

TIN

By James F. Carlin, Jr.

Domestic survey data and tables were prepared by Elsie D. Isaac, statistical assistant, and the world production tables were prepared by Linder Roberts, international data coordinator.

Tin has not been mined in the United States since 1993; consequently, the country is mostly reliant on imports and recycling for its tin requirements. Twenty-five firms consumed 91% of the reported primary tin used domestically in 2002. The major uses were as follows: electrical solders, 24%; metal containers, 21%; transportation, 14%; construction, 11%; and others, 30%. The estimated value of primary tin metal consumed domestically was about \$146 million. Industry stocks declined moderately (table 1).

Approximately 10,000 metric tons (t) of tin, about two-thirds from old scrap and one-third from new scrap, was recycled (table 5). About one-seventh of the tin consumed in the United States was recycled metal produced at 3 detinning plants and 73 secondary nonferrous metal processing plants. Interest remained strong in the recycling of used tin cans, partly because of rising disposal fees and limited space at landfills. The recycling rate for steel cans was 59%, compared with 56% in 1995 and 15% in 1988 (Steel Recycling Institute, 2002).

The Defense Logistics Agency (DLA), which manages the National Defense Stockpile (NDS), sold 8,956 t of pig tin from the stockpile during 2002.

World primary tin mine output declined by 19% because producers adjusted output in view of lower tin prices (tables 1, 9). Industry observers believed that the world tin market was changing from equilibrium between supply and demand to a small supply deficit status. World primary tin smelter production declined by 5%, and the composite tin price declined by 7%. Of the 22 countries in which tin was mined, the top 6 accounted for 94% of the world total of 249,000 t. China was the largest producer (32% of world output) and was followed by Peru (26%), Indonesia (22%), Bolivia (6%), Brazil (5%), and Australia (3%). World tin reserves were estimated to be 8 million metric tons (Mt). Assuming that world primary tin consumption will be about 200,000 metric tons per year (t/yr), these reserves would last 38 years. Most tin reserves are in Asia and South America.

Legislation and Government Programs

In 2002, DLA sold 8,956 t of pig tin to two companies. Both sales were long-term contracts allowing for deliveries of the tin during a 1-year period. There were no spot market sales of tin. The effect of proposed NDS sales on domestic markets is assessed by several Federal agencies, including the U.S. Geological Survey (USGS).

The DLA Annual Materials Plan for tin calls for up to 12,000 t/yr of tin to be sold from the stockpile. However, the DLA changed its tin sales procedure during fiscal year 2002. Although the DLA continued to have long-term (negotiated) sales, other sales were to be conducted through a basic ordering

agreement (BOA) process; the DLA posts the amount of tin that it wants to sell on its Web site every Tuesday. Interested companies submit a quote by the following Wednesday, and the DLA makes a sales determination by the end of the day. BOA sales began in June 2002.

The NDS tin is stored at four government sites, with the largest inventories at Hammond, IN, and Point Pleasant, WV. The other sites are in Baton Rouge, LA, and New Haven, IN. As of December 31, 2002, the tin inventory was 44,262 t.

Production

Mine.—Tin was not produced at any U.S. mine in 2002. Until 1993, a few small tin mines had operated sporadically in the United States. However, USGS canvasses confirm that there has been no domestic tin production since that year.

Secondary.—Industry observers believe that the United States is the world's largest producer of secondary tin. Most secondary tin has been produced in the United States from various scrapped alloys of tin and recycled in those same alloy industries. Secondary tin from recycled fabricated parts has been used in many kinds of products and is a particularly important source of tin for the manufacture of solder and brass/bronze.

The Steel Recycling Institute (SRI), funded by the domestic steel industry, continues to promote the collection, preparation, and transportation of steel can scrap. The domestic recycling rate for steel cans, most of which are made from tinsplate, was 59% in 2002.

Consumption

In 2002, domestic consumption of primary tin declined slightly. Domestic consumption data for tin were developed by the USGS from a voluntary survey of tin consumers. Of the 145 firms to which a survey form was sent, 111 responded—including the major consumers.

The total number of metal cans shipped in 2002 reached 136 billion, just slightly above that during 2001. The Can Manufacturers Institute (2002) no longer provides a categorization by types of can (for example, aluminum versus steel). Steel (essentially tinsplate and tin-free steel) dominated in the food, pet, and the "general line" can markets, and aluminum held 100% of the beverage can market.

About 3% of U.S. steel shipments is tin mill products; a total of seven tin mills are capable of producing 4.3 million metric tons per year (Mt/yr) of tinsplate and tin-free steel products. The largest producers are U.S. Steel Corp. (40% of the market), National Steel Corp. (22%), and Weirton Steel Corp. (21%) (Container Recycling Report, 2002b).

In recent years, many steel producers have declared bankruptcy but have kept operating. Among these are two tinplate producers—Bethlehem Steel Corp. (Bethlehem, PA) and National Steel Corp. (Mishawaka, IN). Toward yearend 2002, events involving these two producers offered some hope for their survival in some form.

International Steel Group Inc. (ISG) (Cleveland, OH) offered about \$1.5 billion to buy Bethlehem Steel, creating the largest integrated steel producer in the United States. The offer came on the final day of a 60-day period in which ISG had exclusive negotiating rights to buy Bethlehem Steel. It remained, at yearend, subject to the approval of the U.S. Bankruptcy Court as well as the approval of Bethlehem Steel's shareholders. Bethlehem Steel filed for Chapter 11 bankruptcy protection on October 15, 2001. If ISG is successful in acquiring Bethlehem Steel, then it is likely to reconstruct the company in a manner similar to the reformation of the former LTV Steel Corp. that it acquired earlier. Bethlehem's tin mill is at Sparrows Point, MD (American Metal Market, 2002b).

