Two Colonial Place ◆ 2101 Wilson Boulevard ◆ Suite 1200 ◆ Arlington, Virginia 22201 T 703.516.7700 F 703.351.6162

NATHAN
ASSOCIATES INC.

May 27, 2004

Copper Short Supply Petition
Regulatory Policy Division
Bureau of Industry and Security
Department of Commerce
PO Box 173
Washington, DC 20044

VIA ELECTRONIC SUBMISSION—(coppershortsupplypetition@bis.doc.gov)

Dear Sirs:

During my testimony at the public hearing on May 19, 2004, I stated that within a week I would provide to the panel a final version of the Nathan Associates report, "The National Inventory of Obsolete Copper Scrap: Accumulation and Availability, 1982-2003," prepared on behalf of the Institute of Scrap Recycling Industries, Inc.

Please note that in the course of finalizing our analysis, changes were made to some of the estimates presented in my testimony. These changes were the result of our effort to model more completely the accumulation of copper scrap inventories over time. Estimates of net additions to the inventory of obsolete copper scrap have not changed, but our estimate of the end-of-year 1982 resource base and, hence, the 1983 beginning-of-year inventory of obsolete copper scrap have been adjusted downward.

As I expressed last week, I appreciate having had the opportunity to speak before the panel. Furthermore, I am hopeful that the data presented both in my testimony and in the enclosed report prove useful to the panel in its deliberations.

Respectfully Submitted,

Robert Damuth
Vice President

Enclosure

The National Inventory of Obsolete Copper Scrap

Accumulation and Availability, 1982-2003

SUBMITTED TO
Bureau of Industry & Security
Department of Commerce
Washington DC

SUBMITTED BY
Nathan Associates Inc.

May 2004

NATHAN
ASSOCIATES INC.
www.nathaninc.com

Contents

Contents (continued)

ILLUSTRATIONS

Figures

Tables

Executive Summary

There is no shortage in the national inventory of obsolete copper scrap.

The inventory has grown steadily since 1982. Net additions to inventory through 2003 totaled 36.5 billion pounds, or 1.7 billion pounds per year.

Each year, enough obsolete copper scrap is generated in the U.S. economy to more than adequately meet domestic demand. At the end of 2003, inventory had reached 73.7 billion pounds. Recycled new (prompt) and obsolete copper scrap in 2003 was equivalent to only 5.5% of the inventory of obsolete copper scrap, lower than the average 6.2% from 1982 through 2003.

Based on the total amount of recycled scrap (prompt and obsolete) in 2003 and the year end inventory of obsolete scrap, there is enough obsolete scrap in the inventory to meet total demand through the year 2021.

Obsolete copper scrap consists of copper contained in installed or in-place products in the U.S. economy. These products, which can be grouped into five end-use product categories, including building construction, electrical and electronic products, industrial machinery and equipment, transportation equipment, and consumer and general products, are manufactured by at least 35 industries defined at the 6-digit level of the North American Industrial Classification System (NAICS). Whether in the form of wiring in a building or product, plumbing pipes and fixtures, sheet roofing, or other products, the defining characteristic of obsolete copper scrap is that it is used and in a position to be reclaimed.

The most appropriate definition of the inventory of obsolete copper scrap — the definition employed in this study — is potential reserves. Estimates of potential reserves of obsolete copper scrap take into account the economic relationship between the availability and price of copper scrap. Measuring potential reserves reflects the reality that additional scrap will be available at higher than current, but still realistic prices. The quantity of copper scrap recycled varies with the price of copper scrap. As price increases, the amount of copper scrap recycled increases.

1. Introduction

This report presents a study and estimates of the national inventory of obsolete copper scrap from 1982 through 2003. Obsolete copper scrap consists of copper contained in installed or in-place products in the U.S. economy. The manufacturing process for copper products generates two additional types of scrap—prompt or new scrap, which is scrap generated in the manufacturing process and returned to mills or refineries, and home scrap which is scrap generated by mills that is reused. Neither prompt nor home scrap is part of the pool of available obsolete scrap, so they are not directly measured in this study.

The study was prepared at the request of the Institute of Scrap Recycling Industries, Inc. (ISRI) in anticipation of public hearings regarding the supply of copper scrap in the United States. In a written petition submitted April 7, 2004 to the Bureau of Industry and Security of the U.S. Department of Commerce, member companies of the Copper & Brass Fabricators Council, Inc., and the Non-Ferrous Founders' Society asked the Department to impose monitoring and controls on exports of recycled metallic materials containing copper pursuant to the provision of section 7(c) of the Export Administration Act of 1979, as amended (EAA) (50 U.S.C. app. 2406(c)) and as implemented by section 754.7 of the Export Administration Regulations (EAR) (15 CFR 754.7).

Government entities, private interest groups and academic researchers have compiled several different statistical series on production, consumption, imports, and exports of primary refined copper, as well as similar data on copper scrap. These sources and statistics are used in this study.

The methodology used here differs from the methodology found in the literature. Other studies present statistics on the available resources of copper in the U.S. economy and employ a methodology that merely adds 75% of the refined copper consumed each year to the resource base. This type of methodology does not reflect the extent to which copper may be unrecoverable. It also ignores the economic relationship between prices of obsolete scrap and supplies of obsolete scrap provided to and by scrap dealers.

The major finding of this study is that no shortage of obsolete copper scrap exists in the United States. The current inventory of obsolete copper scrap is 73.7 billion pounds, or 33.4 million metric tons. Moreover, the inventory has been growing steadily over the past 20 years. Consumption of obsolete copper scrap in 2003 was 4.1 billion pounds or approximately 5.5% of year-end inventory. The average percentage over the entire period 1982 through 2003 was 6.2%. Hence, obsolete scrap consumption as a percentage of year-end inventory in 2003 was less than the historical average.

