petroleum (30%), chemicals (30%), resins (20%), paint (10%), and other cargos. Drums that are burned last contained paint (80%), adhesive (10%), and other cargos. Tight-head drums are washed in caustic and rinsed with water. Caustic wash solution is reused after treatment separate from the wastewater treatment system. Rinse water is not reused. Open-head drums are burned and quenched with water. Wastewater influent to the wastewater treatment system consists of quench wastewater (26%), rinse wastewater, leak test wastewater, and other miscellaneous wastewater streams. The wastewater treatment unit characterized consists of 2 mix tanks and an air flotation vessel. Aluminum sulfate and hydrochloric acid are added in the first mix tank; polymer is added in the second mix tank. The air flotation vessel consists of a 1,500-gallon clarifier which is injected with air. The system detention time is approximately 1 hour.

Tables 6-2 and 6-3 present treatment performance data for chemical precipitation followed by air flotation at Facilities B and D, respectively. At Facility B, suspended solids were removed by 85%; several organics and metals were also substantially removed by the treatment system. At Facility D, pollutant removals for BOD, COD, oil and grease, and suspended solids ranged from 41% to 58%. Several organics, metals, and pesticides/herbicides were also substantially removed by the treatment system; however, 18 pollutants were detected in the effluent that were not detected in the influent. Note that on Day 2, the wastewater treatment system at Facility D was not operating well because some lines were plugged with sludge and only a limited amount of air was available for flotation.

6.5 References

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Table 6-1

Treatment Performance Data for Oil/Water Separation Facility A

Priority Pollutant Code	Analyte	Influent to Treatment	Effluent from Treatment	Percent Removal (a)
Volatile Organics (μg/L)				
P011	1,1,1-Trichloroethane	355	590	0
	2-Butanone (MEK)	534	589	0
	Acetone	ND	673	0
P038	Ethylbenzene	221	308	0
P086	Toluene	507	844	0
P087	Trichloroethene	95	95	0
Semivolatile Organics (μg/L)				
P020	2-Chloronaphthalene	4,609	4,483	3
	Alpha-Terpineol	4,745	4,322	9
	Benzoic Acid	ND	1,460	0
	N-Decane (N-C10)	11,750	ND	100
	N-Docosane (N-C22)	ND	147	0
	N-Dodecane (N-C12)	6,950	10,194	0
	N-Hexadecane (N-C16)	1,066	ND	100
	N-Octacosane (N-C28)	ND	493	0
Metals (μg/L)				
	Aluminum	7,800	5,900	24
P114	Antimony	562	562	0
P115	Arsenic	31	44	0
	Barium	2,600	2,100	19
P117	Beryllium	50	50	0
	Boron	880	960	0
P118	Cadmium	29	18	38
	Calcium	47,000	36,000	23
P119	Chromium	6,700	5,300	21
	Cobalt	210	200	5
P120	Copper	1,400	1,000	29
	Iron	10,000	12,000	0
P122	Lead	27,000	20,000	26
	Magnesium	14,000	12,000	14

Table 6-1 (Continued)

Priority Pollutant Code	Analyte	Influent to Treatment	Effluent from Treatment	Percent Removal (a)
	Manganese	700	480	31
P123	Mercury	0.2	0.2	0
	Molybdenum	340	640	0
P124	Nickel	120	130	0
P125	Selenium	5	5	0
P126	Silver	1	1	0
	Sodium	1,800,000	1,800,000	0
P127	Thallium	10	10	0
	Tin	240	220	8
	Titanium	59	93	0
	Vanadium	12	11	8
	Yttrium	10	10	0
P128	Zinc	13,000	12,000	8
Classicals (mg/L)				
	Ammonia	13	18	0
	BOD_5, Total	3,900	3,780	3
	BOD_5, Dissolved	1,980	1,740	12
	Chloride	50	125	0
	COD, Dissolved	3,140	3,990	0
	COD, Total	6,110	7,380	0
	Dissolved Solids	8,850	7,380	17
	Fluoride	30	34	0
	Oil & Grease	3,240	770	76
	Phenol	1.61	1.13	30
	Sulfide	0.1	0.1	0
	Suspended Solids	4,980	1,880	62
	Suspended Volatile Solids	880	400	55
	TKN	5	13	0
P121	Total Cyanide	8.3	9	0
	Total Organic Carbon	1,520	1,530	0
	Total Volatile Solids	3,200	2,500	22

(a) ND assumed equal to zero when calculating percent removal.
ND - Not detected above detection limit.

Table 6-2

Treatment Performance Data for Chemical Precipitation Followed by Air Flotation
Facility B

Priority Pollutant Code	Analyte	Influent to Treatment	Effluent from Treatment	Percent Removal (a)
Volatile Organics (μg/L)				
	2-Butanone (MEK)	ND	1,001,760	0
	Acetone	ND	1,845	0
P004	Benzene	ND	182	0
P007	Chlorobenzene	ND	56	0
P038	Ethylbenzene	3,179	2,319	27
	Isobutyl Alcohol	3,517	ND	100
P044	Methylene Chloride	ND	500	0
P086	Toluene	55,572	799	99
Semivolatile Organics (μg/L)				
P020	2-Chloronaphthalene	46	48	0
	2-Methylnaphthalene	ND	16	0
P057	2-Nitrophenol	ND	45	0
P058	4-Nitrophenol	ND	ND	0
	Benzoic Acid	ND	ND	0
	Benzyl Alcohol	ND	ND	0
	Biphenyl	14	ND	100
	Hexanoic Acid	383	ND	100
P055	Naphthalene	382	ND	100
P056	Nitrobenzene	16	ND	100
	o-Cresol	143	ND	100
	p-Cymene	72	14	81
	Styrene	144	61	58
	Thioxanthone	311	ND	100
Metals (μg/L)				
	Aluminum	9,900	27,000	0
P114	Antimony	16	50	0
P115	Arsenic	20	5	75
	Barium	1,800	410	77

Table 6-2 (Continued)

Priority Pollutant Code	Analyte	Influent to Treatment	Effluent from Treatment	Percent Removal (a)
P117	Beryllium	1	1	0
	Boron	34	27	21
P118	Cadmium	7	5	29
	Calcium	26,000	22,000	15
P119	Chromium	1,000	230	77
	Cobalt	140	62	56
P120	Copper	400	110	72
	Iron	46,000	15,000	67
P122	Lead	2,400	510	79
	Magnesium	7,600	3,600	53
	Manganese	2,100	980	53
P123	Mercury	1.3	0.34	74
	Molybdenum	100	83	17
P124	Nickel	34	150	0
P125	Selenium	25	5	80
P126	Silver	1	1	0
	Sodium	1,500,000	1,600,000	0
P127	Thallium	10	10	0
	Tin	120	130	0
	Titanium	700	200	71
	Vanadium	60	31	48
	Yttrium	10	10	0
P128	Zinc	17,000	13,000	24
Classicals (mg/L)				
	Ammonia	22.5	8.8	61
	BOD_5, Total	2,200	1,860	15
	BOD_5, Dissolved	2,550	2,100	18
	Chloride	1,500	800	47
	COD, Dissolved	3,860	2,300	40
	COD, Total	3,860	2,400	38
	Dissolved Solids	5,710	6,370	0
	Fluoride	40	31	22
	Oil & Grease	4,810	4,950	0

Table 6-2 (Continued)

Priority Pollutant Code	Analyte	Influent to Treatment	Effluent from Treatment	Percent Removal (a)
	Phenol	1.51	0.58	62
	Sulfide	0.1	0.1	0
	Suspended Solids	1,850	264	86
	Suspended Volatile Solids	63	206	0
	TKN	1.75	40	0
P121	Total Cyanide	1.9	0.58	69
	Total Organic Carbon	1,600	900	44
	Total Volatile Solids	3,170	740	77
	pH	12.6	5.9	53

(a) - ND assumed equal to zero when calculating percent removal.
ND - Not detected above detection limit.

Table 6-3

Treatment Performance Data For Chemical Precipitation Followed by Air Flotation Facility D

Priority Pollutant Code	Analyte	Influent Day 1	Effluent Day 1	Influent Day 2	Effluent Day 2	Influent Day 3	Effluent Day 3	Influent Day 4	Effluent Day 4	Influent Day 5	Effluent Day 5	Average Percent Removal (a)
Volatile Organics (μg/L)												
P011	1,1,1,-Trichloroethane	36,179	4,099	11,825	2,721	71,613	6,780	26,035	14,953	ND	1,893	58
P029	1,1-Dichloroethene	25,286	1,007	ND	ND	ND	ND	ND	1,225	ND	ND	48
P010	1,2-Dichloroethane	ND	ND	ND	631	ND	ND	315	194	ND	ND	19
	2-Butanone (MEK)	987,690	174,905	ND	ND	18,823	19,097	ND	ND	1,351,260	108,185	58
	2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	171	0
	Acetone	498,139	147,138	677,250	ND	ND	ND	2,046,290	103,907	209,456	ND	91
P002	Acrolein	ND	ND	ND	ND	ND	ND	ND	1,783	ND	1,441	0
P038	Ethylbenzene	186,495	4,518	ND	ND	75,039	3,014	7,857	4,532	62,143	6,715	81
P044	Methylene Chloride	ND	ND	15,443	8,161	ND	ND	ND	ND	ND	1,870	24
P085	Tetrachloroethene	ND	ND	ND	ND	86,267	2,776	ND	5,331	ND	1,869	32
P086	Toluene	107,977	7,487	ND	ND	42,672	1,940	6,159	4,248	54,123	ND	80
P030	Trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	917	ND	ND	ND	100
P087	Trichloroethene	ND	ND	ND	151	4,038	104	1,278	199	4,575	156	70
	Vinyl Acetate	ND	1,249	ND	ND	ND	ND	ND	ND	ND	ND	0
Semivolatile Organics (μg/L)												
P037	1,2-Diphenylhydrazine	ND	ND	ND	ND	ND	ND	ND	2,451	ND	ND	0
P020	2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	44,272	ND	ND	0
P057	2-Nitrophenol	ND	ND	ND	5,359	3,256	3,379	2,739	2,082	2,866	ND	31
	4-Chloro-2-Nitroaniline	ND	ND	ND	ND	ND	2,505	ND	ND	ND	ND	0
	Benzyl Alcohol	9,817	2,788	ND	ND	ND	4,146	ND	ND	9,051	ND	57
	Biphenyl	1,266	ND	ND	ND	1,394	ND	ND	ND	ND	ND	100
P066	Bis (2-ethylhexyl) Phthalate	5,419	ND	43,747	3,462	43,078	6,603	9,285	ND	5,718	800	93

Table 6-3 (Continued)

