

97-3986

MICROFILMED
FICHE No. 014196

PROPOSED SILICON-FERRO-SILICON
MAGNESIUM INDUSTRY IN
STH TASMANIA-MAC C FORSTER 1973

PROPOSED

314001

SILICON - FERROSILICON - MAGNESIUM

INDUSTRY

IN

SOUTHERN - TASMANIA

by

Mac Campbell Forster

1973

OPEN FILE

New Address

"Lee Wave",
RMB 341,
KINGSTON,

Tasmania. 7150

97-3986

PROPOSED SILICON-FERRO-SILICON
MAGNESIUM INDUSTRY IN
STH TASMANIA-MAC C FORSTER 1973

C O N T E N T S

ABSTRACT	2
SILICON	3
USES FOR SILICON METAL AND FERROSILICON	4
INTRODUCTION	5
RAW MATERIALS	6
SPECIFICATIONS--QUARTZITE	7
SPECIFICATIONS-- CARBONACEOUS REDUCING AGENTS	7
SPECIFICATIONS-- DOLOMITE	7
SPECIFICATIONS-- ELECTRIC POWER	8
SPECIFICATIONS-- STEEL FOR FERROSILICON	8
LOCATION OF RAW MATERIALS	9
QUANTITY OF RAW MATERIALS -QUARTZITE	10
GEOLOGY OF RAW MATERIAL LOCATIONS	12
QUALITY - QUARTZITE	13
SUMMARY OF RESERVES - QUARTZITE	14
REDUCING AGENTS	15
TIMBER AVAILABILITY	15
TIMBER COSTS	17
GENERAL PROPERTIES OF WOOD	18
PROPERTIES OF CHARCOAL	18
COSTS OF WOOD CHIPS AND CHARCOAL	19
DOLOMITE-- HASTINGS AREA	20
DOLOMITE--HUON RIVER	21
MAGNESITE	23
COAL IN TASMANIA	24
STEEL & IRON ORE FOR FERROSILICON	26
ELECTRIC POWER --AVAILABILITY--COSTS	27
SMELTER LOCATIONS	28
ACCESS--ROADS	30
PORT SITES	31
PORT HUON --PORT & WHARFAGE CHARGES	32

A B S T R A C T

It is suggested that smelting industries could be established in the Huon district of southern Tasmania to produce silicon metal, ferrosilicon, magnesium and perhaps ferronickel, all of which are related metallurgical operations, which would use mostly locally available raw materials of silica, dolomite, and timber as well as State hydro-electric power.

SILICON.

Silicon is used for a number of applications in the metallurgical, refractory, electrical, electronic, optical, and abrasive industries.

Silicon metal is the starting material for making silicone products and is used very extensively as an alloying agent in aluminium, as well as copper and nickel alloys. Other silicon alloys include ferrosilicon, silvery pig iron, silicomanganese, ferroaluminium-silicon, magnesium-ferrosilicon, ferro-chrome-silicon, ferro-manganese-silicon, calcium-silicon, calcium-manganese-silicon, barium-silicon, ferrozirconium-silicon, and zirconium-silicon, all of which are principally used in metallurgical industries.

Ferrosilicon accounts for the largest tonnage of the silicon alloys produced.

Silicon metal is marketed in numerous grades depending principally on iron, aluminium, or calcium specifications.

The raw materials for the production of silicon metal are silica, and a suitable carbonaceous reducing agent or agents and is produced in an electric furnace with a submerged arc, consuming electric power at the rate of 13,000-15,000kw-hr per gross ton of silicon metal produced. Ferrosilicon is produced in a similar way with the addition of iron or scrap steel.

Silica (SiO_2) for producing silicon metal, ferrosilicon, and other silicon alloys is usually quartz, quartzite, or well cemented sandstone with at least 98% silica content. Size requirement ranges between 1 and 6 inches (25mm and 150mm) depending on the type of reduction furnace used in the manufacturing process. Impurities such as lime, magnesium, and aluminium are kept low to reduce the slag volume to a minimum.

Ferrosilicon is used as a reductant in the production of magnesium from dolomite in an electric furnace, in the 'Magnetherm Process'. Ferronickel is also manufactured by the same means by the Uginé Process.

USES FOR SILICON METAL.

The main use for silicon metal is in the production of aluminium alloys, copper, and nickel. Aluminium is alloyed with 2-25% silicon to improve casting fluidity, and at higher percentages to improve both fluidity and wear resistance. It improves corrosion resistance, low thermal expansion, and high thermal conductivity. Casting alloys containing silicon are noted for improved impact toughness and pressure tightness.

Silicon is used as a secondary alloying element in aluminium-magnesium alloys which depend on the formation of magnesium silicide as a hardening agent.

Silicon metal is a basic raw material in the production of silicone type lubricants, hydraulic fluids, resins, plastics, enamels, and rubbers.

Purified silicon metal possesses semiconductive properties suitable for use in miniaturized electronic circuits.

Copper alloys with silicon are strong, weldable, and have good resistance to corrosion, especially salt water.

Nickel with silicon possesses excellent tensile properties, and corrosion resistance to sulfuric acid.

USES FOR FERROSILICON.

As mentioned before, ferrosilicon is used in the silico thermic process for making magnesium, for making ferronickel and silvery pig iron.

Silvery pig is mainly use in the iron and steel industry for the deoxidation of molten metal, as an alloying agent to meet chemical specifications, and in some instances for reduction of metalloids in the slag.

In cast irons, as much as 17% of silicon is used to resist growth and scaling at elevated temperatures, corrosion of certain mineral acids etc.

In combination with magnesium, silicon gives a "plunging alloy" for making ductile, nodular iron.

Silicon imparts high strength to steel at moderately elevated temperatures.

PROPOSED : SILICON - FERROSILICON -MAGNESIUM INDUSTRY

by Mac C. Forster

April, 1973.

Introduction.

Large reserves of high-grade quartzite rock, dolomite and timber, suitable for wood chip and charcoal production as a source of fixed carbon, are located close together and close to deep water ports in southern Tasmania.

These materials could be used in the production of silicon, ferrosilicon and magnesium.

Reserves of coal are also available, but the ash content is high.

Reserves of somewhat over developed hydro-electric power resources of about 200MW could be made available at low cost, and large undeveloped resources remain to be developed.

Large stands of partly burnt and, or, dead trees, which are dry or semi-dry are available for the proposed industry, and are located in the rain forests of the southern part of Tasmania.

These timbers are not suitable for the pulpwood industry or for sawmilling, but would be very suitable for the manufacture of wood chips and charcoal, for use as a source of fixed carbon in the smelting of silicon or ferrosilicon in a submerged arc electric furnace.

As the ash content of timber is very low, often less than $\frac{1}{2}\%$, it may be both feasible and practical to use this material, in the form of wood chips and charcoal, alone or with the addition of only small percentages of other fixed carbon reductants, to produce a very high grade product of silicon or ferrosilicon.

RAW MATERIALS, (Quantity requirements.)