The largest domestic integrated steel producer, U.S. Steel, announced that it planned to acquire bankrupt National Steel for about \$950 million. If the acquisition succeeds, U.S. Steel (which is also a major producer in central Europe with its U.S. Steel-Kosice operations in Slovakia) would emerge as the fifth largest steelmaker in the world. The purchase requires U.S. Steel to assume about \$200 million of National Steel's liabilities. U.S. Steel's raw steelmaking capability is about 18 Mt/yr, and National Steel's is about 7 Mt/yr. U.S. Steel has tin mills at its Gary, IN, and East Chicago, IN, plants. National Steel has a tin mill at its Portage, IN, plant (Platts Metals Week, 2002i).

Ball Corporation (Broomfield, CO) announced details of its agreement to acquire Schmalbach-Lubeca AG, the second largest beverage can manufacturer in Europe. Combined, the two companies produce more than 45 billion beverage cans per year in North America and Europe. Both are major users of tinplate for cans. Ball will be acquiring the Ratingen, Germany-based company for about \$885 million in cash and the assumption of about \$16 million of net debt. The transaction was expected to close in early 2003. Schmalbach-Lubeca operates 12 manufacturing plants—four each in Germany and Britain, two in France and one each in the Netherlands and Poland. The addition of Schmalbach-Lubeca should position Ball as a solid second in the European can market, along with its number one position in the larger North American market. The European beverage can market produced about 38 billion units in 2001, and Schmalbach has about 31% of installed beverage can manufacturing capacity in Europe (Ball Corporation, 2002).

Kester Solder Co. (Des Plaines, IL) announced the permanent closure of its Anaheim, CA, tin alloy solder plant. The closure was caused by a slowdown in the economy, especially in the electronics industry. Solder production will continue at two of Kester's other North American facilities. Kester is a unit of Northrup Grumman's Component Technologies Division (Platts Metals Week, 2002b).

Prices

The Platts Metals Week average composite price for tin metal declined by 7% in 2002. The Platts Metals Week average

composite tin price was \$2.81 per pound in January, reached a peak of \$3.09 per pound in July, and finished the year at \$3.02 per pound. Along with most other base metals, the price of tin declined on the world's metal exchanges as a consequence of a global economic slowdown in the manufacturing sector.

The London Metal Exchange (LME) remained the primary trading arena for tin. Tin is one of only six metals traded on the LME. The other metals are aluminum, copper, lead, nickel, and zinc.

Trade

U.S. imports of refined tin, which supplied most domestic tin requirements, increased by 13%. Imports of tin in all forms (metal, ore and concentrate, scrap, and waste) remained duty free (tables 7, 8). Most of the tin metal imported from a variety of countries was held in U.S. warehouses by trading firms until sold to customers. Foreign-owned trading firms tended to dominate the marketing of imports. U.S. imports of refined tin came mostly from Peru, China, Bolivia, Brazil, and Indonesia, in descending order. Tin exports were small compared with imports (table 6).

On March 5, 2002, the United States imposed 30% tariffs on a variety of steel products including tin mill products, as part of a 3-year program of import restrictions on most steel imports that the U.S. International Trade Commission determined were a substantial cause of serious financial harm to the domestic steel industry. Exempt from the ruling were North American Free Trade Agreement (NAFTA) partners Canada and Mexico as well as developing countries in the World Trade Organization whose exports have been less than 3% of total American imports (including Argentina, Thailand, and Turkey). The 30% tariffs will decrease by 6% per year (Metal Bulletin, 2002a).

World Review

There were an unusually large number of events concerning tinplate in Europe in 2002. Europe remains the world's largest tin consumer market, and the tin can has a far greater share of the metal beverage container sector in Europe than it does in the United States. The Association of European Producers of Steel for Packaging (APEAL) is the leading proponent of expanding the steel container market in Europe. Based in Brussels, Belgium, APEAL is active in marketing, communications, and coordination of legislative and environmental issues. APEAL's membership comprises Europe's four major producers of steel for packaging—Aceralia Sidstahl Ibérica SA (Spain), Anglo-Dutch CORUS Packaging Plus (United Kingdom and Netherlands), Rasselstein Hoesch GmbH (Germany), and Usinor Packaging (France). These four companies account for 90% of Western European steel production for packaging, representing output of about 5 Mt/yr. Among its recent research activities, APEAL conducted a survey in six European countries to establish consumer attitudes and perceptions regarding different packaging concepts for beverages.

Data compiled by APEAL indicate that about 55% of steel packaging (mostly tinplate) in the European Union (EU) was recycled in 2001, with national results ranging from 25% to 88%. Steel packaging has greatly exceeded the recycling targets

of the EU directive on packaging and packaging waste. The directive stipulated that each packaging material needed to achieve a minimum recycling rate of 15% by June 30, 2001, and that recycling of all packaging materials was to be between 25% and 45%. Belgium (88%), Luxembourg and Germany (78%), the Netherlands and Austria (77%), Sweden (71%), and Switzerland (70%) remained the leading countries for steel packaging recovery. Norway, Denmark, and France each achieved about 55%, followed by the United Kingdom (37%), Portugal (28%), and Finland (25%). In 2001, 1.9 Mt of steel packaging was recycled in Europe—15% more than in 2000 and a threefold increase beyond 1990 levels. On an international level, Japan (85%) and Northern Europe (with seven countries exceeding 70%) are the recycling leaders, followed by South Africa (64%), the United States (58%), Korea (53%), Australia (42%), and Brazil (40%) (APEAL News, 2002).

The EU environmental ministers agreed to a directive calling for a sizeable increase in the recycling of packaging, including tinplated cans, by the end of 2003. The directive states that EU member countries must recover between 55% and 80% of all packaging wastes. The measure received wide support, although Belgium and the Netherlands wanted higher recycling targets and a quicker implementation plan. Varying pan-European targets were approved—15% for wood, 23% for plastics, 50% for metal (including tinplate), and 60% for paperboard and glass (Container Recycling Report, 2002a).

