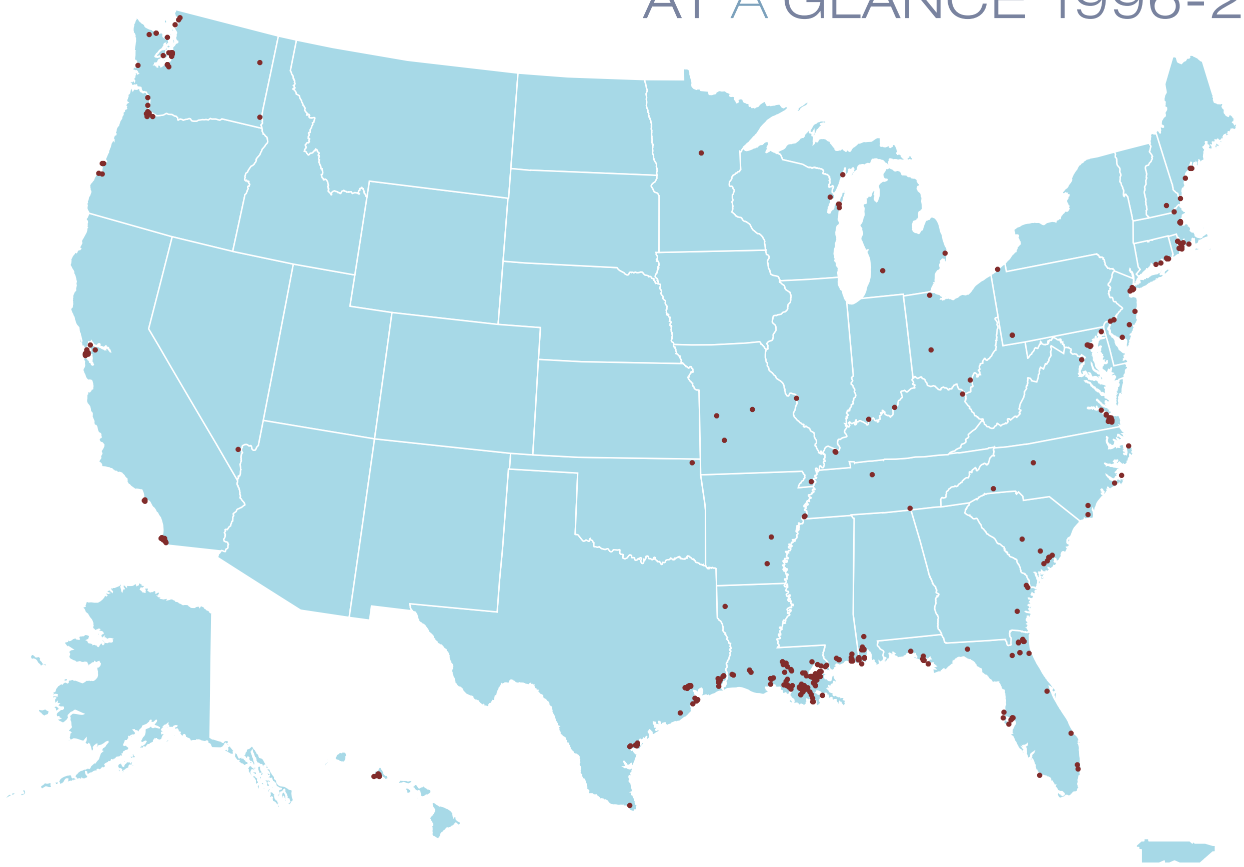
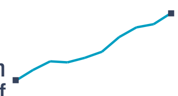
SHIPBUILDING & SHIP REPAIR

AT A GLANCE 1996-2005[1]





Latest Environmental Statistics[2]

Emissions of Criteria Air Pollutants: 5,900 tons

Releases of Chemicals Reported to TRI: 2 million lbs.

Air Emissions: 1.8 million lbs.

Water Discharges: 19,000 lbs.

Waste Disposals: 226,000 lbs.

Recycling, Energy Recovery, or Treatment: 5.1 million lbs.

Hazardous Waste Generated: 7,000 tons

Hazardous Waste Managed: 6,000 tons

The data discussed in this report are drawn from multiple public and private sources. See the Data Guide *and the* Data Sources, Methodologies, and Considerations *chapter for important information and qualifications about how data are generated, synthesized, and presented.*

Profile

Facilities in the Shipbuilding & Ship Repair sector build, repair, or alter ships, barges, and other large vessels for military and commercial clients. Most facilities that build ships can also repair them, but some smaller shipyards only perform ship repair work.

