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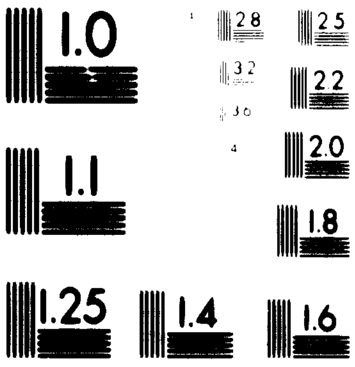

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
ANSI and ISO TEST CHART No. 2

24x
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DRAWINGS IN VOLUME I

EXPLANATION OF SYMBOLS

Three dots (...) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A blank space ( ) in a table means that the item is not applicable.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A space is used to distinguish thousands and millions (1 346 849).

A full stop (.) is used to indicate decimals.

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954.

An asterisk (*) is used to indicate figures partially or wholly estimated.

Use of a hyphen (-) between dates representing years, e.g. 1960-1964, normally signifies an annual average for the calendar years involved, including the beginning and end years. 'To' between the years indicates the full period, e.g. 1960 to 1964 means 1960 to 1964, inclusive.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

1 - INTRODUCTION

Steel is essential to industrial growth and any programme of economic development calls for substantial inputs of steel, for the reason that this material is a component of - or enters into the construction of - all production equipment and machinery, power stations and transmission lines, oil refineries and pipelines, dams and bridges, railways and transport. Iran, in its drive to expand and diversify its economy, has embarked on a programme of rapid industrialisation which envisages an average annual growth rate of 15 per cent in the industrial and 17 per cent in the mining sectors.

As a part of the current efforts at balanced development of the key sectors of the economy, the first integrated steel plant is being installed at Isfahan with an initial capacity of 550,000 tons a year and with provision for substantial expansion in future. Iran is also building heavy machine building facilities at Arak and machine tool and tractor plant at Tabris. A re-rolling mill and a pipe plant are already in production at Ahwas.

Role of alloy steels

The rapid pace of the country's industrial expansion not only calls for development of steel and heavy industries but the setting up of new plants for the production of alloy steels which would be increasingly required by these industries. The consumption of alloy and special steels, often expressed as a percentage of total steel, varies from country to country depending on the nature of the economy and the level of its industrialisation, but generally it ranges from 5 to 10 per cent of total steel in advanced countries and under 4 per cent in the developing countries. With the growth of heavy engineering industries, Iran's present low level of consumption of alloy steels (about 2 per cent of total) would register a rapid increase.

Ferro-alloy essential corrolary

The programme of mild and alloy steel development requires in turn the building up of the raw materials base for these industries. Various ferro-alloys are necessary for the production of steel. The possibilities of producing ferro-alloys indigenously by utilising local materials, and the benefits to the economy which would result from minimising their imports as well as from possible exports, merit serious investigation.

1 - Introduction (cont'd)

Earlier plans

Plans in the past for setting up ferro-manganese and ferro-chrome plants in Iran did not make progress in view of the limited indigenous demand. While preparing the input-output matrices for the years 1972 and 1977, a ferro-manganese and ferro-silicon complex with a total output of 20,000 tons per year which would go into production by 1974 had been visualised in the basic metal sector.

Authorisation

As a part of its efforts to assist the developing countries in their industrialisation programmes, the United Nations Industrial Development Organization (UNIDO) has been actively helping Iran's development programme. The present studies have been undertaken at the instance of UNIDO acting on behalf of United Nations in accordance with Contract No. 29/69 dated 25th June 1969. The Terms of Reference of this Contract are given in Appendix 1-1.

Structure of the report

The report is presented in five volumes. Volume I contains the summary and recommendations incorporating the major findings of the feasibility studies on the three ferro-alloy and alloy steel plants.

1 - Introduction (cont'd)

In Volume II, the sources and availability of raw materials for the production of ferro-alloys and alloy steels are reviewed. Internal requirements of Iran have been assessed, and the past and present international trade in these commodities reviewed.

Selection of production processes, plant capacities and location, plant general layout, plant facilities, estimates of costs and manpower, and financial analysis are dealt with in Volume III for the ferro-chrome plant, in Volume IV for the ferro-silicon and ferro-manganese plant and in Volume V for the alloy steel plant.

The report presents the basic technical and economic data required as well as the essential steps to be taken for implementing the viable projects.

Information on raw materials, prices and other local conditions was collected by teams of the Consulting Engineers in Iran during July, August and September 1969. The itinerary of visits made to the mines and the alternative plant locations and other places is given in Appendix 1-2.

1 - Introduction (cont'd)

Series of discussions were also held by these teams at Teheran, particularly with the Ministry of Water and Power regarding availability and cost of power, with the Geological Survey of Iran, the Rezai organization and other mining companies about raw materials resources and costs, and with the Ministry of Economy and the Plan Organisation on development programmes.