In Europe, the euro was officially introduced January 1, 2002, and has become legal tender in 12 of the 15 EU countries. The material for the 10-, 20-, and 50-cent pieces is “Nordic Gold,” a copper-aluminum-zinc-tin alloy that allegedly is difficult to counterfeit (Advanced Materials and Processes, 2002).

Argentina.—Silver Standard Resources, Inc. (Vancouver, British Columbia, Canada) announced that it agreed to acquire a 43% stake in the Pirquitas silver project in Argentina from Stonehill Capital Management. Pirquitas was estimated to contain 30 Mt of proven and probable reserves at a grade of 128 grams per ton silver, 0.17% tin, and 0.81% zinc. The property has all relevant permits necessary to commence production. Studies indicated a capital cost of \$133 million and a construction time of 24 months for an operation that will produce 11 million ounces per year of silver, 3,200 t/yr of tin, and 16,000 t/yr of zinc during a 9-year mine life (Mining Journal, 2002b).

Australia.—Early in 2002, Murchison United NL announced that it was considering the sale of its Renison Bell tin mine on the island of Tasmania. Officials reported that a sale was under consideration because Murchison wished to focus on its newly acquired copper-tin operation in Portugal. Murchison stated that Renison Bell would produce about 9,000 t of tin in concentrate during 2002, which amounts to most of Australia’s tin production. Murchison executives observed that they had instituted numerous cost-saving projects at Renison Bell in recent years but decided that it would be difficult to further reduce expenses (American Metal Market, 2002a; Metal Bulletin, 2002d).

Marlborough Resources Ltd. announced that it would expand its Ardlethan tin project in New South Wales to nearly 700 t/yr, or 140% of the original design capacity. The expansion was expected to be completed by yearend, when tin production

would begin to increase from the existing output of 500 t/yr. Further incremental expansions are planned with an aim to eventually double production. The capital cost of the new expansion is about \$530,000 compared with Ardlethan’s original acquisition cost of \$2.5 million. Ardlethan is operating at a cash cost of about \$3,000 per metric ton, but the additional output would help the mine become one of the lowest cost tin producers in the world. Currently, the entire mine’s tin concentrate is exported to Malaysia Smelting Corp. under a 2-year contract (Platts Metals Week, 2002d).

Amcor plc has emerged in recent years as a major player in world container markets. Recently, the company completed a \$1.6 billion purchase of Schmalbach-Lubeca’s polyethylene terephthalate (PET) and closures businesses, an entity almost one-half as large as Amcor itself. A few years ago, Melbourne, Australia-based Amcor was almost unknown beyond Australia and New Zealand, where it controls 60% of the packaging market. Although PET sales compose Amcor’s major activity, it also commands 3% of the world market for metal (usually tinplate) and plastic closures. Currently, Amcor is ranked as the world’s ninth largest packaging firm (Canning and Filling, 2002).

Bolivia.—For much of 2002, the world tin industry was roiled by events surrounding the collapse and forced liquidation of RGB Resources Plc (United Kingdom). Legal maneuvers taking place in Bolivia, the United Kingdom, and the United States continued for most of the year. The court-ordered compulsory liquidation of RGB led to the acquisition of RGB’s Vinto (Bolivia) tin smelter by Cia. Minera del Colquiri (CMC), a joint venture between Compañía Minera del Sur (COMSUR) and the UK-based Commonwealth Development Corporation (CDG Capital Partners). Vinto draws 40% of its tin concentrate feed from Huanuni, the tin mine formerly operated by RBG, but now controlled by Corporación Minera de Bolivia, the Bolivian mining organization (Tin International, 2003a).

China.—From 1993 until 2000, Chinese tin production increased at a rate of about 13% per year. In 2000, total output reached 99,000 t/yr. However, since late 2000, the Chinese tin industry has been affected by weak world tin prices. In recent years, the oversupply of tin in the Chinese market was attributed to a large number of poorly regulated smaller mines and smelters. Stricter laws regulating mineral mining and smelting have now been instituted. Illegal mines and smelters have been closed. In 2001, China exported 46,000 t of refined tin, about 27% less than in 2000. It was reported that the Chinese Ministry of Foreign Economy and Trade would only allow 40,000 t of tin metal to be exported in 2002. China also may now have surpassed the United States as the world’s largest tin user (Metal Bulletin, 2002b).

The Ministry of Foreign Trade and Economic Cooperation announced cuts in the tin export quotas for 2003. The published quotas for 2003 were 65,000 t, about 20,000 t less than in 2002. Industry observers expected China’s 2002 total tin exports to reach about 40,000 t, only one-half the quota issued for 2002. The move was generally praised as being critical to reducing world tin supply and increasing the tin price (Platts Metals Week, 2002h).

Yunnan Tin Corp. (YTC) developed a strategy of acquiring smaller mines and smelters in China. YTC does not want an oversupply of tin, so the acquisition strategy allows the

company to limit excess output. The first attempt by YTC to make such an acquisition began in 2001 and started to come to fruition in 2002. Through a \$2.4 million investment, YTC took a majority ownership of a joint venture with private interests at the Chenzhou Mineral Resource Investment Co. in Southern Hunan Province. The 3,000-t/yr Chenzhou smelter was expected to begin operating by yearend 2002 after extensive repair work, although YTC only expected to produce between 1,000 and 2,000 t/yr of tin metal there. Through the Chenzhou venture, YTC also acquired six major mines in Hunan Province. YTC restarted its tin smelter in late November, after a 2-month closure that cost the company at least 3,000 t of tin output. YTC plans to finely tune its tin production to LME prices and stocks (Metal Bulletin, 2002b).

Liuzhou China Tin Group has become China's second largest tin producer. It is involved in mineral exploration, mining, dressing, smelting, and marketing of nonferrous metals including antimony, cadmium, indium, lead, silver, tin, and zinc. Liuzhou's capacity for tin has reached 25,000 t/yr. In 2001, tin ingot production was 10,600 t. During the next 5 years, output may reach 35,000 t/yr (Metal Bulletin, 2002b).

