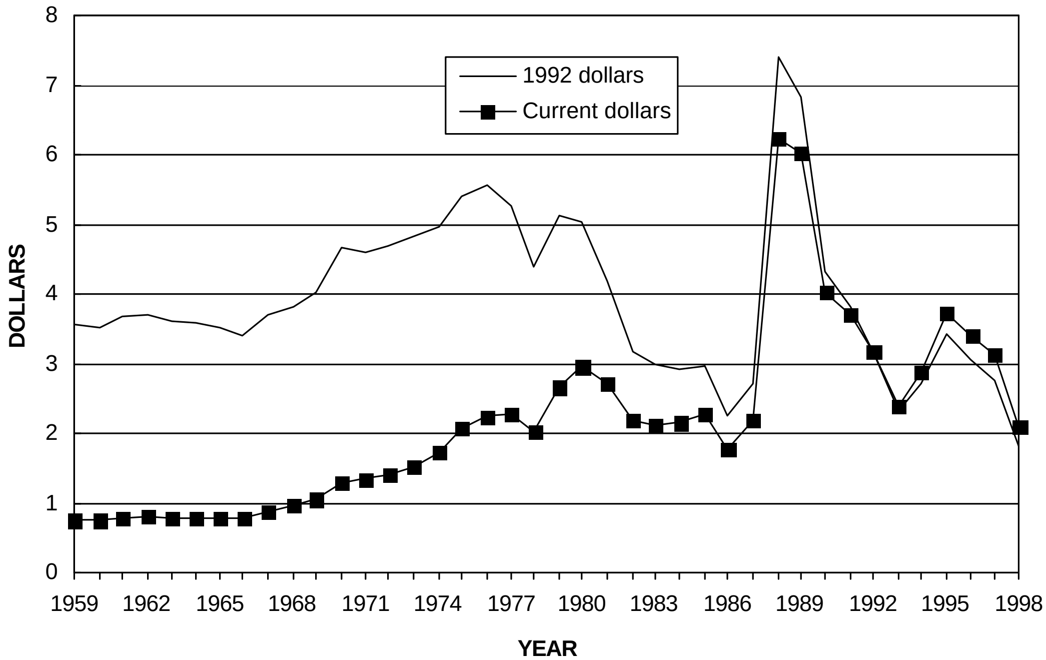
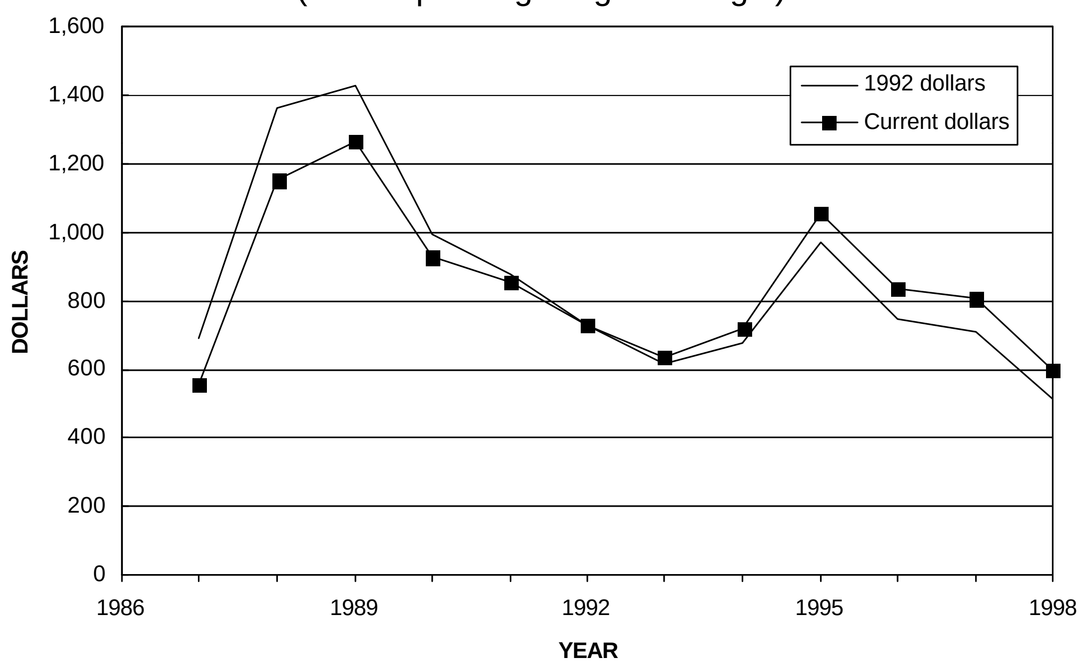
Nickel

by Peter H. Kuck

Annual Average Nickel Price
(Dollars per pound)



