DEVELOPMENT OF THE SOUTH AFRICAN FERRO-ALLOY INDUSTRY SINCE 1960

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SYNOPSIS

African Metals Corporation (Amcor), the forerunner of Samancor, was the founder of the ferro-alloy industry in South Africa, and began producing ferro-manganese in a small blast furnace in 1938.

In 1942 Amcor began operating the first electric furnaces used in South Africa for making ferro-alloys. In 1975 a merger was finalised between the companies - Amcor and S.A. Manganese Ltd. and the name of the new company became S.A. Manganese Amcor Ltd. (Samancor). Today, Samancor operates large ferro-alloy works situated at Meyerton, Witbank and Pietersburg, producing manganese, chrome and silicon alloys. These works make approximately 50 percent of the total South African ferro-alloy output, which is approaching two million tons a year. South Africa is rich in mineral wealth, and in manganese and chrome ores in particular has the major share of the world's reserves. From 1960 onwards, due to an upsurge in the world steel industry, the export market for ferro-alloys from South Africa expanded considerably and during the next ten years five other major ferro-alloy works were built in South Africa. These works which also produce alloys of manganese, chrome and silicon, are controlled by various large mining groups, and have all expanded since their inception.

The infrastructure in South Africa has grown apace with industry, and with thermal power from coal, the South African ferro-alloy industry has become the major supplier to the world's steel industry. Modern air pollution abatement equipment is being installed in all the works.

The South African ferro-alloy industry today exports at least 90 percent of its total output, and the balance is sufficient for the requirements of the local carbon and stainless steel industries.

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Introduction

The growth in the South African ferro-alloy industry has been spectacular, particularly in the last ten years, but in order to provide a complete picture I propose to refer briefly to developments prior to 1960, and to the founding of the industry in 1938.

In this paper I refer largely to African Metals Corporation (Amcor) because for almost twenty years Amcor was the only ferro-alloy producer in South Africa. In 1975 the interests of Amcor were merged with those of S.A. Manganese Limited, and the name of the new company became S.A. Manganese Amcor Limited (Samancor). The writer became associated with the world of ferro-alloys on his appointment as Managing Director of Amcor in December 1968, and in April 1978 became Chairman of Samancor. At the same time Mr. P.E. Streicher was appointed Managing Director.

1938

The ferro-alloy industry in South Africa was founded by the late Dr. H.J. van der Bijl, who was one of South Africa's most brilliant industrialists. He had been vitally interested in the founding of the South African Iron and Steel Industrial Corporation (Iscor) in 1934, and was appointed the first Chairman. He also established the Electricity Supply Commission, which company supplies virtually the entire power requirements for the country, and was also involved in many other large undertakings.

In 1938 Iscor imported all its requirements of alloys, and in that year Dr. van der Bijl formed the company African Metals Corporation (Amcor), and became the first Chairman. Amcor commenced operations in Newcastle, Natal, with one small blast furnace which produced pig iron for local foundries, and high carbon ferro-manganese intermittently for Iscor.

With the outbreak of World War II in 1939, there was an urgent demand for special steels for South Africa's armaments, and Amcor took the decision to build a ferro-alloy works for the production of additional supplies of manganese alloys, as well as chrome and silicon alloys. The works was sited at Vereeniging, Transvaal, and production commenced with two small electric furnaces in 1942.

It is interesting to note that between 1943 and 1947, in addition to manganese, chrome and silicon alloys, this works also produced some 3 000 tons of stainless steel as well as small quantities of lead, ferro-tungsten and ferro-titanium. This was a meritorius achievement for Amcor's technical officials.

1946-1960

In 1946, Amcor built a second blast furnace at Newcastle for pig iron production, and this was followed by a third larger furnace a few years later.

The demand for ferro-alloys also burgeoned and a second ferro-alloy works was built by Amcor at Meyerton, close to Vereeniging, where two 12 MVA furnaces were installed. Production commenced in 1951 and three years later the old Vereeniging works was closed after the two small furnaces were transferred to the new works, where there was ample room for future expansion.

At this time, the total output of ferro-alloys amounted to some 15 000 tons a year - more than the requirements of the South African market - and Amcor began investigating the export field.