Raw Materials used in the production of 1 metric ton of product :-

<u>Silicon,</u>	Quartzite rock	2.9 tons
	Fixed carbon in reductants	1.2 tons
	Electric power	13,000 kWh
	Carbon electrodes.....	0.1 ton

Ferrosilicon

	Quartzite rock	1.9 tons
	Fixed carbon in reductants	0.8 ton
	Electric power	2,000 - 15,000 kWh
	Electrode paste	0.05 ton
	Scrap steel	0.25 ton

Magnesium

	21% Dolomite (MgO)	13 tons
	Bauxite (calcined)	1 ton
	75% Ferrosilicon	1 ton
	Electric power	12,000 kWh
<u>Less recovery</u>	25% Ferrosilicon	0.2 ton
	Slag	5 tons

Specifications for raw materials.

Quartzite rock for the production of silicon metal should contain a minimum of impurities and high resistance to heat fracture in the electric furnace, and should not decrepitate on heating to 950° C, and the softening point should be above 1,700° C. Typical quartzite analyses are as follows:-

	%	to	%
SiO ₂	99.67	to	99.34
Fe ₂ O ₃	0.08	to	0.06
Al ₂ O ₃	0.07	to	0.17
CaO	0.12	to	0.18

Where silicon is to be alloyed with aluminium the Al₂O₃ content is not critical.

The minimum particle size for quartzite rock is 1 inch diameter.

SPECIFICATIONS ---Raw Materials.

Quartzite rock used for the production of ferrosilicon should contain a minimum silica content of 96.0% silica and a minimum of impurities, such as Al_2O_3 which should be less than 2% and the P_2O_5 content less than 0.1% with low levels of MgO and CaO .

The minimum particle size for quartzite rock is $\frac{1}{2}$ inch diameter.

Carbonaceous reducing agents for silicon metal and ferrosilicon production have similar specifications except that in the case of silicon, the iron oxide content should be low.

The reducing agents for both metals should have the lowest possible ash content containing low values of calcium, alumina, arsenic and phosphorus. The sulphur content of the reducing agent is not critical.

The most usual reductants for silicon production are a combination of wood chips, wood charcoal, raw petroleum coke and briquettes sometimes with a limited amount of low ash bituminous coal to give a high or low iron category as required.

The amount of wood chips varies between 0.4 and 1.2 lbs per lb of quartzite.

Reductants for ferrosilicon production includes the above materials as well as by-product bituminous cokes, petroleum coke, sub-bituminous char and lignite chars, all with low fines content and a size range from 5-15 millimetres ($\frac{3}{16}$ to $\frac{1}{2}$ inch).

The fixed carbon content of the mix is usually calculated to 103-105% of that theoretically required for complete reduction assuming the direct reaction, $(SiO_2 + 2C = Si + 2CO)$.

Dolomite rock for the production of magnesium by the "Magnetherm" process requires the dolomite to titrate at least 19 to 20% of MgO and better still 21%.

Magnesite could be used to increase the dolomite titration to 21% or 22%.

SPECIFICATIONS --- Raw Materials.

Electric power required for furnace operation is in the 100-150 volt range A.C. for an average size furnace producing about 11 tons of metal per day with a power consumption of about 13,000 to 15,000 kWh per gross ton of silicon produced and 8,000 to 9,000kWh per ton for ferrosilicon with power available per furnace of 7,000 kW at 120-130 volts and a "K" factor of 0.19-0.24 peripheral ohms.

Power consumption for magnesium production in furnaces producing 6.5 tons of metal per day is 12,000 kWh/ton with power available per furnace of 4,500kW single phase A.C. at 100-150 volts. Three-phase supply has been envisaged as has also a D.C. supply to the furnace.

Steel for ferrosilicon production is usually in the form of scrap steel in short lengths of not more than 4 inches (10cm) which should be clean with a chromium content of less than 0.7%. Cast iron and special steels should be avoided. High grade iron ore can also be used.

Buaxite for use in the production of magnesium should be of calcined white bauxite.

LOCATION OF RAW MATERIAL.RAW MATERIALS FOR SILICON, FERROSILICON & MAGNESIUM PRODUCTION.QUARTZITE.

Deposits of high grade silica in the form of saccaroidal quartzite rock of Upper Precambrian age occur in southern Tasmania in the following locations:-

(1) South Lune River deposits are located close to a Forestry Commission road, 2½ miles (4 kilometres) west of the small mining village of Lune River. They are held under mineral leases by Scamander Mining Corporation N.L. and comprise of sections numbers 71M71 40 acres, 72M71 40 acres.

(2) Caves Road deposits are located close to the main Hastings Caves road, and are situated between 1 and 2 miles (1.6K - 3.2K) south east from the caves road end. They are held under mineral lease by Scamander Mining Corporation N.L. and comprise of sections 68M71 40 acres, 69M71 20 acres, 75M71 10 acres.

(3) South Hogs Back Deposits are located on, and close to a Forestry Commission road, 2 miles (3.2K) south of the Hastings Caves road end and are held under mineral leases by Scamander Mining Corporation N.L. and comprise of sections 70M71 40 ac., and 74M71 20 acres, and 73M71 40 acres.

(4) Hogs Back deposits are located about ½ mile (0.8K) north from a Forestry Commission road and about 1½ miles (2.4K) south from the end of the Hastings Caves road and are held under mineral leases by Australian Commonwealth Carbide Company Limited, and comprises of sections 11647M 50 acres, 58M40 10 acres, 13M41 10a.

(5) Weld River deposits are located 0.7 miles east of a Forestry Commission road (1.1K) and comprise of Glovers Bluff, Camels Back, and Bernard Spur which are located about 3 miles (4.8K) up the Weld River from its junction with the Huon River. They are covered by a Special Prospector's Licence No.122 in the name of B.R. Forster and covers an area of 10 square miles and remains in force until 16th October, 1973 but may be extended subject to certain conditions.

RAW MATERIALS --- QUARTZITE.Quantity. South Lune River.

(1) The quartzite deposits of the South Lune River are situated in open button-grass country of the Lune Plain at the south bank of the river.

It extends over a distance of about 2500 feet (760m) in a southerly direction from a low point near the river bank to an elevation of about 200ft above the bank in the form of a steadily rising wedge shaped ridge, about 500 ft wide. (150 m) The ridge is soil covered with little outcrop and bulldozer cuts were used to sample the rock.

The deposit would require extensive drilling to obtain an accurate estimate of the quantity and grade of the ore.

The quartzite is in contact with Jurassic dolerite on the western side, due to a normal fault with a downthrow to the west, and thus much of the material could be crushed and broken or be contaminated with organic material or iron oxide.

However, tests to date do not indicate contamination.

The deposit could contain more than 5 million tons of material, above the river bank level.

(2) The Caves Road Deposit.

Several deposits occur along the caves road between the Chalet and the Caves, the largest is located close to the road about half a mile beyond the Chalet. The strike of the beds are in a north - south direction and dip at a high angle, but there is little out-crop and the dip of the beds is not easily apparent. Much of the silica seems to be of a finer grain than the deposits at South Lune and Hogs Back which are both on the western side of the same anticline? (T.D.Hughes, 1959) Some of the Caves Road deposits may be secondary quartz and chert due to the replacement of dolomite by silica and not part of the same quartzite bed. The deposit located $\frac{1}{2}$ mile north of the Chalet consists of a hill about 1500 feet long (450m) and rises to a height of about 150ft. (45m) above the road level with an average width of about 400ft. (122m) The quantity of material would be several million tons, but all may not be suitable for silicon production as much of the rock could be broken due to northerly trending normal fault on the eastern side of the hill, with dolerite in contact with quartzite.