Annual Average Price for 18-8 Stainless Steel Scrap
(Dollars per long ton gross weight)



Significant events affecting nickel prices since 1958

1966	Western Mining Corp. discovered nickel sulfide mineralization at Kambalda, Western Australia, triggering extensive exploration of the greenstone belts between Norseman and Wiluna
1969	Canadian labor strike led to a severe spot shortage of nickel and a sixfold increase in the price of cathode
1972	Falconbridge Dominicana C. por A. commissioned its ferronickel smelter at Bonao, Dominican Republic
1977	P.T. International Nickel Indonesia (P.T. Inco) commissioned its Soroako mining and smelting complex on the Indonesian island of Sulawesi; laterite mining began in Guatemala
1978-79	Labor strike in the Sudbury District of Ontario reduced Canadian mine output by more than 40%
1979	Nickel became the seventh metal traded on the London Metal Exchange (LME)
1981-82	A worldwide recession caused nickel demand and prices to fall sharply
1987-88	The Government of the Dominican Republic levied a substantial export duty on ferronickel; Falconbridge Dominicana countered by limiting ferronickel shipments and declaring force majeure
1987-89	Supply shortages; Stainless steel production in the Western World passed the 10-million-metric-ton-per-year mark
1991	Dissolution of the Soviet Union followed by a sharp rise in exports of Russian nickel
1993	Voisey's Bay nickel-copper deposit discovered in northeastern Labrador by diamond prospectors
1999	The Murrin Murrin laterite mine and two other pressure acid-leaching operations came onstream in Western Australia

During the 17th century, German miners had difficulty processing certain copper sulfide ores because of an associated mineral that they called kupfernickel, or "Old Nick's copper." The troublesome mineral turned out to be nickel arsenide and is known today as "niccolite" or "nickeline." In 1751, Axel Fredrik Cronstedt isolated a previously unknown chemical element from niccolite. This element was subsequently named "nickel." Nickel was mined on only a limited scale until the large lateritic nickel deposits in New Caledonia came into production about 1875 (Boldt and Queneau, 1967, p. 61-65). The first nickel operations processed sulfide ores—primarily in Canada, Central Europe, China, Pennsylvania, and Scandinavia. Nickel had little economic or industrial significance until 1820 when Michael Faraday succeeded in making synthetic meteoric iron by adding nickel to pure iron. Faraday's alloy was the forerunner of nickel steel, a family of ferrous alloys that continues to play an important role in industrial development. One of the first uses of nickel steel was for ordnance. Nickel-steel armor plate was first produced commercially in France in 1885 (Hall, 1954). Competitiveness trials of nickel-steel armor took place in the United States in 1890-91, and within a few years, Bethlehem Iron Co. (forerunner of Bethlehem Steel Corp.) was producing large nickel-steel guns for the U.S. military (Wharton, 1897). The nickel steels developed before World War I contained only 1.5% to 4.5% nickel, with a carbon content of 0.2% to 0.5% (Hess, 1917). Other important early uses were bridge structures, railroad rails, axles, ship propeller shafts, and automobile engine parts (Cammen, 1928). The first commercial chromium-nickel steel—and one of the first grades of stainless steel—was made at St. Chamond, France, in 1891. Like nickel-steel armor, chromium-nickel-steel armor proved to be much superior to the carbon-steel plate then in use, triggering extensive production of the new type of steel (Hall, 1954, p. 1-62).

