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21 February 1964

India.

MANUFACTURE OF GRAPHITE ELECTRODES.

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Prepared for the Government of India

by Gregg M. Moga

Appointed under the
United Nations Programme of Technical Assistance

1964

UNITED NATIONS
Commissioner for Technical Assistance
Department of Economic and Social Affairs

64-3[illegible]776

This report is not an official document of the United Nations, but a paper especially prepared by an expert under the United Nations Technical Assistance Programme as his final report to the Government of India.

FOREWORD

In accordance with a request from the Government of India concerning technical assistance, the Bureau of Technical Assistance Operations appointed Mr. G.M. Moga to advise on the manufacturing of graphite electrodes.

The duration of Mr. G.M. Moga's assignment was from 11 April, 1962 to 10 October, 1962.

His final report to the Government follows.

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TABLES

I. INTRODUCTION

1. While the functional title given to this assignment was "Manufacture of Carbon Electrodes" it soon became evident from early discussions that the technical assistance desired was not on carbon but on graphite electrodes. This will explain why this report is written under the title "Manufacture of Graphite Electrodes". In the electrode manufacturing trade and in the field of application, the terms are not used interchangeably since they represent distinctly different products. Carbon electrodes, which may be termed the utility grade, are amorphous, hard and medium conductors of electricity. India is presently producing the bulk of the demand for this type in the form of carbon paste for self-baking carbon electrodes. On the other hand, the higher grade and higher priced graphite electrodes which are soft, crystalline and electrically highly conductive, are not made in India but are all imported.

2. Besides the work of the experts and officials in the Government's Ministry, the work on this project has been going on for over three years by United Nations experts and by representatives of the joint venture group that have been granted an industrial license to manufacture graphite electrodes. In 1959, Mr. Bartley E. Broadwell was given the first assignment by the United Nations on this project. His study resulted in a 229 page report on the technology of amorphous carbon and graphite electrodes as well as a 29 page supplemental report on carbon and graphite specialities. In 1960 and 1961, United Nations

expert, Mr. A.G. White did considerable work investigating the chemical composition and physical characteristics of indigenous bituminous coals and the washing of these coals to reduce their high ash contents. The objective was to produce a low ash foundry coke from which graphite electrodes could be produced. Fortunately, it has not been necessary for India to pursue this difficult and untried avenue to secure a carbonaceous raw material to produce graphite electrodes. Petroleum coke has become available from a refinery at Digboi and within the present year two more refineries, at Guahati and Barauni will be producing by-product coke. As petroleum coke is the accepted standard raw material for graphite electrodes the world over, this material substitution problem has been solved, at least for anodes and small and medium-sized electrodes.

3. On August 25, 1959, Bangur Bros of Calcutta, prospective manufacturers of graphite electrodes, requested an industrial license. A collaboration was entered into with Great Lakes Carbon Corporation of New York City, one of the world's leading manufacturers of graphite electrodes. Subsequently, teams of experts were sent here to explore manufacturing and marketing matters. Negotiations between the parties and the Government continued until full agreement on the terms of collaboration was reached and approved by the Government in May, 1962.

4. Under the circumstances, it was not necessary for this expert to report on the extensive technology but only to review and appraise the work already performed. This effort disclosed that the technical feasibility was satisfactory and under good control for commercialization. This provided the time and opportunity to appraise the economic feasibility of the proposed plant. It was not an obvious conclusion that a graphite electrode plant could be justified because of the limited demands on the one hand and the high capital cost of several millions of dollars, on the other hand.

5. Electrode manufacturing is heavy industry and its product is a supply item for heavy industries; electro-metallurgical, electro-chemical and the steel industry in particular. This economic feasibility study, therefore, set out to determine the present and future status of these industries as consumers of graphite electrodes. There were no records in the Government Ministries of this type of information and so it was necessary for this expert to make direct contacts with the many companies involved for the desired information. Over 200 of several types of questionaires were sent out with over 75% returns. This report in the main is an analysis and summarization of the basic data collected.

6. Dr. S.P. Varma, head of the Mineral Industries Directorate who was appointed counterpart for the assignment was most helpful in his suggestions and general guidance on how to best carry on the work.

II. CONCLUSIONS

(i). The graphite electrode demand in India is now developing to a tonnage which will soon make a manufacturing facility economically feasible.

(ii) While this demand is presently less than 2000 tons per year, in 1965 it will amount to 5000 tons on a conservative estimate which represents about the minimum tonnage for a plant to produce and be economical.

(iii) Electric furnace carbon steel producers and caustic soda-chlorine producers are the main demands, each representing about one-third. The remainder is made up of alloy steel producers and foundry requirements.

(iv) The economic feasibility in 1965 when the demand is 5000 tons is contingent on a price support level of 26 ¢ / pound - the average of American and European markets - in order to produce a fair return on invested capital.

(v) There is a promising future for an electrode plant in India with its fast developing heavy industry, particularly steel and industrial chemicals.

(vi) It is very desirable that graphite electrodes be manufactured rather than imported as they represent a vital supply item for several important industries. In 1965 and thereafter when the demand will be exceeding 5000 tons, the savings in foreign exchange will be over $ 2,000,000 per year.

III. MARKET FOR GRAPHITE ELECTRODES IN INDIA

A. Graphite Electrode Demand as Revealed by Foreign Trade Statistics

8. Inasmuch as all the graphite electrodes consumed have been imported, the first phase of the study was to examine the statistics as reported in weekly and monthly bulletins on imports and import licenses. From the publication "Monthly Statistics of the Foreign Trade of India - Volume II - Imports" the following statistics were obtained being imports of carbon and graphite products as registered by authorities at seaports, airports and land customs stations. The figures given are for the fiscal year ending March, 1962.

Articles	Quantity	Value(Rs.)
Carbon Blocks	3,96,346	12,18,256
Carbon Brushes	20,104	1,15,504
Carbon Electrodes for Cells and Batteries	8,15,66,602	28,12,111
Carbon Furnace Electrodes and Liners	1,567	3,21,270
Carbon for Projection Arc Lamps	1,17,31,461	38,11,645
Others	10,78,535	49,68,401

9. The complete tabulation of this table giving a breakdown of the above articles by countries, is given in Table I. It will be seen that the above tabulation gives only one title "Carbon Furnace Electrodes and Liners" in which furnace electrodes are specified. It is obvious that the reported value in this classification of Rs.3,21,270 (£ 67,000) represents only a part of the total of graphite electrode imported. In discussing this problem with officials of the Office of the

TABLE I

MONTHLY STATISTICS OF THE FOREIGN TRADE OF INDIA

IMPORTS

663 05 Carbon and Graphite Products Except Crucibles Including Lighting Carbons Electrode Carbon Brushes and Brush Stock and Battery Carbons

Articles and countries from which imported	Unit of quantity	TWELVE MONTHS ENDED MARCH, 1962		Article code
		Quantity	Value (Rs)	
Carbon Blocks	No			663050100
Germany E		76200	27661	
Germany W		100440	298329	
Italy		15105	40760	
Japan		8049	329903	
U K		135314	479696	
U S A		53822	33354	
SM VAL TRNS		7416	8553	
		396346	1218256	
Carbon Brushes	No			663050200
Canada		50	1000	
Germany W		6831	31704	
Italy		2004	24201	
Sweden		200	2015	
Switzerland		353	4416	
U K		4413	15645	
U S A		2366	20584	
Yugoslavia		562	1057	
SM VAL TRNS		3325	14882	
		20104	115504	
Carbon Electrodes for Cells and Battery	No			663050300
France		27049265	445344	
Germany W		7276006	112073	
Italy		1500000	9084	
Singapore		2052415	12427	
U K		2360544	99456	
U S A		41213052	2131250	
SM VAL TRNS		95410	2475	
		81566692	2812111	

Contd..

Table I...Contd.

Articles and countries from which imported	Unit of quantity	TWELVE MONTHS ENDED MARCH, 1962		Article code
		Quantity	Value (Rs)	
Carbon Furnace Electrode and Liners	No.			663050400
Germany W		387	126544	
Japan		1068	169415	
U S A		88	24827	
SM VAL TRNS		24	484	
		1567	321270	
Carbon for Projection Arc Lamps	No.			663050500
China		49700	10605	
France		233824	103784	
Germany E		2226750	564806	
Germany W		924331	335801	
Italy		306750	134483	
Japan		509994	227651	
Poland		20000	5038	
U K		1971003	548191	
U S A		5321701	1852418	
SM VAL TRNS		87408	28868	
		11731461	3811645	
Others				663050900
Canada	No	1770	166689	
China		674	1276	
France		29001	43009	
Germany E		99390	544968	
Germany W		479716	878243	
Italy		48000	19087	
Japan		189866	1014350	
Netherlands		351	1755	
Sweden		262	5344	
Switzerland		500	4258	
U K		133602	896284	
U S A		71111	1375627	
SM VAL TRNS		24292	17511	
		1078535	4968401	
			13247187	

Chief Controller of Imports and Exports they stated it would be impossible to get a detailed breakdown of these classifications for the purposes of this market study except by searching the records of the custom authorities of the various seaports. This did not appear to be a promising avenue to obtain the information desired.