RAW MATERIALS --- QUARTZITE.

11.

(3) The South Hogs Back deposit is located on the North Lune Road, and consists of a low hill with little soil cover, showing plenty of quartzite rock outcrop. The rock appears to be solid and unbroken by faulting etc., and some of it has been used for road material. The material could be considered high grade but the quantity available for mining above the general level of the terrain would be limited to about 500,000 tons.

(4) Hogs Back deposit lies about $\frac{1}{2}$ mile north of the South Hogs deposit described above. It consists of high grade quartzite, is about 2000 feet long (600m) in the form of a very sharp ridge rising to a height of about 130 ft. (40m) average above the button grass terrain with a width of about 400ft (122m), with little soil cover. This material has been used to manufacture ferro-silicon in the past.

The beds strike north and dip at high angles, showing plenty of rock exposure, some rock being hard and some soft and weathered to a comparatively soft and friable sandstone, with pronounced jointing in two directions, with a little iron staining in some areas of the otherwise white quartzite.

The quantity of high grade material available for mining above the level of the terrain has been calculated at 1.5 million tons.

GEOLOGY OF THE QUARTZITE DEPOSITS AT HASTINGS, LUNE AND WELD RIVERS.

This white quartzite rock of Upper Precambrian age underlies some extensive dolomite beds, part of which form the Hastings Caves. The dolomite does not out-crop freely, but underlies much of the low-lying plains in this locality.

The quartzite beds strike in a north - south direction are about 500 feet (150 m) thick, and dip at high angles to the east or west, with pronounced jointing in two directions. Weathered out-crops show differences in hardness and grain size and in some deposits a little brown iron staining is apparent.

Quality... Quartzite.

A limited number of chip samples from surface outcrops give the following assay values:-

	Max. %	Min. %
SiO ₂	99.70	99.20
Fe ₂ O ₃	0.20	0.04
Al ₂ O ₃	0.38 *	0.17 *
MgO	0.01 *	0.02 *
TiO ₂	0.10 *	0.02 *
CaO	0.02 *	0.03 *

* Three assays only, by the Mines Department of Tasmania.

The above assays are from the Hastings - Lune River area only and do not include the Weld River deposits. The assays were carried out by the Mines Department in Launceston and by B.H.P. sampling, and testing at Temco in northern Tasmania.

Average values given by Temco for SiO₂ were:-

H71-3 a	99.53%	H71-4 a	99.49
b	99.59%	b	99.65
c	99.55%		
	*****		*****
average	99.55%		99.57
	*****		*****

Samples were heated to 1000° C. for one hour with little or no decrepitation problems evident.

QUALITY --- QUARTZITE.Weld River Quartzite..Continued.

The grade of the Weld River deposit remains to be tested, as only one representative sample has been assayed for evidence of dilutent minerals. This sample was taken from near surface, on the higher part of the south end of the formation, and should not be taken as an average grade, as extensive sampling and at least one drill hole will be required before such an estimation can be made.

Assay results by the Mines Department of Tasmania of this single sample are:-

W1.	SiO ₂	99.3
	Fe ₂ O ₃	0.25
	Al ₂ O ₃	0.05
	TiO ₂	< 0.03 (less than)
	CaO	0.05
	MgO	0.03
	K ₂ O	0.02
	Ign. loss	0.33

		100.06

The future sampling programme will consider the possibility of surface contamination and or leaching with the possibility of a build up of dilutent minerals at depth.

Visual inspection with a x20 magnifier and examination by microscope indicates that the deposit is remarkably uniform, at lease in appearance.

SUMMARY OF RESERVES OF QUARTZITE-SILICA.

Estimated reserves of quartzite.

Deposit	Million tons
South Lune	< 5
Caves Road	< 2
South Hogs Back	0.5
Hogs Back	1.5
Weld River	> 100

(5) The Weld River deposits comprise of a series of ridges with 11 a total length of about 3 miles (4.8km), rising to a height of 600 feet (180m) above the terrain, with a width of over 500ft (150m). The Weld River cuts through the ridge in a steep gorge, with quartzite outcrops on each side. The ridges consist of saccaroidal Precambrian Quartzite with little soil cover and large areas of rock outcrop. On the south side of the Weld River the ridge provides an ideal quarry site, with a very steep slope to the east and with little or no soil cover in places.

The quantity of material in this deposit is thus very large and could be measured in hundreds of millions of tons of high grade quartzite.

Due to the large areas of outcrop, the deposits would be easy to sample for grade, with comparatively little drilling required.

REDUCING AGENTS.Wood chips and charcoal.

Large reserves of dry, semi-dry and dead trees which have been partly burnt are available in southern Tasmania. Other waste wood from logging and sawmill operations would be available also.

It is suggested that it may be technically feasible, and practical to use wood chips and charcoal alone or with the addition of only small percentages of other carbon reducing agents, in the production of silicon and ferro-silicon. The result of this would be to produce a very high grade product (provided other raw materials were also high grade) suitable for a wide range of uses, as the ash content of wood and wood charcoal is very low, often less than $\frac{1}{2}\%$.

The production of carbon electrodes is also suggested, as this material could also be produced from charcoal, and is a high cost factor in the production of silicon.

TIMBER AVAILABILITY.

Most of the State Forests of Tasmania are now covered by pulpwood and woodchip concessions from the State Gov. Forestry Commission.

A.P.M. Ltd. with a paper pulp plant at Geeveston, have a pulpwood concession which includes virtually the whole D'Entrecasteaux Channel and coastline and extends west as far inland as the Weld River -Picton River area; also included in the concession are Bruny Island and Tasman Peninsula.

A.N.M. Ltd. manufacturer of newsprint, has a concession area following the general line of the Derwent as far north as Lake King William and includes the Florentine Valley and the Styx River Valley. It may be possible in the future, to link these two concession areas by road via the Weld River valley road.

A large forest of virgin timber is located in the Weld valley and is not held by concessions at this time.

However, there are large reserves of dry, semi-dry and or partly burnt and dead timbers contained within these concession areas.

Timber availability---continued.

These materials are not suitable for paper pulp, due mainly to the charcoal content, or for sawmilling, but would be very suitable for wood chip and charcoal manufacture for use as reductants in the production of silicon and ferrosilicon.

The Forestry Commission and the pulp wood concession holders have indicated that they would be very pleased to have this class of material removed from the forests, in order to reduce fire risk and damage to other valuable timbers in the event of accidental fires etc...

Most of the wood material now wasted could be utilized, such as fallen trees, the heads and limbs of fallen trees as well as the timbers mentioned above.

In addition to State Forest areas, there are considerable areas of private land forests which could be available as a source of raw material.

The use of portable wood-chipping machines in the forests would be one method of harvesting the smaller wood products, such as limbs and light timber on private lands.

The Forestry Commission has in progress a survey of the timber resources of southern Tasmania which could be made available to the industry.