Priority Pollutant Code	Analyte	Influent Day 1	Effluent Day 1	Influent Day 2	Effluent Day 2	Influent Day 3	Effluent Day 3	Influent Day 4	Effluent Day 4	Influent Day 5	Effluent Day 5	Average Percent Removal (a)
P067	Butyl Benzyl Phthalate	ND	ND	ND	ND	3,281	ND	ND	2,675	ND	ND	50
P068	Di-N-Butyl Phthalate	2,088	ND	ND	ND	13,561	2,736	ND	ND	5,012	1,095	86
	Diphenyl Ether	ND	ND	ND	ND	2,457	ND	ND	ND	ND	ND	100
P054	Isophorone	5,392	3,489	25,392	3,822	3,371	ND	ND	3,081	22,038	ND	64
	Methacrylonitrile	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	0
	N-N-Dimethylformamide	ND	ND	ND	ND	ND	2,690	ND	ND	ND	ND	0
	N-Decane (N-C10)	ND	ND	ND	ND	ND	2,577	ND	1,551	ND	ND	0
	N-Docosane (N-C22)	ND	ND	ND	4,905	ND	ND	3,424	6,312	12,309	ND	33
	N-Hexacosane (N-C26)	ND	ND	ND	ND	ND	ND	ND	ND	ND	805	0
	N-Hexadecane (N-C16)	ND	ND	ND	2,642	ND	160	1,178	ND	ND	ND	33
	N-Octacosane (N-C28)	ND	ND	ND	ND	ND	ND	28,081	ND	ND	2,068	50
	N-Octadecane (N-C18)	3,983	ND	ND	ND	13,354	ND	ND	ND	ND	320	67
	N-Tetradecane (N-C14)	ND	ND	44,127	4,924	ND	ND	5,754	4,657	ND	990	36
P055	Naphthalene	8,842	ND	17,954	2,119	5,503	1,823	2,775	ND	ND	318	71
	p-Cymene	ND	ND	ND	ND	1,996	ND	ND	ND	ND	ND	100
P081	Phenanthrene	ND	ND	ND	ND	ND	ND	11,577	ND	ND	ND	100
P065	Phenol	932	ND	ND	ND	ND	1,127	ND	ND	ND	ND	50
	Styrene	34,620	7,379	30,372	5,193	18,836	6,395	ND	3,248	4,950	ND	66
Organo-Halide Pesticides (μg/L)												
	Dichloran	ND	ND			ND	282					0
P095	Endosulfan I	296	ND			ND	ND					99
P097	Endosulfan Sulfate	ND	ND			528	951					0
P100	Heptachlor	284	1,738			ND	ND					0
	Etridazone	252	ND			ND	ND					99
	Isodrin	ND	2,829			ND	ND					0
	Trifluralin	ND	ND			ND	322					0
Organo-Phosphorous Pesticides (μg/L)												
	Azinphos Ethyl	4,260	ND			ND	ND					99

Table 6-3 (Continued)

Priority Pollutant Code	Analyte	Influent Day 1	Effluent Day 1	Influent Day 2	Effluent Day 2	Influent Day 3	Effluent Day 3	Influent Day 4	Effluent Day 4	Influent Day 5	Effluent Day 5	Average Percent Removal (a)
	Azinphos Methyl	6,207	50,466			4,689	3,769					9
	Fensulfothion	5,795	ND			7,859	4,148					74
	Phosmet	ND	30,972			ND	ND					0
	Diazinon	ND	ND			1,035	ND					99
	Dimethoate	ND	ND			1,500	ND					99
	Leptophos	ND	ND			3,959	ND					99
	TEPP	ND	ND			ND	2,323					0
Metals (μg/L)												
	Aluminum	90,800	91,500	71,700	64,700	61,300	57,400	37,900	75,700	36,100	150,000	3
P114	Antimony	33,600	30,100	9,780	8,980	10,200	4,140	6,820	5,640	6,140	4,650	24
P115	Arsenic	500	103	62	100	72	100	16	19	78	19	31
	Barium	1,230	170	2,200	2,680	1,500	1,930	7,510	2,930	5,260	599	47
P117	Beryllium	7	5	5	5	5	5	5	5	5	5	6
	Boron	7,700	4,870	6,100	6,170	7,270	3,960	6,320	6,640	7,390	5,650	21
P118	Cadmium	695	138	285	229	4,690	1,170	1,340	1,270	883	909	36
	Calcium	120,000	52,700	77,000	72,400	97,000	46,200	40,600	46,900	50,000	43,600	25
P119	Chromium	6,430	2,490	3,360	1,570	4,720	1,060	3,420	1,160	4,120	977	67
	Cobalt	1,700	448	760	500	1,170	410	1,090	582	1,320	587	55
P120	Copper	4,810	1,540	4,780	3,020	5,940	1,610	2,640	1,270	3,240	1,350	58
	Iron	693,000	74,900	201,000	84,500	529,000	96,600	180,000	88,600	216,000	43,000	72
P122	Lead	37,600	8,730	18,200	5,380	34,600	4,760	16,500	4,970	19,300	3,050	78
	Magnesium	40,400	20,600	22,600	22,700	28,300	13,100	11,600	12,600	13,800	11,600	24
	Manganese	5,130	1,810	3,250	2,470	6,890	1,840	2,510	2,290	2,720	1,980	40
P123	Mercury	41	27	20	11	28	0.5	8.5	3.8	10	0.6	65
	Molybdenum	853	362	1,040	705	1,880	830	1,540	1,170	2,230	1,030	45
P124	Nickel	991	161	376	286	1,030	319	363	287	419	280	46
P125	Selenium	5	5	50	50	5	125	5	5	5	25	0
P126	Silver	18	63	8.4	10	5.7	14.6	1	9.2	7.3	1	17

Table 6-3 (Continued)

Priority Pollutant Code	Analyte	Influent Day 1	Effluent Day 1	Influent Day 2	Effluent Day 2	Influent Day 3	Effluent Day 3	Influent Day 4	Effluent Day 4	Influent Day 5	Effluent Day 5	Average Percent Removal (a)
	Sodium	8,800,000	8,690,000	9,090,000	8,190,000	9,510,000	6,100,000	7,290,000	7,130,000	6,720,000	6,730,000	10
P127	Thallium	100	100	100	50	50	100	50	50	50	50	10
	Tin	5,730	692	4,190	1,220	6,390	2,180	5,620	2,550	4,230	495	74
	Titanium	2,610	578	860	434	1,190	289	577	287	666	175	65
	Vanadium	82	50	50	50	95	50	50	50	50	58	17
	Yttrium	50	50	50	50	50	50	50	50	50	50	0
P128	Zinc	80,400	23,200	54,300	37,400	108,000	27,900	44,300	30,600	43,500	17,900	53
Classicals (mg/L)												
	Ammonia	6.59	6.22	16.1	14.4	5.53	5.62	2.25	2.5	11.8	13.8	3
	BOD_5, Total	16,800	9,600	7,500	4,190	10,900	4,370	6,300	4,170	3,140	2,310	41
	BOD_5, Dissolved	9,000	6,600	4,400	3,500	4,640	2,760	2,790	3,240	4,710	1,820	30
	Chloride	2,800	8,000	5,100	10,800	4,200	8,800	3,200	7,400	3,400	9,100	0
	COD, Dissolved	45,500	22,100	26,400	14,900	15,100	6,890	19,000	15,000	22,800	12,500	43
	COD, Total	75,600	40,600	38,100	18,500	102,000	16,500	31,800	22,300	40,600	9,210	58
	Dissolved Solids	29,900	26,500	27,200	23,400	28,200	18,500	20,000	21,800	18,800	20,800	12
	Fluoride	89.7	0.1	59	0.1	53	0.14	37.3	0.52	29	0.01	99
	Oil & Grease	12,900	19,850	5,600	252	33,000	1,480	4940	4,800	2,540	900	52
	Phenol	169	347	87.4	44.5	68.8	58.4	64.7	71.5	53.2	23.4	24
	Suspended Solids	21,800	6,730	9,270	3,220	20,600	2,920	5,220	3,000	5,710	6,140	53
	Suspended Volatile Solids	16,000	5,940	4,033	3,120	15,500	2,070	2,675	1,400	4,700	210	63
	TKN	428	370	270	282	257	153	20.2	190	291	201	17
P121	Total Cyanide	0.57	0.55	0.48	0.32	0.58	0.50	0.48	0.58	0.05	0.43	10
	Total Organic Carbon	19,300	14,500	8,500	4,600	7,200	4,380	5,650	4,290	5,690	3,640	34
	Total Volatile Solids	29,940	12,290	14,280	20,690	26,370	5,440	9,880	7,000	10,590	4,420	45

ND - Not detected above detection limit.
(a) Average percent removed is the mean of positive and zero removals. ND assumed equal to zero.

7.0 COMPARISON OF THE DRUM RECONDITIONING AND TRANSPORTATION EQUIPMENT CLEANING INDUSTRIES

In the mid-1980s, EPA conducted studies of the drum reconditioning and the transportation equipment cleaning (TEC) industries to determine whether national categorical effluent limitations guidelines and standards should be developed for these categories of dischargers. In the case of the TEC industry, EPA promulgated effluent limitations guidelines and standards in June 2000 (65 FR 46995). During development of the TEC rule, information submitted by commenters indicated that there was some overlap in the TEC and the drum reconditioning industries, Specifically, intermediate bulk containers (IBCs), which are portable plastic and metal containers with 450 liters (119 gallons) to 3,000 liters (793 gallons) capacity, were cleaned by facilities in both industries. This was a significant finding because the number of IBC cleanings had increased dramatically since the early 1990s. In the case of the drum reconditioning industry, EPA concluded at that time that the industry did not merit national regulation. In addition, for the drum reconditioning industry study in the mid-1980s, EPA did not collect any data on IBC cleaning because so few IBCs were being used by the industry at that time.

EPA had originally considered including IBCs in the scope of the TEC rule because many TEC facilities also clean IBCs. EPA obtained some IBC data from the data collection phase of the rule (through screener and detailed questionnaires) in 1994. EPA also received public comments on IBCs during proposal regarding their similarities and differences to tanks versus drums, and performed site visits, at the request of commenters, at two TEC facilities that also clean and recondition IBCs. IBCs wastewater was later removed from the scope of the TEC rule because EPA's assessment suggested IBC cleaning wastewater was more similar to drum cleaning wastewater than to TEC wastewater.

While TEC limits and standards do not apply to wastewater from drum reconditioning, EPA believes a comparison of the two industries is appropriate for several reasons. First, the drum reconditioning and TEC industries overlap because both drum reconditioning facilities and TEC facilities clean IBCs. In fact, as discussed in Section 4.1.1, national effluent limitations guidelines and standards for the ICDC industry may affect a greater number of TEC facilities than drum reconditioning facilities. Available data suggest that approximately equal numbers of IBCs are cleaned by drum reconditioning facilities and TEC facilities. Second, available data suggest that similar cargos are transported in drums, IBCs, and tank trucks (see Section 7.1). Third, the lack of national regulations for discharge of IBC cleaning wastewater is perceived by the TEC industry to result in a competitive advantage by drum reconditioning facilities for the IBC cleaning business.[1]

This section describes similarities and differences between the drum reconditioning industry and the transportation equipment cleaning (TEC) industry with respect to size of the industry (Section 7.1), cleaning/reconditioning process (Section 7.2), cargo types cleaned (Section 7.3), water use and wastewater generation (Section 7.4), wastewater characteristics (Section 7.5), pollution prevention and wastewater treatment technologies (Section 7.6), and wastewater treatment performance (Section 7.7).

7.1 <u>Size of the Industry</u>

EPA estimates a total population of 118 ICDC facilities that do not clean transportation equipment (see Section 4.1.1). Available data indicate that as many as 107 of these facilities discharge ICDC wastewater to either a POTW or to surface waters. The remaining 11 or more facilities are considered zero dischargers (see Section 5.2).

EPA estimates a total population of 1,239 TEC facilities of which 692 facilities discharge to either a POTW or to surface waters. The remaining 547 facilities are considered

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[1] IBC cleaning wastewater is excluded from the TEC regulation. However, for TEC facilities that commingle wastewaters generated from IBC and tank cleaning for treatment, IBC wastewater at these facilities can be subject to the TEC rule at the discretion of the permitting authority.

zero dischargers. After accounting for exclusions provided by the TEC rule, EPA estimates that 328 TEC facilities will be affected by the TEC rule. This total includes an estimated 286 facilities in Subpart A - Tank Trucks and Intermodal Tank Containers Transporting Chemical and Petroleum Products, the segment of the TEC industry most analogous to the drum reconditioning industry (2)(3).

Drum reconditioning facilities recondition approximately 40 million drums and 275,000 IBCs per year (see Section 4.1.1). In comparison, the 1,239 TEC facilities described above clean approximately 2.4 million tanks and containers per year, which includes 2.1 million tank trucks, 81,500 intermodal tank containers, and at least 225,000 IBCs (2)(4)(5).

7.2 Cleaning/Reconditioning Processes

This section describes the differences and similarities between drum and tank cleaning processes and their expected impact on wastewater characteristics.