Shipyards typically include drydocks, shipbuilding positions, berthing positions, piers, workshops, and warehouses.

Most domestic shipbuilders make and repair ships for the U.S. Navy, U.S. Coast Guard, and other government agencies. The sector has less than a 1% share of the world's market for commercial vessels of more than 100 gross tons.[3]

Energy Use

According to the U.S. Department of Energy (DOE), energy use for the transportation equipment manufacturing sector, which includes shipbuilding activities as well as motor vehicle manufacturing, totaled 424 trillion Btu in 2002. There are not sufficient data to determine the proportion of energy used by the Shipbuilding & Ship Repair sector alone.[4]

Shipbuilding and ship repair processes that use the most energy are welding (most often electric arc welding), forging, abrasive blasting, and application of marine coatings. Electricity purchases represented 75% to 80% of the sector's expenditures for energy in 2004.[5] The sector's remaining energy expenditures were for fossil fuels such as natural gas, coal, and petroleum. Between 1998 and 2004, shipbuilders use of electricity per dollar value of shipments (VOS) fell 10%.[6]

There are opportunities for shipbuilders to reduce one energy source in favor of another with fewer emissions or greater efficiency. One option is for facilities to replace equipment that consumes fossil fuels with electric-powered equipment. For example, in the forging process, facilities can replace gas-fired heating with electric induction heating, which has lower operational costs and requires less energy. The environmental benefits of switching equipment to electric power will depend in part on the fuels used by the electricity provider.

Air Emissions

Air emissions in the sector include criteria air pollutants (CAPs), greenhouse gases (GHGs), and a number of chemicals reported to EPA's Toxics Release Inventory (TRI). In general, the "toxic chemicals" tracked by TRI are found in the raw materials and fuels used, and can also be generated by their use. Major sources of air emissions for this sector are welding, abrasive blasting, and application

Biodiesel Use

In 2006, Atlantic Marine Alabama, LLC, a shipbuilder headquartered in Mobile, AL, measured the performance of two forklifts powered by a biodiesel blend (B20) against the performance of two forklifts fueled with regular diesel. During the four-month trial, the biodiesel-powered forklifts used nearly 9% less fuel per hour with no difference in performance or the visibility of emissions between the two sets of forklifts. In addition, over the course of the trial, the B20 cost an average of 50 cents less per gallon than standard diesel. Based on these results, Atlantic Marine plans to convert all of its diesel-powered yard equipment to B20 within the next five years.[7]

of marine coatings. CAPs and GHGs are also generated as combustion byproducts from onsite combustion of fuels.

Air Emissions Reported to TRI

In 2005, 54 facilities reported 1.8 million absolute lbs. of air emissions of TRI chemicals, as shown in Figure 1a. TRI-reported air emissions decreased by 44% in absolute pounds from 1996 to 2005. When normalized by the sector's increasing VOS, air emissions decreased 54% from 1996 to 2005.[8]

To consider toxicity of air emissions, EPA's Risk-Screening Environmental Indicators (RSEI) model assigns every TRI chemical a relative toxicity weight, then multiplies the pounds of media-specific releases (e.g., pounds of mercury released to air) by a chemical-specific toxicity weight to calculate a relative Toxicity Score. RSEI methodological considerations are discussed in greater detail in the Data Guide, which explains the underlying assumptions and important limitations of RSEI.

Data are not reported to TRI in sufficient detail to distinguish which forms of certain chemicals within a chemical category are being emitted. For chemical categories such as chromium, the toxicity model conservatively assumes that chemicals are emitted in the form with the highest toxicity weight (e.g., hexavalent chromium); thus, Toxicity Scores are overestimated for some chemical categories.

Summing the Toxicity Scores for all of the air emissions reported to TRI by the sector produces the trend illustrated in Figure 1c. When normalized by the sector's VOS, the sector's Toxicity Scores fluctuated between 1996 and 2005, declining overall by 34%. Fluctuations in the Toxicity Scores were driven by changes in the quantities of manganese and chromium emitted to air over the years, as discussed below.