10. The next phase of the study was to review the weekly bulletins published by the Ministry of Commerce and Industry, "Industrial Licences, Import Licences and Export Licences". A search through the 52 bulletins for the fiscal year ending April 1962 disclosed over 200 cases of goods descriptions, such as "Graphite", "Carbon", "Carbon Elements", "Electrodes", "Synthetic Graphite", "Graphite Plates," etc. In order to get more information on these import licences, questionnires were sent out to 63 companies where the value of the licence was Rs.2000 or more to obtain sizes full description and uses to which the goods were put. Together with a later follow-up letter these requests found a response of 49 replies, or 77% . The information, however, was disappointing as the vast majority of full goods descriptions turned out to be welding electrodes, natural graphite,brush blocks, and graphite crucibles, with only 10 cases being reported of graphite electrodes or graphite anodes.

In explanation of this failure to obtain the desired information from these records, it may be that many individual imports of graphite electrodes are lost because they are parts of larger omnibus licences.

B. Graphite Electrode Demand from Electric Furnace Carbon Steel Producers

11. Since approaches to licensees and importers proved unrewarding, it was decided to write directly to electric furnace steel producers; already producing as well as those granted industrial licences to construct specified capacities. The former list was supplied by Mr. K.A.P. Misra, President of the Indian Furnace Co. of Bombay and the latter by Under Secretary H.S. Gill of the Ministry of Steel and Heavy Industries. Questionaires were sent to 24 producing companies with 70% returns and to 35 new licensees with 55% returns. All the returns with significant data were tabulated - Table II - "Electric Melting Furnaces of Steel Ingot and Billet Producers" which lists 26 companies with a total of 42 electric furnaces, either installed or proposed. With the exception of two companies which are undecided, all the listed companies will be operating in 1965 consuming an estimated 1830 metric tons of graphite electrodes. The estimate is based on an average consumption of 16½ poundsof electrodes per metric ton of steel tapped. The 1962 demand is obtained by selecting only the steel tonnages of the companies shown as operating in the column headed "Status of Furnaces." It amounts to 712 tons of graphite electrodes. In other words, there is a projected expansion of electric steel of 256% in three years time.

12. It is significant to note that the furnace capacities, installed or proposed are mainly small sizes. Of the 42 listed furnaces, 34 are of 6 ton capacity or smaller. Six tons represents a pretty small heat of steel to teem into moulds. The

TABLE II

ELECTRIC MELTI[illegible]

OF

STEEL INGOT A[illegible]

(Figures [illegible])

Company name	Address	Reply from	Status of Furnaces	License Tons	Production 1000 Tons/year 1st	2nd	3rd	Furnaces No.	Make	Tons	KVA	Electrodes Diam.	TONS 1965
1. Aeron Steel Rolling Mills	Tanda Road, Jullundur City		Being installed	6480	6.5	6.5	6.5	1	Birlefco	4	2000	8"	48
2. Andhra Steel Corp.(Pvt)Ltd.	Office: 140 Chittaranjan Ave. Calcutta-7. Plant : Visakhapatnam Port(AP)		Startup 1965	4800	9.6	12	15	1	Nikex-Hungary		2000	8	110
3. Bell Alloy Steels Pvt.Ltd.	1 Race Course Coimbatore-1.	D.Balasundaram,Man.Dir.						1	Local	3		6	42
4. Bhartia Electric Steels Co.,Ltd.	8 Swinhoe St. Ballygunge, Calcutta.	S.N. Goel, Comm. Mgr.	Startup 1922	3600				1 1	Stobie Stobie	3 5	650 1500	7 9	60
5. Canara Workshops Ltd.	P.O.Box 712 Mangalore		Being installed	9600								10	50
6. Dalmia Iron & Steel Ltd.	P.O.Box 814 Stephen House 4,Dalhousie Sq. East Calcutta	V.M.Bhasin, Purch.	1 Fce. operating 1 Fce. being installed.	4500				2	Birlefco	3	1500	8	72
7. Globe Steels Div. of Globe Motors Ltd.	1/1 Jhandewala, New Delhi.	Director	Being installed	6000	7.2	11	12	1 1	Birlefco B.B.	4 2-3	2000 1000	8 7	66
8. Grand Smithy Works	Office: 1 Girish Ghose Rd., Belarmath, Howrah. Plant : No.5 Grand Trunk Rd., Belarmath, Howrah.	C.Vedanthan	Startup 1st Fce. Sept.'62. Startup 2nd Fce. 1965	9600	9	18	18	2	Birlefco	3	1500	8	135
9. Guest, Keen, Williams Ltd.	Office: 41 Chowringhee Rd., Calcutta-16. Plant : 97, Andul Rd. Howrah	A.W. Mac Donald	Operating									10	80

Table II ..... Contd.

Company name	Address	Reply from	Status of Furnaces	License Tons	Production 1000 Tons/year			Furnace				Electrodes	
					1st	2nd	3rd	No.	Make	Tons	KVA	Dia.	TONS 1965
10.B.R. Herman & Mohatta(India) Pvt. Ltd.	Office: Mustafa Bldg.,Sir P.M. Rd.,Ft.Bombay Plant : Uhlas Nagar, Kalyan - C.Rlwy.		Ready - waiting on power	4200	5.5	5.5	5.5	1	Birlefco	5	1500	8"	42
11.Hindustan Iron and Steel Co.Ltd	Office: 8 Rajendra Dev Rd. Calcutta. Plant : 68 Jessore Road, Dum-Dum	Partner	3 ton Fce. operating 4 ton Fce. being installed					1 1	Birlefco Birlefco	3 4	1500 -	6 8	40 60
12.Indian Rolling Mills	79 Fazalganj Kanpur	G.K.Samani	Undecided	4520				1					
13.J.K. Iron & Steel Co.Ltd.	Kalpi Road, Kanpur	Stores-Purchasing	1 Fce. operating 1 Fce. ordered	8400	10	15	15	1 1	BB BB	6-8 7-8		10 10	112
14.J.K. Steel Ltd.	Office: 7 Council House St., Calcutta Plant : Rishra,Dist. Hoogley	P.N.V. Ramani, Mgr.	Will operate '64.	15000	12	15	15	1 or 2		10	5500-4000	12	112
15.Krishna Steel Industries Pvt Ltd.	120 Dinshaw Vachha Rd., Post Box 93-A,Bombay.	Director	Delay in securing land	14400				2 or 3		10			
16.Kumardhubi Engg Works Ltd.	Kumardhubi P.O. Dist. Dhanbad.	Wks.Mgr.	Operating	3600				1 1	BB BB	2 5		7 9	90
17.Mukand Iron & Steel Wks Ltd.	Office: Bombay-Agra Rd., Kurla Bombay-70 Plant : Kalwa, Thana Dist. Maharashtra.	V.N.Lokar Comm. Mgr.	Startup June '64	30000	20	30	30	1		20-25	8000	16	150
18.National Iron & Steel Co Ltd	4, Dalhousie Sq.East, Calcutta.		Operating		14.4	14.4	14.4	1 1 1	Demag Efco Birlefco	10 6 1		12 9 5 1/8	108
19.Prakash Engg Co. & Rolling Works	Freeganj St., Agra		Const.not started	5000	5	5	5	1		5	2500		
20.The Punjab Iron & Steel Corp.	G.T. Road Jullundur Cantt	Partner	Startup Oct.'62	5000	5	6	7	1	Hungarian	5	2250	8	52

Table.....II.....Contd.