7.2.1 Drum Washing and Tank Cleaning

Similarities between drum and tank cleaning processes include the following:

- Inspect the drum or tank to identify excessive heel or unacceptable materials.
- Drain the heel, if necessary. Heel is typically either reused, disposed, or discharged to on-site wastewater treatment.
- Preflush or presteam the drum or tank, if necessary or desired. Preflush or presteam wastewater is either discharged to on-site wastewater treatment or hauled off site.
- Wash the drum or tank using one or more of a variety of cleaning solutions which are typically reused. Make-up solution is typically added to replace

solution lost in the rinses or to boost efficacy. Spent solutions are either discharged to on-site wastewater treatment or hauled off site.

- Rinse the drum or tank with water.
- Wash and rinse the drum or tank exterior, if necessary or desired.
- Dry the drum or tank; and
- Inspect the drum or tank.

Differences between drum and tank cleaning processes include the following:

- Drums are typically washed by turning them upside down and spraying the interior with chemical cleaning solutions. Alternatively, drums are washed by submerging them in a chemical cleaning solution. Tanks are typically cleaned by applying either water or cleaning solutions via low- or high-pressure spinner nozzles which are inserted through the main tank hatch. Differences in the means of applying cleaning solutions are not expected to impact wastewater characteristics.

- Fifty-three percent of TEC facilities use chemical cleaning solutions, and the remainder use only water. In contrast, all drum washing facilities are believed to perform caustic cleaning and approximately 30% are believed to also perform acid cleaning. Greater use of chemical cleaning solutions is expected to increase pollutant loadings in cleaning wastewater as a result of solution carryover in rinsing.

- Drum washing requires a few minutes, while tank washing commonly requires 20 minutes or longer; however, processing time does not directly affect wastewater generation volumes because cleaning solutions are typically recirculated.

- Chaining, a drum cleaning operation, is not performed on tanks. Additional cleaning steps, such as chaining and subsequent rinsing, are expected to increase pollutant loadings and volume in cleaning wastewater.

- Steel drum washing solutions are comprised of either hot caustic solutions or hot acid solutions. Plastic drum washing is commonly performed using detergents. Drums which cannot be adequately cleaned are either converted to open-head drums and burned or recycled as scrap.

In contrast, tank cleaning is performed with a greater variety of cleaning solutions including water, caustic, detergent, caustic with detergent ("booster") additive, acid, presolve (i.e., diesel fuel, kerosene, or other petroleum-based solvent), passivation agents (i.e., oxidation inhibitors), odor controllers such as citrus oils, and sanitizers. The tank cleaning sequence is typically specific to the cargo last contained in each tank cleaned, and processing continues until the tank is clean.

Increased variety of chemical cleaning solutions may increase the number and types of pollutants detected in cleaning wastewater.

- Rust removal using acid cleaning solutions is a common processing step at steel drum reconditioning facilities. Rust in tanks is uncommon; therefore, rust removal is seldom an objective of tank cleaning operations. Rust is expected to be a significant source of iron in steel drum washing wastewater.

- Available data suggest that drum reconditioning facilities typically reuse chemical cleaning solutions for longer durations than TEC facilities. For example, at some drum washing facilities, cleaning solutions are used indefinitely (with periodic make-up and treatment) and are never discharged or disposed. EPA is not aware of any TEC facilities that reuse cleaning solutions indefinitely; a typical reuse cycle is one week to one month. Increased reuse of chemical cleaning solutions is expected to concentrate contaminants in solutions and subsequently increase pollutant loadings in cleaning wastewater as a result of solution carryover in rinsing.

- Although practiced by both types of facilities, available data indicate that cascade rinsing is more commonly used by drum reconditioning facilities than by TEC facilities. In addition, approximately one-quarter of drum reconditioning facilities visited by EPA in the mid-1980s and in 2000 recirculate final rinse water for up to one day; EPA is not aware of any TEC facilities that recirculate final rinse water. Waster conservation in rinsing is expected to reduce the volume of cleaning wastewater, while increasing pollutant concentrations.

- After washing, all drums are leak tested. Steel drums are placed in a submerger, while plastic drums are pressure tested using air. In contrast, tanks are not typically hydrotested following each cleaning, but rather following periodic inspection and repair. Leak testing is a minor source of wastewater at drum washing facilities. Hydrotesting is a minor source of wastewater at most tank cleaning facilities; exceptions include rail facilities and facilities that clean gasoline tankers (gasoline tankers are dedicated to hauling only gasoline and are cleaned only for periodic inspection and repair).

- Several steps in the drum reconditioning process, such as dedenting, rechiming, shotblasting, painting, and curing, are not applicable to the tank cleaning process. Similarly, some common tank cleaning processes, such as hose washing and the cleaning of valves, fittings and other tank components, are not applicable to the drum washing process. In general, these operations unique to drum reconditioning or tank cleaning operations generate relatively little or no wastewater.

In summary, similarities between drum and tank cleaning processes are expected to result in similar water use and sources of wastewater (see Section 7.4), as well as similar types and numbers of pollutants in drum and tank cleaning wastewaters. Differences between drum and tank cleaning processes are expected to impact wastewater generation volume and pollutant concentrations. Section 7.5 compares drum and tank cleaning wastewater characteristics.

7.2.2 Drum Burning and Tank Cleaning

Drum burning processes have no similarities with tank washing, with the exceptions of heel removal, leak testing, and any drum rinsing that may be performed. See Section 7.2.1 for similarities and differences in heel removal, rinsing, and leak testing between drum and tank cleaning processes.

7.2.3 IBC Cleaning/Reconditioning at Drum Washing and Tank Cleaning Facilities

EPA observed IBC cleaning operations at three facilities, two TEC facilities visited in 1999 and one drum reconditioning facility visited in 2000, and these observations are summarized below. Similarities between IBC cleaning processes at these TEC and drum reconditioning facilities are the same as those for drum and tank washing described in Section 7.2.1. Differences between IBC cleaning processes at these TEC and drum reconditioning facilities are minor and may be specific to the individual facilities visited rather than to general industry practices.

IBC cleaning operations at the TEC facilities were nearly identical to those used for tank cleaning, but on a reduced scale. For example, at one TEC facility visited by EPA, IBCs were arranged on a custom-designed IBC "wash rack" using reduced-sized spinner nozzles and other equipment. However, the components of the IBC and tank cleaning processes were identical. IBC cleaning equipment used by the drum reconditioning facility was also custom-designed. Although the specific cleaning equipment differed from that used by the TEC facilities, the system used a spray nozzle controlled by a robotic arm as the design basis.

The drum reconditioning facility that EPA visited cleans only blow-molded plastic IBCs, while the TEC facilities clean blow-molded plastic, rotationally-molded plastic, and metal IBCs. All three facilities use detergent to clean IBCs, although the TEC facilities may also use caustic or other cleaning solutions depending on the cargo. Because blow-molded plastic IBCs often cannot be adequately (or cost-effectively) cleaned for reuse, all three facilities monitor and control resources (e.g., processing time and labor) used for IBC cleaning. IBCs that cannot be adequately cleaned for return to service are instead cleaned for scrap. In contrast, rotationally-molded plastic and metal IBCs are cleaned for return to service, generally regardless of condition, because of their relatively high value. Consequently, cleaning of these IBCs is likely more similar to tank cleaning than to drum reconditioning in that the cleaning process may use a broader range of cleaning solutions, processing steps, and longer processing times. EPA has no data on processes used by drum reconditioning facilities to clean rotationally-molded plastic and metal IBCs.

EPA found that the TEC facilities visited collect and recirculate IBC cleaning solutions, but do not reuse rinse water. The drum reconditioning facility visited does not reuse IBC cleaning solutions or rinse water, and does not reuse drum cleaning solutions or rinse water, with the exception of reuse of final open-head drum rinse water as initial open-head drum rinse water. (Note that the drum reconditioning facility also cleans tight-head and open-head plastic drums.)

7.3 Cargo Types Cleaned

During development of the TEC effluent guidelines, EPA excluded IBC cleaning wastewater from the regulation. IBCs were defined as portable containers with 450 liters (119 gallons) to 3,000 liters (793 gallons) capacity. EPA reasoned that IBCs were being used as a replacement for 55-gallon drums, and that the cargos being transported in IBCs were similar to those being transported in drums. Therefore, resulting IBC cleaning wastewater would be expected to be similar to that of drum reconditioning wastewater.

EPA received comments and other information that both agreed and disagreed with the Agency’s proposal to exclude IBCs from the scope of the TEC regulation; however, EPA did not receive any comments on whether or not the cargos transported in IBCs are similar or dissimilar to those transported by drum or tank truck. Based on site visits and conversations with the National Tank Truck Carriers Inc., EPA believes that all truck facilities which clean IBCs treat IBC and tank truck washwater in the same wastewater treatment system. Personnel at these sites also indicated that they see no significant difference in the types of cargos transported in IBCs or tank trucks. Based on the information collected to date, EPA believes that all drum reconditioning facilities that clean IBCs also treat IBC and drum washwater in the same wastewater treatment system.

Manufacturers generally provide customers with products in quantities to suit their needs. As a result, the same products are likely transported in a variety of transportation modes, including drums, IBCs, tank trucks, intermodal tank containers, and possibly even larger tanks. Just-in-time delivery has also prompted greater variety in product delivery quantities and transportation modes. EPA expects that the same products are transported in drums, IBCs, and tank trucks; however, EPA also expects that certain products, such as food, are more likely to be transported in larger tanks or containers.

The following table provides general information regarding cargos transported in drums, IBCs, and tank trucks/intermodal tank containers (1)(6)(7):

Cargo	**Percentage of Cleanings Performed by Container Type**		
	Drums	**IBCs**	**Tank Trucks/Intermodal Tank Containers**
Oil and Petroleum	36.2	20	8.7
Chemicals (a)	54.8	70	35.6
Food	6.8	10	38.5
Agricultural Chemicals (including pesticides/herbicides)	0.5	--	0.5
Other	1.7	--	3.4
Not Specified	--	–	13.4
Total (b)	**100**	**100**	**100**

(a) Chemicals include industrial chemicals, cleaning solvents, paint and ink, latex, rubber, resins, adhesives, soaps, detergents, and wastes.
(b) Differences occur due to rounding.

Note that food cargos are generally cleaned at TEC facilities that are dedicated to cleaning food grade products. Therefore, the cargo type distribution at non-food grade TEC facilities is much more heavily weighted in the non-food grade cargo categories presented above. EPA has no information regarding whether drums and IBCs that last contained food grade cargos are generally cleaned at facilities dedicated to cleaning food grade products.

7.4 Water Use and Wastewater Generation

Drum reconditioners and tank cleaning facilities share many common characteristics in water use and wastewater generation. The greatest water use and wastewater source by far for both industries is rinse water. Other common water uses include interior preflushes and washes, exterior washes, formulation and make-up of chemical cleaning solutions, leak testing (hydrotesting), and boiler feed water. Other common wastewater sources include interior preflushes and washes, spent cleaning solutions, exterior washwater, leak testing wastewater, compressor condensate, and boiler blowdown.

There are also several differences in water use and wastewater generation between the two industries:

- Acid washing emissions scrubber water is a significant use of water and source of wastewater at many drum reconditioning facilities, but acid washing is less common at TEC facilities, and EPA is not aware of any TEC facilities that operate emissions scrubbers specifically for acid washing operations. (Some TEC facilities operate incinerators, flares, or scrubbers to control emissions from venting, gas-freeing, or steaming tanks that last contained volatile cargos.)
- Label removal is also a significant use of water and source of wastewater at many drum reconditioning facilities but is not applicable to tank cleaning operations.