In the late 1990's, stainless steel production accounts for more than 60% of world nickel consumption and is the primary factor in nickel pricing. Stainless steel is defined as an iron alloy that contains at least 11% chromium. Nickel-bearing stainless steels are termed "austenitic", a reference to their characteristic solid solution microstructure, and typically contain between 6% and 22% nickel—with 18% chromium and 8% nickel being the most common composition. In the Western World, total stainless steel production has grown at about 6.1% per year since 1950 (Inco Limited, 1998, p. 3-8). Since 1985, the austenitic share of Western stainless steel production has accounted for about 75% of total stainless output, the rest being ferritic or martensitic. In recent years, the austenitic percentage for the United States has ranged from 63% to 67% because its steel plants produce significant amounts of ferritic stainless for the North American automobile industry. Since 1970, demand for stainless steel in the United States has grown at a much faster rate than that of carbon steel but still constitutes only 2% of total U.S. raw steel production. For the next 20 years, stainless steel production is expected to continue to play a prominent role in determining nickel price levels.

Like petroleum, nickel is a critical commodity in wartime. Nickel, as well as cobalt, is needed to make superalloys for engines that propel jet aircraft and guided missiles. Pure nickel is used in high-performance batteries, such as those that start jet engines or power satellites. Austenitic stainless steel and nickel-base superalloys are commonly used if chemical corrosion is a serious problem, such as on submarines and surface naval vessels or at food-processing or petroleum-storage facilities. Merchant nickel prices traditionally spike in wartime when demand far exceeds supply and frequently rise in times of political unrest and instability. Producer prices, in contrast, have been frozen in several crises by war-production boards or emergency price-control regulations.

The Korean Conflict is a good illustration of price spiking and distribution controls. During the transition from a civilian to a defense economy, demand for nickel exceeded available supply even though North American nickel mines and plants were operating at full capacity. At the outset of the conflict, the U.S. Government took control of the distribution of nickel, and from 1951 to 1957, all nickel in the United States was under Government allocation. At the same time, the Government also acquired nickel for the national strategic stockpile. The combination of these actions resulted in a severe shortage of nickel for nondefense uses (Davis, 1956). Shortages continued throughout the conflict despite the addition of significant new production capacity in Canada and the United States and the rehabilitation of a number of older mines and plants. Moreover, the U.S. Government continued to purchase nickel for the strategic stockpile after the conflict ended. As a result, supply did not exceed civilian demand until the latter part of 1957, 4 years after the armistice. The producer price of nickel—tracking consumption—began a gradual rise in 1950 and did not peak until 1957. A period of oversupply followed, during which quoted producer and merchant prices for nickel approximately paralleled inflation. This situation produced a constant-dollar price for the metal that was fairly stable for more than 10 years.

In 1969, the Canadian nickel, copper, and iron ore industries were shut down by a prolonged series of labor strikes. Canada was the dominant nickel-producing country in the world at the time. Canada's two largest producers, Inco Limited and Falconbridge Limited, accounted for 48% of world production the previous year. Because of the strikes, Canadian nickel production was almost 20% less than that of 1968 (Morrell, 1971). The strikes took place at a point in time when global stocks were low and world demand was restricted by available supply.

The 1969 strikes affected nickel prices in two ways. Before the strikes, the major producers, led by the Canadians, controlled the nickel price. The short-term effect was a brief price increase. The long-term effect was to diminish the importance of the producer price. Canadian and non-Canadian producers accelerated efforts to expand existing operations and to bring greenfield projects onstream before prices weakened. Between 1969 and 1974, new mines and processing plants were commissioned in Australia, Canada, the Dominican Republic, and New Caledonia. The increased capacity resulted in a reduction of the Canadians' share of the world market and, thus, their influence on prices—a turning point in the history of nickel marketing.

In the mid-1970's, Western Mining Corp. Ltd. (now WMC Ltd. of Southbank, Victoria) sharply expanded its mining operations in the Kalgoorlie region of Western Australia. Australia is now the third largest nickel producer in the world because of additional discoveries in Western Australia, the subsequent construction of a major natural gas pipeline from the North West Shelf to Kalgoorlie, and the advent of new extraction technologies (Government of Australia, 1999).