The first export consignment of alloys actually took place in August 1951, when a parcel of 25 tons of silico-manganese was shipped to the British Iron & Steel Corporation, now the British Steel Corporation. A period of rapid expansion in Amcor followed. By 1956 total ferro-alloy production had reached 53 000 tons. By 1958 there were six electric furnaces at the Meyerton works and two refining units with a total installed capacity of 50 MVA, and production had risen to 70 000 tons annually.

Amcor was by then firmly established in exports, and was exporting some 30 000 tons annually to 37 different countries.

New Producers

By 1960 there were two other ferro-alloy producers in South Africa, both of which had commenced operations in the late 1950's. One was Rand Carbide Limited at Witbank, Transvaal, where a 16 MVA furnace produced ferro-silicon, and the other was Ferrometals Limited, also operating in Witbank with two 7,5 MVA furnaces, making ferro-silicon and ferro-chrome.

With the increasing demand for alloys, further urgent expansion by Amcor became essential, and negotiations were opened by Amcor to take over Ferrometals Limited. This was successfully accomplished in January 1960, and construction began soon after of a third furnace of 15 MVA capacity at the works at Witbank.

In 1960 world steel production had reached a figure of 330 million tons a year, and South African steel production over 3 million tons. This meant that in the world over 2 million tons of ferro-manganese was being consumed annually.

It was at this time some of the large South African mining companies considered entering the ferro-alloy field. Manganese and chrome ores had been exported in mineral form for many years, and with the abundance of these minerals in South Africa, the potential was realised of supplying them in beneficiated form to the world's steel industries.

Associated Manganese Mines of South Africa Limited, part of the Anglo Transvaal Group of companies, had been exporting manganese ore since 1936. Early in 1960 they commissioned a ferro-alloy works, Feralloys Limited, at Cato Ridge near the port of Durban. Two 8 MVA furnaces for the production of high carbon ferro-manganese were installed, and four years later two 9 MVA furnaces were added. Feralloys' production is virtually all exported.

During 1963 two further ferro-alloy plants were commissioned. Successful pilot plant experiments carried out in Norway using as a raw material Transvaal chrome ores, with a chromium to iron ratio of 2:1, led to the formation of Palmiet Chrome Corporation (Pty) Limited. This was established by General Mining and Finance Corporation Limited at Krugersdorp, Transvaal, for the production of low carbon ferro-chrome and charge chrome.

At the Krugersdorp plant there are now three electric furnaces with a capacity of 45 MVA producing approximately 80 000 tons annually of charge chrome.

Pilot plant trials undertaken by Rand Mines Limited also led to the formation of R.M.B Alloys (Pty) Limited, at Middelburg in the Transvaal. Initially, this plant was designed for the production of 16 000 tons annually of low carbon ferro-chrome.

With the development of new decarburising processes overseas in the production of stainless steel, construction of the Southern Cross Steel Company began on the same site as the R.M.B. Alloy's works in 1965, and production of stainless steel began one year later.

Market rationalisation led to a merger between Palmiet Chrome and R.M.B Alloys in 1969, under a holding company Middelburg Steel and Alloys (Pty) Limited (M.S. & A.), which today is part of the Barlow Rand Group of Companies.

At the Middelburg plant there are now eight furnaces with an installed transformer capacity of 96 MVA producing 162 000 tons annually of charge chrome, low carbon ferro-chrome and ferro-chrome silicide.

Since the first ingot of stainless steel was cast in 1966 by the Southern Cross Steel Company, the plant has been extensively expanded to a current ingot capacity of 50 000 tons per annum. Production is by open-arc melting and argon-oxygen decarburisation (AOD) refining, working in tandem. Early in 1980 Southern Cross began a further expansion programme including cold rolling facilities, and estimated to cost R127 million.

In 1964 another producer entered the ferro-alloy field in South Africa, namely Transalloys (Pty) Limited, a joint venture of the Anglo American Corporation and Avesta Jernwerks of Sweden. Their works was built at Witbank, and with two Elkem 15 MVA and two Demag 4 MVA furnaces, they began producing high and low carbon ferro-chrome and silico-chrome alloys. Technical problems and depressed market conditions hampered the envisaged development of Transalloys, and in 1969 production of chromium alloys was discontinued and the production of manganese alloys commenced.