The Commission has already stated that 125,000 tons of green timber would be available, per year, perpetually. This quantity is an assessment from the area at present being logged in the Huon district only and does not include the Weld River Valley or Bruny Island etc. nor does it include dry and semi-dry timber contained in regrowth forests. The total availability is thus likely to be many times this quantity.

The Commission expects to have the total assessment completed within the next few weeks, (22nd May, 1973.) including timber from private lands.

TIMBER COSTS.

The following figures were supplied by a company in Tasmania which produces about 600,000 tons/p.a. of wood chips for export. These costs could be related to costs in the Huon area, and are up to date estimations at April, 1973.

Cost of timber per ton ,using own road constructions.

(1) To bring down, cut and haul to landing and load.....	\$2.50	-	\$3.00
(2) Cost of logging tracks off the main roads.....	0.30	-	0.60
(3) Cost of main roads	0.50	-	0.70
(4) Haulage costs, say 20-30 miles.....	1.50	-	2.00
(5) Forestry royalty rate, (quoted by F.C.).....	0.22	-	0.22
			<u> </u>
Cost of timber at plant.....	\$5.02	-	\$6.52
			<u> </u>

Cost of timber per ton, using Forestry Comm. roads.

(1) To bring down, cut and haul to landing and load.....	\$2.50	-	\$3.00
(2) Cost of using Forestry Comm. roads, flat rate..... (quoted by F.C.)	1.12	-	1.12
(3) Haulage costs, say 20-30 miles.....	1.50	-	2.00
(4) Forestry royalty rate, (quoted by F.C.).....	0.22	-	0.22
			<u> </u>
Cost of timber at plant.....	\$5.34	-	\$6.34
			<u> </u>

These figures indicate an average cost of one ton of wood material, delivered to the plant site of..... \$5.80/ton.

GENERAL PROPERTIES OF WOOD.

Wood is a mixture of complex organic compounds; when it is heated in the absence of air, the compounds which it contains are decomposed. A good deal of the carbon it contains remains as charcoal, most of the other products of decomposition passing off as vapours. If the vapours are caught and cooled, they will deposit a large amount of liquid material and quantities of uncondensable gases will remain. In some places these by-products are caught and many valuable materials such as methanol, acetone and acetic acid are obtained from them. The quantities of the different products obtained from wood naturally vary with the species and its moisture content.

An average dry hardwood, furnishes approximately by weight 25% of charcoal, 25% gases, 50% liquids.

The yield of charcoal obtained by weight is dependent mainly upon the moisture content of the wood used. Charcoal contains comparatively little moisture, so that the higher the moisture content of the wood, the more fuel must be burned to drive off the moisture as steam, and the greater is the loss of weight.

Charcoal yields of 25% can be expected when using dead, but not specially dry timber, although yields up to 30% are quite possible with such material; while with very wet wood the weight of charcoal may be as little as 15-20% of the original weight of timber.

A number of experiments as to the suitability of different species of timbers have been conducted, and the results so far obtained indicate that almost any sound timber will yield sound charcoal. The higher the density of the wood, the higher will be the density of the charcoal. The denser Eucalypt hardwoods yield the heaviest and hardest charcoal, and are, therefore, preferable. As a general guide it may be said that the heavier a timber is, the more suitable it is for charcoal production.

PROPERTIES OF CHARCOAL.

The properties of charcoal may vary widely according to the species of timber used, but it has certain general properties.

Reactivity. --- Charcoal is a very reactive fuel, it ignites very readily, and will continue to burn in a weaker draught of air than any similar fuel.

COMPOSITION OF CHARCOAL.

The composition of charcoal, generally varies between the following limits:-

Hygroscopic moisture	5%	to	10%
Volatile matter	5%	to	20%
Fixed carbon	70%	to	90%
Ash ----- up to			1%

Moisture content of charcoal will vary with the humidity of the air, but under normal conditions should not be more than 10%.

Tar-content, of charcoal is generally less than 300g per ton when the volatile content is less than 15%.

Absorptive Properties. The absorption of moisture and other gases from the atmosphere by freshly made charcoal liberates their latent heat, which is considerable and may cause fire spontaneously when the atmosphere is humid and the charcoal is in small pieces. Precautions should thus be taken in the storing of charcoal.

FIXED CARBON COSTS IN WOOD-CHIPS & CHARCOAL.

Taking an average charcoal yield from wood of 25% by weight and an average fixed carbon content of charcoal of 80%, then :----

1 ton of wood yields 0.20 tons of fixed carbon or 20%.

1 ton of fixed carbon costs \$5.80 x 5 = \$29
 (Average wood cost @ \$5.80/ton.)

plus the cost of chipping and carbonization costs,
 less profit from sale of by-products such as methanol, acetone.

Costs in this order of \$30/ton for fixed carbon could be considered very competitive with other materials, especially considering the very low ash content and resulting purity of products.

Costs of chipping and carbonization have not been estimated nor has the profitability of producing by-products .

DOLOMITE --- HASTINGS AREA

Extensive beds of dolomite are thought to over-lie the precambrian quartzites of the Hastings area.

They can be seen in the vicinity of the Caves which are composed of dolomite. In other areas it does not outcrop freely, but probably under-lies much of the low-lying plains in this locality. Outcrops can be seen high above the plain in a road cutting just south of the caves reserve.

No estimate of reserves could be made without further prospecting, and sampling for grade. It would be preferable to locate deposits well removed from the Caves area.

Assays by the Mines Department of Tasmania of a sample of dolomite taken from the road cutting on the hillside, about $\frac{1}{2}$ mile (0.8km) S.E. of the caves reserve, gave the following results:-

HD.1.	SiO ₂	0.57%	
	FeO + Fe ₂ O ₃	0.21% + 0.04%	
	Al ₂ O ₃	0.34%	
	CaO	30.3 %	
	MgO	21.4 %	
	P ₂ O ₅	0.02%	
	CO ₂ + C	45.9 %	by ignition loss
		<u>98.8 %</u>	

The above sample was light cream in colour, and had a fine grain. Other outcrops were light grey to dirty-white in colour and fine-grained, with numerous joints at right angles to the bedding, which cause it to break in rectangular pieces.

The location of these deposits close to the Hastings caves could present some problems, however from a quarrying point of view, the site is a good one as it is located high up on the side of a ridge.

DOLomite ---HUON RIVER.Location.

Deposits of dolomite are located near Blake's Opening, between Mt. Picton and the Huon River and may extend further northwards. The eastern side of the deposit is about $4\frac{1}{2}$ miles (7.3km) upstream on the Huon River from its junction with the Picton River.

Access.

Access is by four wheel drive vehicle or motor cycle etc., from the Arve Road at the Tahune Bridge over the Huon River. The distance from the Tahune Bridge to the eastern side of the deposit is about 5 miles (8km). There is no vehicle bridge over the Picton River on this track, but a foot-suspension bridge only. The Picton can be forded by vehicle only after dry weather conditions.