As discussed in Section 5.2, the ICDC industry generates an estimated 290 million gallons of wastewater per year. Approximately 83% of this volume is generated by drum reconditioning operations, and the remainder is generated by IBC reconditioning operations at both drum reconditioning and TEC facilities. Limited available data suggest that an estimated 5% of ICDC wastewater generated is contract hauled rather than discharged. For the remaining 95% of ICDC wastewater generated (approximately 275 million gallons per year), EPA believes that the vast majority is discharged indirectly, and a very small portion, if any, is discharged directly.

EPA estimates that 328 TEC facilities, discharging approximately 1.05 billion gallons of TEC wastewater per year, will be affected by the TEC rule. These estimates include 286 facilities in Subpart A that discharge approximately 845 million gallons of TEC wastewater per year. Like the ICDC industry, the vast majority of TEC wastewater is discharged indirectly, and a very small portion is discharged directly (2).

7.5 Wastewater Characteristics

Table 7-1, at the end of this section, presents mean raw wastewater concentrations for steel drum washing, plastic drum and IBC washing, steel drum burning, and tank truck/intermodal tank container washing. The table includes all priority pollutants, dioxins and furans, and pesticides and herbicides detected in any sample because of their relatively high toxicity, as well as other pollutants detected at concentrations greater than 1 mg/L in any sample type. The table excludes pollutants analyzed for in only one sample type. EPA applied these data editing criteria to facilitate data comparison by reducing the number of pollutants listed.

Steel drum washing wastewater characterization data represent the mean pollutant concentrations for 11 samples collected at 6 facilities sampled in the mid-1980s and in 2000. For samples in which individual pollutants were not detected, the sample detection limit was used in calculating the mean concentration. The methodology used to calculate the mean concentration involved first calculating a mean concentration for each facility characterized and then calculating a steel drum washing mean concentration using applicable mean facility concentrations.

Plastic drum and IBC washing wastewater characterization data represent the average concentration for two samples (sample duplicates) collected at one facility. Steel drum burning wastewater characterization data represent pollutant concentrations from one sample.

Tank truck/intermodal tank container washing wastewater characterization data represent the mean pollutant concentrations for 10 samples collected at 5 facilities that clean tanks that last contained chemical cargos. The mean concentration was calculated using the methodology described above for steel drum washing wastewater.

As expected, similar types and numbers of pollutants were detected in the steel drum washing and tank truck/intermodal tank container washing wastewaters. In general, pollutant concentrations in steel drum washing wastewater are significantly greater than those in tank truck/intermodal tank container washing wastewater. For example, 22 volatile and semivolatile organic pollutants and 14 metals were detected at average concentrations greater than 1 mg/L in steel drum washing wastewater. In comparison, only 14 volatile and semivolatile organic pollutants and 9 metals were detected at average concentrations greater than 1 mg/L in tank truck/intermodal tank container washing wastewater. In addition, concentrations of the classical pollutants BOD_5, COD, oil and grease/HEM, and TSS range from 1.5 to 6.8 times greater in steel drum washing wastewater as compared to tank truck/intermodal tank container washing wastewater.

EPA selected SGT-HEM, copper, and mercury for regulation for indirect dischargers in Subpart A of the TEC rule. These pollutants were detected at similar concentrations in tank truck/intermodal tank container washing and steel drum washing wastewaters. ERG received comments from pretreatment authorities that EPA should regulate pollutants identified in TEC wastewater that may pass through the POTW or which may accumulate in the POTW sludge. One commenter specifically identified copper, lead, and mercury as pollutants of concern. For Subpart A, EPA regulated copper and mercury but determined lead did not warrant regulation because it was detected at very low concentrations. Lead concentrations in steel drum washing wastewater are nearly three orders of magnitude greater than those in tank truck/intermodal tank container washing wastewater.

EPA decided not to regulate zinc in Subpart A of the TEC rule because zinc levels present in wastewater from Subpart A facilities may be due to source water contamination rather than a direct result of cleaning tanks. In contrast, zinc levels in steel drum washing wastewater (average of 23 mg/L) are significantly greater than levels typically present in drinking water (less than 5 mg/L) and levels present in tank truck/intermodal tank container washing wastewater (average of 0.83 mg/L).

EPA concluded that chromium is a pollutant of interest for Subpart A but did not regulate chromium because EPA's chromium treatment performance data was not representative of practices that may be performed by tank truck washing facilities (i.e., exterior acid brightener washes to remove tarnish from chrome parts), and because chromium limits based on EPA's sampling data may not be achievable for facilities that are performing exterior acid brightener washes for their customers. Exterior acid brightener washes for chrome parts are not applicable to steel drum washing operations. Chromium levels in tank truck/intermodal tank container washing wastewater (average of 2.4 mg/L), which do not reflect the impact of exterior acid brightener washes, are similar to those in steel drum washing wastewater (average of 2.5 mg/L).

EPA also identified several semivolatile organics (bis (2-ethylhexyl) phthalate and straight chain hydrocarbons), dioxins and furans, and pesticides/herbicides as pollutants of interest for indirect dischargers in Subpart A. EPA decided not to regulate these pollutants because the selected technology options were demonstrated to control these pollutants (due to control of TSS and oil and grease) and because pollutant monitoring is very expensive. Concentrations of semivolatile organics in steel drum washing wastewater are greater than those in tank truck/intermodal tank container washing wastewater, while concentrations of dioxins and furans are lower. Available data sets are too limited to assess the comparability of pesticide and herbicide concentrations.

Significantly fewer pollutants were detected in steel drum burning wastewater as compared to steel drum washing wastewater; however, this may be because only one steel drum burning wastewater sample was analyzed. For pollutants that were detected in steel drum burning wastewater, concentrations are generally similar to or less than concentrations in steel drum washing wastewater, but greater than concentrations in tank truck/intermodal tank container washing wastewater. Notable exceptions include chromium and zinc which were detected in drum burning wastewater at significantly greater concentrations than those in steel drum washing wastewater and tank truck/intermodal tank container washing wastewater.

Relatively few pollutants were detected in plastic drum and IBC washing wastewater; however, this may be because only one plastic drum and IBC washing wastewater sample was analyzed. Pollutant concentrations were also relatively low. The plastic drum and IBC washing facility that was sampled cleans very few drums and IBCs that last contained hazardous materials (approximately 2% to 5% of drums and IBCs washed). Plastic drum and IBC washing wastewater contained the highest concentrations of chloroform, dioxins and furans, and chloride as compared to other wastewaters. These pollutants may be generated by the use of bleach (hypochlorite) in the washing process at this facility. In addition, the mercury concentration in plastic and drum washing wastewater is 15 times greater than the average mercury concentration in other wastewaters. The source of mercury is not known; the facility sampled cleans primarily drums and IBCs that last contained dyes.

7.6 Pollution Prevention and Wastewater Treatment Technologies

Similarities and differences in pollution prevention controls and flow reduction technologies in cleaning/reconditioning processes at drum reconditioning and TEC facilities are described in Section 7.2.

Typical end-of-pipe treatment currently used by TEC facilities includes pretreatment and primary treatment such as equalization, pH adjustment, gravity settling, oil/water separation, air flotation, coagulation/flocculation followed by clarification, and sludge dewatering. These are the same treatment technologies commonly used by drum reconditioning facilities visited by EPA in the mid-1980s and in 2000. Prior to implementation of the TEC effluent guidelines, 44% of facilities in Subpart A operated technology equivalent to Option I (Equalization, Oil/Water Separation, Chemical Oxidation, Neutralization, Coagulation, Clarification, and Sludge Dewatering), EPA’s technology basis for the final rule. Eighty-six percent of facilities in Subpart A operated technology equivalent to Option A (Equalization and Oil/Water Separation). EPA has no data on the percentage of drum reconditioning facilities that use these technologies; however, observations based on EPA's site visits suggest use similar to that of tank truck washing facilities.

TEC facilities that operate biological and/or advanced treatment are commonly those that practice extensive water and wastewater recycle and reuse, or that discharge directly to U.S. surface waters. EPA has not identified any drum reconditioning facilities that operate biological and/or advanced treatment, nor has EPA identified any drum reconditioning facilities that discharge directly to U.S. surface waters. EPA has visited four drum reconditioning facilities in the mid-1980s that recycle 100% of treatment wastewater effluent in cleaning/reconditioning processes (see Section 6.2.5); however, biological and/or advanced treatment is not necessary to provide adequate wastewater quality for recycling.

7.7 References

1. U.S. EPA, Office of Water Regulations and Standards, Preliminary Data Summary for the Drum Reconditioning Industry, EPA 440/1-89/101, September 1989 (DCN D00001).

2. U.S. EPA, Office of Water, Final Development Document for Effluent Limitations Guidelines and Standards for the Transportation Equipment Cleaning Category, EPA-821-R-00-012, June 2000.

3. U.S. EPA, Office of Water, Economic Analysis of Final Effluent Limitations Guidelines and Standards for the Transportation Equipment Cleaning Category, EPA-821-R-00-013, June 2000.

4. Reusable Industrial Packaging Association. http://www.reusablepackaging.org.

5. Wilson, C., "IBCs Grow in Popularity," Modern Bulk Transporter, August 1999 (DCN D00043).

6. Dixon, B., The Future of the IBC Market - A Hazardous Cargo Bulletin Report, Intapress Publishing Ltd. London, England, 2000 (DCN D00008).

7. U.S. EPA, Office of Water, 1994 Detailed Questionnaire for the Transportation Equipment Cleaning Industry - Part A: Technical Information, April 1995.

Table 7-1

Comparison of Raw Wastewater Characterization Data for Drum Reconditioning and TEC Facilities

Priority Pollutant Code	Analyte	Units	Mean Raw Wastewater Concentration			
			Steel Drum Washing(a)	Plastic Drum & IBC Washing	Steel Drum Burning	Tank Truck/Intermodal Tank Container Washing
Volatile Organics						
	Acetone	μg/L	120,000	240	16,000	24,000
P004	Benzene	μg/L	110	ND	ND	35
P048	Bromodichloromethane	μg/L	ND	91	ND	10
P007	Chlorobenzene	μg/L	100	12	ND	16
P023	Chloroform	μg/L	310	4,000	ND	65
P013	1,1-Dichloroethane	μg/L	ND	ND	ND	12
P010	1,2-Dichloroethane	μg/L	110	ND	ND	400
P029	1,1-Dichloroethene	μg/L	910	ND	ND	14
P032	1,2-Dichloropropane	μg/L	ND	ND	ND	11
P038	Ethylbenzene	μg/L	12,000	ND	12,000	440
	— + p-Xylene	μg/L	2,300	ND	ND	1,700
P044	Methylene Chloride	μg/L	1,300	ND	100,000	12,000
	Methyl Ethyl Ketone	μg/L	210,000	120	68,000	5,200
	Methyl Isobutyl Ketone	μg/L	26,000	ND	18,000	1,600
P085	Tetrachloroethene	μg/L	3,000	ND	ND	1,100
P006	Tetrachloromethane	μg/L	ND	ND	ND	14
P086	Toluene	μg/L	20,000	ND	17,000	1,600
P030	Trans-1,2-Dichloroethene	μg/L	110	ND	ND	ND
P047	Tribromomethane	μg/L	ND	ND	ND	10
P011	1,1,1-Trichloroethane	μg/L	4,900	ND	17,000	710
P087	Trichloroethene	μg/L	430	ND	ND	26
Semivolatile Organics						
P001	Acenaphthene	μg/L	ND	ND	ND	130
	Benzoic Acid	μg/L	38,000	350	ND	24,000
	Benzyl Alcohol	μg/L	1,800	ND	4,600	410
P066	Bis (2-Ethylhexyl) Phthalate	μg/L	3,700	16	880	900
P067	Butyl Benzyl Phthalate	μg/L	230	ND	ND	ND
P020	2-Chloronaphthalene	μg/L	830	ND	ND	ND

Table 7-1 (Continued)