Reports indicate that rich tin resources have been discovered in Qitianling, in the southern part of Hunan Province. Demonstrated tin reserves, which lie in the middle of the Nan Ling Mountain range, stand at 500,000 t of tin, while inferred tin reserves are estimated to be 700,000 t. Also, a new tin prospect has been discovered in Jiangxi Province. Reserves there are estimated to be 214,000 t, and resources are thought to be 400,000 t (Tin International, 2003b).

Germany.—A new beverage container deposit program was scheduled to start in Germany in 2003. An effort to stop the redemption program was rejected by the country's Federal Constitutional Court. Under the program, consumers are to pay a 25-cent deposit on a small container and a 50-cent deposit on containers larger than 1.5 liters (Container Recycling Report, 2002a).

Indonesia.—The world's largest tin mining organization, PT Timah, planned to cut costs by merging subsidiaries that duplicate functions. The new organizational structure, which will cost \$20 million to achieve, calls for removal of non-tin mining units and the streamlining of Timah's investment unit (Platts Metals Week, 2002g). Reportedly, Timah is on the verge of bankruptcy owing in large part to Government liberalization policies in industry that inadvertently boosted illegal mining. In an effort to avoid bankruptcy, Timah has drawn up a plan to lay off 3,800 of the firm's 5,000 employees, return most of its land-based mining territory to the Government, and sell unproductive assets or those that have no direct relation to tin production. Also, Timah halted operations at most of its dredges, which had contributed roughly one-half of its total tin production.

The Indonesian Government has vowed to combat illegal miners. However, government officials admit it will be difficult to eliminate the estimated 130,000 illegal operations because about 13% of the one million citizens of Babel Province rely on illegal mining for their income. Complaints about illegal tin mining in the country have also been voiced internationally. In a special meeting in London, United Kingdom, during October 2001, four of the world's largest tin mining companies—Tambang Timah of Indonesia, Minsur SA of Peru, Hunan Tin

Corp. of China, and Murchison NL of Australia—together with the subsidiary of Australia's Iluka Resources Ltd. PT Koba Tin (Indonesia) issued a joint statement expressing concern about illegal mining in Indonesia. Illegally mined tin ore has led to a significant drop in tin prices, causing these firms to incur large losses.

Significant government liberalization of the Indonesian tin industry was implemented in 1999. Liberalization policies removed tin from a list of strategic commodities, such as oil, allowing the metal to be traded and exported freely without strict surveillance. As a strategic commodity, only a few companies had an official license to export and trade tin. The liberalization policy set no limit on tin exports and exempted tin ore producers from paying royalties to the Government. As a result, the Government lost \$5 million in royalties during 2001. Moreover, the illegal miners produced only tin ore, costing the country \$50 million of added value that could have been derived from processing ore into tin concentrate. According to government officials, the policy was intended to boost exports and create new job opportunities. Nevertheless, within a year of being introduced, the policy caused the number of illegal tin operations to balloon from only a few hundred to 7,000. Government officials now also acknowledge that rampant illegal mining led to massive environmental destruction throughout Babel Province, where about 90% of Indonesia's tin deposits are found. Legal and illegal mining operations in Babel Province account for about one-third of the world's tin production, which totaled almost 250,000 t in 2002. Production by illegal miners in Babel Province exceeds Timah's output of 40,000 t/yr (Nikkei Weekly, 2002).

Koba Tin announced that it is considering building a new tin smelter on Bangka Island, just off the coast of southern Sumatra. Malaysia Smelting Corp. holds a controlling 75% stake in Koba, with PT Tambang Timah holding the remaining 25%. Koba's tin smelter has only two furnaces with a total design capacity of 12,000 t/yr of tin (Platts Metals Week, 2002c).

Japan.—NKK Corp. and Kawasaki Steel Corp., the country's second and third largest steelmakers, respectively, announced the terms of their merger, thereby creating the world's largest steelmaker. The merger, set to be completed in 2003, would create a company with the capacity to produce 25 Mt/yr of steel. Both premerger firms are important producers of tinplate. Presently, four companies produce tinplate in Japan. Apart from NKK and Kawasaki, the other producers are Nippon Steel and Toyo Kohan (a subsidiary of Toyo Seikan, which is Japan's largest canmaker and packaging company). Unlike the three other companies, which supply tinplate to the open market, Toyo Kohan supplies the company's own domestic can manufacturing operations.

Following the NKK and Kawasaki merger, the new company, known as JFE Steel, will have three tinplate and three tin-free steel (TFS) lines. Currently, NKK operates one 220,000-t/yr electrolytic tinplate line and two 50,000-t/yr TFS lines, giving a combined capacity of 320,000 t/yr. Kawasaki has two tinplate lines and one TFS line. The two tinplate lines have a combined production capacity of 360,000 t/yr. In addition, Kawasaki's TFS production is believed to exceed 110,000 t/yr. In 2002, tinplate and TFS demand in Japan was 1.29 Mt, a drop of 10% from the 1.44 Mt in 2001; this decline was owing to a shift

toward packaging fruit juices, coffee, and tea drinks in PET bottles (Tin International, 2002a).

Korea, Republic of.—Pohang Iron and Steel Corp. (POSCO) has grown rapidly in recent decades to become not only the largest steelmaker in the Republic of Korea, but also the largest in the world. In addition, the company has long been an important producer of tin mill products. In the tinplate field, POSCO has been attempting to decrease costs and promote increased use of steel cans. One such effort has reduced the thickness of the steel in two-piece cans from between 0.26 and 0.28 millimeters (mm) to between 0.23 and 0.24 mm; this decreased steel use by 6% to 15%. POSCO's market share of domestically produced steel cans increased to 79% in 2000 from 69% in 1998 (Steel Times International, 2002).