It is the intention of the Forestry Commission to construct a road up both sides of the Huon River, beyond Blake's Opening, in the future. (*Picton River Bridge completed 1978.*)

Geology. F. Blake in 1935, has this to say:-

" Dolomite is exposed in the bed and banks of the Huon River at Blake's Opening, and on the northern slopes of Mt. Picton to the south of the former. The rock is again in evidence in creeks flowing easterly to Craycroft River, over open plains, on the south side of the Razorback. The dolomite is generally fine grained, but in places is slightly crystalline. It is massive or thickly bedded and although jointing is present it is not prominent. The rock is light-grey in colour, but weathers to almost white at the surface." -----

On the northern face of Mt. Picton at Red Rag Scarp, there are cliff faces where the dolomite is well exposed, but there is little exposure between here and the Huon River, however the dolomite beds are thought to extend continuously over the area, and beyond. The beds strike NNW, and dip steeply to the east. Sampling of outcrops indicates that the higher grade beds are about 5000 feet (1530m) wide and extend several miles in length.

DOLOMITE -----HUON RIVER.

The following analytical results are of samples collected and assayed by the Mines Department of Tasmania in 1972.

<u>Sample No.</u>	<u>% MgO</u>	<u>% CaO</u>	<u>% Acid Insoluble</u>	<u>% Loss on Ignition</u>	<u>Total</u>
HP 10A	6.0	7.7	65.7	10.4	89.8
10B	5.6	4.9	69.7	7.9	88.1
11	6.6	4.7	67.9	9.1	88.3
12	4.5	5.0	72.4	7.8	89.7
13	3.7	2.3	74.5	6.8	87.3
14	15.3	23.2	26.7	33.5	98.7
15	20.5	30.2	2.6	42.8	96.1
16	20.9	31.7	0.5	46.6	99.7
17	20.9	31.1	1.1	46.3	99.4
20	20.9	29.5	3.6	45.1	99.1
21	20.5	28.5	6.2	43.9	99.1
22	21.3	29.9	2.0	45.8	98.0
23	19.0	26.0	14.3	39.8	99.1
24	21.8	29.1	1.7	45.5	98.1
26	19.5	29.1	7.4	42.1	98.1
27A	3.6	5.0	83.1	7.5	99.2
27B	21.1	30.6	1.0	47.1	99.8
28	19.2	27.9	10.0	42.4	99.5
29	20.9	30.6	1.2	46.3	99.0
30	13.7	20.5	34.4	30.1	98.7
31	18.5	26.4	14.1	40.5	99.5
32	16.6	24.5	22.0	35.9	99.0
33	15.0	22.6	30.0	31.5	99.1
1	20.2	31.6	1.8		
4	21.7	29.7	5.4		
5	21.2	30.2	2.0		
6	21.6	30.2	1.8		
8	20.9	31.4	1.4		
9	18.6	26.9	14.0		

Note:- The above samples were from the Huon River - Red Rag Scarp area.

Sample 11 taken about 30m upstream from 10.

Sites 20,25,33 sited fairly accurately on photos.

Samples 20-25 roughly evenly spaced.

Samples 25-33 " " " "

Some quartz veins, max 5%-10% of outcrop, but usually not present in area from sample 20-29.

Sample 27A virtually all quartz vein.

Sample 27B adjacent to quartz shows silicification doesn't affect rock strongly.

Most consistent quartz veining in area that samples 30-33 taken - on average 20% of rock quartz veined.

Samples 1 - 9 taken from Huon River bedrock outcrop at Blake's Opening.

Dolomite--geology continued.

The dolomite bed conformably overlies the slate, quartzite stage. They are thought to occur at the base of the Cambrian or top of the Precambrian.

Mining.

The most suitable mining location would be at the vertical cliff face of Red Rag Scarp, where excellent quarry sites are available for low cost dolomite mining production. About 5 miles (8km) of road construction would be required, and a bridge over the Picton River would have to be constructed. The Forestry Commission have plans to build a road into the area, and a sharing of costs could be arranged, no doubt, or a road toll such as is used on other Forestry roads.

Quantity and Quality of Dolomite, Huon River Deposit.

Testing by the Mines Department of Tasmania indicates that an enormous quantity of material is contained in the Huon River dolomite deposit, and from the above descriptions it will be realised that the extent and depth of the dolomite deposit are so large that the quantities available may be considered practically inexhaustible.

Included with this report are details of the analytical results of samples collected by a mines department geologist in 1972. These results indicate that there are thick beds of high grade dolomite, and surface sampling shows that an average grade of dolomite may contain an average of 20.9% MgO with low levels of impurities.

MAGNESITE.

Magnesite has not been reported in the Hastings or Huon-Weld River area. However suitable host rocks occur in the lower Weld River to the east of the precambrian quartzite where a green basic igneous rock of cambrian age has intruded siltstones and other rocks, and has been described as an andesitic intrusion, in an area where precambrian rocks are in contact with permian sediments, similar to conditions at the Arthur River deposit.

TASMANIAN COAL, AS A FORM OF CARBON REDUCTANT

Coal occurs in Tasmania in the rocks of Permian and Triassic age.

In the Permian there are two horizons at Mt. Cygnet, in the Huon district which are at the top of the sequence, which was mined by the E.Z. Company for metallurgical processes involved in the extraction of zinc oxide from zinc residues.

Throughout the Mt. Cygnet area the average thickness of the main seam has been computed at 2.75 feet (0.97^m).

In general the coal is sub-anthracitic, dull in appearance and is hard and compact. It breaks down in large masses, and the percentage of slack is very low. It is capable of withstanding the shock of severe handling, and is not greatly affected by weathering agents. The ignition point is high, and combustion is slow, and is not accompanied by decrepitation. In the furnace it gives out great heat.

Reserves are not known, but the coal bed has been opened in trenches and in dip and strike tunnels at widely separated points along the outcrop, over a distance of 3 miles (4.8km).

Sample, Reg. No. 478 is from the Mt. Cygnet Coal Mine and sample No. 480 from the Heaney Mine in the same area.

Contents of coal in relation to fixed carbon :-

	<u>Sample No. 478</u>	<u>Sample No. 480.</u>
Fixed Carbon	100.00	100.00
Moisture	2.0	1.5
Volatile Matter	16.6	11.9
Ash	36.0	24.3

Ash contents in relation to fixed carbon:-

SiO ₂	26.0	16.0
Fe ₂ O ₃	2.6	2.5
Al ₂ O ₃	4.2	5.1
MnO	0.2	-
CaO	1.7	0.2
MgO	0.1	0.4
So ₃	<u>1.0</u>	<u>0.1</u>
	35.8	24.3

Tasmanian coal, continued.

From these figures, it will be seen that although the ash content is high, the contents of the ash is mostly silica. However the Fe₂O₃ and Al₂O₃ may be too high for some reduction purposes such as for high grade silicon etc., but perhaps could be used in limited quantities for this and ferrosilicon where the Al₂O₃ content is not important.

The cost of mining this coal would be high as it would involve underground operations.

The principal commercial coal supplies have been mined from the New Town Coal Measures of Triassic age which occur towards the top of this sequence. They have been developed at the Kaoota Mine near Sandfly (situated between North West Bay and Cygnet) and in the Esperance-Southport area as well as other places in southern Tasmania. Like the Cygnet coals they are high in ash, which in this case are also high in both silica and Al₂O₃. The beds are from 2-5 feet (.6-1.8^m) thick, is dense and hard, withstands weathering very well, dull-black in colour, and is of the sub-humic variety.