A draft of this report was submitted in December 1969 and discussed with the Imperial Government of Iran (Ministry of Economy) in April 1970. The comments received and suggestions made during the discussions have been borne in mind while finalising the report.

Acknowledgement

His Excellency Dr M. Yeganeh, former Minister of Economy and His Excellency Dr J. Ashrafi, present Deputy Minister of Economy, the Imperial Government of Iran, had many discussions with the teams of the Consulting Engineers and made valuable suggestions, for which we are thankful.

The Consulting Engineers gratefully acknowledge the cooperation and help extended by Dr Nagaraja Rao and other United Nations experts in Teheran, the officials of the

Ministry of Economy and numerous other Government and private agencies in Iran, particularly those listed in Appendix 1-3. The arrangements made by the Ministry of Economy for visiting the mines and sites as well as the help rendered by Rezai Brothers, Iranian Rolling Mills Co, National Iranian Steel Co, and National Iranian Oil Company to visit their industrial installations are acknowledged.

2 - SUMMARY AND RECOMMENDATIONS

1. Industrialization requires assured supplies of steel. As a part of the current efforts at balanced development of the key industrial sectors, Iran is already installing its first integrated steel plant at Isfahan and various heavy machine building facilities. The rapid pace of industrial expansion envisaged calls also for setting up of new plants for the production of alloy steels as well as the building up of the raw material base for these industries, particularly ferro-alloys.

Purpose of report

2. This report presents studies on the techno-economic feasibility of the installation of plants for production of three ferro-alloys, that is, ferro-chrome, ferro-silicon, ferro-manganese, and an alloy & special steel plant in Iran.

FEASIBILITY REPORT

TO

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

Iran. **FERRO-ALLOY PLANTS AND ALLOY STEEL PLANT** .

FOR

THE MINISTRY OF ECONOMY, IMPERIAL GOVERNMENT OF IRAN

01602
(1 of 5)

VOLUME I
SUMMARY AND RECOMMENDATIONS

MAY 1970

M. N. DASTUR & COMPANY PRIVATE LTD, CALCUTTA
DASTUR ENGINEERING INTERNATIONAL GMBH, DUSSELDORF
Consulting Engineers

2 - Summary and recommendations (cont'd)

RAW MATERIALS AND MARKETS FOR FERRO-ALLOYS (VOL.II)

Raw materials

3. The report commences with an appraisal of the major raw materials required - chromite, manganese ore, quartzite, limestone, coke, charcoal and electrode paste. The quantities needed per year for the proposed outputs of ferro-alloys are given in Table 2-1.

Table 2-1

ANNUAL RAW MATERIALS REQUIREMENT FOR FERRO-ALLOYS

		Ferro-chrome tons/year	Ferro-silicon tons/year	Ferro-manganese tons/year
Proposed output	..	14 500	17 000	38 000
Chrome ore	..	34 500		
Quartzite	..	10 800	33 000	
Manganese ore	..			85 000
Scrap	..		3 400	
Limestone	..	21 000		20 000
Coke	..	3 500	7 200	23 000
Charcoal	..	5 000	9 300	
Electrode paste	..	735	1 190	840

Chromite

4. The chromite deposits of Iran occur mainly in the northern and south-eastern parts of the country. Mining has been intensified since the last two decades for exports. Although no systematic exploration has been taken up to arrive at an overall estimate of reserves, the data from the existing mines indicate

the existence of large reserves of chrome ores of different grades. This is particularly true of the deposits in the Faryab region in the south where the possible reserves may be an estimated 2.5 million tons. The ore exported from this area analyses 48 per cent Cr_2O_3 with a Cr/Fe ratio of 3:1. The quality and extent of Iran's chromite reserves are considered adequate to sustain a major indigenous ferro-chrome manufacturing industry.

<u>Manganese ore</u>

5. Occurrences of manganese ore in Iran have been reported in the north and north-central parts. At present only one mine, the Shahrokh mine in the Ghom area, is in operation. Available data on the quality of run-of-mine manganese ore indicate that it is <u>not</u> suitable for manufacture of standard grade ferro-manganese because the manganese content is low. The hand-sorted ore presently exported could possibly be utilised after blending with imported high grade ore. It is suggested that geological investigations be intensified to find additional deposits and obtain definite information on the extent of reserves and their quality. There are possibilities of making increased use of local ore in the blend with imported ores for ferro-manganese production.

6. Iran should not have difficulty in importing initially the required quantity of manganese ore as the international trade in this ore is growing. Supplies may be considered from USSR or from India.