Priority Pollutant Code	Analyte	Units	Mean Raw Wastewater Concentration			
			Steel Drum Washing(a)	Plastic Drum & IBC Washing	Steel Drum Burning	Tank Truck/Intermodal Tank Container Washing
P024	2-Chlorophenol	µg/L	ND	ND	ND	67
	2,3-Dichloroaniline	µg/L	ND	ND	ND	3,600
P025	1,2-Dichlorobenzene	µg/L	ND	ND	ND	190
P031	2,4-Dichlorophenol	µg/L	ND	ND	ND	57
P068	Di-n-Butyl Phthalate	µg/L	750	ND	ND	ND
P059	2,4-Dinitrophenol	µg/L	690	ND	ND	ND
P035	2,4-Dinitrotoluene	µg/L	72	ND	ND	ND
P069	Di-n-Octyl Phthalate	µg/L	ND	ND	ND	350
P063	Di-n-Propylnitrosamine	µg/L	ND	ND	ND	270
P080	Fluorene	µg/L	72	ND	ND	140
	Hexanoic Acid	µg/L	20,000	69	ND	77
P054	Isophorone	µg/L	2,000	ND	14,000	140
P060	2-Methyl-4,6-Dinitrophenol	µg/L	350	ND	ND	ND
	n-Decane (N-C10)	µg/L	2,400	120	ND	350
	n-Dodecane (N-C12)	µg/L	1,500	ND	ND	1,100
P062	n-Nitrosodiphenylamine	µg/L	ND	ND	ND	270
	n-Octacosane (N-C28)	µg/L	1,100	ND	ND	940
	n-Tetradecane (N-C14)	µg/L	1,700	ND	ND	560
	n-Triacontane	µg/L	ND	ND	ND	1,200
P055	Naphthalene	µg/L	1,300	13	5,300	330
P056	Nitrobenzene	µg/L	73	ND	ND	ND
P057	2-Nitrophenol	µg/L	1,100	ND	ND	110
P058	4-Nitrophenol	µg/L	1,100	ND	ND	270
	o-Cresol	µg/L	130	ND	2,600	160
	p-Cymene	µg/L	130	ND	1,000	150
P081	Phenanthrene	µg/L	450	ND	ND	180
P065	Phenol	µg/L	760	180	ND	2,000
P084	Pyrene	µg/L	ND	10	ND	ND
	Styrene	µg/L	3,000	ND	13,000	3,300
P021	2,4,6-Trichlorophenol	µg/L	ND	44	ND	180
	Tripropyleneglycol Methyl Ether	µg/L	1,700	3,900	ND	1,300

Table 7-1 (Continued)

Priority Pollutant Code	Analyte	Units	Mean Raw Wastewater Concentration			
			Steel Drum Washing(a)	Plastic Drum & IBC Washing	Steel Drum Burning	Tank Truck/Intermodal Tank Container Washing
Dioxins and Furans						
	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/L	160	2,100	15	690
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/L	100	610	2.0	220
	1,2,3,4,7,8,9-Heptachorodibenzofuran	pg/L	ND	310	ND	ND
	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	pg/L	ND	1,400	0.37	ND
	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	pg/L	ND	230	0.36	97
	1,2,3,4,7,8-Hexachlorodibenzofuran	pg/L	ND	97	0.55	ND
	1,2,3,6,7,8-Hexachlorodibenzofuran	pg/L	ND	51	ND	120
	2,3,4,6,7,8-Hexachlorodibenzofuran	pg/L	ND	420	0.54	ND
	2,3,7,8-Tetrachlorodibenzofuran	pg/L	ND	ND	0.21	ND
	Octachlorodibenzo-p-dioxin	pg/L	1,300	12,000	200	6,100
	Octachlorodibenzofuran	pg/L	270	6,600	10	560
Pesticides and Herbicides (b)						
	Azinphos Ethyl	µg/L	2,100	ND	NA	(b)
	Azinphos Methyl	µg/L	5,400	ND	NA	(b)
	Dalapon	µg/L	ND	210	NA	(b)
	Diazinon	µg/L	520	ND	NA	(b)
	Dimethoate	µg/L	750	ND	NA	(b)
	Endosulfan I	µg/L	150	ND	NA	(b)
	Endosulfan Sulfate	µg/L	260	ND	NA	(b)
	Etridazone	µg/L	130	ND	NA	(b)
	Fensulfothion	µg/L	6,800	ND	NA	(b)
	Heptachlor	µg/L	140	ND	NA	(b)
	Leptophos	µg/L	2,000	ND	NA	(b)
	MCPA	µg/L	ND	2,300	NA	(b)
Metals						
	Aluminum	µg/L	19,000	39,000	47,000	6,100
P114	Antimony	µg/L	2,400	22	600	57
P115	Arsenic	µg/L	49	ND	10	15
	Barium	µg/L	2,000	57	5,700	530
P117	Beryllium	µg/L	9.9	0.47	5.0	0.92
	Boron	µg/L	6,700	78	7,300	4,700

Table 7-1 (Continued)

Priority Pollutant Code	Analyte	Units	Mean Raw Wastewater Concentration			
			Steel Drum Washing(a)	Plastic Drum & IBC Washing	Steel Drum Burning	Tank Truck/Intermodal Tank Container Washing
P118	Cadmium	μg/L	280	7.0	730	18
	Calcium	μg/L	36,000	68,000	170,000	300,000
P119	Chromium	μg/L	2,500	84	12,000	2,400
	Cobalt	μg/L	460	14	3,500	85
P120	Copper	μg/L	1,300	360	1,200	1,100
	Iron	μg/L	130,000	2,300	47,000	30,000
P122	Lead	μg/L	11,000	61	11,000	25
	Magnesium	μg/L	11,000	14,000	30,000	72,000
	Manganese	μg/L	1,400	54	1,500	800
P123	Mercury	μg/L	4.1	63	0.80	1.8
	Molybdenum	μg/L	690	1,700	790	100
P124	Nickel	μg/L	210	30	1,200	360
P125	Selenium	μg/L	9.7	5.1	25	11
P126	Silver	μg/L	4.3	ND	1.0	3.5
	Sodium	μg/L	4,900,000	2,000,000	770,000	1,000,000
P127	Thallium	μg/L	13	ND	50	3.7
	Tin	μg/L	1,100	700	350	12,000
P128	Zinc	μg/L	23,000	3,200	110,000	830
Classical Pollutants						
	Ammonia	mg/L	20	21	33	79
	BOD5, Dissolved	mg/L	2,500	NA	1,500	NA
	BOD5, Total	mg/L	3,600	440	2,600	2,300
	Chloride	mg/L	1,400	2,200	330	900
	COD, Dissolved	mg/L	8,500	NA	18,000	NA
	COD, Total	mg/L	15,000	2,400	52,000	6,600
	Dissolved Solids	mg/L	15,000	NA	6,200	5,000
	Fluoride	mg/L	34	NA	11	21
	Nitrate/Nitrite	mg/L	360	5.3	NA	2.6
	Oil & Grease/HEM	mg/L	8,900	21	5,300	1,300
	pH	mg/L	10 to 12	NA	8.2	7 to 12
P065	Phenol	mg/L	35	NA	39	2.6
	SGT-HEM	mg/L	140	ND	NA	150
	Suspended Solids	mg/L	3,600	1,500	9,500	1,600

Table 7-1 (Continued)

Priority Pollutant Code	Analyte	Units	Mean Raw Wastewater Concentration			
			Steel Drum Washing(a)	Plastic Drum & IBC Washing	Steel Drum Burning	Tank Truck/Intermodal Tank Container Washing
	Suspended Vol. Solids	mg/L	2,400	NA	14,000	NA
	TKN	mg/L	71	NA	560	NA
P121	Total Cyanide	mg/L	3.3	0.78	0.28	0.02
	Total Organic Carbon	mg/L	2,800	1,300	4,000	1,500
	Total Phosphorus	mg/L	17	20	NA	22
	Total Volatile Solids	mg/L	6,000	NA	19,000	2,900

(a) Mean pollutant concentrations for 11 samples collected at 6 facilities sampled in the mid-1980s and in 2000 (see Table 5-1).

(b) Pesticides and herbicides results for steel drum washing are based on data from one facility known to clean drums that last contained pesticides and herbicides. Results for plastic drum and IBC washing are based on data from one facility that reportedly does not clean drums or IBCs that last contained pesticides or herbicides. Results for tank truck/intermodal tank container washing are not presented because of some uncertainty in the identification of these analytes. Data for 39 pesticides and herbicides identified in tank truck/intermodal tank container washing wastewater are provided in Reference 2.

ND - Pollutant not detected.

NA - Pollutant not analyzed.

8.0 POLLUTANT LOADINGS AND COSTS TO MANAGE ICDC WASTEWATER

As part of the characterization of the ICDC industry, EPA evaluated wastewater pollutant loadings and costs to manage ICDC wastewater. EPA obtained pollutant loadings and costing data from information gathered during site visits to ICDC facilities, data collected by EPA in the mid-1980s, technical literature, and engineering judgement.

8.1 Estimated Pollutant Loadings

This section describes EPA's methodology to estimate raw wastewater pollutant loadings for the ICDC industry. For the purpose of this analysis, EPA segmented the ICDC industry as follows: steel drum washing, plastic drum washing, steel drum burning, and IBC washing. EPA's primary data source for this analysis is the raw wastewater characterization data presented in Section 5.0. Data presented in Table 5-1 were used to estimate steel drum washing pollutant loadings; data presented in Table 5-2 were used to estimate plastic drum washing pollutant loadings because the sampled facility cleans predominantly plastic drums; and data presented in Table 5-3 were used to estimate steel drum burning pollutant loadings.

EPA has no raw wastewater sampling data representative of wastewater generated solely from cleaning IBCs. To estimate IBC washing pollutant loadings, EPA considered two possible approaches based on two different data sources, and presents the results as a range of possible IBC washing pollutant loadings. The first source is wastewater characterization data presented in Table 5-2, which predominantly represents plastic drum washing wastewater, but also represents plastic IBC washing wastewater. The second source is wastewater characterization data for tank truck/intermodal tank container washing presented in Table 7-1.

EPA considered two approaches for projecting the wastewater characterization data described above to represent the entire ICDC industry. The first approach uses EPA's estimate of the total annual volume of wastewater generated by the ICDC industry presented in

Section 5.2. The second approach uses EPA's estimate of the total annual production of the ICDC industry (i.e., numbers of drums and containers cleaned per year) presented in Section 4.2. EPA selected the second approach because it considers the annual production estimate to be more reliable than the annual wastewater generation estimate. Use of the second approach requires that EPA first estimates pollutant loadings on a per drum and per IBC basis as described below.

Pollutant loadings are commonly expressed in pounds of pollutants generated per year or per unit production. However, simply summing the pounds of different pollutants generated ignores significant differences is the toxicity expressed by the pollutants. For example, a pound of zinc in a wastewater stream has a significantly different, less harmful effect than a pound of dioxins. To account for differences in toxicity, EPA develops pollutant toxic weighting factors which are standardized by relating them to a "benchmark" toxicity value of 1. Use of the toxic weighting factor converts pollutant loadings expressed in pounds of pollutants to pollutant loadings expressed in "pound-equivalents."

EPA's methodology for estimating raw wastewater pollutant loadings (in pound-equivalents) for the steel drum washing, plastic drum washing, and steel drum burning segments of the ICDC industry was as follows:

(1) Calculated average pollutant concentrations (mg/L or μg/L) for each sampled facility. The sample-specific detection limit was used for non-detect values.

(2) Converted facility average pollutant concentrations to average pollutant loadings (lb/yr) using each facility's annual flow rate.

(3) Converted facility average pollutant loadings to pound-equivalent pollutant loadings by multiplying by EPA-derived toxic weighting factors. For pollutants without a toxic weighting factor, EPA used a toxic weighting factor of zero.

(4) Calculated total facility pound-equivalent loadings by summing the pollutant pound-equivalent loadings generated by each facility.

(5) Calculated total facility production-normalized pound-equivalent loadings (lb/drum) by dividing by each facility's annual production.