Company name	Address	Reply from	Status of Furnaces	License Tons	Production 1000 Tons/Year			Furnaces				Electrodes	
					1st	2nd	3rd	No.	Make	Tons	KVA	Diam.	TOTAL 1965
21.The Singh Engineering Wks Pvt. Ltd.	Post Box 66 Kanpur	Shri Singh	1 Fce. operating.	15200	7.5	7.5	7.5	1	Birlefco	4		8"	50
			1 Fce. applied for.		5.2	5.2	5.2	1	Birlefco	6	2500	10	24
22.Steel Rolling Mills of Hindustan Pvt. Ltd.	47 Hide Road Extension Calcutta-27.	Surrendra Paul	Started Dec.'60	10560	5	6	10	1	Daido	4	1250	8	75
								1	Tagliaferri	2	1500		
23.Surrendra Overseas Pvt. Ltd.	Office: 24 Baroda St.Iron Market,Bombay-9 Plant : Thana - Bombay Suburb	S.P.Sharma	Startup end '62	4500	4.5	5	5	1	Birlefco	5	1500	8	58
24.The Tata Iron and Steel Co. Ltd.	Jamshedpur	Genl.Mgr.	Operating					1	Heroult	4		9	110
								2	Heroult	5½			
25.Textool Co. Ltd.	Ganapathy P.O. Coimbatore-6	Purchase Officer	Operating					5	Self	0.75		5	56
26.Upper India Steel Mfg. & Engg.Co. Pvt. Ltd.	Office: Rattan Bldgs.Civil Lines,Ludhiana. Plant : Village Sherpur Kalan,Tehsil Dist. Ludhiana.	Man.Dir.	Startup Dec.'62		6	8	9	1	BB	5.4	1500	8	68
								42					1850

explanation may be a matter of limited capital and perhaps desire to have the furnace do double duty - to produce ingots and also castings. Because of small furnaces, the electrodes required are small in size; 6 inch diameter being the most popular with 16 inch diameter being the largest size contemplated, in only one case.

Present Graphite Electrode Demand as Determined from Published Figures on Electric Steel Capacity and Production

13. Ordinarily, the major demand for the output of a graphite electrode plant comes from the electric furnace steel producers with demand from foundries, caustic soda-chlorine producers representing lesser requirements. Because of the small present demand of 712 tons per year from electric furnace steel producers and the need to have an output of at least 4500 tons per year in total, it was decided to check this figure against another source of information to affirm or deny its correctness.

An Indian authority, Mr. R.N. Dutt, former Additional Iron and Steel Controller, reports 12 firms with electric furnaces in the October 1961 issue of the Iron and Steel Review in his article, "Iron and Steel Scrap - Control and Procedure". The names and annual capacity of these firms is given in Table III amounting to 79,560 tons per year. Regarding the utilization of this capacity the most recently published figures on electric steel production are also shown in this table. These were obtained from the statistical pink sheets of the Iron and Steel Review. These figures are for the three month period, November 1961, December 1961 and January, 1962 which production represents an

annual rate of 71,000 metric tons per year. Translating to graphite electrode consumption by assuming an average usage of 16½ pounds per ton, we have 550 tons.

Since the steel production figures used are for November 1961, December 1961 and January 1962, the turn of the year, it is reasonable to assume that the usage for the calendar year 1962 will be higher than 550 tons in view of the general increasing trend of output in the steel industry. Perhaps the total will reach 650 or 700 tons, in any case a reasonable check on the figure of 712 tons which was developed from the returned questionaires.

TABLE III

ELECTRIC STEEL
CAPACITY AND PRODUCTION
INGOT METRIC TONS

	Annual Capacity (R.L.Dutt)	Production (Iron & Steel Review) Nov. 1961	Dec. 1961	Jan. 1962	Total	Yearly Rate
1. Bhartia Electric Steel Co. Ltd., Calcutta.	12000	500	600	400	1500	6000
2. Guest,Keen, Williams Ltd., Calcutta.	12000	1400	1500	1400	4300	17200
3. Hindustan Iron & Steel Co. Ltd., Calcutta.	3600	200	200	200	600	2400
4. Indian Iron & Steel Co. Ltd., Calcutta.	-	-	100	400	500	2000
5. J.K. Iron & Steel Co.Ltd., Kanpur.	7800	600	800	900	2300	9200
6. Krishna Steel Industries Pvt. Ltd., Bombay.	3000	-	-	-	-	-
7. Mukand Iron & Steel Works Ltd., Bombay.	8400	200	200	100	500	2000
8. Mysore Iron & Steel Works, Mysore.	-	200	-	-	200	800
9. National Iron & Steel Co. Ltd., Calcutta.	14400	900	1200	1100	3200	12800
10. Singh Engg. Works Pvt.Ltd., Kanpur.	7800	400	900	700	2000	8000
11. Steel Rolling Mills of Hindustan Pvt. Ltd.,Calcutta	10560	-	-	-	-	-
12. Tata Iron & Steel Co.Ltd., Jamshedpur.	-	1100	1100	1200	3400	13600
TOTAL :	79560	5500	6600	6400	18500	74000

Classifications in Tables II and V

14. In Tables II and V of this report, the classifications of the listed companies as between ingot producers and foundries should not be regarded as absolute. A company with the name "Blank Iron & Steel" may be either an ingot producer, foundry or both. Many of the companies reported in Table II as steel ingot and billet producers also produce castings but, it is believed, the production tonnage and the graphite electrode consumption reflects the combinations. To make a close reporting and separation in this regard it would be necessary to make a field survey. In a few cases of larger companies, listings have been made under two headings. These are the following:

	Table II Carbon Steel Ingots	Table IV Alloy Ingots	Table V Castings
Guest,Keen & Williams Ltd.	x	x	
Hindustan Steel Ltd.		x	x
Mukand Iron & Steel Works Ltd.	x		x
The Mysore Iron & Steel Ltd.		x	x
Tata Iron & Steel Co. Ltd.	x	x	

Listed Licensees Vs. Potential Producers

15. Over one half of the 26 companies listed in Table II, "Steel Ingot and Billet Producers" are new companies who are about to start production or projecting to start in production. There may be other companies planning to proceed with their Government licences even though they did not reply to requests for information. Also, there is some unreported electric furnace capacity of Government Ordinance plants such as at Ishapori.

As far as the market for graphite electrodes is concerned, it is believed fair to assume that such additional demand will be offset by some listed demand which will fail to materialize. Illustration of this latter condition is the case of a graphite electrode market study which was made a few years ago by Mr. M. Wrotniak of the Great Lakes Carbon Corporation. His list of companies shown as requiring 3,342 tons are now in the market for only 2053 tons by this survey. In other words, nearly 40% of that proposed capacity has failed to materialize.

C. Graphite Electrode Demand from Electric Furnace Alloy Steel Producers

16. Currently only modest tonnages of alloy steel, special steel and tool steel are being produced. Tata Iron and Steel and Mysore Iron and Steel probably produce 1000 tons per year. Bhartia Electric Steels and Mukand Iron and Steel are also reported as being small producers. The total production in the country is only a few thousand tons and as such represents an insignificant demand for graphite electrodes, at the present time.

17. Table IV lists 10 reporting companies which have licences to produce alloy steel and they are either installing or proposing to install electric furnaces. K.T. Rolling Mills of Bombay, Man Industrial Corporation of Jaipur, Textile Machine Corporation of Belgharia and Khandelwal Ferro Alloys failed to report on two requests for information, hence, they are not shown in Table IV.

18. The Planning Commission's target for the Third Plan is 375,000 tons per year of alloy steels, however, this study is only able to report on a total of 243,400 tons. No doubt the main problem standing in the way of advancing this programme is securing foreign collaborators who are competent in this complex and guarded field of industrial technology. Existing producers prize highly the art and science of their respective enterprises and are reluctant to share it with others, fearful that it may fall in the hands of their competitors. To date, collaborators announced as entering into agreements have been Atlas Steel Ltd. of Welland, Ontario with Hindustan Steel Ltd.,

and Ugine of France with Mahindra and Mahindra Ltd. The former project which is estimated to cost Rs.38.4 crores is proceeding at Durgapur with request for tenders on site leveling. It is planned to begin operation, September 1965.