2. Theory

Conceptually, the national inventory of obsolete copper scrap can be thought of as a pool of old (obsolete) copper-containing products, the size of which fluctuates according to rates of additions and withdrawals. Additions to the pool occur as products containing copper reach the ends of their economic lives. Withdrawals occur as the copper in these products is removed and recycled by industries that utilize copper as a manufacturing or fabricating input.

Inventory, in the normal business sense, is a stock of immediately available materials or products used to even out market fluctuations in supply and demand. However, the pool of obsolete copper scrap is not necessarily immediately available for use. Obsolete copper scrap must be extracted from copper-containing products that have reached the ends of their useful lives. Useful lives, which vary from product to product, are determined by economic conditions and technological innovations.

To define what is meant by an inventory of obsolete copper scrap, the narrow notion of business inventories must be broadened by incorporating geologic concepts of resources and reserves. In geology, resources are concentrations of elements in the earth's crust or under the sea existing in such a form that they may be extracted and used. Reserves are masses of rock whose extent and grade are known to a lesser degree and whose physical natures are such that they may be extracted at a profit with existing technology and present price levels.

These concepts have technical discovery and economic dimensions, only the latter of which is especially relevant to defining the inventory of obsolete copper scrap. In geology, resources are presumed to exist but must be discovered; measured as "proved" in terms of composition, grade, and quantity; and either employed, held for future use, or abandoned. The technical discovery dimension is not relevant to copper scrap. Copper scrap exists in and can be derived from copper-containing materials and products that have reached the ends of their useful lives.

Focusing on the technical economic dimension leads to a three-part classification that provides insight into the different ways in which the inventory of copper scrap can be defined.

- Resources of copper scrap: Copper-containing materials and products located on the earth's surface or in landfills, existing in a form that allows extraction and use.
- Potential reserves of copper scrap: Concentrations of known or inferred quantity in an immediately usable condition that can be recovered within the constraints of high but realistic prices, *i.e.*, prices possibly several times higher than current prices.
- Reserves of copper scrap: Concentrations of known extent and quality economically recoverable at generally prevailing prices using known technology.

The most appropriate definition of the inventory of obsolete copper scrap is potential reserves. As a concept, potential reserves obsolete copper scrap include only copper in products that have reached the ends of their useful economic lives, that is relatively accessible, and that offers the advantage of scrap, *i.e.*, existing in a metallic state not needing further reduction. Therefore, potential reserves of obsolete copper scrap can be drawn from within a short time frame when scrap is demanded by the economy and prices reach appropriate levels.

In contrast to potential reserves, a measure of the larger pool of "resources" includes material that is economical to access only in emergency situations such as wartime conditions.

A measure of the smaller pool of "reserves" inadequately accounts for the relationship between scrap price fluctuations that have occurred during the past several years and movements of obsolete copper scrap from the pool of resources to the pool of potential reserves.[1]

[1] The movement of copper scrap from the pool of resources to the pools of potential reserves and reserves is at least in part determined by the responsiveness of quantities of scrap supplied to changes in scrap prices (supply elasticity), an issue beyond the scope of this study.

3. Data

This study utilizes data from multiple government, private sector, and academic sources. The U.S. Geological Survey (USGS) compiles and publishes data on consumption of primary and scrap copper. The Copper Development Association (CDA), an industry trade group, also compiles statistics on mine production and consumption of copper by categories of end-use products. Other government agencies and academic researchers have addressed specific data issues in the copper industry, including prompt scrap generation rates, product life cycles, and recovery rates of obsolete scrap.

The basis for estimating annual additions to the inventory of obsolete copper scrap is a historical series of the total amount of copper consumed in end-use markets in the United States from 1932 through 2002 (Table 3-1) This series was developed from two historical datasets. One is provided by CDA; the other by USGS. CDA statistics measure total consumption of copper by five end-use product categories for 1982 through 2002, but not for earlier years. Because of the long lives of copper and some copper-containing products, it is necessary to backcast this series to earlier years. The backcast is developed using USGS statistics on apparent consumption of copper for 1932 through 2002.[2] First, total consumption reported by CDA in 1982 through 2002 is measured as a percentage of total apparent consumption reported by USGS over the same period. Next, this percentage is multiplied by annual apparent consumption reported by USGS in 1932 to 1981. Finally, the backcast of annual total consumption is allocated to end-use product categories based on distributions in the CDA data for 1982 through 1984.

Additional data from USGS and CDA are the basis for estimating withdrawals from the inventory of obsolete copper scrap. USGS publishes statistics on annual production of obsolete copper scrap (secondary production) and on prompt copper scrap (new scrap).

---

[2] USGS estimates apparent consumption on an annual basis as primary consumption (refinery production) plus secondary consumption (obsolete scrap recovery) plus imports minus exports plus the net change in the stocks of copper. CDA defines end-use consumption as the supply of mill, foundry and powder products and their consumption in the five end-use markets.

Combined, these two series yield the annual amount of total copper scrap recycled in the U.S. economy (Table 3-2). CDA provides statistics on total copper scrap imports and exports (Table 3-3). These series are used to adjust USGS statistics on total copper scrap recycled to account for trade flows.

Prompt scrap must be excluded from estimates of the inventory of obsolete copper scrap. Data on the rates at which prompt scrap, or scrap generated in the manufacturing process and returned to foundries or mills for recycling, is generated are sparse. The U.S. Business and Defense Services Administration published an exhaustive survey of prompt scrap generation rates estimated by SIC code in 1957 (Table 3-4). More recent estimates are not available.