Kyrgyzstan.—The Kyrgyzaltyn organization, which holds the development license to the Lesisty section of the Trudovoye tin and tungsten deposit, announced that it is considering setting up a joint venture with Russia's Novosibirsk Tin Combine. The venture would involve developing the Lesisty deposit within the context of the economic cooperation program between Kyrgyzstan and Russia underway through 2009. Kyrgyzaltyn is considering building a mill at the deposit with capacity of 400,000 to 500,000 t/yr of ore. The State Geology Agency of Kyrgyzstan states that the entire Trudovoye deposit has reserves of 149,000 t of tin and 96,000 t of tungsten trioxide (Metal Pages, 2003¹).

A tin and tungsten processing works is expected to start operating in Kyrgyzstan during 2003. The facility, which is being built by a Russian-Kyrgyz joint venture, will process nonferrous ores from the Sary-Dzhazsk Mine in Kyrgyzstan's Issy K-Kul region. The Kyrgyz Government estimates tin reserves at the mine to be 160,000 t and tungsten reserves, several thousand metric tons. The construction of the works was started several years ago but stopped in the early 1990s owing to a lack of funding (Metal Bulletin, 2002c).

Malaysia.—Malaysia Smelting Corp. announced plans to reduce the company's 2003 tin metal output from its Butterworth tin smelter to 60% of its usual target of 25,000 t. The smelter will operate only two of its four furnaces after November 2002. Officials attributed the revisions to the continuing weak global tin market, low tin prices, and the consequent closure of most marginal and high-cost mines in many tin producing countries (Platts Metals Week, 2002f).

Peru.—Minsur SA, the country's only tin miner, expected its tin output to increase in 2002. Minsur's underground San Rafael tin mine is in the southern highlands region of Puno; production capacity is 2,500 metric tons per day. The mine produced 38,000 t of tin-in-concentrate in 2001. Minsur also had planned to invest at least \$8 million in exploration at concessions around the country to boost tin reserves. In addition, Minsur planned to refine all of its tin output at its 45,000-t/yr Funsur tin refinery in the southern Peruvian Port of Pisco. About 60% of Minsur's exports is sold to the United States, and 35% is shipped to Europe. Minsur is studying the possibility of a \$20 million upgrade to expand capacity at the refinery to 60,000 t/yr in 2003. The San Rafael Mine has

reserves of 14 Mt with an ore grade of 5% tin, making it one of the world's richest tin deposits. The mine's estimated life is 15 years. Minsur (controlled by the local Brescia Group) makes Peru the world's third ranked tin producer after China and Indonesia. Its production costs are about \$1,200 per ton (Platts Metals Week, 2002e).

Portugal.—Tin miner Murchison United NL (Australia) acquired the Rio Tinto Group's 49% stake in Sociedade Mineira de Neves-Corco S.A., the Portuguese organization that operates the Neves Corvo copper-tin mine. Reportedly, Murchison purchased the 49% stake for \$78 million (Mining Journal, 2002a).

Russia.—In contrast to many other countries, most of Russia's tin resources (86%) are lode deposits, and only 14% are placer deposits. Of these resources, only 30% are economically viable. Moreover, Russia's largest tin deposits contain only low-grade ore. Ore treatment capacity and production of tin concentrate decreased significantly in the 1990s. Nearly all the metallurgical treatment of tin concentrate in Russia takes place at one plant, the Novosibirsk Tin Combine. Currently, production capacity at Novosibirsk is more than 20,000 t/yr (Tin International, 2002b). Novosibirsk announced that it was seeking investment to revive production at its ailing mines. In order to return tin smelter output to full capacity, the company is also seeking to import more tin concentrate through its London-based affiliated trading firm, Russian Tin Sales. The Molodyozhny and Perevalny tin mines (owned by the Novosibirsk-owned mining company Dalnevostochnaya) ceased operations in early 2002. In 2001, Novosibirsk produced 5,000 t of tin metal compared with 13,000 t in 1995 (Metal Bulletin, 2002e).

Rwanda.—The Metal Processing Association commissioned the first furnace at its tin smelter. The smelter was slated to produce 200 t/yr of refined tin, with the furnace expected to reach full production before yearend (Ryan's Notes, 2002b).

South Africa.—The country will soon have a new tin smelter owned by Phamine Mining. Phamine currently processes tin scrap. By early 2003, Phamine hopes to have a single furnace tin smelter producing 120 t of refined tin monthly (Ryan's Notes, 2002a).

United Kingdom.—In recent years, Rio Tinto Plc (formerly known as RTZ Corp.) faced charges that emissions from its former Capper Pass tin smelter in the United Kingdom caused a range of illnesses among former employees and local residents, before the plant closed in 1991. An independent claims review board was formed in January 2002, following lengthy negotiations between Rio Tinto and former Capper Pass workers and area residents. The solicitor designated to coordinate the health claims has reported that hundreds of families have registered their intention to lodge a claim before the 2003 deadline for filing claims. As of August 2002, however, no claims had been submitted. The Capper Pass tin smelter was acquired by Rio Tinto in 1967 and was demolished in 1993. After remediation work was completed in May 1995, the site was sold, and all Capper Pass assets and liabilities passed to new owners, who changed the company's name to Melton Land Ltd. in 1998. At its peak, the smelter produced up to 15% of the Western World's refined tin requirements. The facility operated as a custom smelter, recovering tin and other metals (including antimony, copper, lead, and precious metals) from low-grade concentrates and residues (Platts Metals Week, 2002a).

¹A reference that include a section mark (§) is found in the Internet Reference Cited section.

Vietnam.—A new tin mill owned by Malaysian tinplate producer Perusahaan Sadur Timah is expected to start up in Vietnam by October 2003. The new facility will have a tinplating capacity of 90,000 t/yr. Feedstock will come mainly from Japan and the Republic of Korea. About 50% of the plant's output will be sold within Vietnam, with the rest sold to Cambodia, China, and Laos (Platts Metals Week, 2002j).