TABLE IV

ELECTRIC MELTING FURNACES

ALLOY STEEL PRODUCERS - FURNACES PROPOSED OR UNDER INSTALLATION

Company name	Address	Reply from	Startup of Furnaces	License Tons	Production 1000 Tons/Year 1st	2nd	3rd	Furnaces No.	Tons	KVA	Electrodes Diam.	Tons 1965	Later Max.
1. All Steel Industries Corp. Ltd.	Office: 509 Avanashi Rd. Coimbatore-1. Plant : Doddampatti, Salem Dist. Madras.	Director	Sept'62	50000	2.0	6.5	14.5	1 1 1	5 6 10	1200 - -		105	105
2. Bagla Alloy Steels Ltd.	55/115 Generalganj, Kanpur	Partner	Latter half '64	19800	12	18	20	2	10	4500		80	150
3. Guest, Keen, Williams Ltd.	Office: 41 Chowringhee Rd. Calcutta-16. Plant : 97 Andul Road, Howrah	A.W.Macdonald	Apr.'64	51000	6	20	31	2	12-14	6500	12"	110	230
4. Hindustan Steel Ltd. Alloy Steels Project	Durgapur, W. Bengal	K.P.Chowbey, Engr.	Sept.'65	50000	20	38	48	1 2	10 40	4500 15000	12 18	75	360
5. Mahindra & Mahindra Ltd.	Office: Hall & Anderson Bldg. Park St., Calcutta. Plant : Mettupalayam, Madras.	A. Mitra	Early'65	15000	10	13.5	16	2	5 15	3000 8000	8 14	75	120
6. The Mysore Iron & Steel Ltd.	Bhadravati, South Railway	B.S. Sharma Genl.Mgr.	Not set	15000			25					75	185
7. The Punjab Steel Rolling Mills	Office: Old Station, Baroda-5 Plant : Makarpura, Baroda		Mid.'64	5600	1.8	2.7	5.6	2	10	4500	12	15	25
8. Rajiv & Co.	12 Meghdoot, 95 Marine Dr., Bombay-2.	P. Shah		5000	Requesting license for 10,000 tons								
9. The Tata Iron & Steel Co. Ltd.	Office: Jamshedpur Plant : Tatanagar, [illegible]	Tech.Adviser	End '65	49000	25	37	49	2 2	15 7			285	565
10. Vummidiars (Mfrs.) Pvt. Ltd.	162 Mount Road, Madras-2	V.Pandurangiah		7000	Scheme in planning stage								
			TOTAL:	243400						TOTAL:		820	1540

D. Graphite Electrode Demand from Electric Furnaces in Foundries

19. Mr. P.M. Ghosh, President, Indian Foundry Association, states that there are 2000 foundries in India with a total capacity of 1,400,000 tons per year (Iron and Steel Review mid 1961). Only a little over 1% of this number (27 to be exact) are listed in Table V comprising foundries with electric furnaces. The melting equipment of the great majority of foundries are cupalos which are lower in capital cost and cheaper to operate. Complaints are voiced of shortages of hard coke, necessity to use off-grade pig iron as well as problems in transportation. Foundries with electric furnaces can use off-grade and low-grade pig iron and scrap since they permit refining and slag control which cupalos do not offer. Their end product, furthermore, is of higher quality and of consistent quality and can be produced to meet exact specifications. The same cannot be said about cupalo metal.

20. While the electrode demand in 1965 is estimated at 878 tons, the present demand is practically one half of this total; 434 tons. Furnace capacity runs from 3 to 6 tons with a maximum of 8 tons. The most popular electrode diameter is 8 inches and the largest 12 inches.

TABLE V

ELECTRIC MELTING FURNACES

FOR

IRON AND STEEL CASTINGS

Company name	Address	Reply from	Startup of Furnaces	License Tons	Production 1000 Tons/Yr.			Furnaces				Electrodes	
					1st	2nd	3rd	No.	Make	Tons	KVA	Dia	TONS 1965
1. Apeejay Steel Casting Co. Pvt. Ltd.	Tanda Road, Jullundur City		Constructing	4500	4.5	4.5	4.5	1	Birlefco	5	1500	8"	22
2. The Iron Industries	Office: Lalbagh Crossing, Sitapur, U.P. Plant : Mile 50, Barailly G.T.Road, Lucknow.		End.'65	5600	2.2	5	5.6	1	Self	5	1500	8	15
3. The Britannia Engineering Co. Ltd.	Titaghur, 24 Parganas (W.B.)	S.C. Kela, Genl. Mgr.	Aug.'62	4800	1.8	2.8	4.0	1	Birlefco	4-5	2250	8	20
4. Carborandum Universal Ltd.	P.B.No.2272 Tiruvottiyar, Madras-19.	T.W.Jackson Genl.Mgr.	Operating					3	Birlefco	8		10	22
5. Central India Machinery Mfg.Co. Ltd.	P.O.Birlanagar, Gwalior (M.P.)	A.K.Gargye, Mgr.	Dec.'65	6000	4	6	6	2	Birlefco	1-½ 1-4	350 2000	8	30
6. Chittaranjan Locomotive Works	Chittaranjan, W.B.	T.C.Chadda	Aug.'65				10	2	BB	7		12	150
7. Enmore Foundries Ltd.	Enmore, Madras	S.S. Gopa	Operating					1	Birlefco	4		8	34
8. Hind Overseas Pvt.Ltd.	7 Narain Prasad Babu Lane, Calcutta-7.	Director	July,'64	3000	2.5	3.0	3.0	1	BB	5	2200	8	15
9. Hindustan Steel Ltd.	Durgapur - 3 P.O.	M.S. Srinivasan, P.R.	Sept.'60		1.2	1.5	2.0	1	Birlefco	6		9	10
10. Indian Commerce and Industries Co.Pvt.Ltd.	Beehive Bldg. 95 Broadway, Madras-1.	Director						1	Rocking	½		6	8
11. Indian Iron & Steel Co. Ltd.	12 Mission Row, Calcutta		Operating		6			2		5			30
12. The Indian Standard Metal Co. Ltd. 1/	I.S.M. Estate, Chinchpokli Lane, Bombay-27.	C.Chatterjee Asst. Mgr.	1957	4200						½	125	5	5

1/ Non-ferrous.

Contd...

Table V.....Contd.

Company name	Address	Reply from	Startup of Furnaces	License Tons	Production 1000 Tons/Yr. 1st	2nd	3rd	Furnaces No.	Make	Tons	KVA	Electrodes Diam	TONS 1965
15. Jamshedpur Engg. & Machine Mfg.Co.Pvt.Ltd.	P.O. Telco Works Jamshedpur-4.	Secretary	Dec.'62	3840	2.4	3.0	3.6	1	Birlefco	4	1500	8"	50
14(1) The K.C.P. Ltd.	Office: Central Workshops, Madras-19. Plant : Tiruvohiyar	N.V. Das, Plant Mgr.	Later	4000	1	2	5	1	Otto Junker	3/4	550	2	5
15(1) The Malleable Iron & Steel Castings Co. Pvt.Ltd.	Tulsipipe Road, Lower Parel, Bombay-13	Priolkar, Ch.Engr.		750					Otto Junker				-
16(*) Motilal Padampat Sugar Mills Pvt. Ltd.	P.O.Box 69 Gutaiya Kanpur	Mgr.		5000	2.5	2.7	3.0	1	Birlefco	4	500		-
17. Mukand Iron & Steel Works Ltd.	Bombay-Agra Road, Kurla Bombay-70	L.C. Mehta, Engr.	Operating	15000	8	10	10	5	EFCO BB OWN	4 1/2 5 1/2 4 1/2	1800 1665 1500	8	50
18(2) Murlimal Shrikishandas & Co.(India)Pvt.Ltd.	New Iron Market, Carnac Bunder, Bombay-9	Director			4	4	4	1	BB		2500	9	-
19. The Mysore Iron & Steel Ltd.	Bhadravati, S. Rlwy.	Purch.Mgr.	Operating	5400				1 1 1	Heroutt Lectromelt Demag	3 5 6		5 1/8 8 10	110
20. Northern India Iron & Steel Co.Ltd.	57 Gadodia Market, Delhi	Puran Chand Director.		5000					Birlefco	4		8	40
21(*) Orissa Industries Ltd.	P.O.Barang, Dist.Cuttack		1964	4800	2.4	3.6	4.8						15
22. Pearl Mech.Engg. & Foundry Wks.Pvt.Ltd.	425 Industrial Area A P.O.Box 73 Ludhiana	Kant Behal	June'63	2800	5	5	7.5	1	BB	5	2760	8	55
23. R.R. Engineering Co. Ltd.	P.O.Clutterbackganj, Dist. Bareilly.	Exec.Officer	End.'63	5000	1.5	2.2	3.0	1	Electro-tekmik Berlin	5	1500		15
24. Saru Smelting & Refining Corp.Pvt.Ltd.	Sardhana Road,Meerut Cantt	Secretary		5000	Indefinite								
25. Steel Cast Corp.	Ruvapari, Bhavnagar	Partner						1	Taglia ferri	1		4	50
26(3) Tata Engg. & Locomotive Co.Ltd.	Bombay House,24 Bruce St. Bombay-1.	M.M. Bhandarkar	Operating.					2 2	Birlefco	4 8	1500 3000	8 10	155
27. Textile Machinery Corp.Ltd.	24 Parganas,Belgharia,WB	V. Newar Salas	1955 1963	6900	2.5 3.0	2.5 4.0	2.5 4.0	1 1	Demag Hungary	3 5	1200 3500	7 -	52
												TOTAL:	878

(1) 650 & 1100 KVA Induction Fcs. (2) 500 & 450 KVA Induction Fcs. (.) Await Import License (2) Await land & Import License (*) Await Import License
(3) Planning on 4 more Fcs. during 1963-64.