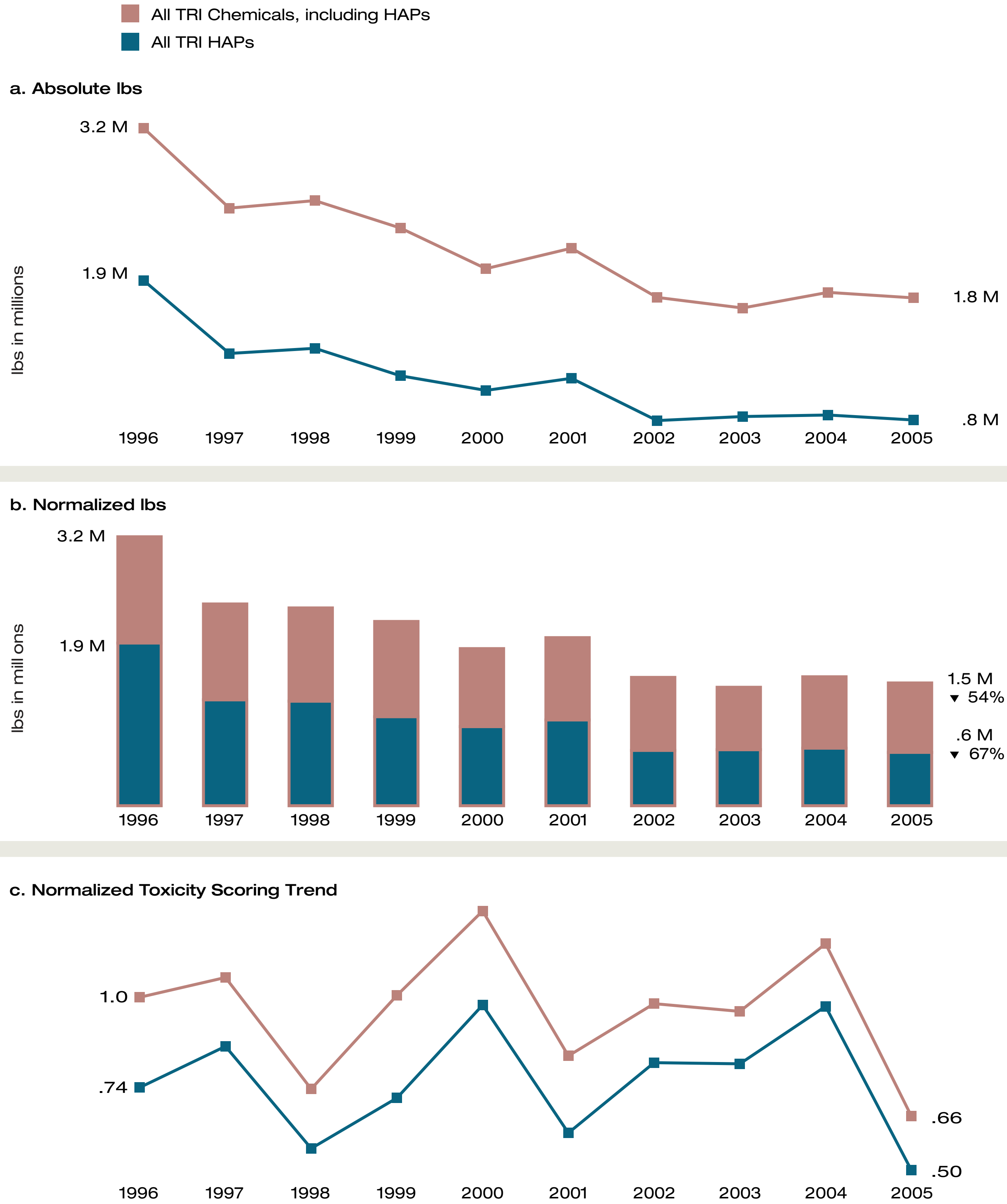
The TRI list of toxic chemicals includes all but six of the hazardous air pollutants (HAPs) regulated under the Clean Air Act. In 2005, 47 Shipbuilding & Ship Repair facilities reported about 800,000 lbs. of HAPs emitted to air, representing 43% of the total pounds of air emissions that the sector reported to TRI for 2005, and 76% of the Toxicity Score.