Current Research and Technology

Substitutions for lead in various applications are on the increase, often spurred by environmental legislation. Fishing weights is one such use of lead linked to environmental damage. In the United Kingdom, investigations during the 1970s and 1980s led authorities to conclude that lead poisoning may have been a major influence in high swan death rates near fishing areas. Consequently, the use of lead in fishing weights weighing between 0.6 and 28.3 grams (0.02 to 1 ounce) was banned by legislation in the United Kingdom in 1987. Subsequently the swan population has recovered.

Although there are regional bans in parts of Canada and the United States, no other country has banned the use of lead-containing fishing weights. An estimated 2,700 t/yr of lead fishing weights is sold in the United States. Split lead shot comprises 50% of this market, and it is in this form that has reportedly the most damaging impact on waterfowl through ingestion. In 1994, the U.S. Environmental Protection Agency proposed a ban on the manufacture, sale, and use of lead fishing tackle, but no Federal legislation has been enacted. In this application, as in many others involving lead, tin is one of the obvious candidates as a replacement. It is nontoxic, has a low melting point, is soft, and does not corrode. However, tin is not as dense as lead, and it is more expensive. Nevertheless, fishing weights and sinkers form such a small proportion of angling expenses that their cost should not be a significant impediment. The lighter density of tin is the metal's principal drawback. One significant advantage tin has over other competing metals is its reusability as split shot. Because it is soft and deformable and does not work-harden, it can be pinched and unpinched onto the fishing line many times (Tin International, 2003c).

Japanese electronics manufacturers intend to phase out the use of conventional tin-lead solders during the next 4 years, boosting demand for tin. Conventional electronic solders are 70% tin and 30% lead. Authorities predict widespread adoption of lead-free solders containing about 96% tin, 3% silver, and 1% copper. This alloy, which is recommended by the Japan Electronics and Information Technology Industries Association, has a melting point of 220° C compared with 182° C for conventional solders. Some companies are experimenting with other alloys with lower melting points. Experience to date shows that products that use small printed circuit boards, for instance mobile phones, work well with lead-free solders, but those with large ones, such as computers, face some problems (CRU Tin Monitor, 2002).

Accelerated research and development efforts by government agencies, industry, national laboratories, and universities have been identifying several promising lead-free solders to replace lead-containing solders in electronics applications. The leading candidates are tin with 3.5% silver; tin with 3.5% silver and

0.7% copper; tin with 4.8% bismuth; and tin with 0.7% copper (all weight percentages). These lead-free solders are all tin-rich with a melting temperature between 210° C and 227° C. They are recommended for such soldering applications as ball grid arrays, fling chips, plated through-holes, surface-mount technology, and others. Some unresolved issues still persist—the reliability of lead-free solder joints, the possible need for new surface finishes, and the nature of the solidification mechanisms in solder joints.

At the 2002 Metallurgical Society annual meeting in Seattle, WA, a technical symposium on lead-free solders was held and sponsored by the Electronic Packaging Interconnection Materials Committee (JOM, 2002).

Outlook

Domestic demand for primary tin is expected to grow slowly in the next few years, at a rate of about 1% per year. That rate, however, could double in a few years if new applications—especially those in which tin is substituted for toxic materials—find acceptance in the marketplace.

World tin reserves appear to be adequate to meet foreseeable demand. Secondary sources of tin are likely to remain an important component of tin supply, especially in the United States. National Defense Stockpile sales are expected to continue in coming years and remain an important segment of domestic supply until the inventory is exhausted. Domestic tin needs will probably continue to be met primarily through imports.

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Waste Age.

TABLE 1
SALIENT TIN STATISTICS¹

		1998	1999	2000	2001	2002
United States:						
Production, secondary, contained tin ^e	metric tons	16,300	16,400	15,700	13,900	10,000
Exports, refined tin	do.	5,020	6,770	6,640	4,350	2,940
Imports for consumption, refined tin	do.	44,000	47,500	44,900	37,500	42,200
Consumption, contained tin:						
Primary	do.	37,100	38,000	38,100	34,200	34,000
Secondary	do.	8,620	8,890	8,940	7,630 ^r	5,830
Stocks, yearend, U.S. industry, contained tin	do.	10,500	10,700	10,400 ^r	9,620 ^r	9,100
Prices, average, contained tin:						
New York, NY market	cents per pound	261.38	254.54	254.92	211.48	194.75
Platts Metals Week composite	do.	373.26	365.98	370.16	314.88	291.97
London, United Kingdom	do.	251.00	245.00	246.00	203.00	184.00
Kuala Lumpur, Malaysia	do.	246.06	240.70	244.12	200.77	184.35
World, production, contained tin:						
Mine	metric tons	231,000 ^r	245,000 ^r	278,000 ^r	308,000 ^r	249,000 ^e
Smelter:						
Primary	do.	235,000 ^r	249,000	271,000	279,000 ^r	264,000 ^e
Secondary	do.	11,900 ^r	17,200 ^r	16,600 ^r	16,200 ^r	13,900 ^e
Undifferentiated	do.	200	100	--	--	75 ^e

^eEstimated. ^rRevised. -- Zero.

¹Data are rounded to no more than three significant digits, except prices.

TABLE 2
U. S. CONSUMPTION OF PRIMARY AND SECONDARY TIN¹

(Metric tons of contained tin)

	2001	2002
Stocks, January 1 ²	8,830 ^r	8,500
Net receipt during year:		
Primary	34,500 ^r	34,300
Secondary	2,180 ^r	1,610
Scrap	4,770 ^r	4,320
Total receipts	41,400 ^r	40,300
Total available	50,200 ^r	48,800
Tin consumed in manufactured products:		
Primary	34,200	34,000
Secondary	7,630 ^r	5,830
Total	41,900 ^r	39,800
Intercompany transactions in scrap	164	216
Total processed	42,000 ^r	40,000
Stocks, December 31 (total available less total processed)	8,220 ^r	8,730

^rRevised.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes tin in transit in the United States.