In 1975 Highveld Steel and Vanadium Corporation acquired the majority shareholding in Transalloys from Anglo American Corporation, and a stronger base load for the domestic market was developed with Transalloys supplying Highveld's requirements of ferro-manganese and ferro-silicon.

After Transalloys' technical and marketing activities had been placed on a firm footing, construction began of a 48 MVA Elkem furnace for silico-manganese production, and this was commissioned in 1977.

The older furnaces of Transalloys have all been uprated and today the capacity is as follows:

Silico-manganese	1 - 48 MVA) 1 - 22 MVA)	66 000 t p a
Refined ferro-manganese (M C)	1 - 7 MVA) 1 - 7 MVA)	33 000 t p a
Ferro-silicon (70/75%)	1 - 22 MVA	13 000 t p a

Pig Iron

Amcor, meanwhile, continued to expand and a noteworthy event in their history was in 1962 with the announcement of the signing of a contract for the

supply of 5 000 000 long tons of pig iron to the Yawata Iron and Steel Company of Japan. This valuable contract amounted to R180 million, and the pig iron was to be delivered over a ten year period commencing in 1964. Amcor immediately commenced the erection of their fourth blast furnace at Newcastle. This furnace, with a hearth diameter of 28 feet, was estimated to cost R12 million, and have a production capacity of 720 000 tons of pig iron annually.

In the execution of this contract, close collaboration was maintained with the South African Railways' administration. Incoming raw materials consisting of iron ore, coke and dolomite required a vast amount of transport; two trainloads of pig iron a day were required from Newcastle to Durban, and new loading facilities at the port of Durban were established by the S.A. Railways.

Discovery of Chrome Ore

Another fortuitous event in 1962 was the discovery of chrome ore in the Potgietersrus district of the northern Transvaal. A lump of chrome ore was accidentally unearthed by a roadscraping machine, and the sample was taken to Amcor. Options on three farms in the area were taken up by Amcor and a prospecting programme was undertaken which proved the presence of vast reserves of chrome ore. It was a hard lumpy type of ore with 42% Cr_2O_3 and a chrome to iron ratio of 2,3:1.

The reef is part of what is known as the Bushveld Igneous Complex, and ironically had, in fact, been prospected many years before, although at that stage the prospecting trenches had just missed the chrome seam.

The largest known chromite deposits in the Western World are concentrated in the Transvaal, and the chromite reefs extend as a crescent for 180 miles near Rustenburg, re-emerging for a 100 miles near Lydenburg, and again for nearly 40 miles near Potgietersrus. The South African chromite reserves have been calculated to be at least 3 billion tons - 80% of the world total. There are 18 active mining operations which currently produce over 3 million tons annually - 23% of the world total.

Further Ferro-Alloy Developments

By 1964 there were six ferro-alloy producing companies in South Africa and the South African Ferro-Alloy Producers' Association was formed. The Association filled a useful role - particularly in the rationalisation of exports, ship chartering and other matters of mutual interest to members.

The next five years, that is from 1965 to 1970, was a period of consolidation in the South African ferro-alloy industry. World steel production rose from 460 to 600 million tons a year during this period, and was expected to achieve a steady growth rate in the next few years. The fortunes of the world ferro-alloy industry, which are interlinked with the steel industry, had fluctuated during this period to a very low ebb in 1968 due to over capacity, but were recovering by 1970.

In mid 1971 Feralloys Limited opened their second ferro-alloy works at Machadodorp, eastern Transvaal, for the production of chromium alloys. This plant now has five furnaces with a total installed capacity of 96 MVA, and in addition to charge chrome also produces silico-chrome and low carbon ferro-chrome.

Meanwhile, overseas, ferro-alloy producers of the industrialised world had been under growing pressure from the environmentalist lobby to reduce the levels of air pollution emitted from their works. The cost of making these modifications was prohibitive. As a result the growth of capacity within the industry began to slow down, and the steel industries of the United States, Japan and Western Europe looked to imports of alloys to make up the deficit.

South Africa had built up a reputation for reliability and stability in export markets, and Amcor, in correctly assessing the trend overseas, immediately acted upon it. Its two ferro-alloy companies were rapidly expanded - incorporating the largest and most technically advanced furnaces available.