E. Graphite Anode Demand From Caustic Soda-Chlorine Producers

21. The caustic-soda-chlorine industry in India has enjoyed a spectacular growth. In 1948, the year after independence, production amounted to 5,800 tons. By 1958, it rose to 57,000 tons and by 1960, it exceeded 100,000 tons. Until 1956, there was a problem in the disposal of the by-product chlorine which has now been solved to a great extent with the rapid expansion of the paper industry as well as demands from manufacturers of bleaching powder, insecticides, etc. An important point in favour of developing the caustic soda-chlorine industry is that indigenous salt is the only raw material required. The other major requirement is power to the extent of 3500-4000 Kwh per ton.

22. In the development of this industry, in India, special emphasis has been made on dispersal of the productive units throughout the country. There are now 19 plants, six attached to paper mills and one to a rayon factory and by 1965 there will be a total of 31 plants with at least one in every State with the exception of the two States of Assam and Jammu and Kashmir. With the plants spread throughout the country, close to consuming centres, transportation costs are held to a minimum. With prices based on f.o.b. works (or seaport in the case of imports), the lower transportation costs accrue to the benefit of the user. This is at variance to government policy in the iron and steel industry where prices are uniform at all railhead destinations.

23. The data given in Table VI "Existing and proposed caustic soda-chlorine installations" was secured directly from the various producing companies, who were very cooperative in filling out and returning questionaires sent to them. The table is a summary of these data except for a few revisions on the projected 1965

caustic tonnage to make the figures in line with licences granted by the Alkali Industries Directorate and except for certain revisions on graphite consumption to make the values in better accord with standard experience. The anode consumption in 1962 is shown in column 11, "New Capacity" and column 12 "Replacement Capacity" being 337 and 687 tons respectively for a total of 1024 tons. Related to the estimated caustic production for 1962 of 135,000 tons the anode consumption of 687 tons amounts to 11 pounds per ton of caustic which is a little high as a ratio but not badly out of line.

24. It is most encouraging for the economic justification of an Indian graphite electrode plant that the demand in 1965 is indicated to be a handsome total of 1598 tons for replacement and 562 tons for new capacity totalling 2150 tons. This figure exceeds various informed estimates of which were in a range of 600-1200 tons per year. There is every reason to believe that the current rate of growth will continue and by 1970 the production will be double that of 1965 with a corresponding increased demand for graphite anodes. Quite a large number of round and rectangular sizes make up the requirements because the installations represent several licensees; Hooker, Krebs, Uhde, de Nora, etc. This will not cause too much of a problem in a graphite electrode plant as the dies for extruding these small sizes are not very costly. Perhaps the greatest disadvantage resulting from this condition is the need to carry inventories in this wide range of sizes.

TABLE VI

CAUSTIC SODA-CHLORINE INSTALLATIONS

EXISTING AND PROPOSED

Company name	Address	Reply from	Operating now	Diaphragm or mercury	CAUSTIC Tons 1962	CAUSTIC Tons 1965	Plate size	Rod size	Treated/ Untreated	TONS GRAPHITE 1962 New	1962 Repl.	1965 New	1965 Repl.	Supplier
1. Alkali & Chem.Corp. of India, Ltd.	P.O. Rishra, Dist.Hooghly.	B.Mukherjee for Director	Yes	D	7.000	9,000	2x2x36"		U	55	55	70	45	N.C.K. Japan UCI
2. The Andhra Sugars Ltd.(Ranga Rao & Co)	Venkatarayapuram, P.O.Box 2, Tanuku.	M.Gangarah Sec.	1963	M	-	9,900	530x170x60 mm 915x318x75 mm	75x350 mm 80x320 mm	Plates U Rods T&U	-	-	-	50	Germany & Japan
Factory address:	Kouvur W. Godavary Dt. A.P.													
3. The Atul Products Ltd.(Lalbhai Sons & Co.)	P.O. Atul Dist.Surat	T.P. Desai	Yes	M	6,300	12,600	2x11/16x17 23/32"	4x6 5/8	U(Va 20 ppm)	20	-	20	60	Hoechst Uhde Corp.
4. Calico Mills Chemical Division. The Ahmedabad Manufacturing & Calico Printing Co.Ltd. (Kamamchand Premchand Private Ltd)	Anik Chambur Bombay-71	V.S. Mankikar, Manager.	Yes	M	3,350	9,950	700x175x60 mm 441x415x82 mm	68.5x250 mm 92/65x205mm	U U	-	15	27	45	Sigri & G.L.C.
5. Same Company	P.O.Box 12, Ahmedabad.		Yes	D	2,700	2,700	18x6½x1½"		T			12	12	UCI
6. Century Rayon (Birla Gwalior Pvt. Limited)	P.O.Box 22 Murbad Road Kalyan	D.Y. Gaitonde	No	M	10,000								50	
Factory address	State of Maharashtra													
7. D.C.M. Chemical Works	P.O.Box 1211 Najafgarh Rd Delhi 15	M.L. Seth	Yes	D	15,000	18,000	2x2x36"		T		120	45	90	UCI & Japan

Table VI ..... Contd.

Company name	Address	Reply from	Operating now	Diaphragm or Mercury	CAUSTIC Tons 1962	CAUSTIC Tons 1965	Plate size	Rod size	Treated/Untreated	TONS GRAPHITE 1962 New	1962 Repl.	1965 New	1965 Repl.	Supplier
8. Dhrangadhra Chemical Works (Sahu Bros.(Saurashtra) Pvt.Ltd.)	Arumuganer, P.O. Sahupuram	A.R. Narasimhan Wks.Mgr.	Yes	M	50,000	49,500	80x175x700 mm	710x285 mm	U(Va 10 ppm)	100	100	-	25	Sigri & Savoie Acheson
9. Durgapur Projects Ltd.	New Sectt. Bldg., 1, Hastings St. Calcutta.	G. Modak Project Officer	Before 1965	M	-	10,500	-	-	U	-	-	54	50	
Factory address	Durgapur													
10. Hindustan Heavy Chem. Ltd., (Talukdar Law & Co.Private Ltd)	15 BT Rd. P.O.Khardah 24 Paraganas W.B.	Kalyan Krishna	Yes	Both	1,750	6,500	1½x7x31½" 70x175x720 mm	70x230 mm	U	7	7.5	7	50	
11. Hindustan Organic Chemicals Ltd.	Bombay	Mr Machirju	No	M		10,000							50	
12. Hukumchand Jute Mills Ltd. (Ramdutt Ram Kissendass)	9 Brabourne Rd., Calcutta	Mr.Goenka	No	M	-	10,800							50	
Factory address	Amlai M.P.													
13. J.K.Chemicals Ltd.	Dougall Rd. Ballard Estate, Bombay	Mr.A.S. Natarajan Tech Mgr.	Yes	M	2,700	9,000	700x175x50 &70 mm	65x250 mm	U	-	7.25	60	45	GLC & Sigr.
Factory address	Thana Near Bombay													
14. Jayshree Chem Ltd.	14 Netaji Subhas Calcutta-1	P.R. Biyani	End 1965	M		16,500	600x175x80 mm		T			26	75	Krebs & Co.
Factory address	Ganjam Orissa													
15. Kanoria Chem & Ind. Ltd. (Kanoria Co.Ltd)	9 Brabourne Calcutta	Radha K. Raman Tech. Adviser	No	M	-	16,500	441x422x80 mm	200x100 mm	U	-	-	-	80	Krebs & Co.
Factory address	Pipri Mirsapur Dist.UP													

Table VI.....Contd.