Also, data on the useful lives of products are necessary to estimate each year's addition to the pool of products that have reached the ends of their useful lives (Table 3-5). Data on the useful lives of copper-containing products were gathered primarily from two sources. An earlier study by Nathan Associates estimated the average and maximum useful lives of a number of product categories similar to those used in this report.[3] To the extent that these categories were comparable, the useful lives previously estimated were used. For product categories that have seen significant technological or qualitative changes, additional data from a study by Robert U. Ayres, *et al*., were used.[4]

Recovery rates indicate the amount of newly obsolete scrap that can be recovered and added to the potential reserves of obsolete copper scrap. Recovery rates of copper in obsolete products vary by product category. The copper content of these items and the ease of their recovery affect these recovery rates. Data on recovery rates in the US economy are not widely available. Ayres, *et al*., provides recovery rates in Japan and the United States that were used in this study (Table 3-6).

Finally, dissipation of copper must be accounted for. Copper generally does not corrode, nor is copper involved in any use that is significantly dissipative or destructive to the copper content. As a result, nearly all of the copper that is incorporated into products is theoretically recoverable. Most sources place the wear and dissipation rate of copper at 1% or less. In this study, a 1% dissipation rate is used.

---

[3] Robert R. Nathan Associates, Inc., "Iron and Steel Scrap: Its Accumulation and Availability as of December 31, 1975," ISRI, Washington, 1977.

[4] Robert U. Ayres, *et al*., "The Life Cycle of Copper, Its Co-Products and By-Products," Mining, Minerals and Sustainable Development, International Institute for Environment and Development, January 2002.

Table 3-1

Copper Consumed in U.S. End-Use Markets, 1932-2002 [a] (million pounds)

Year	Building Construction (1)	Electrical and Electronic Products (2)	Industrial Machinery and Equipment (3)	Transportation Equipment (4)	Consumer and General Products (5)	Total End Use Consumption [b] (6)	U.S. Apparent Consumption [c] (7)
1932	356	253	148	117	108	982	1,043
1933	468	332	194	153	142	1,290	1,371
1934	351	249	146	115	107	968	1,029
1935	622	442	258	204	189	1,715	1,823
1936	820	582	340	268	249	2,260	2,402
1937	838	595	348	274	255	2,310	2,456
1938	545	387	226	178	166	1,503	1,598
1939	862	613	358	282	262	2,377	2,527
1940	1,077	765	447	353	327	2,970	3,157
1941	1,690	1,201	702	553	514	4,659	4,953
1942	1,666	1,184	692	545	507	4,594	4,883
1943	1,771	1,258	735	580	538	4,883	5,190
1944	1,641	1,166	681	537	499	4,524	4,809
1945	1,583	1,125	658	518	481	4,366	4,640
1946	1,561	1,109	648	511	474	4,303	4,573
1947	1,527	1,085	634	500	464	4,210	4,475
1948	1,526	1,084	634	499	464	4,207	4,472
1949	1,228	872	510	402	373	3,385	3,598
1950	1,342	953	557	439	408	3,699	3,932
1951	1,484	1,054	616	486	451	4,091	4,348
1952	1,549	1,101	643	507	471	4,270	4,539
1953	1,537	1,092	638	503	467	4,239	4,506
1954	1,291	917	536	422	392	3,558	3,782
1955	1,562	1,110	649	511	475	4,307	4,578
1956	1,513	1,075	628	495	460	4,170	4,433
1957	1,363	969	566	446	414	3,759	3,995
1958	1,245	885	517	407	379	3,433	3,649
1959	1,477	1,050	613	483	449	4,073	4,329
1960	1,394	990	579	456	424	3,843	4,085
1961	1,440	1,023	598	471	438	3,971	4,220
1962	1,579	1,122	656	517	480	4,354	4,628
1963	1,665	1,183	691	545	506	4,591	4,880
1964	1,760	1,250	731	576	535	4,851	5,156
1965	1,996	1,418	829	653	607	5,502	5,848
1966	2,213	1,572	919	724	673	6,101	6,485
1967	1,843	1,310	765	603	560	5,081	5,401
1968	1,912	1,359	794	626	581	5,272	5,604
1969	2,095	1,489	870	686	637	5,777	6,140
1970	1,876	1,333	779	614	570	5,171	5,497
1971	1,933	1,373	803	633	588	5,329	5,665
1972	2,185	1,553	908	715	664	6,025	6,404
1973	2,281	1,620	947	746	693	6,288	6,683
1974	2,194	1,559	911	718	667	6,049	6,429

Table 3-1 continued...

Table 3-1 (continued)

Year	Building Construction (1)	Electrical and Electronic Products (2)	Industrial Machinery and Equipment (3)	Transportation Equipment (4)	Consumer and General Products (5)	Total End Use Consumption [b] (6)	U.S. Apparent Consumption [c] (7)
1975	1,519	1,080	631	497	462	4,189	4,453
1976	1,943	1,381	807	636	591	5,357	5,694
1977	2,076	1,475	862	679	631	5,723	6,083
1978	2,350	1,670	976	769	714	6,478	6,886
1979	2,545	1,808	1,057	833	773	7,015	7,457
1980	2,259	1,605	938	739	687	6,229	6,621
1981	2,322	1,650	964	760	706	6,402	6,805
1982	1,857	1,489	849	568	630	5,393	5,362
1983	2,197	1,517	906	708	625	5,953	5,890
1984	2,568	1,699	995	891	758	6,911	6,110
1985	2,587	1,472	898	814	626	6,397	6,129
1986	2,719	1,533	899	814	619	6,584	6,140
1987	3,047	1,633	942	817	669	7,108	6,422
1988	2,908	1,660	993	844	695	7,100	6,622
1989	2,799	1,612	981	806	685	6,883	6,493
1990	2,696	1,655	902	770	642	6,665	6,486
1991	2,635	1,537	820	715	620	6,327	6,096
1992	2,702	1,655	858	774	638	6,627	6,674
1993	2,825	1,761	825	878	611	6,900	7,179
1994	3,179	1,934	962	959	776	7,810	7,743
1995	3,104	1,955	934	943	746	7,682	7,522
1996	3,220	2,039	950	978	742	7,929	8,197
1997	3,469	2,154	942	1,038	821	8,424	8,609
1998	3,604	2,327	948	855	849	8,583	8,689
1999	3,900	2,366	1,005	915	902	9,088	8,814
2000	3,881	2,501	946	902	1,083	9,313	9,014
2001	3,522	1,994	748	719	798	7,781	6,917
2002	3,384	1,662	725	744	798	7,313	-

[a] Copper only for 1932-1981. Copper and alloys for 1982-2002.