As with overall TRI air emissions, manganese and chromium, both classified as HAPs, drove the sector's Toxicity Scores for HAPs.[9] Welding activities and the use of certain abrasives such as coal and smelter slags can result in air emissions of these metals. In addition, in 1999 and 2000, a major source of chromium air emissions from repair shipyards was related to a primer called Ameron 385. The U.S. Navy required the use of this primer on Military Sealift Command ships. In 2001, the primer was reformulated to remove chromium, resulting in a significant drop in the quantity of chromium emitted by the sector.[10]

Table 1 presents the top TRI-reported chemicals emitted to air by the Shipbuilding & Ship Repair sector based on three indicators. Each indicator provides data that environmental

FIGURE 1

Air Emissions Reported to TRI 1996–2005



Note:
Normalized by annual value of shipments.

Sources: U.S. Environmental Protection Agency, U.S. Department of Commerce

TABLE 1

Top TRI Air Emissions 2005

Chemical	Absolute Pounds Reported[1]	Percentage of Toxicity Score	Number of Facilities Reporting[2]
1,2,4-Trimethylbenzene	185,100[3]	9%	8
Chromium	1,397	19%[4]	17
Ethyl Benzene[5]	91,900	<1%	7
Manganese	8,077	45%	19
N-Butyl Alcohol	606,700	<1%	21
Nickel	1,798	10%	17
Propylene	106,900	<1%	11
Sulfuric Acid	30,400	8%	1
Xylene	529,700	1%	28
Percentage of Sector Total	87%[6]	92%[7]	91%[8]

Notes:
1. Total sector air releases: 1.8 m llion lbs.
2. 54 total TRI reporters in the sector.
3. Red indicates that the chemical is one of the top five chemicals reported in the given category.
4. Calculation of Toxicity Score for chromium conservatively assumed that all chromium emissions were hexavalent chromium, the most toxic form, with significantly higher toxicity weights than trivalent chromium. However, hexavalent chromium may not constitute a majority of the sector's chromium releases. Thus, RSEI analyses may overestimate the relative harmfulness of chromium emissions.
5. *Italics* indicate a hazardous air pollutant under section 112 of Clean Air Act.
6. Chemicals in this list represent 87% of the sector's air emissions.
7. Chemicals in this list represent 92% of the sector's Toxicity Score.
8. 91% of facilities reported emitting one or more chemicals in this list.

Source: U.S. Environmental Protection Agency

managers, trade associations, or government agencies might use in considering sector-based environmental management strategies.

1) Absolute Pounds Reported. N-butyl alcohol and xylene were the highest-ranking chemicals based on the pounds of each chemical emitted to air in 2005.
2) Percentage of Toxicity Score. The top chemicals based on Toxicity Scores were dominated by metals, as described above.[11]
3) Number of Facilities Reporting. Xylene and n-butyl alcohol were also the most frequently reported chemicals, with most of the TRI-filers in the sector reporting air emissions of at least one of these chemicals.

Criteria Air Pollutants

Table 2 shows CAP and volatile organic compound (VOC) emissions for 81 facilities in the sector in 2002.[12]

To prepare vessel surfaces for coatings, shipyards typically apply a dry abrasive material at high velocity. This blasting process, which is usually performed outside due to the size of the ships, generates particulate matter (PM) emissions from both the break-up of the abrasive material and the removal of the existing coatings. Common blasting abrasives include coal slag, copper slag, garnet, and other metallic grit and shot.[13] To reduce PM emissions, shipyards shrink-wrap vessels or use shrouds to reduce wind speed in the blasting area. In addition, some shipyards use alternative technology such as ultra-high pressure water blasting to reduce PM emissions.

TABLE 2

Criteria Air Pollutant and VOC Emissions 2002

	Tons
SO_2	1,000
NO_X	900
PM_{10}	800
$PM_{2.5}$	400
CO	200
VOCs	3,000

Note:
PM_{10} includes $PM_{2.5}$ emissions.

Source: U.S. Environmental Protection Agency

The coatings applied to a vessel's surface typically contain VOCs that are emitted to the environment during application. To reduce VOC emissions, shipyards have been working with coatings manufacturers to reformulate coatings to reduce the content of VOCs and other air toxics. In addition, shipyards are using new application technologies that reduce overspray and waste, resulting in less paint used overall.

Greenhouse Gases

Shipbuilding & Ship Repair GHG emissions are primarily attributable to fossil fuel combustion for non-road equipment. Other likely GHG sources include refrigerants, welding gases, thermal oxidizers to destroy VOCs, and CO_2-based fire extinguishers. However, there are currently no data available on the quantity of such emissions. The generation of electricity purchased by sector facilities also emits GHGs.