Company name	Address	Reply from	Operating now	Diaphragm or Mercury	CAUSTIC Tons 1962	CAUSTIC Tons 1965	Plate size	Rod size	Treated/Untreated	TONS GRAPHITE 1962 New	1962 Repl.	1965 New	1965 Repl.	Supplier
16. The Mettur Chem & Ind.Corp. Ltd. (Seshasayee Bros. Pvt. Ltd.)	Mettur Dam R.S. Salem Dist.	S.Ramaswamy General Supdt.	Yes	Both	11,000 ($KClO_3$) 660	33,000 ($KClO_3$) 1620	12½x6¼x18" 100x250x80 mm 1200x180x38 mm	-	T T	-	70 12	-	190 27	GLC UCI Nippoo Sigri Conradty
17. Mysore Paper Mills Ltd.	Bhadravati (S.Rly.)	-	Yes	D	575	575							5	
18. Mysore Chemicals & Fertilisers Ltd.	Post Box No.8 Vani Vilas Road, Mysore-1.	Krishnaswamy	No	M		15,200							60	
Factory address	Belagula													
19. The National Newsprint & Paper Mills Ltd.	Nepanagar Dist.Nimar, M.P.	S.Majumdar Asst.Wks Mgr.	1965	M	(1965) 5,000	5,600	482x441x80 mm	65/92x201	U		(1965) 10.5	18		Toho Sangyo Ltd. Osaka
20. The National Organic Chem. Ind. Ltd.	Mafatlal House Backbay Reclamation Bombay.	H.Thakde Secy.	No	M		12,350 (KOH) (4920)	450x200x80 mm 250x250x50 mm	65x600	T		(1965) 60		55	Sigri
Factory address	Kalyan Maharashtra.													
21. National Rayon Corp. Ltd. (Chinai & Co. Pvt .Ltd.)	P.O.Box 200 Ewart Hse,Bruce St.Fort Bombay	S.L. Hemmady	Yes	M	11,000	13,000	2½x12x29½"	4x7½"	P-U R-T		40		60	UCI
Factory address	Mohone Kalyan													
22. Nepa Chemicals Ltd.	Pratibha Press Bldg. Wardha Rd. Nagpur-1	V.N.Iyer	1965	M	-	4,000	985x325x75 mm	-	T	(1965) 10	-	-	20	Tokai Tokyo (Marubani -Iida)
Factory address	Ballarpur Dist.Chanda													

Table IV.....Contd.

Company name	Address	Reply from	Operating now	Diaphragm or Mercury	CAUSTIC Tons 1962	CAUSTIC Tons 1965	Plate size	Rod size	Treated/Untreated	TONS GRAPHITE 1962 New	1962 Repl.	1965 New	1965 Repl.	Supplier
25. Orient Paper Mills Ltd. (Birla Bros. Pvt. Ltd.)	P.O.Brajraj Nagar Dist. Sambalpur Orissa	D.R. Bhuto	Yes	M	5,450	5,450	220x200x60 mm 65x175x695 mm	68.5/65 250	P-U R-T	-	10.5	-	17	Sigri
24. Rajasthan Vinly & Chem. Ind.(of DCM) Bharat Ram Charat Ram Pvt.Ltd.)	Bara Hindu Rao, Delhi-6.	Dr.Garud	Yes	M	10,000	10,000	50x525x1184 mm 75x525x1184 mm		T T	60	11		50	Japan initially
Factory address	Kotah Rajasthan													
25. Rohtas Industries Ltd.	Dalmia Nagar Bihar	Mr.Uppal	Yes	Both	5,500	9,900	30½x7x1½" 720x178x60 mm	240x71 mm	30½ - T Bal - U	2	27	15	50	
26. Shree Gopal Paper Mills Pvt.Ltd. Karamchand Thaper and Bros. Ltd.)	P.O. Yamuna Nagar Ambala.		Yes	D	660	660	36x7x1½"	-	T	-	4.5		5	UCI
27. Sirpur Paper Mills (Birla Bros.Pvt. Ltd.)	Sirpur Kaghas Nagar C.Rly.A.P.		Yes	D	5,940	5,940	31½x7x1½"		T	36	36	36	36	UCI
28. Tata Chemicals Ltd.	24 Bruce St Fort Bombay	M.D. Parlewalla Controller Stores	Yes	D	4,000	6,000	1¼x6¼x18"		T	11	20	-	35	Nisshe Co Ltd. Nicol Rd Bombay
Factory address	Mithapur Okhamandal													
29. Titaghur Paper Mills Co. Ltd. (F.W.Heilgers & Co.Pvt.Ltd.)	24 Paraganas Titaghur (West Bengal).		Yes	D	4,430	5,410	4x4x17"	2⅜x12"	U	26	93	-	30	Kishimoto Shoton

Table VI.....Contd...

Company name	Address	Reply from	Operating now	Diaphragm or Mercury	CAUSTIC Tons 1962	CAUSTIC Tons 1965	Plate size	Rod size	Treated/Untreated	TONS GRAPHITE 1962 New	1962 Repl.	1965 New	1965 Repl.	Supplier
50. The Travancore Cochin Chem.Ltd. Factory address	Udyogmondel, P.O. Via Alwaye Kerala Eloor, Kerala	L.R.Krishnamurthy	Yes	M	11,000	55,000	460x150x52 mm 700x270x80 mm 460x80x480 mm	65x480 mm 92/65x201 mm 92/65x215 mm	P-U R-T	-	60	200	165	USA W.Germany Japan
51. West Coast Paper Mills Ltd.	Shreeniwas House Wandly Rd. Fort Bombay	B.D. Somani	No	M		10,000							50	Krebs & Co.
			TOTAL:		135,000	372,075			TOTAL:	537	687	552	1598	

NOTE: Company names in parenthesis are Managing Agents.

F. Graphite Demand from Atomic Power Plants

25. With two atomic power plants projected to be built, one at Tarapur near Bombay and the other at Rana Pratap Sagar near Kotah, there is a chance that one or both of these plants will require moderator graphite. The former plant capacity will comprise two 150 megawatt reactors and the latter, one 200 megawatt reactor. The atomic power programme will complement the thermal stations and hydro programmes. Areas far removed from coalfields like Rajasthan may find atomic power more economical than thermal power while in hydro-electric areas, atomic power can be used to "firm" up the load during the dry season. India is in fortunate possession of the atomic minerals, uranium and thorium.

26. It remains to be announced if these atomic power plants will use moderator graphite or not. If graphite is required then it will be a matter of getting the specifications as nuclear graphite covers a wide range of grades and properties. It may or may not be economic or feasible for a new graphite plant to manufacture the required grades and sizes. It depends upon the extent of special processing and whether indigenous or imported coke and pitch will be needed. With our lack of knowledge of the situation we cannot definitely figure on any graphite demand in this feasibility evaluation.

G. Total Graphite Demand and Some Factors Influencing It

27. Recapitulating the graphite electrode demand figures from the previous sections, we have the following:

		1962	1965
Electric Furnace Carbon Steel Producers	- Table II	712	1830
Electric Furnace Alloy Steel Producers	- Table IV	-	820
Electric Furnace Casting Producers	- Table V	434	878
Caustic Soda-Chlorine Replacement	- Table IV	687	1598
Atomic Power Plants	-	-	-
Total in metric tons:		1833	5126

In addition to this demand there are anode requirements for new installations amounting to 337 tons in 1962 and 552 tons in 1965. Generally, this initial complement forms a part of an omnibus import licence covering the new plant equipment and supplies. Mr. P.K. Seshan, Head of the Alkali Industry Directorate states, however, that with an indigenous electrode plant operating say in 1964, arrangements could be made for the new caustic plant requirements of 1965 to be allocated to its manufacture. The demand in 1965 could, therefore, be as much as 5126 plus 552 tons, or 5678 tons depending on how far the construction is along on the new chlorine plants when the electrode plant starts in operation.

Miscellaneous Requirements

28. There are miscellaneous requirements such as tapping rods for electric pig iron, calcium carbide and ferro alloy furnaces

and various refractory, chemical and metallurgical applications which could account for an additional 100 tons per year. With this and taking about half of the new caustic soda demand we come up with a rounded-out total of 5500 tons in 1965. If the objective of a 20% export market were realized, there would be a total domestic and foreign demand of 6600 metric tons.

Utilization of Iron and Steel Scrap

29. Present practice is to export iron and steel scrap to Japan, Great Britain and other countries instead of converting it to specification grade steel by melting and refining in electric furnaces. According to Mr. R.K. Dutt, India exported 314,300 tons of scrap in 1960 and by 1965-1966 this figure will amount to over 600,000 tons per year. These exports are not old rails and old structurals which can be used by rerollers but scrap bundles of manufacturer's shearings, punchings and turnings, miscellaneous bazaar scrap and ladle skulls. All this low grade metallic scrap can be handled expeditiously in top-charged electric furnaces. Even with low bulk density material, a number of back charges can be made to make a full heat of steel. Utilization of indigenous scrap would be a potent factor in enhancing the market for graphite electrodes. Illustrative of this condition if the aforementioned 600,000 tons of scrap were converted instead of exported, it would require 4000 tons of electrodes alone.