[b] Total end-use consumption is reported by the Copper Development Association Inc. (CDA) for 1982 through 2002 in its publication "Annual Data 2003, Copper Supply & Consumption, 1982-2002." For 1932 through 1981, total end-use consumption is estimated based on ratios of end-use consumption to apparent consumption, which is estimated by USGS and reported by CDA in Table 6 of its publication, "The U.S. Copper-Base Scrap Industry and Its By-Products, 2002."

[c] From USGS as reported by CDA in "The US Copper-Base Scrap Industry and Its By-Products, 2002."

Sources: See notes.

Table 3-2

Total Copper in Recycled Scrap Consumed in the United States, 1982-2001, (million pounds)

Year	Secondary Production [a] (1)	New Scrap [b] (2)	Total Copper in Recycled Scrap Consumed in U.S. (3) = (1) + (2)
1982	1,142	1,477	2,619
1983	990	1,398	2,388
1984	1,016	1,453	2,469
1985	1,109	1,402	2,511
1986	1,052	1,431	2,483
1987	1,098	1,578	2,676
1988	1,142	1,739	2,881
1989	1,208	1,678	2,886
1990	1,182	1,709	2,891
1991	1,175	1,470	2,645
1992	1,221	1,592	2,813
1993	1,197	1,649	2,846
1994	1,102	1,823	2,925
1995	977	1,927	2,904
1996	944	1,964	2,908
1997	1,098	2,132	3,230
1998	1,027	2,108	3,135
1999	840	2,092	2,932
2000	787	2,105	2,892
2001	697	1,836	2,533

[a] As reported by the USGS, secondary production describes the quantity of copper recovered from old scrap. See Copper Worksheet Notes of source below for definition.

[b] The USGS defines new scrap as the "quantity of copper that is recovered from copper and copper alloy scrap generated during manufacturing and returned to smelters, fire refineries, brass mills, etc. for reprocessing." See Copper Worksheet Notes of source below for definition.

Source: U.S. Geological Survey Open-File Report 01-006
Historical Statistics for Mineral and Material Commodities in the United States, "Copper Statistics" available online at http://minerals.usgs.gov/minerals/pubs/of01-006/copper.pdf.

Table 3-3
Copper Scrap Imports and Exports, 1982-2001, (million pounds)

Year	Total Copper in Scrap Imports (1)	Total Copper in Scrap Exports (2)
1982	78	251
1983	121	222
1984	121	333
1985	103	497
1986	124	519
1987	145	505
1988	162	551
1989	196	646
1990	236	573
1991	218	560
1992	300	454
1993	345	484
1994	317	659
1995	349	862
1996	392	715
1997	393	702
1998	297	559
1999	237	579
2000	247	911
2001	201	1,009

Source: Copper Development Association, Inc., "The US Copper-Base Scrap Industry and Its By-Products, 2002."

Table 3-4

Prompt Scrap Generation Percentages by End-Use Product Category

End-Use Category	Prompt Scrap Percentage
Building construction	28.2
Electrical and electronic products	14.3
Industrial machinery and equipment	20.2
Transportation equipment	18.8
Consumer and general products	20.3

Sources: Nathan Associates Inc. for building construction. U.S. Business and Defense Services Administration, "Industrial Scrap Generation: Iron and Steel, Copper, Aluminum," 1957 for all others.

Table 3-5

Average Median and Total Lives of Products by End-Use Product Category

End Use Category	Median Life	Total Life
Building construction	40	50
Electrical and electronic products	8	16
Industrial machinery and equipment	24	35
Transportation equipment	10	18
Consumer and general products	14	20

Sources: Robert R. Nathan Associates, Inc., "Iron and Steel Scrap: Its Accumulation and Availability as of December 31, 1975," ISRI, Wahsington, 1977 and Robert U. Ayres, *et al .*, "The Life Cycle of Copper, Its Co-Products and By-Products," Mining, Minerals and Sustainable Development, International Institute for Environment and Development, January 2002.

Table 3-6

Recovery Rates of Copper by End-Use Product Category

End-Use Category	Recovery Rate [a]
Building construction	68%
Electrical and electronic products	44%
Industrial machinery and equipment	81%
Transportation equipment	65%
Consumer and general products	45%

[a] Recovery rates for building construction and industrial machinery were taken directly from Ayres, *et al* . The recovery rate of electrical and electronic products is estimated as the average of electrical products, electrical appliances and computers; transportation equipment is estimated as the average of railroad equipment and automobiles (weighting automobiles twice); consumer and general products is estimated as the average of large appliances and electrical appliances.

Source: Robert U. Ayres, *et al .*, "The Life Cycle of Copper, Its Co-Products and By-Products," Mining, Minerals and Sustainable Development, International Institute for Environment and Development, January 2002.

4. Model

Measuring the inventory of obsolete copper scrap requires detailed analysis of the flow of copper metals through the U.S. economy (Figure 4-1). Copper refineries turn ore into refined copper. Refined copper is used in production processes of foundries, wire, rod, brass, and powder mills. These processes generate "home" scrap that is recycled at the mills. Fabricators and manufacturers of end-use products generate prompt scrap that is recycled through refineries or returned to the mills. When end-use products containing copper reach the ends of their useful lives, their copper content can be extracted and recycled.

The model constructed to estimate the inventory of obsolete copper scrap estimates annual additions to and withdrawals from the inventory of obsolete copper scrap.