To reduce their GHG footprint, facilities in the sector could improve on-site energy efficiency and could purchase electricity produced without combustion of fossil fuels. The American Shipbuilding Association and the Shipbuilders Council of America are working with EPA to develop a tool to measure GHG emissions, which should provide better data on the sector's GHG emissions in the future.

Water Use and Discharges

Shipbuilding & Ship Repair firms typically obtain water from public water systems, and sometimes pull water directly out of the rivers for non-contact cooling. There are currently no aggregate data available on the quantity of the sector's water use.

In 2005, 16 facilities reported water discharges of about 19,000 lbs. of TRI chemicals. When normalized by VOS, water discharges declined by 30% from 1996 to 2005.[14] The sector discharges water to Publicly Owned Treatment Works and, in some cases, directly to water bodies. Stormwater run-off is also an important issue for the sector.

Proper management of stormwater is a concern for the sector because shipyards are adjacent to major water bodies and include outdoor operations where materials and equipment can be exposed to precipitation. Chemicals discharged in stormwater primarily consist of blasting and painting materials. Of particular interest are discharges of copper, zinc, and lead from anti-foulant coatings, which retard the growth of aquatic organisms.

Best Management Practices (BMPs) for Cleaning Drydocks

Drydocks, which are typical features of shipyards, are work areas that can be flooded to allow a vessel to enter or leave. The industrial activities that take place on drydocks (e.g., abrasive blasting, painting) can generate significant concentrations of pollutants such as heavy metals, oil and paint residues, spent abrasive, and other debris. Thorough cleaning of the drydock prior to its submergence ensures that these pollutants are not discharged to receiving waters.

BAE Systems San Diego, CA, has implemented BMPs to ensure that its dry docks are clean before they are submerged, thus preventing particles generated during ship construction and maintenance from being discharged into nearby waters.

Before clean-up activities begin, the company inspects the drydock and determines clean-up details, such as number and size of hoses for washing, number of pumps to collect washwater, and number and capacity of tanks to hold washwater. Some notable practices utilized by BAE Systems during drydock cleaning include:

- Ensuring proper trim of the drydock,
- Installing splash boards to prevent washwater from spilling into the bay when washing near the edge of the dock,
- Monitoring the trough and sump to prevent overflows,
- Ensuring sufficient holding capacity for washwater (including planning for rain),
- Thoroughly inspecting the drydock after cleaning and before submergence, and
- Documenting all of the above actions.[15]

Shipyards' stormwater runoff is typically regulated under a multi-sector general industrial stormwater permit. However, some states require facilities to have individual National Pollutant Discharge Elimination System permits for stormwater and to meet discharge limits. Permit requirements vary from state to state and can range from requiring a stormwater management plan, to using BMPs, to requiring zero discharges.

Waste Generation and Management

Wastes in the sector can be generated from process-related functions or from other activities such as operation of pollution control devices or remediation of past contamination. Spent abrasives and oil or oily water are typically the largest volumes of waste generated in shipyards.

Hazardous Waste Management

In 2005, 96 facilities in the sector reported to EPA's *National Biennial RCRA Hazardous Waste Report* (BR) generating about 7,000 tons of hazardous waste. Waste paint and spent solvents, although produced less than spent abrasive and oily waste, generally constitute the sector's largest hazardous waste stream. In 2005, painting and coating processes accounted for 42% of the total hazardous waste generated (about 3,000 tons).[16]

Improvements in process management of coating application and equipment cleaning have resulted in reductions in the amount of painting and coating waste. For instance, in-line plural component mixers prepare coatings as they are required. This prevents the generation of paint waste from mixing more paint than is required to complete a job. Additionally, paint waste is now used in fuel blending, whereas previously it would have been solidified for land disposal. Shipyards are also reclaiming and reusing solvents used to clean spray paint equipment.