In all, five 48 MVA furnaces were built during the next four years, which trebled their ferro-alloy capacity. Three furnaces were erected by Ferrometals Limited at Witbank, two being for ferro-chrome and one for ferro-silicon production. At the works at Meyerton, now operated by Metalloys Limited (a wholly-owned Amcor subsidiary), which concentrated on manganese alloys, two 48 MVA furnaces were built. These furnaces were subsequently uprated to 75 MVA each. Amcor thus fully exploited its specific advantage of having domestic supplies of raw materials.

South Africa also has very stringent environmental laws regarding air pollution and each of the new furnaces built by Amcor were fitted with modern gas cleaning equipment. From 1970 onwards all the furnaces erected by various South African companies have been equipped with air pollution control devices. A programme was also initiated in 1970 to provide pollution control on all the older furnaces, and today this programme is virtually complete.

Amcor/Samangan Merger

Throughout its existence Amcor had always been closely associated with the company, South African Manganese Limited (Samangan), from whom supplies of manganese ore had been obtained. For a number of years Amcor had acted as technical and financial consultants to Samangan.

Samangan commenced mining operations in the north-west Cape Province as far back as 1926 and by 1939 had developed a large export market for their ore, as well as supplying Amcor's full requirements.

After World War II, there was an increase in the demand for manganese ore and the two main mining companies, namely Samangan and Associated Manganese Mines began searching for new sources of ore, and extensive geophysical work was undertaken. The result was a spectacular success, and a new field known as the Kalahari Field was discovered some 150 kilometres north of the then mining area near Postmasburg.

The Kalahari Field is the largest known manganese field in the world, and several new mines were opened in the area. By 1975 the two companies were producing over five million tons of ore annually, or 23% of the world total. The reserves of manganese ore are at least 12 000 million tons, enough for hundreds of years, and are over 80% of the world total reserves.

In 1975 Samangan merged its interests with Amcor, and a new company was formed -S.A. Manganese Amcor Limited (Samancor).

Samancor is a fully independent public company.

Stainless Steel

The largest single factor affecting the ferro-chrome market has been the introduction of the argon-oxygen decarburising vessel (AOD) into stainless steel making. By 1975 the development added a new dimension to what was already a changing picture. Various forecasts of stainless steel production growth rates were influenced upwards by the success of the AOD.

The following schedule shows the growth in the Western world production of stainless steel up to 1974:

1960	2,150 million tons
1970	4,950
1971	4,290
1972	5,000
1973	6,250
1974	6,650

The growth rate encouraged two new South African producers to erect plants for the production of charge chrome. The first was Tubatse Ferrochrome (Pty) Limited; this was a joint venture of General Mining and Finance Corporation Limited of South Africa and Union Carbide Corporation of the U.S.A. The first furnace of the Tubatse plant at Steelpoort in the Eastern Transvaal, came into production in December 1976. Its three 30 MVA electric furnaces were designed to smelt untreated 'run of mine' chrome ore from General Mining's nearby Montrose and Groothoek mines in order to achieve low costs in their production of charge chrome for export into major world markets.

The second furnace began operating in 1977; because of depressed markets, capacity operating rate of 130 000 tons annually was not reached until June 1979, when the third furnace came into production. Provision has been made by Tubatse Ferrochrome for the addition of a fourth furnace when justified by increased world demand.

The second producer of charge chrome, namely Consolidated Metallurgical Industries Limited (C.M.I.),was established by the Johannesburg Consolidated Investment Company Limited, the works being sited at Lydenburg, also in the Eastern Transvaal.

CMI's first 32 MVA furnace came on stream in April 1977, and the second 32 MVA furnace two months later, with a total design capacity of 120 000 tons of charge chrome per annum. At this plant, chrome ore fines are pelletised and pre-reduced before being utilised in the furnaces, where charge chrome, in both granulated and lumpy form, is made and exported to world markets.

With an extra quarter of a million tons of charge chrome becoming available in the export market, for a period there was an over -supply, and early in 1977 this alloy was being offered at a very low selling price.

Compared with overseas producer costs, South African production costs are lower due to cheaper coal-based thermal power, close proximity of raw materials as well as modern efficient plants. Although the lower price still reflected a profit to the South African charge chrome producer, the profits

made by producer companies in the U.S.A.,Japan and the E.E.C., were severely affected. Petitions of protest were submitted to International Trade Commissions, and certain new minimum price levels were established.