Nickel prices, reflecting consumption, rose slightly from 1970 until 1975, when the cumulative effect of opening several new production facilities began to be felt. In 1975, U.S. demand for nickel weakened, partially because of the termination of U.S.-led military operations in Vietnam. In 1977, P.T. Inco commissioned its Soroako mining and smelting complex on the Indonesian island of Sulawesi, bringing additional metal into the marketplace. An oversupply situation and declining consumption caused prices to remain flat until the Inco strike of 1978-79. The strike at Inco's operations in the Sudbury District lasted from September 16, 1978, to June 3, 1979 (Inco Limited, 1980, p. 4-9). Between February 1979 and the end of the year, Inco raised its Port Colborne price for cathode six times. The effect of the Inco strike on prices was compounded by the fact that major producers had been operating at 55% to 60% of capacity to reduce inventories and to improve the price situation.

The Inco strike helped accelerate major changes in nickel pricing. In spring 1979, nickel became the seventh metal traded on the LME—marking a major turning point in pricing of the metal. Today, nickel prices are set by the LME rather than by the producers. Since 1979, nickel has become a commodity whose price is driven by world supply and demand, irrespective of production costs. Many consumers, as well as producers, were opposed to LME trading at the time. Most, however, would now agree that the LME is a practical and effective forum for establishing an international reference price for nickel, improving price transparency, and rapidly disseminating price data. It is difficult to say how much nickel, probably a small proportion, actually sells at the LME price. The LME price has more importance than appears at first glance because it is used as a reference price in long-term contracts. For example, a large nickel producer might ask for a premium to the LME price, and a smaller one might sell at a discount. Because of the LME, producer prices became irrelevant in the early 1980's.

The Second Oil Crisis (1979-82), triggered by the revolution in Iran, had a major dampening effect on world consumption of steel and most metals. The resulting recession that began in summer 1981 caused a marked decline in nickel consumption. Nickel demand in the Western World declined about 8% in 1981; this was the first time since the late 1940's that demand had declined for two consecutive years. The recession ended in November 1982, but prices continued to weaken until 1985 because of slackening demand. In 1987, the market suddenly changed direction, catching producers off guard. The annual average price surged from its lowest level ever in 1986 to its highest in 1988 (in terms of 1992 constant dollars for the period 1910-97).

The monthly average LME cash price rose gradually from $1.60 per pound at the beginning of 1987 to $2.69 in November. In December 1987, it suddenly shot up to $3.48. The rapid increase continued in 1988, with the monthly price reaching $8.17 in April. These price levels would have been unimaginable to the nickel market 4 years earlier. Three factors were primarily responsible for the increase. The first was a substantial and unforseen increase in demand for stainless steel, the largest end use for nickel. More than 50% of stainless steel production in the United States and Europe is sold through service centers (companies that buy directly from a stainless mill and sell to customers). Service centers do not publish detailed sales statistics in terms of end use, making it difficult for stainless producers to monitor consumption of their product. The second factor was that nickel producers reduced world production capacity because of low metal prices during the early and mid-1980's. At least five nickel producers closed operations during this period. A third factor was the decreased availability of stainless steel scrap.

Although Western demand for nickel grew continuously between 1985 and 1991, the LME price peaked in 1988 and declined each year afterward until 1994. The reasons for this paradoxical trend were threefold—the former Soviet Union (FSU) began gradually increasing nickel shipments to the West, scrap availability increased worldwide, and world production of primary nickel increased.

The breakup of the Soviet Union in December 1991 produced massive changes in the Russian economy, one of which was the partial privatization of the largest nickel producer in the country, RAO Norilsk Nickel. At the same time, the downsizing of the FSU military-industrial complex caused nickel consumption within Russia to plummet. In 1997, Russia consumed only 20,000 metric tons of primary nickel, compared with 180,000 tons in 1989 (International Nickel Study Group, 1998). Russian consumption weakened even more in 1998, slipping to less than 18,000 tons. These changes led to a surge of primary nickel from Russia, putting downward pressure on world prices for primary nickel and nickel-bearing scrap. Russian exports of stainless steel scrap and high-nickel scrap to the European Union (EU) also sharply increased, further depressing world nickel prices. Russia continues to maintain its position as the largest nickel producer in the world despite its difficult economic situation. More than 90% of Russia's output currently (1998) comes from mines operated in the Arctic by Norilsk Nickel. Because of internal demands within Russia for hard currency and the depressed state of the Russian stainless steel industry, Norilsk Nickel is expected to continue exporting the bulk of its production to the West at least until 2005.