Electric Steel Development

30. With India's leaders dedicated to the idea of basing its future industrial development on steel it is fair to assume that electric steel production will follow the pattern of industrial

developed nations, as well. The following table gives the present comparison of electric and total steel capacities in some selected countries :-

	Total steel Capacity	Year	Electric steel Capacity	Per Cent
India	6,000,000 tons	1962	74,000	1.2
Great Britain	34,000,000 tons	1965	4,000,000	11.8
Japan	23,000,000 tons	1960	4,464,000	19.4
U.S.A.	160,000,000 tons	1962	14,000,000	8.8

31. The main restraint to the development of electric steel capacity is the acute shortage of power all over the country and the rapid pace at which the demand is increasing. Installation of power generating capacity, however, is going on at a rapid pace, too. At the end of the 2nd Plan this totalled 5,700,000 Kw of which 1,900,000 was hydro and 3,800,000 was thermal. The target for the 3rd Plan is 12,700,000 Kw and the 4th 23,500,000 Kw so the outlook for power availability is fairly bright despite the general increasing demand.

Manufacturing Electric Furnaces in India

32. A powerful incentive to the electric steel industry is the plan to build two plants for manufacturing electric furnaces. This will make furnace units available at lower prices and without the impediment of foreign exchange. The first Indian made furnace is now being installed at Dalmia Iron and Steel Co. in Calcutta being a Birlefco licence and manufactured by Associated Electrical Industries. The other is a joint venture between Kulkarni Foundries Pvt. Ltd. of Poona and Whiting Furnace Co. of Illinois, the largest manufacturers of small furnaces in

the USA. As transformers for electric furnaces are of special design with heavy built-in resistance, the plan at the outset is to import them from Canada. The first Indian built Whiting furnace will be installed in the shop of the Kulkarni Foundries.

[illegible]

A. [illegible] Electrode Plant Capacities

33. Production capacities of companies manufacturing graphite electrodes around the world vary from 5,000 to 150,000 tons per year for a total of 523,[illegible] tons and an average capacity per company of about 20,000 tons. A listing of these companies and their capacities is given in Table VII. Smaller capacities than 5000 tons per year cannot be justified because a single unit of many of the items of equipment will produce this amount and more in the smallest size available. For instance, one extrusion press of a size to make medium-sized electrodes will turn out 30,000 or more tons per year. Similarly many of the conveyors, elevators, crushers, mills and ovens will have a capacity in excess of 5000 tons per year.

TABLE VII

GRAPHITE ELECTRODE CAPACITIES

TONS PER YEAR - DETAILED

West Europe		
Skandinaviska Grafitindustrie, Trollhatten, Norway	...	10,000
British Acheson, England	...	20,000
Anglo Great Lakes, England	...	15,000
Siemens, Germany	...	30,000
Conradty, Germany	...	15,000
Cece, Switzerland	...	10,000
Savoi Acheson, France	...	15,000
Steeg, Austria	...	12,000
Genossa, Spain	...	10,000
Elettrographite de Forno Allione, Italy	...	20,000
East Europe		
Electro Kohl, Germany	...	15,000
Koteborg, Poland	...	15,000
Russia	...	50,000
China	...	10,000
Japan		
Showa Denka	...	23,000
Nippon Carbon	...	15,000
Showa Electrode	...	5,000
Kyno	...	5,000
Toyo Carbon	...	5,000
Two others	...	20,000
USA		
Union Carbide Corp.	...	150,000
Great Lakes Carbon Corp.	...	50,000
International Graphite Co.	...	25,000
Mexico	...	10,000

F. Graphite Electrode Plant Capital Costs

34. Even a minimum-sized electrode plant will represent an investment of several millions of dollars. It is typical of heavy industry that a large investment is involved whether viewed as the total sum or as a ratio of investment to annual ton of product or investment per employee. Preliminary estimates made by experts of Great Lakes Carbon Corporation give the capital cost for a plant to fill India's demands as follows:

Imported equipment and supplies	₹ 2,270,792
Indigenous equipment supplies and construction	₹ 3,326,605
TOTAL:	₹ 5,597,397

To this figure must be added the necessary working capital including monies required for inventories of raw materials, product in process and finished product inventory. This will bring the total investment to between ₹ 6,500,000 and ₹ 7,000,000 depending upon the particular management policy which is applied on quantities of inventories carried and amounts of bank balances to meet payrolls, operating expenses, and invoices payable.

C. Estimated Return on Investment

35. A preliminary estimated return on investment is given below assuming sales of 5000 metric tons per year, ₰ 7,000,000 capital cost and working capital and a 40% equity (₰ 2,800,000), 60% (₰ 4,200,000) debt financing :

	Yearly Total
Product cost - 15 ¢ /lb.	₰ 1,655,000
7½% sales and administration	124,000
6⅔% interest on ₰ 4,200,000	284,000
8% depriciation on ₰ 5,600,000 plant	448,000
Total Cost of sales	₰ 2,511,000
Gross sales income @ 20 ¢ /lb.	2,205,000
Loss	₰ 306,000
Gross sales income @ 23 ¢ /lb.	₰ 2,535,000
Total cost of sales	2,511,000
Gross profit (before taxes)	₰ 24,000
Per cent return on investment(before taxes)	0.9
Per cent gross profit on sales	1.0
Gross sales income @ 26 ¢ / lb.	₰ 2,865,000
Total cost of sales	2,511,000
Gross profit (before taxes)	₰ 354,000
Per cent return on investment (before taxes)	12.6
Per cent gross profit on sales	12.4

36. This gross profit rate could be expected to begin after about a year and a half from start-up of operations. This length of time would cover the shake-down period of equipment, the build-up of required efficiency of personnel and the gradual increase of production to the 5000 ton per year rate of O.K., finished product.

37. These preliminary calculations indicate that a price level of around 26 ¢/lb. f.o.b. works will need to be established. While this price is higher than the present c.i.f. prices at Indian seaports of Japanese electrodes, it is in line with the price

range in the U...A. and Europe of 24 to 27 £ /lb. f.o.b. factories.

V. OTHER CARBON AND GRAPHITE PRODUCTS

A. Carbon Paste for Submerged Arc Furnaces

38. There are approximately 25 submerged arc furnaces in India of which 18 are of Elektrokemisk (Norway) design and the others by Demag of Germany and Birlefco of Associated Electrical Industries. These furnaces are producing pig iron, calcium carbide, ferro manganese and ferro silicon. Their electrodes are all of the self-baking (Soiderberg) type with the exception of one furnace of Mysore Iron and Steel producing ferro manganese which uses 20-inch prebaked carbon electrodes. All these producers have to be supplied with the carbon paste for the self-baking electrodes which paste is charged into the sheet metal casings on the furnaces. There are two main suppliers; Indian Aluminium Corporation furnishing currently 8000 tons a year and Elektrokemisk which supplied 2000 tons in 1961. Indaluco have paste capacity at both of their plants at Alwaye, Kerala and Hirakud, Orissa which totals 15,000 tons per year in addition to the paste capacity for their own requirements for carbon anodes and cathodes for their reduction furnaces. The northeast demand is supplied from Hirakud, the south from Alwaye with the western and Bombay area open territory. Their paste is a mixture of 40% gas calcined anthracite, 10% metallurgical coke and 50% gas calcined petroleum coke with a binder of soft pitch and tar. For best performance in service the preferred raw material is electrically calcined anthracite which material makes a more conductive and stronger electrode with greater thermal shock resistance. A graphite electrode plant in India will be able to make a better

quality paste than presently supplied by Indaluco as it will have by-product electrically calcined coke which it can incorporate into this carbon paste. Its production could be handled in its regular milling and mix plant without additional equipment by observing precautions to avoid mix contamination. In the more critical applications such as ferro manganese and in the case of larger furnaces with greater diameter electrodes, it may become necessary to supply this demand from the graphite electrode plant. Also as Indaluco expand their operation of aluminium at Hirakud beyond 20,000 tons per year and Alwaye beyond 6,000 tons per year, their carbon paste capacity would then be required for their own needs at some level of production increase.

B. Prebaked Anodes and Cathodes for Aluminium Reduction Plants

39. With the continued expansion of the aluminium industry added by the indigenous bauxite deposits and the rising demand for the metal, another potential market opens for the proposed graphite plant. Reference is to petroleum coke base blocks in the gas-baked form as cathodes and anodes for the aluminium reduction pots. The most recent new producer, Birla-Kaiser at Rihand U.P. is a good prospect as Kaiser Aluminium in the USA has favoured prebaked anodes in their plants and their last large plant at Ravenswood, W. Virginia is of prebaked anode design. Of course, an aluminium reduction plant of a large capacity can justify its own prebaked anode facility in preference to purchasing from a supplier.

40. There is a better potential source of business which will apply to all the producers and that is prebaked cathode or hearth blocks. These are of larger sizes than anodes and are best extruded in large presses. This precludes the aluminium companies from making their own as they can't justify the capital investment on their relatively small requirements. The press for the graphite electrode plant will be ideal for producing these cathode blocks. They can be made up in multiplies and with slots for the collector bars to eliminate expensive machining.