(6) Calculated industry average production-normalized pound-equivalent loadings for each industry segment by averaging the applicable facility loadings.

(7) Calculated industry annual pound-equivalents generated by multiplying by the industry annual drum cleaning production.

Note that EPA analyzed for dioxins and furans in raw wastewater samples collected at only two of the six steel drum washing facilities sampled. EPA assumed that raw wastewater dioxin and furan loadings for each of the remaining four steel drum washing facilities equaled the average raw wastewater dioxin and furan loadings for the two steel drum washing facilities that were sampled. Note also that EPA's raw wastewater pollutant loadings estimates do not include pollutant loadings that may be contributed by pesticides and herbicides. Although EPA believes pesticides and herbicides are present in ICDC wastewaters, the Agency also believes their detection in ICDC wastewater may be site-specific occurrences. Available pesticide and herbicide data are too limited to estimate pesticide and herbicide pollutant loadings that are representative of the ICDC industry. Therefore, raw wastewater pollutant loading estimates presented in this section may include a low bias.

EPA's methodology for estimating raw wastewater pollutant loadings (in pound-equivalents) for the IBC washing segment of the ICDC industry was as follows. For the first approach, EPA used the industry average production-normalized pound-equivalent loadings per plastic drum washed calculated in step (6) described above. EPA then prorated the plastic drum washing loading by multiplying by 11.1, which represents the ratio of the volume of wastewater generated by cleaning an IBC to that generated by cleaning a drum (100 gallons of wastewater per IBC washed divided by 9 gallons of wastewater per drum washed). This proration accounts for the assumed greater pollutant loadings generated per IBC cleaning, as compared to those generated per drum cleaning, because of the larger container size and commensurate heel volumes. EPA then multiplied this result by the annual IBC cleaning production.

For the second approach, EPA used the methodology described in steps (1) through (6) above to calculate the production-normalized pound-equivalent loadings per tank truck/intermodal tank container cleaned (excluding pesticides and herbicides). EPA then prorated the tank truck/intermodal tank container cleaning loading by multiplying by 0.165, which represents the ratio of the volume of wastewater generated by cleaning an IBC to that generated by cleaning a tank truck/intermodal tank container (100 gallons of wastewater per IBC washed divided by 605 gallons of wastewater per tank truck/intermodal tank container washed). This proration accounts for the assumed lower pollutant loadings generated per IBC cleaning, as compared to those generated per tank truck/intermodal tank container cleaning, because of the smaller container size and commensurate heel volumes. EPA then multiplied this result by the annual IBC cleaning production.

The following table summarizes estimated raw wastewater pollutant loadings for the ICDC industry:

Container Type	Raw Wastewater Pollutant Loadings (Pound-Equivalents/ Container)	Number of Containers Cleaned/Year	Total Annual Raw Wastewater Pollutant Loadings (Pound-Equivalents/Year)
Steel Drum Washing	0.037	11.0 million	410,000
Plastic Drum Washing	5.5	7.6 million tight-head	42,000,000
		664,000 open-head	3,700,000
Steel Drum Burning	0.0023	20.2 million	46,000
IBC Washing	0.014 to 61	500,000	7,000 to 31,000,000
Total			**46,000,000 to 77,000,000**

Greater than 90% of the estimated total annual raw wastewater pollutant loadings for all segments of the ICDC industry are contributed by dioxins and furans, and metals comprise the majority of the remaining pollutant loadings. Available treatment performance data for technologies similar to those used by ICDC facilities visited by EPA in the mid-1980s and in 2000 (e.g., oil-water separation, chemical precipitation, and clarification) suggest that dioxins and furans would be expected to be removed by 62% to 98% (1). Available treatment performance data presented in Section 6.0 suggest that these technologies also generally remove priority pollutant metals. Note that available data suggest that the majority of ICDC facilities operate wastewater treatment; however, EPA has no information regarding the specific treatment technologies used by these facilities (see Section 6.3). With the exception of any ICDC facilities that discharge wastewater directly (EPA is not aware of any direct discharging facilities), ICDC wastewater will also receive additional treatment at publicly-owned treatment works or centralized waste treatment facilities prior to discharge to U.S. surface waters (see Section 5.2).

Excluding the adjustment for pollutant toxicity, raw wastewater pollutant loadings (in pounds) are predominantly (80% to 90%) contributed by classical pollutants such as chemical oxygen demand, solids, oil and grease, and biochemical oxygen demand. Metals contribute approximately 1% to 20% of raw wastewater pollutant loadings, and volatile and semivolatile organics contributed approximately 0.2% to 3% of pollutant loadings.

8.2 Estimated Costs

For the purpose of developing effluent limitations guidelines and standards, EPA estimates capital and operating and maintenance costs to implement the practices and technologies used as the bases of regulatory options. Capital costs include direct and indirect costs associated with the purchase, delivery, and installation of pollutant control equipment. Annual operating costs include all costs related to operating and maintaining the control technologies for one year. This includes costs for operational labor, maintenance and repair labor, operating and maintenance materials, electricity, treatment chemicals, disposal of treatment system residuals, and compliance monitoring of wastewater discharges. This section presents actual wastewater treatment costs incurred at ICDC facilities visited by EPA in 2000. Note that costs for similar treatment can vary significantly depending on the specific technology design basis and capacity; therefore, costs presented in this section should be considered as examples within a possibly wide range of costs.

The following table presents the capital and operating costs for wastewater treatment technologies at the three ICDC facilities visited in 2000. These costs do not include costs incurred for heel management and water conservation, which are expected to be relatively small.

Wastewater Treatment Costs at ICDC Facilities

ICDC Facility	Wastewater Treatment Technologies	ICDC Operations	Wastewater Flow (gal/day) (Design Capacity)	Capital Costs	Associated Operating Costs ($/yr)
1	Equalization, Chemical Precipitation, Dissolved Air Flotation, and Filter Press	Plastic Drum and IBC Washing	20,000 - 23,000 (100 gal/minute capacity)	$350,000 (2000 dollars)	Chemical Costs = $14,400 Monitoring/ POTW Discharge Fees = $36,000 Other Operating Costs Unknown
2	Equalization, pH Adjustment, Chemical Precipitation, and Gravity Separation Oil/Water Separation, Mix Tanks, Dissolved Air Flotation, Bag Filters, and Vacuum Filter (a)	Steel Drum Washing and Burning	12,000 - 15,000 (30,000 gal/day capacity)	>$1,000,000 (a) (late-1980s dollars)	Chemical Costs = $180,000 to $200,000 Other Operating Costs = $500,000
3	Equalization, Chemical Precipitation, Oil Skimming, pH Adjustment, and Filter Press	Steel Drum Washing	2,500 - 3,000 (Capacity unknown)	$129,000 (1989 dollars)	Chemical Costs = $15,000 to $16,000 Filter Cake Disposal = $3,000 to $5,000 Labor Costs = 25% of one employee’s time

(a) These technologies are no longer used. Costs include all technologies.

Wastewater treatment costs are strongly correlated to wastewater flow rates, which determine equipment sizing and chemical addition rates. According to data provided by RIPA, wastewater flows for drum reconditioning facilities (washing and burning) range from 500 gallons per day to 50,000 gallons per day, and average 14,300 gallons per day (2). Therefore, the costs shown above are from facilities with wastewater flow rates typical of those in the ICDC industry. Note that available data suggest that the majority of ICDC facilities operate wastewater treatment; however, EPA has no information regarding the specific treatment technologies used by these facilities (see Section 6.3).

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9.0 TRENDS IN THE INDUSTRY

This section describes trends in the ICDC industry size (Section 9.1), types of ICDC facilities (Section 9.2), cleaning/reconditioning processes (Section 9.3), and pollution prevention and wastewater treatment technologies (Section 9.4).

All of the apparent trends discussed in this section are based on information obtained during EPA's data-collection activities and subsequent analyses, which are described throughout this report. Note, however, that the vast majority of these sources are not statistically reliable. Accordingly, the trends described in this section should be considered qualitative or anecdotal because available data are insufficient to validate trends statistically.

9.1 ICDC Industry Size

Section 4.1.1 describes EPA's estimate of the total ICDC industry population of 291 facilities, including ICDC facilities that do not clean transportation equipment and ICDC facilities that also clean transportation equipment. According to the Reusable Industrial Packaging Association (RIPA), there has been no growth in the number of drum burning facilities and very few new drum washing facilities since EPA's study of the drum reconditioning industry in the mid-1980s (1).

Although available data show significant growth in the IBC washing segment, EPA has identified only a few new facilities that wash only IBCs. Instead, industry growth in this segment consists of installing new IBC washing lines at existing drum washing and transportation equipment cleaning (TEC) facilities. Data from the Association of Container Reconditioners (now RIPA) prior to 1993 indicated that 35% of their membership of about 100 companies at that time received IBCs for reconditioning (2). EPA estimates that 173 TEC facilities reconditioned at least one IBC in 1994. EPA believes both estimates represent a low bias because of significant growth in this market since 1994. EPA expects that additional drum washing facilities and TEC facilities will add IBC washing lines if growth of IBC use continues in the future. Therefore, future growth in the number of ICDC facilities will likely be comprised of TEC facilities that begin washing IBCs.

Available data suggest the following trends in the ICDC industry since the mid-1980s:

- The total number of drums reconditioned has decreased;
- The number of tight-head drums reconditioned has decreased, while the number of open-head drums reconditioned has increased;
- Plastic drums have gained market share from steel drums;
- The total number of IBCs reconditioned has increased; and
- IBCs have gained market share predominantly from drums, but also from tank trucks.

According to the Preliminary Data Summary for the Drum Reconditioning Industry, in 1985, approximately 50 million steel drums were reconditioned. Approximately 33 million of these drums were washed (tight-head drums), and 17 million were burned (open-head drums). Very few plastic drums were manufactured or reconditioned at that time, and plastic drums were not considered to present a serious competitive threat to the use of steel drums (3). Data from RIPA indicate that, according to association surveys, 35 million steel and 5 million plastic drums are reconditioned per year. Approximately 17 million of these steel drums are washed (tight-head drums), 5 million plastic drums are washed (tight-head and open-head drums), and 18 million steel drums are burned (open-head drums) (4). Future growth or decline in the total number of drums reconditioned may be expected to equal growth or decline in the general chemical industry.

In the mid-1980s, industry began using plastic drums to transport food and beverage cargos. Use of plastic drums in these industries has since grown significantly, and has expanded to growth in other industries following improvements in plastic drum quality, purity, sanitation, and washing, and in plastics recycling. Improved multi-layer blowmolding technology enables use of different material characteristics for different layers (i.e., inner, middle, and outer) of plastic drum construction. Plastic drum manufacturers continue to improve drum purity, such as manufacturing drums in clean rooms and rinsing with deionized water. As a result, new plastic drum designs have little or no trade-off between safety and purity, which has fueled the growth in use of plastic drums and greatly expanded the variety of cargos that can be transported in plastic drums. Newer applications for plastic drums include transport of plastic resins, other resins, pigments, chemicals, and pharmaceuticals. Open-head plastic drums are replacing fiber drums for transporting solids and highly viscous liquids (5)(6). The advantages of plastic drums compared to steel drums include: lighter weight; one-piece construction; and no flaking, rusting, corroding, or denting (7). However, plastics drums are incompatible with concentrated chemical solvents and many flammable materials (5). EPA expects that expansion in the application of plastic drums in the chemical industry will increase the variety of pollutants found in plastic drum cleaning wastewater.