Annual additions to the inventory of obsolete copper scrap are estimated in five major steps. First, total copper in end-use consumption in each of the five end-use markets is estimated from total end-use consumption of copper and alloy metals. Next, prompt scrap is estimated and subtracted to calculate total copper in U.S. produced end-use products. The third step adjusts this total by adding imports and subtracting exports to derive total copper in end-use products consumed in the United States. In the fourth step, annual amounts of newly obsolete copper scrap are estimated based on the useful economic lives of products in each of the five end-use categories, the historical series of copper consumption in end-use product markets from 1932 through 2002, and dissipation rates. The fifth step calculates the annual addition to inventory by estimating the amount of newly obsolete copper scrap that is recoverable based on end-use market recovery rates.

Annual withdrawals from the inventory are estimated in two steps. First, statistics on annual prompt and obsolete scrap recovered in the United States are adjusted to exclude scrap that was imported into the United States and include scrap that was exported to foreign markets. From these data, estimated amounts of prompt scrap recovered are subtracted to derive a series of withdrawals of obsolete copper scrap only.

Finally, the model calculates the national inventory of obsolete copper scrap at the end of 1982 before accounting for annual net additions to inventory in 1982 through 2003. The calculation occurs in two stages. First, amounts of copper in products whose useful lives will expire sometime between 1982 and 2003 are estimated. These amounts must be subtracted from the beginning-of-year 1982 resource base to avoid double counting of net additions of obsolete copper to the inventory of potential reserves over the period 1982 through 2003. Second, estimated annual net additions to the potential reserve of obsolete copper scrap from 1983 through 2003 are summed. The sum is measured as a percentage of the cumulative additions to the adjusted resource base over the same period. This percentage — approximately 67% — is then multiplied by the adjusted end-of-year 1982 resource base to derive the end-of-year 1982 potential reserves or inventory of obsolete copper scrap.

Figure 4-1
Flow of Copper Metals

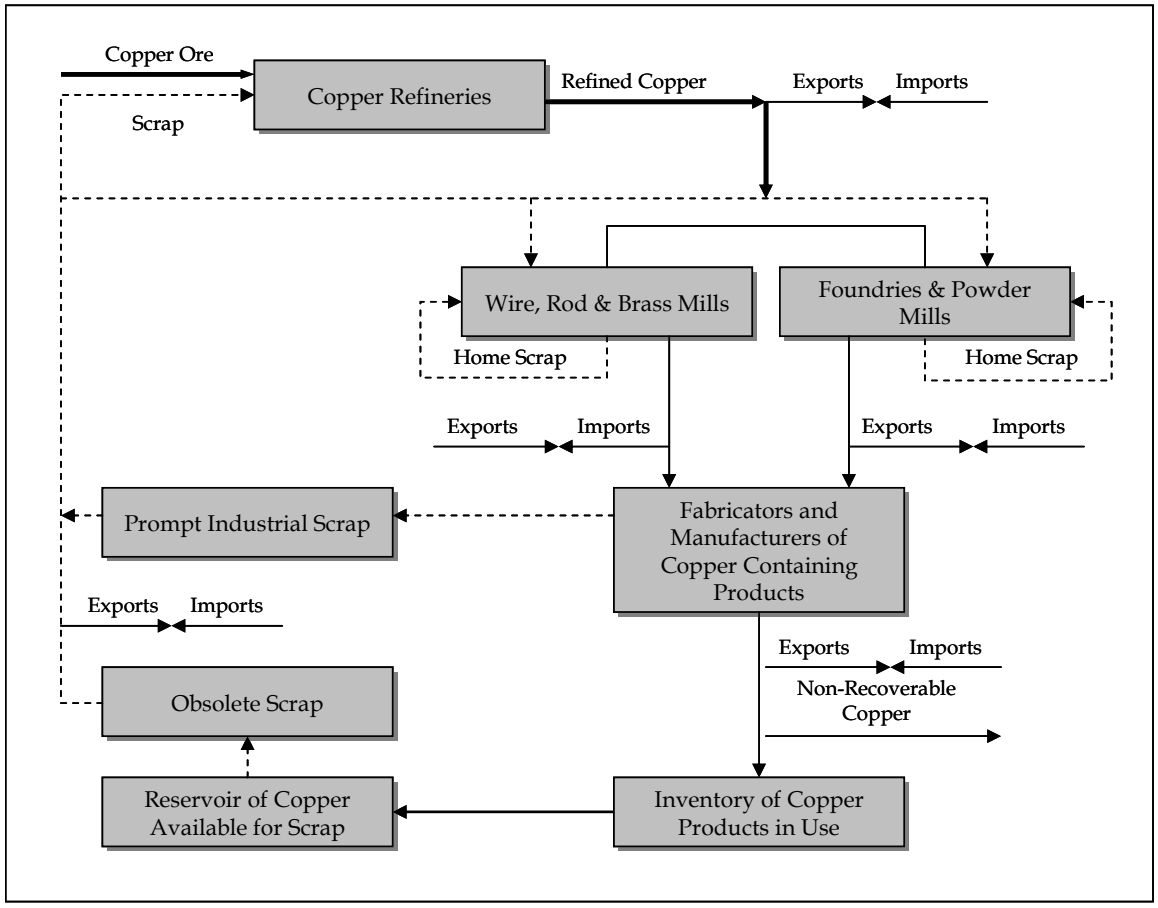
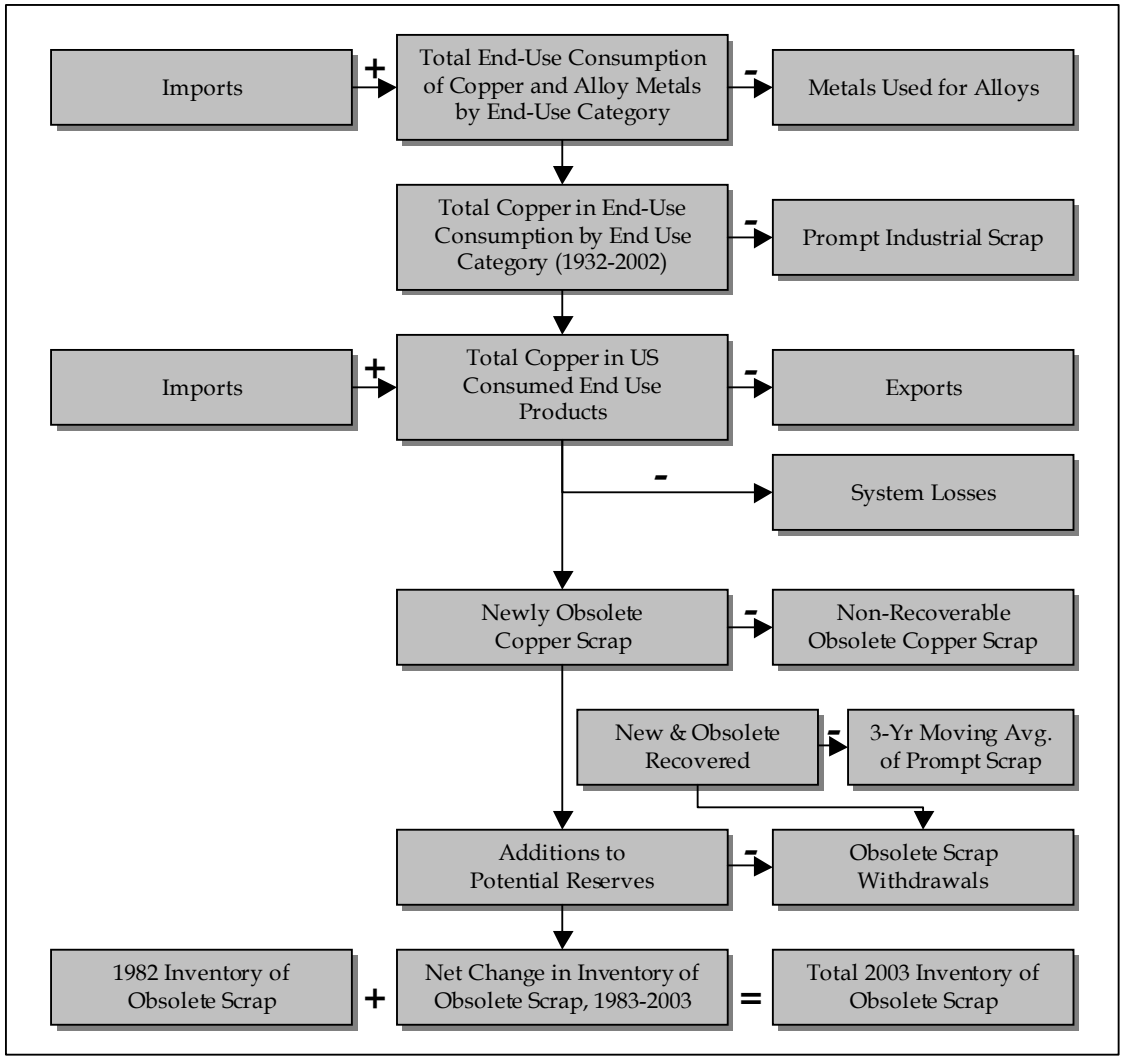