Sample, Reg. No.434 is from the Kaoota Mine, Sandfly --- and Sample, Reg. No.480 is from the Strathblane Mine, Esperance. Contents in relation to fixed carbon:-

	<u>Sample No. 434</u>	<u>Sample No.480.</u>
Fixed Carbon	100	100
Moisture	6.9	15.8
Volatile Matter	49.8	43.0
Ash	46.5	40.9
Ash content in relation to F.C.		
SiO ₂	25.6	27.3
Fe ₂ O ₃	2.4	1.8
Al ₂ O ₃	15.1	10.5
CaO	2.0	0.5
MgO	0.5	0.7
SO ₃	0.9	-
	<u>46.5</u>	<u>40.9</u>

RAW MATERIALS ---Ferrosilicon production.

SCRAP STEEL.

Only limited quantities of scrap steel suitable for Ferrosilicon production are available in southern Tasmania, presently about 2000 tons/ year.

Iron ore.

The Savage River Consortium produce over 2 million tons/p.a. of high grade iron ore averaging 67½% Fe in the form of ½ inch (13mm) pellets.

This is the highest grade iron ore produced in quantity in Australia, and could be a suitable material for ferrosilicon production.

Bulk loading facilities are located at Port Latta, in North Western Tasmania.

ELECTRIC POWER.

Availability. Most of the electric power generated in Tasmania is produced by the State Government, Hydro-Electric Commission of Tasmania. This Commission is at the moment satisfying an average load demand of 800MW. and could generate 1000MW. continuously.

The Commission has indicated that 200MW. of power could be made available at short notice at Geeveston, but transmission lines would have to be extended to smelter sites further south, i.e. in the case of the proposed Huon-Weld smelter site, about 5 miles (8km) or in the case of the Hastings-Lune site, about 15-20 miles (24-32km).

COST OF ELECTRIC POWER.

The H.E.C. have indicated that they would expect to be able to make the supply available at rates which would at this date, 1st March, 1973 result in an average price per kWh in the vicinity of 0.72 cents per kWh. This is based on the Commission being responsible for a local substation, a power demand of 45,000kW with an annual load factor around 90%, and subject to negotiation of a long term contract similar to those which apply in respect

Cost of electric power, continued.

of similar industries in Tasmania.

The Commission says this is an indicative price only at this stage and should not be construed as a firm offer. The latter would depend on more definite information regarding the location and nature of the load.

The tariff would be subject to periodic adjustment by formulae taking account of variations in wages, interest rates and fuel costs.

The Company would be required to enter into a guarantee in a form acceptable to the Commission in respect of its compliance with the terms and conditions of the power supply agreement.

FUTURE POWER DEVELOPMENTS.**THE GORDON CATCHMENT**

The Gordon River Power Development Stage 1 will create the largest water storage in Australia (capacity 11.8 million acre-feet). It will comprise two lakes, each with a surface area of about 100 square miles, joined by a canal. A 460 ft. high dam on the Gordon River above its junction with the Serpentine River will create Lake Gordon. Two more dams, one on the Serpentine River above its junction with the Gordon and one on the upper reaches of the Huon River, will create another lake. Water from that catchment will flow into Lake Gordon through a short canal at McPartlan Pass. A tunnel will lead the water to the underground — GORDON POWER STATION. Head, 610 ft.

THE PIEMAN RIVER CATCHMENT

A hydro-electric development has been proposed of the Pieman, Murchison and Mackintosh Rivers in Western Tasmania. The area of the catchment is 1,034 square miles but only 2 pc. (about 24 square miles) would be inundated. Rainfall varies over the catchment from 90 to 140 inches a year. The approximate total installed capacity would be 420,000 kW.

BELL BAY THERMAL STATION

In addition to the Mersey-Forth development a new source of power was needed to meet the forecast demand in 1971. Another major hydro-electric development could not be designed and built in time so it was decided to build an oil-fired thermal station near Bell Bay on the River Tamar. A steam turbine will drive a single 120,000 kW generator in — BELL BAY POWER STATION.

It is now proposed to double the capacity of this station by installing a second 120,000 kW generator, to be ready by 1974.

THE GENERATING SYSTEM

Power Station	Commissioning Date	Turbines No. Type	Installed Capacity kW	Average Annual Output kWh Units
Waddamana	1944	4 Pelton	48,000	—
Tarraleah	1938	6 Pelton	90,000	593 million
Butlers Gorge	1951	1 Francis	12,200	63 million
Tungatinah	1953	5 Francis	125,000	560 million
Trevallyn	1955	4 Francis	80,000	541 million
Lake Echo	1956	1 Francis	32,400	76 million
Wayatinah	1957	3 Francis	38,250	274 million
Liapootah	1960	3 Francis	83,700	455 million
Catagunya	1962	2 Francis	48,000	260 million
Poatina	1964	5 Pelton	250,000	1,322 million
Tods Corner	1966	1 Francis	1,600	13 million
Meadowbank	1967	1 Kaplan	40,000	209 million
Cluny	1967	1 Kaplan	17,000	105 million
Repulse	1968	1 Kaplan	28,000	160 million
Rowallan	1968	1 Kaplan	10,450	40 million
Lemonthyme	1969	1 Francis	51,000	286 million
Devils Gate	1969	1 Francis	60,000	300 million
Wilmot	1970	1 Francis	30,600	126 million
Bell Bay 1	1970	1 Steam	120,000	788 million
Cethana	1971	1 Francis	85,000	409 million
Paloona	1971	1 Kaplan	28,000	130 million
Fisher	1972	1 Pelton	43,200	247 million
Bell Bay 2	1974	1 Steam	120,000	739 million
Gordon	1975	3 Francis	240,000	1,333 million
Pieman (proposed)	1978	—	420,000 (estimated)	1,770 million (estimated)

LOCATION OF SMELTER.

The raw materials, electric power resources, services, housing, roads and port should, ideally, be situated in close proximity to each other. However, the smelter should not be sited too close to habitation or agricultural lands as there are gases and slag residue to be disposed of.

The Hastings-Lune River and the Weld-Huon schemes both have suitable sites, situated between the raw materials resources and the port sites.

Hastings- Lune River Scheme.

The area between Lune-Southport-Esperance is sparsely populated and contains very little cultivated land.

A smelter site at the port site at Southport is the most obvious.

There is flat land near 'The Deep Hole' where limestone is loaded on small vessels for transport to North West Bay.

Foundations would be on Jurassic Dolerite and a road would have to be constructed from Ida Bay, a distance of $3\frac{1}{2}$ miles (5.6km).

Prevailing N.W. winds blow out to sea from this site.

Construction of a transmission line from Geeveston would be also required---a distance of about 21 miles (34km).

The site is a considerable distance from any sizable town, so that housing would need to be provided in the area.

Other good sites would be on the Old Hastings Road at Strathblane Plain, not far from the old coal mines.

Foundations would be in flat bedded Triassic sandstone, providing ideal foundations of semi-porous material for the absorption of any waste residues from slags etc..

Disposal of gases may be a problem in this area, as fogs are frequent in the winter months; prevailing winds are from the N.W., however in the town of Dover a short distance away, fogs are almost unknown. There is little or no habitation at Strathblane Plain at this time.