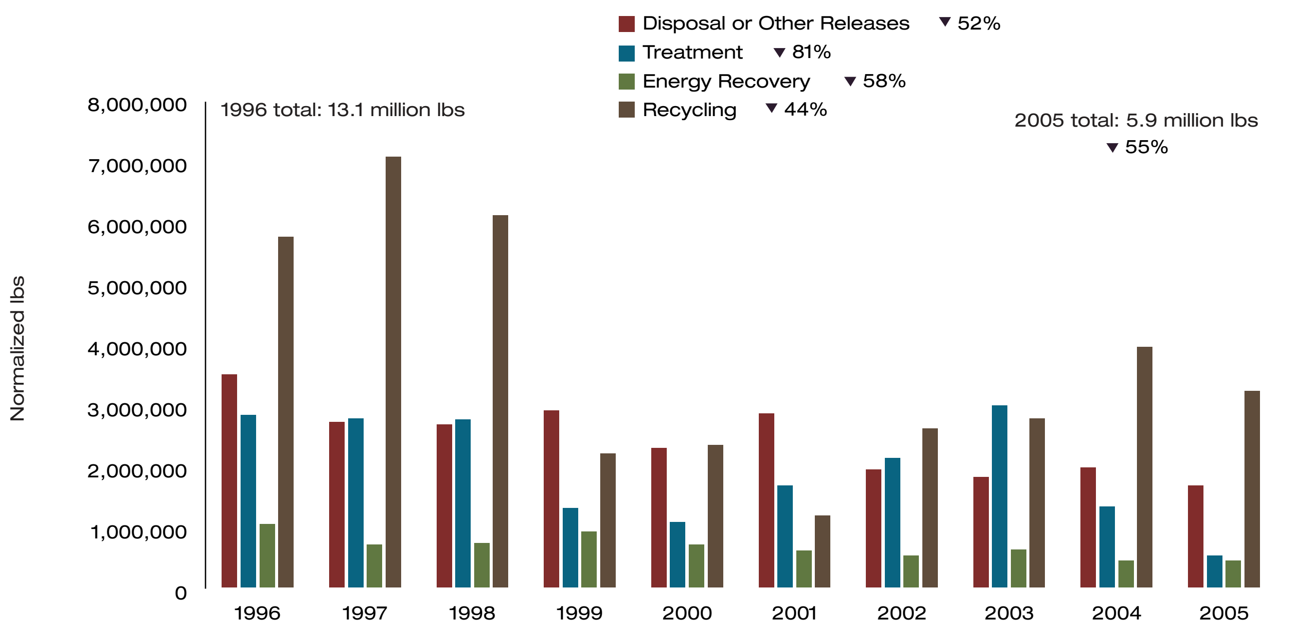
The sector managed its hazardous waste in 2005 through disposal, treatment, and reclamation and recovery, in roughly equal proportions. The sector reported managing 6,000 tons of hazardous waste. The primary method of reclamation and recovery used by the sector was fuel blending.

Waste Management Reported to TRI

In 2005, the sector managed 7.2 million absolute lbs. of TRI-reported chemicals. When normalized by VOS, this was 55% less than in 1996. Figure 2 shows the trends in waste management by the sector. In 2005, 29% of the TRI-reported waste was disposed to land or released, 9%

FIGURE 2

TRI Waste Management 1996–2005



Notes:
1. Normalized by annual value of shipments.
2. Disposal or other releases include air releases, water discharges, and land disposals.

Sources: U.S. Environmental Protection Agency, U.S. Department of Commerce was treated, 8% was used for energy recovery, and 55% was recycled. Of the waste disposed or released, 11% was disposed. As shown in Table 3, copper and zinc accounted more than half of the total disposals in 2005; copper and nickel were the most frequently reported chemicals for this sector during the same year.[17]

The quantity of waste that shipyards disposed, as reported to TRI, decreased from about 251,000 lbs. in 1996 to about 226,000 lbs. in 2005. The chemicals were disposed to land or transferred to offsite locations for disposal.

TABLE 3

Top TRI Disposals 2005

Chemical	Absolute Pounds Reported[1]	Number of Facilities Reporting[2]
Chromium	12,900[3]	13
Copper	69,100	14
Lead	8,900	9
Manganese	7,300	9
Nickel	10,400	14
Phenol	21,000	1
Xylene	13,600	3
Zinc	46,100	7
Percentage of Sector Total	84%[4]	54%[5]

Notes:
1. Total sector disposals.: 226,000 lbs.
2. 54 total TRI reporters in the sector.
3. Red indicates that the chemical is one of the top five chemicals reported in the given category.
4. Chemicals in this list represent 84% of the sector's disposals.
5. 54% of facilities reported disposals of one or more chemicals in this list.

Source: U.S. Environmental Protection Agency