TABLE 3
U.S. CONSUMPTION OF TIN, BY FINISHED PRODUCT¹

(Metric tons of contained tin)

Product	2001			2002		
	Primary	Secondary	Total	Primary	Secondary	Total
Alloys, miscellaneous ²	W	W	W	W	W	W
Babbitt	770	W	770	1,310	W	1,310
Bar tin	570	W	570	617	W	617
Bronze and brass	1,240	2,190 ^r	3,430 ^r	1,330	1,720	3,040
Chemicals	7,590	W	7,590	8,400	W	8,400
Collapsible tubes and foil	W	W	W	W	W	W
Solder	12,000 ^r	5,010	17,000 ^r	10,000	3,790	13,800
Tinning	1,040	31	1,070	679	W	679
Tinplate ³	7,800	--	7,800	7,750	--	7,750
Tin powder	W	W	W	W	W	W
Type metal	W	W	W	W	W	W
White metal ⁴	1,390	W	1,390	1,320	W	1,320
Other	1,840 ^r	391	2,230 ^r	2,590	327	2,920
Total	34,200	7,630 ^r	41,900 ^r	34,000	5,830	39,800

^rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other." -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes terne metal.

³Includes secondary pig tin and tin acquired in chemicals.

⁴Includes pewter, britannia metal, and jewelers' metal.

TABLE 4
U.S. INDUSTRY YEAREND TIN STOCKS¹

(Metric tons)

	2001	2002
Plant raw materials:		
Pig tin:		
Virgin ²	6,870 ^r	6,770
Secondary	677 ^r	393
In process ³	985 ^r	987
Total	8,530 ^r	8,150
Additional pig tin:		
Jobbers-importers	1,050	916
Afloat to United States	40	40
Total	1,090	956
Grand total	9,620 ^r	9,100

^rRevised.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes tin in transit in the United States.

³Data represent scrap only, tin content.

TABLE 5
U.S. STOCKS, RECEIPTS, AND CONSUMPTION OF NEW AND OLD SCRAP AND TIN RECOVERED, BY TYPE OF SCRAP¹

(Metric tons)

Type of scrap	Stocks, January 1	Receipts	Gross weight of scrap			Stocks, December 31	Tin recovered ^c		
			New	Old	Total		New	Old	Total
2001:									
Copper-base scrap									
Ingot makers	6,180 ^r	109,000	28,000 ^r	81,400 ^r	109,000	6,110 ^r	1,170 ^r	3,120	4,290 ^r
Brass mills ²	--	140,000	140,000	--	140,000	--	1,690	--	1,690
Foundries and other plants	1,780	27,700 ^r	16,500	11,000 ^r	27,500 ^r	1,970 ^r	W	381 ^r	381 ^r
Total	XX	XX	XX	XX	XX	XX	2,860 ^r	3,500 ^r	6,360 ^r
Lead-base scrap									
Lead-base scrap	22,100	1,100,000	68,100	1,030,000	1,100,000	31,100	1,790	3,200	4,980
Tin-base scrap ³	W	W	W	W	W	W	2,560	W	2,560
Grand total	XX	XX	XX	XX	XX	XX	7,210 ^r	6,700	13,900
2002:									
Copper-base scrap									
Ingot makers	6,110	91,700	21,000	70,400	91,400	6,430	818	2,650	3,470
Brass mills ²	--	98,400	98,400	--	98,400	--	1,450	--	1,450
Foundries and other plants	1,970	27,800	16,500	10,900	27,400	2,350	W	430	430
Total	XX	XX	XX	XX	XX	XX	2,270	3,080	5,350
Lead-base scrap									
Lead-base scrap	31,100	1,140,000	50,200	1,090,000	1,140,000	27,800	1,320	3,330	4,650
Tin-base scrap ³	W	W	W	W	W	W	W	W	W
Grand total	XX	XX	XX	XX	XX	XX	3,590	6,410	10,000

^cEstimated. ^rRevised. W Withheld to avoid disclosing company proprietary data. XX Not applicable. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Consumption is assumed to be equal to receipts.

³Includes tinplate and other scrap recovered at detinning plants.

TABLE 6
U.S. EXPORTS OF TIN IN VARIOUS FORMS¹

Year	Tinplate and terneplate				Tin scrap and other tin-bearing material except tinplate scrap ²	
	Quantity		Ingots and pigs		Quantity	
	(metric tons, gross weight)	Value (thousands)	(metric tons)	Value (thousands)	(metric tons, gross weight)	Value (thousands)
2001	233,000	\$123,000	4,350	\$21,200	27,500	\$33,200
2002	219,000	129,000	2,940	14,800	24,500	32,200

¹Data are rounded to no more than three significant digits.

²Includes rods, profiles, flakes, tubes, and pipes.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF TIN IN VARIOUS FORMS¹

Year	Miscellaneous, ³ value (thousands)	Dross, skimmings, scrap residues, tin alloys, n.s.p.f. ²		Tinplate and terneplate		Tin compounds		Tinplate scrap	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
		(metric tons, gross weight)	(thousands)	(metric tons, gross weight)	(thousands)	(metric tons, gross weight)	(thousands)	(metric tons, gross weight)	(thousands)
2001	\$2,940	5,920	\$10,900	344,000	\$199,000	375	\$3,180	5,900	\$1,040
2002	1,510	2,280	7,170	254,000	143,000	449	3,230	12,800	1,820

¹Data are rounded to no more than three significant digits.

²n.s.p.f. Not specifically provided for.