The Russian situation, the current recession in Japan, and economic problems in other parts of East Asia have caused the monthly LME cash price to decline from $3.20 per pound in June 1997 to $1.76 in December 1998. Since 1997, Western nickel producers have had to struggle to cut costs in the face of weakening prices for the metal. Prices improved slightly in the first half of 1999, climbing back to the $2.25 to $2.50 level. The commissioning of three nickel mining and metallurgical complexes in Western Australia at the beginning of 1999 is, however, expected to put renewed downward pressure on prices. All three operations use variations of a high-pressure acid leach process to extract nickel and cobalt from limonitic laterite ores. The nickel is then separated from the cobalt by solvent extraction. Several analysts believed that the three Australian complexes will have low operational costs and will be extremely competitive because of their cobalt byproduct credits.

Inco remains committed to the development of the huge Voisey's Bay nickel-copper-cobalt deposit in northeastern Labrador (Inco Limited, 1999, p. 20-21). In December 1997, Inco submitted a comprehensive environmental impact statement on the proposed mine and mill to Canadian regulatory authorities. Since then, the Voisey's Bay project has undergone extensive environmental and socio-economic scrutiny. In March 1999, a special panel overseeing the environmental review recommended that the project proceed, subject to a number of stipulations. Complex and lengthy negotiations are currently (1999) underway with the Provincial Government and other key stakeholders. The development of the deposit, which Inco acquired in 1995-96, is expected to have a major impact on the world nickel market sometime after 2003.

Pricing Mechanisms for Nickel Metal

On April 23, 1979, nickel contracts were introduced for the first time on the LME. Leading nickel producers at first stiffly opposed the LME pricing mechanism. Nickel business on the LME, however, steadily grew in spite of the producers' opposition, convincing the producers to reverse their position. Producer participation has increased considerably since 1985 because of the LME's hedging and options capabilities. Today, LME prices are the principal pricing mechanism used worldwide by producers and consumers of nickel. LME prices and archival statistics are available 24 hours a day at the LME website, thus minimizing arbitrage. LME prices are also quoted by day in a variety of weekly trade publications, including Metal Bulletin, Platt's Metals Week, and Ryan's Notes. In 1999, the LME pricing system had the support of nine of the larger nickel producers in the world. Five of the nine are Associate Trade Members of the Exchange—Inco; Falconbridge (through its principal shareholder, Noranda Inc.); Outokumpu Oyj of Espoo, Finland; Rio Tinto Plc. of London; and WMC. All five sell metal that meets LME specifications. Metal produced by Norilsk Nickel and the ERAMET Group—two other major producers—has also been approved for delivery on LME warrants, together with metal from Sumitomo Metal Mining Co. Ltd. and several smaller producers. QNI Limited of Brisbane, Australia—the ninth company—recently became a major player in the nickel market. QNI has ties to the LME through its parent, Billiton Plc., but produces material unlisted on the LME: sintered-nickel rondelles, nickel oxide powder, nickel oxide granules, and ferronickel.

The principal purpose of the LME since its opening in 1877 has been to serve as a futures market, providing protection to producers, traders, and consumers alike against unpredictable price fluctuations (Rudolf Wolff & Co. Ltd., 1995). The LME has a membership of more than 100 firms. Of these, 15 take part in Ring dealing, which consists of open outcry trading sessions that take place twice a day. Unlike other futures markets, the LME also serves as a center for physical trading and has an international network of approved warehouses. In the case of nickel, the bulk of the warehousing is done in the Netherlands at Rotterdam. The LME is regulated by the British Treasury under the Financial Services Act of 1985.

Hedging, a form of insurance available to producers and consumers alike, is a key component of the futures market and reduces a producer's exposure to price changes while the raw nickel is moving through different processing stages at the producer's facilities. To guard against sudden price movements, the producer will hedge a planned physical transaction by entering into an offsetting forward contract on the LME. The forward contract is often designed to mature at about the same time as the physical sales date. Most hedged contracts are bought or sold back before they mature. Only about 5% of LME contracts result in an actual delivery.

Speculators play an important role in futures trading because they bring liquidity to the market and assume the risk that the hedger is trying to avoid. Because metals speculation is a high-risk venture, only professional investors or institutions with sufficient capital to withstand the risk are normally allowed to participate. Option contracts give hedgers and investors more flexibility than a straight futures hedge. The option allows the hedger to lock in a contract at a fixed price but, at the same time, gives the hedger the flexibility to abandon the option if a favorable price movement occurs.