IBC reconditioning is not discussed in the Preliminary Data Summary for the Drum Reconditioning Industry, suggesting that a negligible number of IBCs were cleaned by the ICDC industry in the mid-1980s. In comments submitted in response to the TEC proposed rule in 1998, The Association of Container Reconditioners (now RIPA) stated that members clean 70,000 to 90,000 IBCs annually (8). In more recent communications, RIPA stated that members wash approximately 250,000 rigid IBCs annually, reflecting both market increase and new membership (1)(9). The total number of IBCs reconditioned annually by drum reconditioners and TEC facilities is not known, but is believed to range between 500,000 to 1,000,000 per year (10)(11)(12). Available data suggest that although continued growth in the use of IBCs is expected (perhaps 10% per year), growth is slowing because of the increasing maturity of the IBC market. Most users who intend to switch to IBCs have already switched (13).

Literature sources demonstrate that the growth in use of IBCs is predominantly a replacement for use of drums. The advantages of IBCs compared to drums include: more efficient filling, shipping, and storage; potential reduced liability because of improved life cycle management; longer lifespan; and improved health and safety and reduced spills because fewer units are handled (7)(14)(15)(16). IBCs are also used in-process rather than solely for distribution and delivery; many IBCs are translucent with gallon markers to monitor dispensing (15)(16). Nalco Chemical Company has replaced 2.5 million drums with a fleet of 60,000 containers ranging in size from 15 gallons to 800 gallons, and many other chemical and food companies now transport a substantial percentage of product by IBCs rather than by drums (14).

In June 1991, Dow Corning initially sought to replace drums with IBCs because of their more efficient space loading. However, ensuing research showed that 35% of their customer base would not convert from drums for a variety of reasons:

> “Many customers can’t afford to tie up that much cash flow in inventory. Some companies don’t have a forklift to transport IBCs, and this would be a major investment for them. In mature factories, the aisles are too narrow to accommodate an IBC. Sometimes the production site doesn’t have the necessary room to park an IBC. Some of our silicone products have a 6-month shelf life. Putting this material into IBCs can mean a lot of waste at the customer site.” (2)

Industrial packaging solutions ultimately are not “drums versus IBCs,” but rather providing a mix of industrial packaging alternatives to meet the needs of customers.

IBCs have also replaced some deliveries by tank truck. For example, IBCs are one solution for just-in-time delivery. Although IBCs are more expensive than other bulk delivery modes on a per gallon basis, IBCs are delivered by the chemical manufacturer/distributer more quickly (with less lead time) and with minimal logistics hassles. Single-use IBCs are also increasingly used in place of tank trucks to transport difficult to clean commodities such as inks, dyes, creosote, and paint. Finally, rather than comply with new permanent storage tank requirements, some manufacturing facilities are substituting IBCs for permanent tanks (17)(18). IBC companies are also targeting the intermodal tank container market, arguing that a mix of IBCs and tanks in their fleet provide customers more flexible service (13).

9.2 Drum and Container Recycling

The Pollution Prevention Act of 1990 (42 U.S.C. 13101 et seq., Pub. Law 101-508, November 5, 1990) made pollution prevention a national policy of the United States by declaring that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible; pollution that cannot be prevented or recycled should be treated; and disposal or other release into the environment should be chosen only as a last resort and should be conducted in an environmentally safe manner. Similar environmental regulations were also passed in Europe, concurrent with expanding global markets for chemical companies and industrial packaging companies. For example, the German take-back legislation, Duales System Dueschland, requires producers to provide opportunities to recycle their product packaging or to take the packaging back themselves (19).

Corporations around the world began incorporating environmental management as part of the business process (19). The chemical industry responded with product stewardship initiatives under Responsible Care®. Product stewardship means making health, safety, and environmental protection an integral part of designing, manufacturing, marketing, distributing, using, and recycling and disposing of products (20). Product stewardship activities may include recovering containers (i.e., those used for shipping) with product residues. In 1992, EPA published a report, Characterization of Municipal Solid Wastes in The United States, which documented that packaging comprised 30% of waste disposed in landfills, and that industrial packaging comprised the majority of the packaging waste stream (21). Life cycle responsibility for packaging is increasingly placed in the hands of the shipper, who is increasingly responsible for the actions of other parties in the safe disposal or reconditioning of drums and containers (22).

Many shippers are implementing product stewardship programs by converting from short-term, one-way drums and IBCs to use of “fleet” drums and IBCs. The “fleet” may be owned by the shipper, the drum or IBC manufacturer, or the emptier/end user. Used drums and

IBCs are often returned to the shipper for refilling without prior cleaning. Otherwise, used drums and IBCs may be cleaned and reused/recycled by the shipper, the manufacturer, the end user, or an independent cleaning facility. Drums and IBCs may be managed in closed-loop systems, where the customer's drums and IBCs are used only for the customer's products, or in open-loop systems, where multiple customers share drums and IBCs. Drum and IBC management ranges from participation in recycling/reconditioning programs to "cradle-to-grave" management systems encompassing drum and IBC manufacture and design, delivery, retrieval, tracking and shipping paperwork, cleaning and maintenance, re-certification, destruction, and replacement (23).

As a result of these initiatives, disposal of industrial packaging has reduced dramatically. Steel drums that cannot be reconditioned are cleaned, crushed, and reused to make new steel products. Plastic drums and IBCs that can not be reused are cleaned and shredded to make a variety of products including fence and sign posts, drainage pipes and tile, park benches, garbage disposal containers, truck bed liners, pallets, and sheet stock (14)(24)(25). One company, CoExcell, accepts clean, spent drums from a network of plastic drum recyclers. The drums are reground and used to blow mold coextruded plastic drums with a center layer of recycle (26).

The following examples illustrate the current trends in drum and IBC management, which are based on alliances between shippers, drum and IBC manufacturers, and reconditioners. EPA expects continued development of alliances as additional chemical industry facilities commit to achieve 100% implementation of Responsible Care® initiatives.

Dow Corning and Van Leer Containers - Drum Recycling Program

In January 1992, Dow Corning and co-sponsor Van Leer Containers (a drum and IBC manufacturer) initiated the "Drum Recycling Program." For this program Dow Corning and Van Leer Containers formed a network of 12 (now 16) drum reconditioners with a "gentlemen's agreement" to pick up and recondition or recycle used drums throughout the continental United

States. To be included in the network of Authorized Reconditioners, facilities were required to pass a rigorous audit and inspection program, including a detailed review of environmental, Occupational Safety and Health Administration, operational, managerial, and financial records. The program includes a “no excuses” drum pick-up policy whereby customers call a 24-hour toll-free number and drums are picked up by the reconditioner within 15 days of the request. Reconditioners agree to pay the customer the highest price or charge the minimum fee for drums, depending on the local scrap steel market, and agree not to broker drums to non-system members. Drums are either reconditioned, shredded, or crushed, depending on their condition (2).

Many other chemical companies, such as Johnson Wax, Ashland Chemical, and GE Silicones, have since joined Van Leer Containers’ drum collection system, each with its own network of reconditioners (2)(14)(24).

Hoover Materials Handling Group - Closed Loop Packaging

Hoover Materials Handling Group (Hoover) is the largest supplier of IBCs in the United States. Hoover offers customers an IBC management program which uses computer software and bar codes to track IBC deliveries, pick-ups, and inventory. Customers may either buy or lease IBCs from Hoover, and the IBCs are dedicated to individual customers. Hoover coordinates IBC cleaning and reconditioning among its own reconditioning facilities and with Allwaste Container Services (now owned by Philip Services Corporation), a transportation equipment cleaning company with multiple facilities nationwide. Allwaste manages disposal or recycling of residual products, cleans and repairs IBCs, and performs necessary IBC inspections and recertification (27).

Schutz Container Systems and Sonoco Product Co. - Returnable IBCs

Schutz Container Systems (Schutz) and Sonoco Products Co. (Sonoco) are IBC manufacturers that provide IBCs to customers primarily on a trip lease basis and provide for the return and reconditioning of the used IBCs. The Schutz program is referred to as "The North American Ticket," and the Sonoco program is referred to as "We Make It, We Take It Back." Customers pay daily use costs and are required to return the IBC. Customers have the use of the IBC for less than the purchase cost. IBCs generally can be used for three or four trips, and the recovered IBCs are eventually sold into the secondary market to recover costs. Schutz IBCs include a ticket that the emptier completes and faxes to Schutz, who arranges pick-up and delivery of the IBC to either their subsidiary Cardinal Container Services or to one of 29 Schutz-designated recycling locations. Sonoco IBCs include a label with a toll-free number to arrange pick-up and delivery of the IBC to the Sonoco recycling center or to local drum reconditioners (19)(27)(28)(29).

Arena Fleet Services, Soltralentz, SH Containers (now part of Blagden Packaging), and other IBC manufacturers offer similar services (15)(27).

Russell-Stanley Services - Returnable Drums and IBCs

Russell-Stanley Services (Russell-Stanley) is a steel and plastic drum manufacturer that operates a leasing program in which plastic drums and IBCs are leased to customers and returned to Russell-Stanley by the end-user. The company manages the return and reuse of a fleet of over 2 million drums and IBCs from over 14,000 end user locations. Each drum and IBC label has a phone number that the end-user can use to call the company for pick up, and drums and IBCs are picked up in 24 hours (30).

9.3 Cleaning/Reconditioning Process

EPA is not aware of any significant trends in drum washing processes. Some facilities visited by EPA plan facility modernization to improve efficiency and reduce labor requirements, particularly for mechanical steps to restore the shape and integrity of steel drums. New, turn-key reconditioning processes may improve water conservation by increasing water recirculation and reuse, but are not otherwise expected to impact the characteristics of drum washing wastewater.

Most facilities have added IBC washing processes within only the last 5 to 8 years, and IBC washing is typically a small, but growing, operation at most facilities. IBC washing operations are primarily manual, either because facilities have not yet invested in automated systems or because automated systems are not adequate to clean the variety of IBC sizes and designs received by independent ICDC facilities. Many facilities have either built cleaning equipment in-house, or worked with vendors to build specially-designed equipment. The industry has also benefitted from developments in cleaning nozzle design and recirculation systems which improve washing efficiency and significantly reduce wastewater flow (11).

EPA has no information on trends in drum burning operations. EPA visited one drum burning facility in 2000 that operated a state-of-the-art drum furnace. Advanced features of the furnace include an afterburner for emissions control, fully automated controls for the primary burners and afterburners, and continuous emission monitors for carbon monoxide and temperature. Upset conditions trigger automatic shutdown protocols. Based on this information, EPA believes trends in drum burning operations likely focus on reducing air emissions rather than water pollution controls.

9.4 <u>Pollution Prevention and Wastewater Treatment Technologies</u>

EPA expects that compliance with the Resource Conservation and Recovery Act (RCRA) has significantly reduced the volume of heel in drums and IBCs received by ICDC facilities. EPA also expects that chemical industry commitments to Responsible Care® initiatives have improved the safe management and reduction of wastes, including product residues in industrial packaging. EPA is not aware of any trends specific to end-of-pipe wastewater treatment.

IBC manufacturers are continually adding new products and changing existing product design and materials of construction to meet the needs of their customers and to expand the variety of cargos that can be transported. Some changes are specifically designed to maximize product drainage. For example, improved IBC designs include a sloping floor which drains to a bottom outlet that is positioned below the level of the IBC floor. Other designs allow more efficient cleaning by avoiding difficult to clean corners and seams (13). However, many of these features are not provided in the most popular, low cost composite IBCs. EPA expects that drainage design will be an increasingly important issue for IBC users to reduce product waste, which will result in less heel in IBC cleaning wastewater. In addition, continued expansion in the application of IBCs in the chemical industry will increase the variety of pollutants found in IBC cleaning wastewater.

Steel drum designs are relatively standard as compared to IBC designs; however, some designs can improve emptying. For example, Dow Chemical has converted to Optimally Drainable Drums, some with concave heads to allow drip-dry emptying (14).

The chemical industry has recognized and acted on the potential liability of unsafe or improper disposal or reconditioning of drums and containers. Specifically, Dow Corning’s drum recycling program has set a standard for more responsible management and provided guidance for auditing reconditioning facilities (14). Reconditioners who recognize the opportunities of responsible management will make necessary investments and improvements in methods of operation, including pollution prevention and wastewater treatment to comply with environmental permits (2).