There are several other suitable areas for a smelter in the Ida Bay - Esperance district.

LOCATION OF SMELTER. (continued.)Weld - Huon Scheme.

The most obvious smelter sites are situated, between the silica and dolomite deposits of the Weld and Huon Rivers, and Port Huon. They are (1) at the Huon River Plains between the Picton and Weld Rivers, and (2) on the Arve or Lidgerwood Roads within about 2 miles of their junction.

(1) The Huon River Plains consist of thick beds of gravels, sand, and clays skirt the river. They represent old terrace deposits along previous courses of the Huon River and in places have a vertical thickness up to 40 feet (12^m). Consideration as to the suitability of this material for foundations should be given.

The area is well away from habitation and agricultural lands, but consideration should also be given to gas dispersion problems, as the valley is subject to fogs in winter also.

Construction of a power transmission line from Geeveston would be required, the distance being about 12 miles (19km).

(2) The Arve - Lidgerwood Road location provides for good foundations on flat bedded sandstone of Triassic age, consisting of semi-porous material for the absorption of residue wastes from slags etc.....

The location is on high ground, at an elevation of 800-900 feet (244-274^m) above sea level, near a saddle area, and should be suitable for the effective dispersion of gases to the atmosphere.

Winds blow predominantly from a N.W. direction most of the year. A power transmission line, 5 miles (8km) long would have to be constructed from near Geeveston.

Other sites on the lower tidal part of the Huon River could be considered, but the dispersal of gases may be a problem. Winds tend to blow in two directions only, up and down the River. Fogs are common in winter months.

ACCESS --- ROAD

Road access from Hobart to the Hastings-Lune Quartzite deposits is by the Huon Highway, and Hastings Caves Road.

Road distances from Hobart are:-

	<u>miles</u>	<u>km</u>
to Huonville	23	37
Port Huon	35	56
Geeveston	37	60
Dover	50	80
Hastings turnoff	60	96
Caves Rd. deposit	65	105
Hogs Back "	67	108

The South Lune deposit is via the Hastings Caves Road-Catamaran Road-

and South Lune Road.

70

113

Road access from Hobart to the Weld River deposit is by the Huon Highway to Geeveston, thence by the Arve Road to Tahune Bridge over the Huon River, thence by the South Weld Road.

The last several miles are still under construction and should be completed by the end of 1973.

Road Distances from Hobart are:-

	<u>Miles</u>	<u>KM</u>
to Huonville	23	37
Port Huon	35	56
Geeveston	37	60
Smelter site	41	67
Tahune Bridge	54	87
Weld River deposit	58	94

Road distances from Port Huon are:-

to Caves Rd. deposit	30	49
South Lune "	35	57
Weld River "	23	38

Road distances from Port Esperance are:-

to Caves Road dpt.	12-15	19-24
South Lune deposit	15	24

Road distances from Southport are:-

(port site)

South lune	8	13
Caves Road	9	14

Access.--continued

The existing roads to the various deposits in the Hastings-Lune River area, as well as the Arve-Weld River area, have been designed and constructed to meet Standard Specifications.

They carry heavy logging trucks, with loads of up to 16 tons in all weather conditions.

PORTS AND PORT SITES.

There is a public wharf at Port Huon, situated on the Huon River in D'Entrecasteaux Channel under the control of the Marine Board of Hobart. Its eastern side has been dredged to a depth of 30ft. (9m) for 450 feet (137^m) from its outer end, its western side, to a similar depth for 560 ft (170^m) from its outer end.

Ships of 13,000 tons use the Port for the export of fruit.

Further down the Huon River there are numerous excellent port sites available, located in smooth-water with a small tidal range with very deep water close to the shore line, the Huon River would provide relatively low cost berthing for the largest ships now afloat, without dredging of the port site or approaches.

Port Esperance also provides an excellent port site with good shelter from the sea, deep water close to the shore and a least depth of over 50 feet (15^m).

Southport is less sheltered from S.E. seas and weather but provides good shelter in other weathers, with deep water on the S.W. side.

About 1971 the Hobart Marine Board completed establishing a wharf at Triabunna, on the east coast of Tasmania. The location was in more open sea conditions than the enclosed waters of the Huon River etc., and is suitable for ships of 35,000 tons and with a length of 600 feet (183^m). The cost of this installation was about \$850,000 and was financed by the Marine Board who operate and maintain the wharf at a cost to the exporters of about 21cents per long ton on 600,000 tons/ p.a.

The above figures are to give some idea of local construction costs and charges.

PORT & WHARFAGE CHARGES -----PORT HUON

The charges for tonnage and wharfage are the same for both Port Huon and Port of Hobart as follows:- (1973)

Wharfage : 50 cents per ton.

Tonnage : For vessels within the Commonwealth of Australia : for the first 24 hrs. or part thereof for each 12 tons of G.R.T... 11 cents thereafter for each 6 hr. period or part thereof for each ton of G.R.T... 0.12 cents

For vessels outside the Commonwealth of Australia ; for the first 24 hrs. or part thereof for each ton of gross reg. tonnage..... 1.2 cents thereafter for each 6 hr. period or part thereof for each ton of G.R.T. 0.12 cents

Pilotage : At the rate of 4 cents per G.R.T. with a max. charge of \$80 both in and out.

Port Usage: The Port Huon Wharf is little used outside the normal fruit exporting season of April-May each year.
There is a large storage shed on the wharf.

ACKNOWLEDGMENTS

The author wishes to gratefully acknowledge the support provided by the Minister Administering the Hydro-Electric Commission Act, Hon. R.F.Fagan, the Chief Commissioner of Forests (Mr. Paul Unwin) for the report on timber reserves, and the Commissioner for the Hydro-Electric Commission of Tasmania (Sir Alan Knight), the Marine Board of Hobart, and the Director of Mines and staff for their assistance.

References.

- Fairchild, W.T., 1970. Electric furnace manufacture of silicon metal, J. Metals, 22(8): 55-8.
- Morning, J.L., 1965. Silicon, in Mineral Facts and Problems, U.S Bureau of Mines Bulletin 630.
- Blake, F., Acting Gov. Geologist, Report -- Glen Huon to Frankland Range, July, 1935.
- Hope, J.M. and Nicholson, D.S. and Marshall, T., Feasibility study for a silicon industry in Southland, N.Z. Proc. Aust. Inst. Min. Met. No. 240, Dec. 1971.
- Metal Bulletin. 6th Nov. 1970. The Magnetherm Process.
- Jaeger, J.C. and Johnson, Cynthia M., A Study of the Carbonization of some Tasmanian Timbers. Pap. & Proc. Roy. Soc. Tas. 1941
- Hughes, T.D., Limestones in Tasmania. Tas. Dept. Mines, Geol. Survey Min. Res. No. 10. 1957. and Tech. Rept. No. 4. 1959.

314030

Page 15

6.1.4.2 Ucar "S"

Material

Price US \$1540 firm 'till 06/90
 Assume 7% increase, US \$=0.75
 (1540x1.07/0.75) = \$2197.06

Assume transport wharfage same
 as S30 = \$ 27.82

Total = \$2224.89

6.1.5 CHARCOAL:

The budget is based on a specific consumption of charcoal of 186Kg/Tonne S1 with 50% supplied from Echuca, Vic., and 50% from Singapore.