Subsequently, prices have stabilised at a higher level.

Electrolytic Manganese

There are two manufacturers of electrolytic manganese in South Africa. The first to come into existence was the Electrolytic Metal Corporation in 1955, with a small plant at Krugersdorp in the Transvaal. Successful pilot plant operations produced half a ton per day, and, based on this experimental work, the main plant was erected. This has been gradually expanded to achieve a current production figure of 17 000 tons annually, which is exported to consumers throughout the Western World.

The other producer, Delta Manganese (Pty) Limited, a subsidiary of Delta Metal Holdings, came into production in 1974. Their plant is at Nelspruit in the Eastern Transvaal, where the geographical situation enables the company to utilise the harbours of Durban or Maputo for its exports - depending on the availability of shipping.

Initial capacity of Delta Manganese was 12 000 tons of manganese metal a year, which subsequently increased to 17 500 tons, and for the year 1980 capacity has been still further increased to 26 000 tons, with an estimated sales value of R36 million. Virtually the entire tonnage is exported.

Delta Manganese also produces manganous oxide which is used as a trace element in animal feedstuffs and fertilizers, and will shortly be producing manganese sulphate for use in fungicides.

As the main raw material, both Delta Manganese and the Electrolytic Metal Corporation use manganese ore fines supplied from the Samancor manganese ore mines in the north-west Cape.

Silicon

Another alloy produced in South Africa since 1975 is silicon. The company, Silicon Smelters (Pty) Limited was formed in 1973 and sited at Pietersburg, northern Transvaal, adjoining a high grade quartz mine.

Smelting is in three 25 MVA submerged arc electric furnaces with a capacity of 32 000 tons a year. About 98% of production is exported to markets in the U.S.A., Germany, the U.K. and Japan.

Due to a position of over-supply in world markets this company experienced lean years until the end of 1978. Early in 1979 the market stabilised and in April of that year Samancor acquired the entire interests of Silicon Smelters.

South African Technical Research

The South African ferro-alloy industry based its original technology on equipment and processes used overseas, without considering too carefully their suitability for local raw materials and conditions.

As the industry grew and production units were gradually increased in size, technical problems arose which were difficult to resolve with the limited research facilities within the industry. Gradually South African research institutes began to assist. These were the S.A. Iron & Steel Industrial Corporation Pilot Plant, the Fuel Research Institute, the National Institute for Metallurgy and several of our Universities. Under the auspices of the South African Ferro-Alloy Producers' Association (FAPA), a technical sub-committee was formed to coordinate the research.

Smelting problems were analysed with bench scale trials, which were undertaken by the Pyrometallurgical post-graduate school of the University of the Witwatersrand, where a number of post graduate students from all over the world are engaged in ferro-alloy theses. These students are subsidised by study and travelling bursaries granted by FAPA and the National Institute for Metallurgy (NIM).

An important investigation into computer aided control of smelting processes was successfully undertaken by NIM, and micro computers are now being adopted for use in large furnace smelting control.

For a better understanding of raw material flow and retention times in large submerged arc furnaces, scientists from the South African Atomic Energy Board were consulted, and they successfully produced suitable radioactive isotopes for tracer tests in the furnaces.

A further investigation is the study of material left inside ferro-chrome and ferro-manganese furnaces when taken out for relining. The mineralogical analyses of these samples are presently being studied, and it is clear that there is still a lack of understanding regarding many reactions that occur in the smelting process.

There is no doubt that this effective collaboration between the ferro-alloy industry and the research centres has resulted in better performance of the smelting units.

Recent Developments

Of the eleven different companies producing ferro-alloys in South Africa, practically all of them have installed additional furnace capacity in recent years.

In 1974 there were in total 40 electric furnaces operated by the various companies with a total installed capacity of 580 MVA. In 1980, only six years later, there are now 52 furnaces with a capacity of 1 200 MVA.

In mid 1978 Samancor switched in the largest furnace in the southern hemisphere. This furnace is of Japanese design and was built on a greenfield site adjoining the Metalloys plant at Meyerton at a cost of 46 million dollars. It is equipped with the most modern and effective gas cleaning system for pollution control, and has a capacity of 81 MVA. Originally designed for the production of 100 000 tons of high carbon ferro-manganese annually - due to sophisticated electronic control and other factors - it is currently producing at a rate of 150 000 tons a year, all of which is exported to world markets.