Figure 4-2
End-Use Product Categories and Component Industries

End-Use Category	Component Industry	NAICS Codes Included
Building construction	Building wire	331422
	Plumbing and heating	332913, 332998
	Air conditioning and commercial refrigeration	333415, 334512
	Builders hardware	335932
	Architectural	332323
Electrical and electronic products	Power utilities	221121
	Telecommunications	234920, 334210
	Business electronics	334111
	Lighting and wiring devices	335121, 335122
Industrial machinery and equipment	In-plant equipment	-
	Industrial valves and fittings	332911
	Non-electrical instruments	334515, 334513
	Off-highway vehicles	333120, 336999
	Heat exchangers	332410
Transportation equipment	Automobile	332510
	Truck and bus	336211, 335931
	Railroad	336510
	Marine	336611
	Aircraft and aerospace	336413, 332510
Consumer and general products	Appliances	333319, 335222
	Cord sets	314991
	Military and commercial ordnance	332992, 332993
	Consumer electronics	334310, 334111
	Fasteners and closures	332115, 339993
	Coinage	339911
	Utensils and cutlery	332211
	Miscellaneous	

Figure 4-3
Data Flow in the Obsolete Copper Scrap Inventory Model



Source: Nathan Associates Inc.

5. Results

There is no shortage in the national inventory of obsolete copper scrap.

The inventory has grown steadily since 1982 (Table 5-1). Net additions to inventory through 2003 totaled 36.5 billion pounds, or 1.7 billion pounds per year. Annual additions to inventory have averaged 3.5 billion pounds since 1983 (Table 5-2). These additions reflect annual amounts of newly obsolete copper scrap and amounts of this that are recovered (Table 5-3). Newly obsolete copper scrap is based on end-use products previously produced that have reached the ends of their useful economic lives. Amounts recovered are based on recovery rates that vary by end-use product category. Annual withdrawals have averaged 1.7 billion pounds (Table 5-4).

Each year, enough obsolete copper scrap is generated in the U.S. economy to more than adequately meet domestic demand. At the end of 2003, inventory had reached 73.7 billion pounds. Recycled new (prompt) and obsolete copper scrap in 2003 was equivalent to only 5.5% of the inventory of obsolete copper scrap, lower than the average 6.2% from 1982 through 2003.

Based on the total amount of recycled scrap (prompt and obsolete) in 2003 and the year end inventory of obsolete scrap, there is enough obsolete scrap in the current inventory to meet total demand through the year 2021.