Five different price series for nickel are available from the LME:

- Cash
- Settlement
- 3-month futures
- 15-month futures
- 27-month futures.

Prices are quoted at midday and at the close of the afternoon session. Metal Bulletin and Platt's Metals Week also publish daily LME mean or index prices. The data shown in the accompanying table for the years since 1979 represent the annual average cash price.

North American consumers have several other price series that they can use in contract negotiations. For example, Platt's Metals Week and Ryan's Notes compile and publish their own copyrighted prices. Three of the Metals Week prices most commonly quoted are New York Dealer Cathode, New York Dealer Melting Grade, and New York Dealer Plating Grade. The New York Dealer Cathode price closely tracks the LME cash price but is normally slightly higher because it reportedly incorporates insurance and freight costs incurred when cathode is transferred from LME warehouses in Europe to the East Coast. Prices for plating grades typically carry a premium of 15 to 25 cents (U.S.) per pound, and melting grade premiums are on the order of 5 to 15 cents per pound (Platt's Metals Week, 1972-98).

Pricing Mechanisms for Stainless Steel Scrap

Nickel is less abundant than either chromium or iron in the Earth's crust because of nickel's higher atomic number and differences in the nuclear stability of the respective isotopes of the three elements. As a result, on an elemental basis, ferronickel is about 5 to 8 times more expensive than ferrochromium and 30 to 50 times more expensive than pig iron, depending upon the market situation at the time. As a rule of thumb, austenitic (Ni+Cr) stainless steel scrap is roughly three times more valuable than ferritic (Cr only) stainless steel scrap. Because the highest value material in austenitic stainless steel is nickel, stainless steel scrap prices closely track those of nickel cathode except when ferrochromium is in short supply.

Almost all stainless steel produced in the United States is made in electric-arc furnaces. The majority of the stainless steel production facilities are in Pennsylvania. Nickel-base superalloys and other nickel-chromium alloys also are commonly made in electric-arc furnaces. The characteristics of the electric furnace permit the operator to use a large percentage of scrap, economizing on consumption of virgin chromium and nickel.

The stainless steel scrap prices shown in the accompanying table were derived from daily data published by American Metal Market. The data represent consumer buying prices in the Pittsburgh, PA, area for austenitic stainless steel scrap and are quoted in dollars per long ton gross weight. The scrap is in the form of bundles, solids, and clippings typically containing 18% chromium and 8% nickel. Turnings of 18-8 alloy are more difficult to handle than bundles and fetch only about 85% of the bundle price. American Metal Market also publishes estimated prices that a dealer, broker, or processor would pay for 18-8 scrap delivered to yards in 10 different areas of the United States plus the Montreal area of Canada.

Although many types of nickel scrap are recycled in the United States, most is in the form of stainless steel. Stainless steel scrap currently (1999) accounts for about 85% of reclaimed nickel in the country. This includes scrap consumed in foundries in addition to that used in raw steelmaking. Scrap accounts for as much as 80% of total feed materials at some European stainless steel production facilities but typically 60% to 70% in the United States—the remainder being ferroalloys or virgin metals. The bulk of the scrap is conventional austenitic or ferritic stainless steel. The scrap is often blended and may include lesser amounts of low alloy steel, superalloys and other high-nickel-chromium alloys, and/or specially-processed fines of high-carbon ferro-chromium. A high scrap ratio (i.e., a high percentage of scrap in the total charge) reduces melting time and electricity consumption but makes final chemical adjustments to the melt more difficult. A few foreign mills have recently dropped their scrap ratio down to 30% or 40% because of problems in purchasing quality scrap at a reasonable price.

Copper-nickel and superalloy scrap make up a large portion of the remaining 15% of nickel reclaimed in the United States. Aircraft engine manufacturers return turnings, chippings, and similar forms of prompt superalloy scrap to superalloy producers for remelting. Segregation of these materials by the engine manufacturers is absolutely critical. Because of quality control concerns, part of the obsolete superalloy scrap generated at aircraft engine repair facilities is downgraded and used to make stainless steel.