It is estimated that the present capacity for ferro-alloy annual production in South Africa is as follows:

Manganese Alloys	800 000 tons
Chromium Alloys	820 000 tons
Silicon Alloys	150 000 tons
	1 770 000 tons

More than half of this tonnage is produced by the two Samancor works.

Between 80 and 90% of the total tonnage is exported to the steel producing industries of the Free World, representing some 20% of total requirements in manganese alloys. This figure is much higher if one calculates in manganese units, taking into account the South African manganese ore exports.

The production of chromium alloys increased at the rate of 25% a year between 1973 and 1978, and half a million tons are now exported annually, representing some 50% of the Free World trade.

Infrastructure

South Africa's infrastructural status, as a factor in the development of its mineral resources is impressive by any standards. The country's transport networks are continually being improved, and two further large ports were established in recent years, namely Saldanha Bay and Richards Bay.

Saldanha Bay, which lies approximately 160 kilometres north-west of Cape Town, was constructed for the export of iron ore from the Sishen area of the northern Cape Province. The railway line from Sishen to Saldanha Bay is 860 kilometres long, and over 15 million tons of iron ore is now conveyed over this line for export, annually.

Richards Bay is approximately 200 kilometres north of Durban, and this port was constructed as a coal export terminal, some 14 million tons of coal being exported annually. It is presently being extended to facilitate the export of other bulk commodities.

Power supplies in South Africa are predominantly from coal based sources, and the Electricity Supply Commission (Escom) supplies over 90% of the total requirements from its 18 coal-fired power stations.

When the additional two oil from coal complexes, termed Sasol II and Sasol III come on stream in the fairly near future, more than half the country's liquid fuel requirements will be met. Within the next few years our fuel needs will also be supplemented by methanol and ethanol, both of which products are to be made in South Africa. This will free the country from much of the vagaries of the OPEC cartel.

General

In this paper I have endeavoured to present as complete a picture as possible of the development of the South African ferro-alloy industry.

As I commented earlier, international trade in ferro-alloys is dependent on the world's carbon and stainless steel industries. Although steel is the

backbone of any nation, its growth may not be either as spectacular or profitable as that of chemicals or paper for example, and in recent years many nations, including South Africa, have suffered setbacks in their steel industry.

In 1979 South Africa produced approximately 9 million tons of the world steel production figure of 750 million tons. The major markets for steel, namely, construction, automotive, machinery, containers and durable equipment, will always continue to grow.

With almost inexhaustable reserves of raw materials, coal based energy and expertise, South Africa is capable of meeting the demands of the world steel industry for their requirements of what has been termed the "salt and pepper" of steel production - namely ferro-alloys.

Development of the South African Ferro-Alloy Industry

Milestones

1938	Amcor begins production of ferro-manganese
1942	First ferro-alloy works (electric furnaces) built by Amcor
1951	Second ferro-alloy works built by Amcor at Meyerton
1955	Production of electrolytic manganese by Electrolytic Metal Corporation
1956	Rand Carbide Ltd starts production of ferro-silicon
1960	Establishment of Feralloys Ltd for ferro-manganese production
	Amcor acquires Ferrometals Ltd
	S.A. production of ferro-alloys reaches 100 000 tons per annum
1963	Establishment of Palmiet Chrome Corporation
	Establishment of R.M.B. Alloys
1964	Transalloys commences production of ferro-alloys
1966	First production of stainless steel by Southern Cross
1969	Merger of Palmiet Chrome Corporation and R.M.B. Alloys under holding company, Middelburg Steel & Alloys (M.S.& A.)
1970	Amcor decision to build five 48 MVA furnaces
1974	Delta Manganese begins production of electrolytic manganese
1975	Merger between Samangan and Amcor and formation of Samancor
	Production of silicon begins by Silicon Smelters
	Samancor production of ferro-alloys reaches 500 000 tons p.a.
1976	Tubatse Ferrochrome Ltd establishes works
1977	Consolidated Metallurgical Industries (C.M.I.) starts production of charge chrome
1978	Samancor switches in 81 MVA furnace at Meyerton
1979	Samancor acquires Silicon Smelters