C. Carbon and Graphite Brushes

41. By invitation of Dr. G.P. Kane, Senior Industrial Adviser some time was spent and some advice offered on projects other than graphite electrodes but in the general field of carbon and graphite manufacture. One of these was carbon and graphite brushes and it concerned a joint venture between B.M. Singh & Sons of Calcutta and Ringsdorff-Werke Gmb H of Mehlem, Germany. B.M. Singh have a small brush plant now operating in Patiala but they have run into problems in manufacturing and in applications. This is understandable for brush manufacturing is one of the most sophisticated lines of manufacturing which exists and also the field of application is most complex. A brush may be a small item on a motor or generator but it is an important one for on it depends the efficient passage of current and the minimum of commutator wear as well as its own wear. Various types of brushes are required to meet different applications; these being hard carbon, natural graphite, electrographitized carbon and metal graphite brushes. These are only the main grades, sub-grades will run 40 or more with variations in sizes and power connections swelling the total into the hundreds. There is no question but what Ringsdorff-Werke can furnish the required "know-how and show-how". They have been in this business for 80 years and enjoy a high reputation of competence and integrity.

42. The brush business is not a profitable line even in such a highly industrialized country as the USA. Manufacturing costs, laboratory control, research and development, high costs of sales - the usual order covers only a dozen brushes - and the expense of service to the users in solving their problems account for this condition. The biggest producer in the USA - National Carbon

Co. - has seriously considered giving up the business a number of times. A new venture in India will need to be protected from foreign and domestic competition as much as possible in order that it can perform a vital service to the country and still survive.

D. Cinema Arc and Battery Carbons

43. Cinema arc carbon manufacturing is akin to carbon and graphite brush manufacturing in that it is a very sophisticated industrial endeavour. It differs from brush manufacturing in capital investment; as several millions of dollars are involved for a complete plant compared to ¼ to ½ million dollars for a brush plant. While one firm, Industrial National Carbons of Delhi copper-plate and finish cinema shells which they purchase, there is no firm doing the entire manufacturing. Many auxiliary processes are involved including production of special pitch and tar, of lampblack, of calcined raw materials and making ceramic saggars. The principal operations include, milling, mixing, extrusion, baking, coring and core baking, sawing and some 15 machining operations. There has been very little published on cinema carbon manufacturing and an attempt to enter into manufacturing without an experienced collaborator would be fraught with trouble. Moreover, there is no single consultant or no single consulting firm that is competent to advise on the proper technology and know-how. Illustrative was the report recently written by the Industrial Consulting Bureau of New Delhi which proposed to build a plant for ₹ 400,000 on a site of one acre (40 acres would be a minimum) a line of equipment each item producing less than ¼ ton per day - hence minature laboratory size, the insertion

of 2 to 3 mm hand cores in shells which would be impractical and using an electric bake of an Acheson type which would be unnecessary. Significantly they approached 25 different companies for process know-how and equipment information without any results. Imports of cinema carbons for the year ending April 1, 1962 amounted to 11,731,400 pieces with a value of Rs.3,811,645. The demand is growing year by year emphasizing the need for an Indian manufacturing plant.

44. A product which is regularly made with cinema carbons is battery carbons for dry cells, radio batteries, flashlight batteries, etc. A total of 81,567,000 were imported in the year ending April 1, 1962 with a value of Rs.2,812,111. The one-inch diameter battery carbons are required to protect cinema carbons from breakage when packed in ceramic saggars to be gas baked. They are needed to line the saggar to moderate the increases in temperature during gas baking. These large battery carbons should therefore be reserved for the cinema carbon manufacturing plant.

E. Petroleum Coke Calcination

45. An opinion was asked of this expert on the advisability of the Government constructing a coke calciner at the Barauni refinery. A coke calciner in the private sector - India Carbon Ltd. at Gauhati - started operation in September 1965 to produce 30,000 tons of calcined coke per year. The principal user of calcined petroleum coke is the aluminium reduction industry which is currently requiring 20,700 tons per year and 50,000 tons by 1968. Calculations disclosed that there would be a surplus of calcined petroleum coke of 10,000 tons in 1968, 11,000 tons in 1967 with demand and supply in balance in 1964. The Gauhati calciner, however, can produce 50,000 tons of calcined coke per year if it is provided with sufficient raw coke including some coke from the Barauni refinery. With this provision the Gauhati calciner can take care of the demand for calcined petroleum coke to 1967 or 1967. Under the circumstances it was recommended not to undertake a second coke calciner before 1966-67 and meanwhile dispose of the excess raw petroleum coke to meet the urgent need of reductant to produce calcium carbide, electric pig iron and for foundries. This will help to fill the shortage of metallurgical coke required by these industries.

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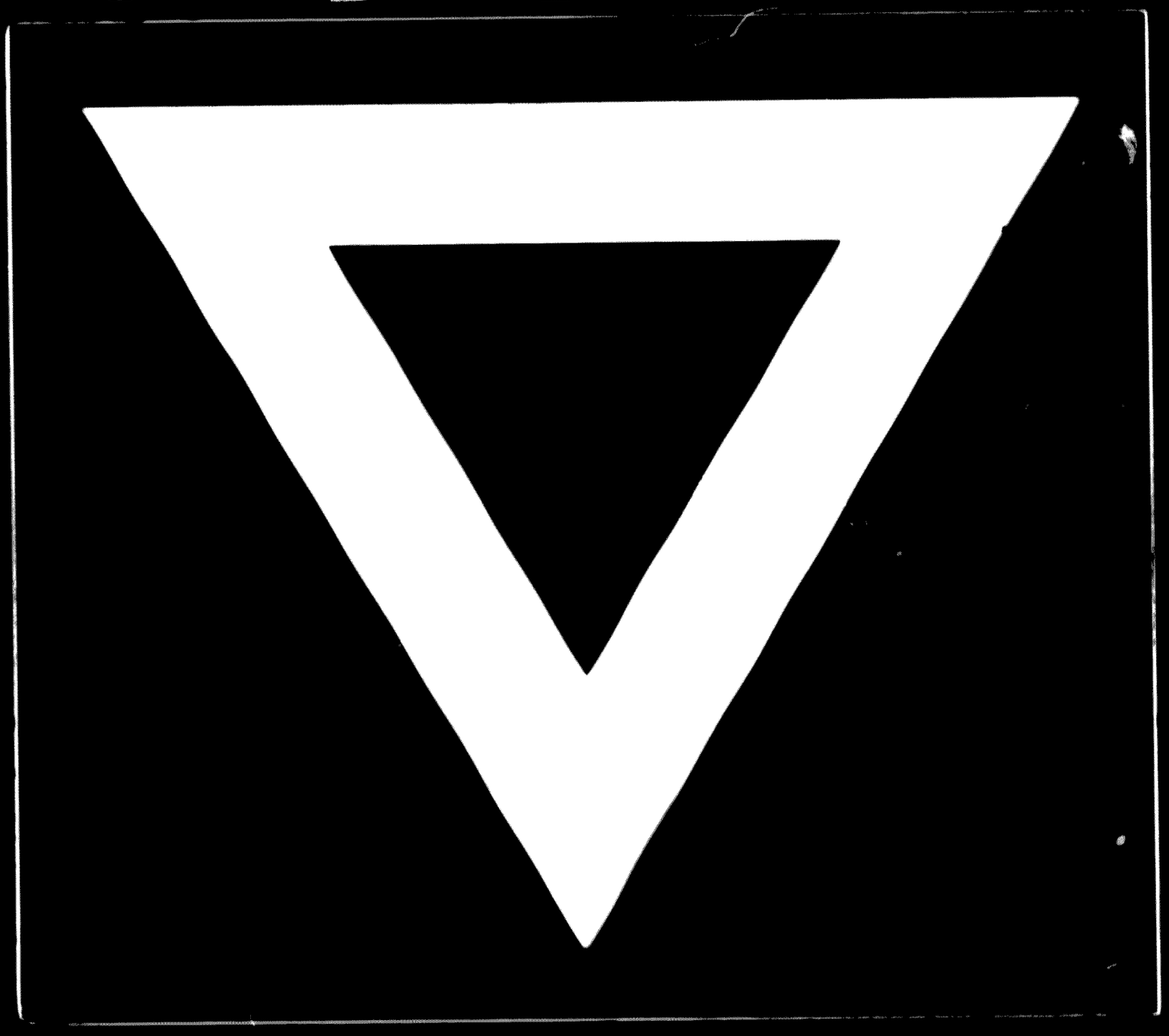

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