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Annual Average Price for 18-8 Stainless Steel Scrap
(Dollars per long ton gross weight[1])

Year	Price	Year	Price	Year	Price	Year	Price
1987	560	1990	927	1993	634	1996	834
1988	1,150	1991	855	1994	719	1997	808
1989	1,266	1992	728	1995	1,055	1998	600

[1] To convert to dollars per metric ton, multiply by 0.984207.

Note:
1987-98, Derived from the average of the Friday consumer buying price range for 18% Cr-8% Ni scrap in bundles, solids, and clips, Pittsburgh, PA, *in* American Metal Market.

Annual Average Nickel Price

(Dollars per pound[1])

Year	Price	Year	Price	Year	Price	Year	Price
1840	1.70	1880	0.95	1920	0.42	1960	0.74
1841	1.70	1881	0.91	1921	0.42	1961	0.78
1842	2.09	1882	0.99	1922	0.38	1962	0.80
1843	2.40	1883	1.11	1923	0.36	1963	0.79
1844	2.75	1884	0.70	1924	0.30	1964	0.79
1845	3.05	1885	0.65	1925	0.33	1965	0.79
1846	3.05	1886	0.48	1926	0.36	1966	0.79
1847	2.89	1887	0.62	1927	0.35	1967	0.88
1848	2.19	1888	0.58	1928	0.37	1968	0.95
1849	1.93	1889	0.65	1929	0.35	1969	1.05
1850	1.93	1890	0.65	1930	0.35	1970	1.29
1851	1.93	1891	0.55	1931	0.35	1971	1.33
1852	1.93	1892	0.75	1932	0.35	1972	1.40
1853	1.70	1893	0.52	1933	0.35	1973	1.53
1854	1.70	1894	0.57	1934	0.35	1974	1.74
1855	1.57	1895	0.30	1935	0.35	1975	2.07
1856	1.57	1896	0.33	1936	0.35	1976	2.25
1857	1.45	1897	0.33	1937	0.35	1977	2.27
1858	1.20	1898	0.33	1938	0.35	1978	2.04
1859	1.20	1899	0.32	1939	0.35	1979	2.66
1860	1.20	1900	0.50	1940	0.35	1980	2.96
1861	1.20	1901	0.56	1941	0.35	1981	2.71
1862	1.08	1902	0.45	1942	0.32	1982	2.18
1863	1.65	1903	0.40	1943	0.32	1983	2.12
1864	2.29	1904	0.40	1944	0.32	1984	2.16
1865	1.68	1905	0.40	1945	0.32	1985	2.26
1866	1.55	1906	0.40	1946	0.35	1986	1.76
1867	1.52	1907	0.45	1947	0.35	1987	2.19
1868	1.14	1908	0.45	1948	0.36	1988	6.25
1869	1.39	1909	0.40	1949	0.40	1989	6.04
1870	1.28	1910	0.40	1950	0.45	1990	4.02
1871	1.32	1911	0.40	1951	0.54	1991	3.70
1872	2.25	1912	0.40	1952	0.57	1992	3.18
1873	3.84	1913	0.42	1953	0.60	1993	2.40
1874	3.10	1914	0.41	1954	0.61	1994	2.88
1875	2.96	1915	0.41	1955	0.66	1995	3.73
1876	2.52	1916	0.42	1956	0.65	1996	3.40
1877	1.60	1917	0.42	1957	0.74	1997	3.14
1878	0.95	1918	0.41	1958	0.74	1998	2.10
1879	0.89	1919	0.40	1959	0.74		

[1] To convert to dollars per metric ton, multiply by 2,204.62.

Note:

1840-1912, Price of refined metal, *as* supplied by Inco Ltd.

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1948-61, Contract price to U.S. buyers of electrolytic nickel cathode in carlots, f.o.b. Port Colborne, Ontario, including duty of 1.25 cents per pound, *in* the nickel chapter of the U.S. Bureau of Mines Minerals Yearbook. [Duty was halved on January 1, 1948.]

1962-79, Contract price to U.S. buyers of electrolytic nickel in carlots, f.o.b. Port Colborne, Ontario, *in* American Metal Market. Weighted average for the year. U.S. import duty of 1.25 cents per pound was suspended on September 27, 1965.

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