Quartzite

7. Quartzite occurrences are reported in Ghazvin and Lachoulleh areas. The Ghazvin deposit is at present being exploited for the glass factory, but this may not be suitable or adequate for ferro-silicon smelting. The Lachoulleh deposit has been prospected by the National Iranian Steel Company and reserves of about 3 million tons have been proved. The quality of this quartzite is expected to be suitable. The Lachoulleh deposit has, therefore, been considered as the possible source of quartzite for the proposed ferro-silicon plant.

8. As all the possible sites for the ferro-chrome plant - Ahwaz, Bandar-Abbas and Faryab - are at considerable distances from Lachoulleh, suitable sources of quartzite in these areas would have to be located to meet the requirement of ferro-chrome production.

Limestone

9. Though limestone occurs widely, no systematic work has been done to estimate the reserves and grades in most areas in Iran. Some of the deposits are being utilized for cement manufacture and lime burning. If Isfahan

is finally selected as the site for the ferro-manganese plant as proposed in this report, the limestone requirements can be met from the same deposits which have been explored by the Isfahan steel plant. However, extensive prospecting work would have to be carried out in Ahwaz, Arak and Faryab areas to identify suitable sources of limestone for the alloy steel and ferro-chrome plants (in case these locations are chosen).

Reductants

10. The carbonaceous reductants required for ferro-alloys manufacture are coke, charcoal and woodchips. It is assumed that small size coke will be available from the Isfahan steel plant as a by-product of the coke oven plant. However, because of the high ash content (13 to 14%) and high sulphur content (1.3 to 1.4%) of the coke, it is essential to utilize partly charcoal for the production of ferro-silicon (75% grade) and ferro-chrome.

11. Charcoal is available in the Isfahan and Caspian sea regions. Further investigations are necessary to ensure availability to meet the requirements for ferro-alloys production. Small quantities of woodchips for ferro-chrome manufacture are proposed to be met from local sources around the possible locations.

2 - Summary and recommendations (cont'd)

Electrodes

12. Electrode paste is an important material which is not available in Iran. Electrode paste for ferro-alloy manufacture as well as graphite electrodes for the electric arc furnace for alloy steelmaking would have to be imported initially.

Steel scrap

13. Steel scrap is a major raw material for alloy steel manufacture. It is also required in limited quantities for ferro-silicon production (which could be met from local sources). However, this study indicates that scrap will generally be in short supply in Iran in the coming years and therefore scrap required by the alloy steel plant would have to be imported, at prices substantially higher than local scrap prices. This also emphasizes the need to expedite the proposed sponge iron project.

14. Special ferro-alloys needed in small quantities for alloy steel manufacture would have to be imported.

Ferro-alloy demand in Iran

Present consumption in Iran

15. The current ferro-alloy consumption in Iran is limited to foundries and is entirely met by imports. The available statistics of past consumption show considerable variation from year to year. A study of the current foundry practice indicates that the average

consumption of ferro-alloys is about 40 kg per ton of casting, of which the bulk (38 kg) is constituted by ferro-silicon (75% grade).

Future steel capacity

16. In future the major consumption of ferro-alloys will be in the steel plants for production of mild and alloy steels. In the absence of definite plans of future steel development, the probable production of iron and steel including castings has been assumed and the corresponding ferro-alloy requirements estimated, as shown in Table 2-2.

Table 2-2

ESTIMATED FERRO-ALLOY REQUIREMENTS
(in the years 1972, 1977 and 1982)

		1972 tons	1977 tons	1982 tons
Probable productions				
Tonnage steel	..	350 000	2 500 000	3 400 000
Alloy and special steel	..		50 000	80 000
Silicon steel	..			6 000
Steel castings	..	6 000	15 000	30 000
Iron castings	..	30 000	40 000	80 000
Ferro-alloy requirements				
Ferro-silicon	..	1 400	9 000	13 000
Ferro-manganese	..	4 000	26 000	38 000
Ferro-chrome	..		500	500

Ferro-alloy export possibilities

Export possibilities

17. The world ferro-alloy demand and trade have registered steady growths in recent years, in tune with the rise in world steel production and increased consumption of ferro-alloys per ton of steel. Iran's successful participation in the world market would of course depend on its ability to produce consistent, high quality products and to offer them at competitive prices.

18. The East European countries as well as RCD partners of Iran offer good prospects for ferro-alloy exports from Iran. An entry into the UK market, at present the largest ferro-alloy importer, may also be possible if Iran suitably prices its ferro-alloys. In addition, the countries of South East Asia, the Far East and Oceania may eventually provide additional outlets for some quantities of ferro-chrome.

19. The export targets considered feasible for Iran are given in Table 2-3, side by side with the estimated world demand for ferro-alloys.