6.1.5.1 Echuca

Price at Nov., '89 = \$470

at 31/12/90
 assume 7% increase = \$ 502.92

TFES no change
 (9.6 t/ctn) \$560/9.6t = (\$ 58.30)

Transport

Currently \$98/ctn
 assume 7% increase
 98/9.6 x 1.07 = \$ 10.92

= \$ 433.68

Losses at 4%

Total = \$ 451.03

6.1.5.2 Singapore

Price at May '90 = \$434.75

Purchase price

US\$280/t CIF Burnie = AUS\$373.33

Aus\$ 0.75 against US\$
 10.2 tonnes per ctn.

Assume Singapore price
 4% lift = 373.33 x 1.04 = \$ 388.26

Cartage, etc component
 = (434.75 - 373.33)
 = 61.42

Transport increase
 8% 61.42 x 1.08 = \$ 66.33

= \$ 454.56

Losses at 4%

Total = \$ 472.74

314037

Page 14

6.1.3 COAL:

The budget is based on using Lemington coal for all the year, with a specific consumption of 961Kg/Tonne Si-metal.

Cost Estimate

Material - escalation clause
based on 80% of CPI

Price at 31/03/90 was \$96.01
Therefore at 31/12/90
= 96.01 [1+(9/12x7%x80%)] = \$100.04

Transport

Presently \$1825/ctn set at
October, 1989

Assume 7% increase at Dec., '90
Assume 19.5 tonnes/ctn.
\$1825/19.5x[1+(1/2x7%)] = \$ 96.87

Assume TFES unchanged
= \$560/19.5 = (\$ 28.72)

= \$166.19

Losses at 2%

Total = \$171.55

6.1.4 ELECTRODES:

The budget is based on a specific consumption of electrode of 112Kg/Tonne Si. Two columns will use ELCA S30 electrodes and one column UCAR"S" type.

6.1.4.1 ELCA S30**Material**

S30 price held at US\$1450/t CIF
Hobart 'till end 1990.

Assume 7% rise thereafter
therefore
[1+(1/2x7%)]x1450/0.75 = \$2001.00

Transport/Wharfage

Total at 12/89 was \$26

Assume 7% increase
= 26 x 1.07 = \$ 27.82

Total = \$2028.82

MAC

Attached are our BUDGET COSTINGS FOR
90/91 MAR.

COSTING NOTES

Revised Mix

6.1 RAW MATERIALS:-6.1.1 QUARTZ:

The budget is based on using only Besser quartz in the mix at a specific consumption of 2480Kg/Tonne Si (400Kg per mix x 6.2 mix/tonnes).

Cost Estimate - Besser

Material Cost

Price at March 1990 = \$ 14.03/tonne

Escalated price to Dec. '90

= 14.03 x (9/12 x 7% +1)

= 14.77

= \$ 14.77

Transport

Quote for '90/'91 is \$23/tonne = \$ 23.00

= \$ 37.77

Assume losses at 15%

Total = \$ 43.44/tonne

6.1.2 WOODCHIPS:

The budget is based on a specific consumption of woodchips of 2108Kg/Tonne Si.

Cost Estimate

Price at Sept. '89 = \$ 78.64/t(dry)

Escalation formulae allows for inflation x 44%

Price at Dec., '90

= [1+(15/12x7%x0.44)]x78.64 = 81.67

Average moisture content from 01/10/90 to 15/05/90

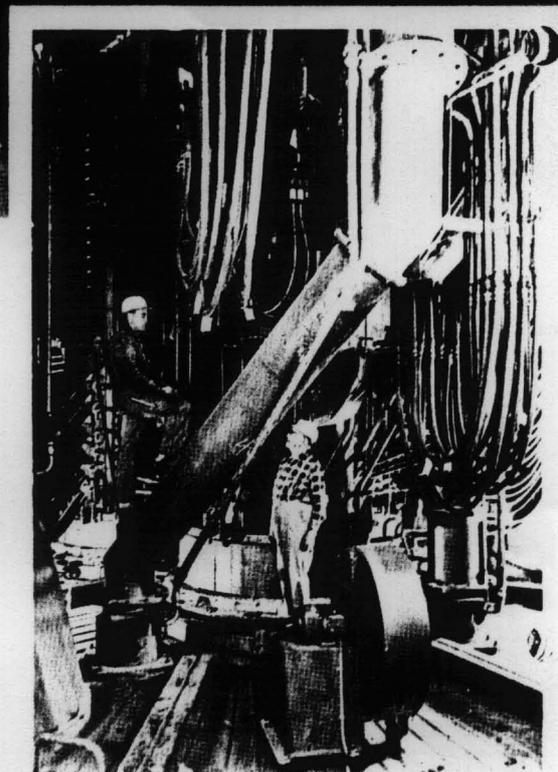
= 37.7%

Price at 37.7% M.C.

= \$ 50.88/tonne



39.000 kVA ELKEM FeSi-furnace - view of furnace floor.



Inspecting electrode equipment above smoke-hood roof.

Silicon Alloys

Today the different grades of FeSi as well as «silvery pig» and Si metal are produced only in electric smelting furnaces. The parameters of the furnace differ with the grade of metal to be produced. In a period of about ten years the max. size of the ELKEM FeSi furnace has increased from 24 MVA to 75 MVA. The 75 MVA unit has been in operation since 1972.

Equipment for rotation of the furnace crucible is recommended for all Si-reduction furnaces.

The quality of the quartzite and reducing agents used is of vital importance in the production of FeSi and Si metal.

Due to environmental regulations, cleaning of the exhaust gases from open Si furnaces is almost universally required. Equipment to meet the emission problems is supplied by the Engineering Division. A special furnace design has been developed to reduce the amount of gas to be cleaned.

Type of furnace	Open rotating (alt. semi-closed, rotating)						
	7.500	15.000	24.000	33.000	48.000	60.000	75.000
Transformer cap. kVA	7.500	15.000	24.000	33.000	48.000	60.000	75.000
Nominal load kW	6.500	13.000	20.000	25.000	35.000	40.000	50.000
Approximate annual production in m. tons							
a) 45-50 % FeSi:	10.000	20.000	30.000	40.000	55.000	60.000	75.000
b) 75 % FeSi:	6.000	11.000	17.000	21.000	30.000	35.000	43.000
c) 90 % FeSi:	4.500	9.000	13.000	17.000	23.000	—	—
d) Si-metal :	4.000	8.000	12.000	15.000	—	—	—

Normal operational figures per metric ton of product:

Si-grade		45%	75%	90%	Si-metal
Quartz	kgs	1.100	1.800 - 2.000	2.300 - 2.500	2.800 - 3.000
Reductants	kgs	600	850 - 1.050	1.300 - 1.500	1.800
Fe material	kgs	600 - 650	250 - 275	80 - 90	—
Electric power	kWh	4.800 - 5.100	8.500 - 9.200	11.000 - 13.000	12.000 - 14.000
Electrode paste	kgs	25 - 40	50 - 70	70 - 100	100 - 150

314039