Table 5-1

U.S. Inventory of Obsolete Copper Scrap, 1982-2003 (million pounds)

Year	Starting Inventory (1)	Net Change in Inventory of Obsolete Scrap [a] (2)	Year End Inventory [b] (3) = (1) - (2)	Total Copper in Recycled Scrap [c] (4)	Total Copper in Recycled Scrap as a Share of Year End Inventory (5) = (4) / (3)
1982	-	-	37,239	2,870	7.7%
1983	37,239	1,761	39,000	2,610	6.7%
1984	39,000	1,788	40,788	2,802	6.9%
1985	40,788	1,660	42,448	3,008	7.1%
1986	42,448	1,710	44,158	3,002	6.8%
1987	44,158	1,676	45,834	3,181	6.9%
1988	45,834	1,404	47,239	3,432	7.3%
1989	47,239	1,409	48,648	3,532	7.3%
1990	48,648	1,488	50,136	3,464	6.9%
1991	50,136	1,674	51,811	3,205	6.2%
1992	51,811	1,730	53,541	3,267	6.1%
1993	53,541	1,784	55,325	3,330	6.0%
1994	55,325	1,730	57,055	3,584	6.3%
1995	57,055	1,680	58,735	3,766	6.4%
1996	58,735	1,877	60,612	3,623	6.0%
1997	60,612	1,815	62,427	3,932	6.3%
1998	62,427	2,083	64,510	3,694	5.7%
1999	64,510	2,207	66,717	3,511	5.3%
2000	66,717	1,628	68,345	3,803	5.6%
2001	68,345	2,003	70,348	3,542	5.0%
2002	70,348	1,666	72,014	3,927	5.5%
2003	72,014	1,678	73,692	4,054	5.5%
1983-2003	-	**36,453**	-	**72,268**	**6.2%**

[a] See Table 5-2.

[b] 1982 is the adjusted cumulative resource base of copper multiplied by 0.6659 to convert to potential reserves. Successive years equal starting inventory plus inventory change in column two.

[c] Equals the total copper (prompt and obsolete, excluding imports) in recycled scrap consumed in and exported from the United States.

Source: Nathan Associates Inc.

Table 5-2

Calculation of Annual Net Changes in U.S. Inventory of Obsolete Copper Scrap, 1983-2003 (million pounds)

Year	Additions to Potential Reserves [a] (1)	Withdrawals from Potential Reserves [b] (2)	Net Change in Inventory of Obsolete Scrap (3) = (1) - (2)
1983	3,075	1,315	1,761
1984	3,216	1,428	1,788
1985	3,257	1,597	1,660
1986	3,248	1,538	1,710
1987	3,327	1,651	1,676
1988	3,271	1,867	1,404
1989	3,378	1,968	1,409
1990	3,397	1,909	1,488
1991	3,365	1,691	1,674
1992	3,388	1,658	1,730
1993	3,367	1,583	1,784
1994	3,516	1,786	1,730
1995	3,538	1,857	1,680
1996	3,495	1,618	1,877
1997	3,678	1,863	1,815
1998	3,719	1,636	2,083
1999	3,659	1,452	2,207
2000	3,410	1,782	1,628
2001	3,685	1,682	2,003
2002	3,811	2,145	1,666
2003	3,960	2,282	1,678
1983-2003	**72,760**	**36,307**	**36,453**

[a] See Table 5-3.

[b] See Table 5-4.

Source: Nathan Associates Inc.

Table 5-3

Additions to Potential Reserves of Obsolete Copper Scrap, 1983-2003 (million pounds)

Year	Newly Obsolete Copper Scrap [a] (1)	Non-Recoverable Obsolete Copper Scrap [a] (2)	Additions to Potential Reserves (3) = (1) - (2)
1982	4,984	2,063	2,921
1983	5,122	2,047	3,075
1984	5,388	2,171	3,216
1985	5,488	2,231	3,257
1986	5,479	2,231	3,248
1987	5,647	2,320	3,327
1988	5,518	2,247	3,271
1989	5,681	2,304	3,378
1990	5,664	2,267	3,397
1991	5,619	2,254	3,365
1992	5,731	2,343	3,388
1993	5,626	2,259	3,367
1994	5,848	2,332	3,516
1995	5,930	2,393	3,538
1996	5,860	2,365	3,495
1997	6,116	2,438	3,678
1998	6,188	2,469	3,719
1999	6,086	2,428	3,659
2000	5,791	2,381	3,410
2001	6,221	2,535	3,685
2002	6,442	2,632	3,811
2003	6,668	2,708	3,960
1983-2003	**122,114**	**49,354**	**72,760**

[a] See Appendix Tables A-1 through A-5 for totals by end-use market.

Source: Nathan Associates Inc.

Table 5-4

Withdrawals from Potential Reserves of Obsolete Copper Scrap, 1983-2003 (million pounds)

Year	Total New (Prompt) and Obsolete Scrap Recovered [a] (1)	Withdrawals from Potential Reserves [b] (2)
1983	2,489	1,315
1984	2,681	1,428
1985	2,905	1,597
1986	2,878	1,538
1987	3,035	1,651
1988	3,270	1,867
1989	3,337	1,968
1990	3,228	1,909
1991	2,987	1,691
1992	2,967	1,658
1993	2,984	1,583
1994	3,267	1,786
1995	3,417	1,857
1996	3,230	1,618
1997	3,539	1,863
1998	3,397	1,636
1999	3,273	1,452
2000	3,556	1,782
2001	3,342	1,682
2002	3,703	2,145
2003	3,855	2,282
1983-2001	**67,341**	**36,307**

[a] Total copper in recycled scrap consumed in the United States, including imports, plus total copper in scrap exports.

[b] Excludes prompt scrap that is included in previous column.

Source: Nathan Associates Inc.