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10.0 GLOSSARY

Agency - The U.S. Environmental Protection Agency.

BOD_5 - Five day biochemical oxygen demand. A measure of biochemical decomposition of organic matter in a water sample. It is determined by measuring the dissolved oxygen consumed by microorganisms to oxidize the organic matter in a water sample under standard laboratory conditions of five days and 20° C, see Method 405.1. BOD_5 is not related to the oxygen requirements in chemical combustion.

Capital Costs - Capital costs associated with the purchase, installation, and delivery of a specific technology. Direct capital costs are estimated by the TECI cost model.

Cargo - Any chemical, material, or substance transported in a drum, container, or tank.

Centralized Waste Treatment (CWT) Facility - A facility that recycles, reclaims, or treats any hazardous or nonhazardous industrial wastes received from off site.

Chaining - Within a steel drum cleaning process, the insertion of chains into the drum, along with caustic, and tumbling the drum to remove remaining materials (i.e., heel) from the drum interior.

CFR - Code of Federal Regulations, published by the U.S. Government Printing Office. A codification of the general and permanent rules published in the Federal Register by the Executive departments and agencies of the federal government.

Classical Pollutants - A general term for parameters, including conventional pollutants, that are commonly analyzed by a wet chemistry laboratory. Classical pollutants may also be referred to as classical wet chemistry parameters.

COD - Chemical oxygen demand. A nonconventional, bulk parameter that measures the oxygen-consuming capacity of refractory organic and inorganic matter present in water or wastewater. COD is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test, see Methods 410.1 through 401.4.

Contract Hauling - The removal of any waste stream from the facility by a company authorized to transport and dispose of the waste, excluding discharges to sewers of surface waters.

Conventional Pollutants - The pollutants identified in Sec. 304(a)(4) of the Clean Water Act and the regulations thereunder (i.e., biochemical oxygen demand (BOD_5), total suspended solids (TSS), oil and grease, fecal coliform, and pH).

CWA - Clean Water Act. The Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1251 et seq.), as amended, inter alia, by the Clean Water Act of 1977 (Public Law 95-217) and the Water Quality Act of 1987 (Public Law 100-4).

Direct Discharger - A facility that conveys or may convey untreated or facility-treated process wastewater or nonprocess wastewater directly into surface waters of the United States, such as rivers, lakes, or oceans. (See Surface Waters definition.)

Discharge - The conveyance of wastewater to: (1) United States surface waters such as rivers, lakes, and oceans, or (2) a publicly-owned or centralized treatment works.

Drum - A metal or plastic cylindrical container with either an open-head or a tight-head (also known as bung-type top) used to hold liquid, solid, or gaseous commodities or cargos which are in direct contact with the container interior. Drums typically range in capacity from 30 to 55 gallons.

Drum Reconditioner - Any facility that washes or burns the interiors of used drums and restores the integrity of the drum.

Effluent - Wastewater discharges.

Effluent Limitation - Any restriction, including schedules of compliance, established by a State or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean. (CWA Sections 301(b) and 304(b).)

Emission - Passage of air pollutants into the atmosphere via a gas stream or other means.

EPA - The U.S. Environmental Protection Agency.

Facility - A facility is all contiguous and non-contiguous property within established boundaries owned, operated, leased, or under the control of the same corporation or business entity. The property may be divided by public or private right-of-way.

FR - Federal Register, published by the U.S. Government Printing Office, Washington, D.C. A publication making available to the public regulations and legal notices issued by federal agencies.

Heel - Any material remaining in a drum or container following unloading, delivery, or discharge of the transported cargo. Heels may also be referred to as container residue, residual materials or residuals.

Hexane Extractable Material (HEM) - A method-defined parameter that measures the presence of relatively nonvolatile hydrocarbons, vegetable oils, animal fats, waxes, soaps, greases, and related materials that are extractable in the solvent n-hexane. See Method 1664. HEM is also referred to as oil and grease.

Indirect Discharger - A facility that discharges or may discharge pollutants into a publicly-owned treatment works (POTW).

Industrial Container and Drum Cleaning (ICDC) Facility - Any facility that cleans and reconditions metal and plastic drums and intermediate bulk containers for resale, reuse, or disposal.

Intermediate Bulk Container (IBC or Tote) - A completely enclosed storage vessel used to hold liquid, solid, or gaseous commodities or cargos which are in direct contact with the container interior. Intermediate bulk containers may be loaded onto flat beds for either truck or rail transport, or onto ship decks for water transport. IBCs are portable containers with 450 liters (119 gallons) to 3,000 liters (793 gallons) capacity. IBCs are also commonly referred to as totes.

Intermodal Tank Container - A completely enclosed storage vessel used to hold liquid, solid, or gaseous commodities or cargos which come in direct contact with the tank interior. Intermodal tank containers may be loaded onto flat beds for either truck or rail transport, or onto ship decks for water transport. Containers larger than 3,000 liters capacity are considered intermodal tank containers. Containers smaller than 3,000 liters capacity are considered IBCs.

MP&M - Metal Products & Machinery Effluent Guidelines, new regulation proposed in December 2000 (designated as 40 CFR Part 438).

Nonconventional Pollutant - Pollutants other than those specifically defined as conventional pollutants (identified in Section 304(a)(4) of the Clean Water Act) or priority pollutants (identified in 40 CFR Part 423, Appendix A).

Nondetect Value - A concentration-based measurement reported below the sample-specific detection limit that can reliably be measured by the analytical method for the pollutant.

Off Site - "Off site" means outside the established boundaries of the facility.

Oil and Grease (O&G) - A method-defined parameter that measures the presence of relatively nonvolatile hydrocarbons, vegetable oils, animal fats, waxes, soaps, greases, and related materials that are extractable in either n-hexane (referred to as HEM, see Method 1664) or Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane, see Method 413.1). Data collected by EPA in support of the TECI effluent guideline utilized Method 1664.

On Site - "On site" means within the established boundaries of the facility.

Operating Costs - All costs related to operating and maintaining a treatment system for a period of one year.

Point Source Category - A category of sources of water pollutants.

Pollution Prevention - The use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes. It includes practices that reduce the use of hazardous and nonhazardous materials, energy, water, or other resources, as well as those practices that protect natural resources through conversation or more efficient use. Pollution prevention consists of source reduction, in-process recycle and reuse, and water conservation practices.

POTW - Publicly-owned treatment works, as defined at 40 CFR 403.3(o).

PPA - Pollution Prevention Act. The Pollution Prevention Act of 1990 (42 U.S.C. 13101 et. seq., Pub. Law 101-508), November 5, 1990.

Preflush - Within a drum or container cleaning process, a rinse, typically with hot or cold water, performed at the beginning of the cleaning sequence to remove residual material (i.e., heel) from the drum, container, or tank interior.

Presolve Wash - Use of diesel, kerosene, gasoline, or any other type of fuel or solvent as a drum, container, or tank interior cleaning solution.

Presteam - Within a drum or container cleaning process, use of steam at the beginning of the cleaning process to remove residual material (i.e., heel) from the drum, container, or tank interior.

Pretreatment Standard - A regulation that establishes industrial wastewater effluent quality required for discharge to a POTW. (CWA Section 307(b).)

Priority Pollutants - The pollutants designated by EPA as priority in 40 CFR Part 423, Appendix A.

Process Wastewater - Any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

RCRA - Resource Conservation and Recovery Act (PL 94-580) of 1976, as amended (42 U.S.C. 6901, et. seq.).

SIC - Standard industrial classification. A numerical categorization system used by the U.S. Department of Commerce to catalogue economic activity. SIC codes refer to the products, or group of products, produced or distributed, or to services rendered by an operating establishment. SIC codes are used to group establishments by the economic activities in which they are engaged. SIC codes often denote a facility's primary, secondary, tertiary, etc. economic activities.

Silica Gel Treated Hexane Extractable Material (SGT-HEM) - A method-defined parameter that measures the presence of mineral oils that are extractable in the solvent n-hexane and not adsorbed by silica gel. See Method 1664. SGT-HEM is also referred to as non-polar material.

Source Reduction - Any practice which reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment prior to recycling, treatment, or disposal. Source reduction can include equipment or technology modifications, process or procedure modifications, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.

Surface Waters - Waters including, but not limited to, oceans and all interstate and intrastate lakes, rivers, streams, mudflats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, and natural ponds.

Tank - A generic term used to describe any closed container used to transport commodities or cargos. The commodities or cargos transported come in direct contact with the container interior, which is cleaned by TEC facilities. Examples of containers which are considered tanks include: tank trucks, closed-top hopper trucks, intermodal tank containers, rail tank cars, closed-top hopper rail cars, tank barges, closed-top hopper barges, ocean/sea tankers, and similar tanks. Containers used to transport pre-packaged materials are not considered tanks, nor are 55-gallon drums or pails or intermediate bulk containers.

Tank Truck - A motor-driven vehicle with a completely enclosed storage vessel used to transport liquid, solid or gaseous materials over roads and highways. The storage vessel or tank may be detachable, as with tank trailers, or permanently attached. The commodities or cargos transported come in direct contact with the tank interior. A tank truck may have one or more storage compartments. There are no maximum or minimum vessel or tank volumes. Tank trucks are also commonly referred to as cargo tanks or tankers.

Transportation Equipment Cleaning (TEC) Facility - Any facility that cleans the interiors of tank trucks, closed-top hopper trucks, rail tank cars, closed-top hopper rail cars, intermodal tank containers, tank barges, closed-top hopper barges, ocean/sea tankers, and (excluding drums and intermediate bulk containers).

TSS - Total suspended solids. A measure of the amount of particulate matter that is suspended in a water sample. The measure is obtained by filtering a water sample of known volume. The particulate material retained on the filter is then dried and weighed, see Method 160.2.

U.S.C. - The United States Code.

Zero Discharge Facility - A facility that does not discharge pollutants to waters of the United States or to a POTW. Also included in this definition are discharge or disposal of pollutants by way of evaporation, deep-well injection, off-site transfer to a treatment facility, and land application.

Attachment A

§261.7 Residues of hazardous waste in empty containers.

(a)(1) Any hazardous waste remaining in either (i) an empty container or (ii) an inner liner removed from an empty container, as defined in paragraph (b) of this section, is not subject to regulation under parts 261 through 265, or part 268, 270, or 124 of this chapter or to the notification requirements of section 3010 of RCRA.

(2) Any hazardous waste in either (i) a container that is not empty or (ii) an inner liner removed from a container that is not empty, as defined in paragraph (b) of this section, is subject to regulation under parts 261 through 265 and parts 268, 270, and 124 of this chapter and to the notification requirements of section 3010 of RCRA.

(b)(1) A container or an inner liner removed from a container that has held any hazardous waste, except a waste that is a compressed gas or that is identified as an acute hazardous waste listed in §§261.31, 261.32, or 261.33(e) of this chapter is empty if:

(i) All wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container, *e.g.*, pouring, pumping, aspirating *and*

(ii) No more than 2.5 centimeters (one inch) of residue remain on the bottom of the container or inner liner, *or*

(iii)(a) No more than 3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is less than or equal to 110 gallons in size, or;

(b) No more than 0.3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is greater than 110 gallons in size.

(2) A container that has held a hazardous waste that is a compressed gas is empty when the pressure in the container approaches atmospheric.

(3) A container or an inner liner removed from a container that has held an acute hazardous waste listed in §§261.31, 261.32, 261.33(e) is empty if:

(i) The container or inner liner has been triple rinsed using a solvent capable of removing the commercial chemical product or manufacturing intermediate;

(ii) The container or inner liner has been cleaned by another method that has been shown in the scientific literature, or by tests conducted by the generator, to achieve equivalent removal; or

(iii) In the use of the container, the inner liner that prevented contact of the commercial chemical product or manufacturing chemical intermediate with the container, has been removed.

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