³Includes tinfoil, tin powder, flitters, metallics, manufactures, and n.s.p.f.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF UNWROUGHT TIN METAL,
BY COUNTRY¹

Country	2001		2002	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Australia	300	\$1,320	100	\$363
Belgium	46	419	92	492
Bolivia	6,040	28,800	6,150	24,300
Brazil	5,510	24,600	4,840	19,000
Canada	2	9	20	37
Chile	122	630	--	--
China	6,360	31,200	7,600	31,000
Hong Kong	20	101	--	--
Indonesia	3,880	17,500	3,340	11,600
Malaysia	674	2,860	122	501
Peru	14,000	64,100	19,900	79,300
Singapore	145	710	--	--
United Kingdom	118	596	2	18
Other	228	1,160	72	535
Total	37,500	174,000	42,200	167,000

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 9
TIN: WORLD MINE PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country	1998	1999	2000	2001	2002 ^c
Australia	10,204	10,011	9,146	9,602	6,268 ³
Bolivia	11,308	12,417	12,464	12,298 ^r	15,242 ³
Brazil	14,238	13,202	14,200 ^r	12,500 ^r	13,000
Burma ⁴	221	149	212	230 ^e	240
Burundi	9 ^e	18 ^e	7 ^r	4 ^r	5
China ^e	70,100	80,100	99,400	95,000 ^r	80,000
Congo (Kinshasa)	-- ³	50 ^e	50 ^e	50	20
Indonesia	53,959	47,754	51,629	90,000 ^{r,e}	54,000
Kyrgyzstan ^e	250	250	300	300	300
Laos	627	404	414	400 ^e	400
Malaysia	5,754	7,340	6,307 ³	4,972 ^r	4,215 ³
Mexico	5	4	4	8 ^r	10
Mongolia	40	--	--	-- ^e	--
Niger ^e	10	32 ^{r,3}	22 ³	20	20
Nigeria ^{e,5}	200	200	300	200	200
Peru	49,574 ^r	59,191 ^r	70,501 ^r	69,696 ^r	65,400 ³
Portugal	3,100	2,200	1,200 ^e	1,200 ^e	1,000
Russia ^e	4,500	4,500	5,000	4,500	2,900
Rwanda	187 ^r	248 ^r	276 ^r	171 ^r	170
Spain ^e	2	2	3	2	2
Thailand	1,656	2,712	2,166	2,522	1,104 ³
Uganda	1	(6)	(6)	18 ^r	20
United Kingdom	376	--	-- ^e	--	--
Vietnam ^e	4,500	4,000 ^r	4,100 ^r	4,500 ^r	4,700
Zimbabwe ^e	1	1	-- ^{r,3}	-- ^{r,3}	--
Total	231,000 ^r	245,000 ^r	278,000 ^r	308,000 ^r	249,000

^eEstimated. ^rRevised. -- Zero.

¹World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through July 18, 2003.

³Reported figure.

⁴Includes content of tin-tungsten concentrate.

⁵Concentrate gross weight reported, estimated 62% Sn content.

⁶Less than 1/2 unit.

TABLE 10
TIN: WORLD SMELTER PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country	1998	1999	2000	2001	2002 ^e
Australia:					
Primary	655	600	775	1,171	611 ³
Secondary ^c	300	300	300	300	300
Total ^c	955	900	1,080	1,470	911
Belgium, secondary ^c	2,500	8,100	8,500	8,000	6,000
Bolivia, primary	11,102	11,166	9,353	11,300 ^r	10,976 ³
Brazil:					
Primary	14,900 ^r	12,787 ^r	13,773 ^r	12,300 ^{r,c}	12,500
Secondary ^c	250	250	250	250	250
Total ^c	149,000 ^r	13,000 ^r	14,000 ^r	12,600 ^r	12,800
Bulgaria, secondary ^c	10	10	10	10	10
Burma, primary	31	32	30 ^e	30 ^e	30
China, primary ^c	79,300	90,800	112,000	105,000 ^r	93,000
Czech Republic, secondary ^c	100	100	100	100	100
Denmark, secondary ^c	100	100	100	100	100
Germany, primary and secondary ^c	100	--	--	--	--
Greece, secondary ^c	200	200	150	150	150
Indonesia, primary	53,401	49,105	46,432	53,470 ^r	53,000
Japan, primary	500	568	593	668	659 ³
Malaysia, primary	27,201	28,913	26,228	30,417 ^r	30,000
Mexico, primary	1,078	1,258	1,107 ^r	-- ^r	1,200
Nigeria, primary ^c	150 ³	50	50	50	50
Norway, secondary ^c	50	50	50	50	50
Peru, primary	25,907	30,618	37,410	38,182	35,828 ³
Portugal, primary and secondary ^c	100	100	--	--	--
Russia: ^c					
Primary	3,000	3,400	3,700 ^r	3,100 ^r	3,150
Secondary	500	400	500	500	500
Total	3,500	3,800	4,200 ^r	3,600 ^r	3,650
Rwanda:	--	--	--	--	75
Spain: ^c					
Primary	100	50	--	--	--
Secondary	50	50	25	25	25
Total	150	100	25	25	25 ³
Thailand, primary	15,353	17,306	17,076	21,357	21,500 ³
United Kingdom, secondary ^c	50	--	--	--	--
United States, secondary	7,790 ^r	7,720 ^r	6,600 ^r	6,696 ^r	6,413 ³
Vietnam, primary ^c	2,400	2,400	2,400 ³	1,800	1,500
Grand total:	247,000 ^r	266,000 ^r	288,000 ^r	295,000 ^r	278,000
Of which:					
Primary	235,000 ^r	249,000	271,000	279,000 ^r	264,000
Secondary	11,900 ^r	17,200 ^r	16,600 ^r	16,200 ^r	13,900
Undifferentiated	200	100	--	--	75

^cEstimated. ^rRevised. -- Zero.

¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Whenever possible, total output has been separated into primary (from ores and concentrates) and secondary (tin metal recovered from old scrap). This table reflects metal production at the first measurable stage of metal output. Table includes data available through July 18, 2003.

³Reported figure.