Appendix

Table A-1

Additions to Potential Reserves of Obsolete Copper Scrap in the Building Construction End-Use Products Market, 1982-2003 (million pounds)

Year	Newly Obsolete Copper Scrap [a] (1)	Non-Recoverable Scrap [b] (2)	Additions to Potential Reserves (3) = (1) - (2)
1982	1,334	427	907
1983	1,792	574	1,219
1984	1,756	562	1,194
1985	1,847	591	1,256
1986	1,753	561	1,192
1987	1,684	539	1,145
1988	1,634	523	1,111
1989	1,678	537	1,141
1990	1,700	544	1,156
1991	1,512	484	1,028
1992	1,622	519	1,103
1993	1,663	532	1,131
1994	1,771	567	1,204
1995	1,825	584	1,241
1996	1,724	552	1,172
1997	1,859	595	1,264
1998	1,805	577	1,227
1999	1,755	562	1,193
2000	1,576	504	1,072
2001	1,793	574	1,219
2002	1,833	586	1,246
2003	1,885	603	1,282
1983-2003	**37,801**	**12,096**	**25,705**

[a] Newly obsolete copper scrap is the amount of copper in copper-containing products that reach the ends of their useful lives during the year.

[b] Approximately 32 percent of newly obsolete copper scrap.

Source: Nathan Associates Inc.

Table A-2

Additions to Potential Reserves of Obsolete Copper Scrap in the Electrical and Electronics End-Use Products Market, 1982-2003 (million pounds)

Year	Newly Obsolete Copper Scrap [a] (1)	Non-Recoverable Scrap [b] (2)	Additions to Potential Reserves (3) = (1) - (2)
1982	1,612	903	709
1983	1,312	735	577
1984	1,507	844	663
1985	1,574	882	693
1986	1,620	907	713
1987	1,769	990	778
1988	1,665	933	733
1989	1,688	945	743
1990	1,602	897	705
1991	1,609	901	708
1992	1,752	981	771
1993	1,556	871	685
1994	1,612	902	709
1995	1,691	947	744
1996	1,697	951	747
1997	1,689	946	743
1998	1,764	988	776
1999	1,685	944	741
2000	1,778	996	782
2001	1,880	1,053	827
2002	2,018	1,130	888
2003	2,057	1,152	905
1983-2003	**35,526**	**19,894**	**15,631**

[a] Newly obsolete copper scrap is the amount of copper in copper-containing products that reach the ends of their useful lives during the year.

[b] Approximately 56 percent of newly obsolete copper scrap.

Source: Nathan Associates Inc.

Table A-3

Additions to Potential Reserves of Obsolete Copper Scrap in the Industrial Machinery and Equipment End-Use Products Market, 1982-2003 (million pounds)

Year	Newly Obsolete Copper Scrap [a] (1)	Non-Recoverable Scrap [b] (2)	Additions to Potential Reserves (3) = (1) - (2)
1982	686	130	556
1983	637	121	516
1984	711	135	576
1985	645	123	523
1986	695	132	563
1987	747	142	605
1988	779	148	631
1989	840	160	680
1990	891	169	722
1991	955	181	773
1992	810	154	656
1993	857	163	694
1994	925	176	749
1995	841	160	682
1996	869	165	704
1997	961	183	779
1998	1,006	191	815
1999	992	188	803
2000	778	148	630
2001	875	166	708
2002	928	176	751
2003	1,020	194	826
1983-2003	**17,763**	**3,375**	**14,388**

[a] Newly obsolete copper scrap is the amount of copper in copper-containing products that reach the ends of their useful lives during the year.

[b] Approximately 19 percent of newly obsolete copper scrap.

Source: Nathan Associates Inc.

Table A-4

Additions to Potential Reserves of Obsolete Copper Scrap in the Transportation Equipment End-Use Products Market, 1982-2003 (million pounds)

Year	Newly Obsolete Copper Scrap [a] (1)	Non-Recoverable Scrap [b] (2)	Additions to Potential Reserves (3) = (1) - (2)
1982	701	245	456
1983	709	248	461
1984	735	257	478
1985	733	256	476
1986	728	255	473
1987	736	258	478
1988	743	260	483
1989	748	262	486
1990	762	267	496
1991	804	281	523
1992	808	283	525
1993	800	280	520
1994	801	280	521
1995	817	286	531
1996	830	291	540
1997	844	295	548
1998	872	305	567
1999	880	308	572
2000	896	314	583
2001	887	311	577
2002	882	309	573
2003	895	313	582
1983-2003	16,910	5,919	10,992

[a] Newly obsolete copper scrap is the amount of copper in copper-containing products that reach the ends of their useful lives during the year.

[b] Approximately 35 percent of newly obsolete copper scrap.

Source: Nathan Associates Inc.

Table A-5

Additions to Potential Reserves of Obsolete Copper Scrap in the Consumer and General End-Use Products Market, 1982-2003 (million pounds)

Year	Newly Obsolete Copper Scrap [a] (1)	Non-Recoverable Scrap [b] (2)	Additions to Potential Reserves (3) = (1) - (2)
1982	651	358	293
1983	672	369	302
1984	678	373	305
1985	689	379	310
1986	683	376	307
1987	710	390	319
1988	697	383	314
1989	728	400	327
1990	709	390	319
1991	740	407	333
1992	738	406	332
1993	751	413	338
1994	740	407	333
1995	757	416	340
1996	740	407	333
1997	763	420	343
1998	742	408	334
1999	775	426	349
2000	762	419	343
2001	785	432	353
2002	782	430	352
2003	811	446	365
1983-2003	15,449	8,497	6,952

[a] Newly obsolete copper scrap is the amount of copper in copper-containing products that reach the ends of their useful lives during the year.

[b] Approximately 55 percent of newly obsolete copper scrap.

Source: Nathan Associates Inc.