2 - Summary and recommendations (cont'd)

Table 2-3

TENTATIVE EXPORT POSSIBILITIES FOR FERRO-ALLOYS, 1977 AND 1982

		Probable world demand 1977 tons	Tentative export targets for Iran	
			1977 tons	1982 tons
Ferro-chrome	..	1 700 000	13 000 to 15 000	20 000 to 30 000
Ferro-silicon	..	860 000	5 000 to 7 000	6 000 to 8 000
Ferro-manganese	..	5 700 000	6 000 to 8 000	8 000 to 10 000

The realisation of these export possibilities depends to a large extent on (i) the costs at which indigenously mined ores (chromite, quartzite, fluxes, reductant) can be delivered to the ferro-alloy plants and (ii) the rates at which electric power (which constitutes about 20 per cent of ferro-alloy production costs) can be made available. It also depends on Government policy in respect of assistance for exports by the mineral-processing industry.

FINANCIAL ANALYSIS

20. In making the financial analyses of the three projects the following procedure has been adopted:

i) The capital structure is envisaged on an equity : loan ratio of about 50:50.

2 - Summary and recommendations (cont'd)

ii) The borrowed capital is considered as a long-term loan bearing interest at 8 per cent per annum and re-payable in 10 equal instalments commencing from about the third year of operation.

iii) Deferred charges which include promotional expenses, start-up, training, technical assistance, know-how and interest during construction are amortised in equal annual instalments over the first ten years of plant operation.

iv) The sales prices have been estimated taking into consideration local prices prevailing in September 1969, international market prices in 1969, and the present policy of the Imperial Government of Iran to grant, where considered necessary, protection to local producers for selling in the internal market and subsidy for export.

v) The requirement of working capital is assumed as equivalent to manufacturing expenses for 3 months to be met by loans bearing interest at 12 per cent per annum.

2 - Summary and recommendations (cont'd)

vi) Depreciation is calculated on a straight line basis at 8 per cent per annum on the cost of plant ready to operate, excluding the cost of land.

vii) The profit and loss, and cash flow statements are prepared for the first 15 years of plant operation.

viii) Contributory margins have been worked out in the first year in which the respective plants are estimated to attain the full rated capacity and ratios of contributory margins to total sales have been indicated.

ix) Break-even charts are prepared indicating the fixed cost, total cost and sales receipts at various levels of output except for the ferro-chrome project which does not reach the break-even point even when it attains the rated capacity. The break-even points are worked out in typical years in which the respective plants are expected to operate at full rated capacity.

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CALCUTTA-13

Phone: 23-7272
Gram: DASTURENG

30th May 1970
5130-235A

Chief, Technical Procurement and
Contracting Office
United Nations Industrial
Development Organization
A 1010 Vienna, Austria.

FEASIBILITY STUDIES ON FERRO-ALLOY PLANTS
AND ALLOY STEEL PLANT IN IRAN

Dear Sir,

We have pleasure in submitting our feasibility report on the installation of plants for production of ferro-chrome, ferro-silicon and ferro-manganese as well as a plant for alloy and special steels in Iran.

The report is presented in five volumes, Volume I containing the Summary of the whole report, Volume II covering the raw materials and the markets for ferro-alloys and alloy steels, Volume III the study on the ferro-chrome project, Volume IV the ferro-silicon and ferro-manganese project, and Volume V the alloy steel project. An abstract precedes each volume. The report is in considerable detail than is customary for feasibility studies of this type, in order that all the basic data for decision making is available in one place and also to focus attention on the action points for implementing the viable projects.

With the establishment of machine-building and other heavy industries in Iran, the demand for mild steel is rising rapidly. In turn, the need for alloy and special steels (which form essential components in equipment or are used to cut and shape metals) will also rise. A legitimate

x) For working out excess present value and the internal rate of return, the following assumptions have been made:

a) The cost of capital for excess present value analysis is considered at 8 per cent per annum.

b) The commencement of operations is considered as 'zero' point.

c) All outflows are assumed to be occurring at the beginning of the year and inflows at the end of the year.

d) All cash flows before 'zero' point have been compounded and all cash flows after 'zero' point have been discounted.

e) At the end of 15 years of operation, the residual value of plant and equipment has been assumed at 10 per cent of the original cost and shown as an inflow in the 15th year.

f) The working capital is considered as fully salvaged at the end of 15 years of operation and included as an inflow in the 15th year.

2 - Summary and recommendations (cont'd)

xi) The pay-back period has been computed on the traditional basis as well as by discounting the estimated future inflows.

xii) Wherever exports are considered, net foreign exchange savings or earnings have been computed for the first 15 years of plant operation.

xiii) For computing the foreign exchange rate of return, the same assumptions as given in item (x) above have been made for estimating foreign exchange flows.

xiv) The social benefits to the national economy resulting from the projects have been briefly mentioned.

FERRO-CHROME PLANT (VOLUME III)

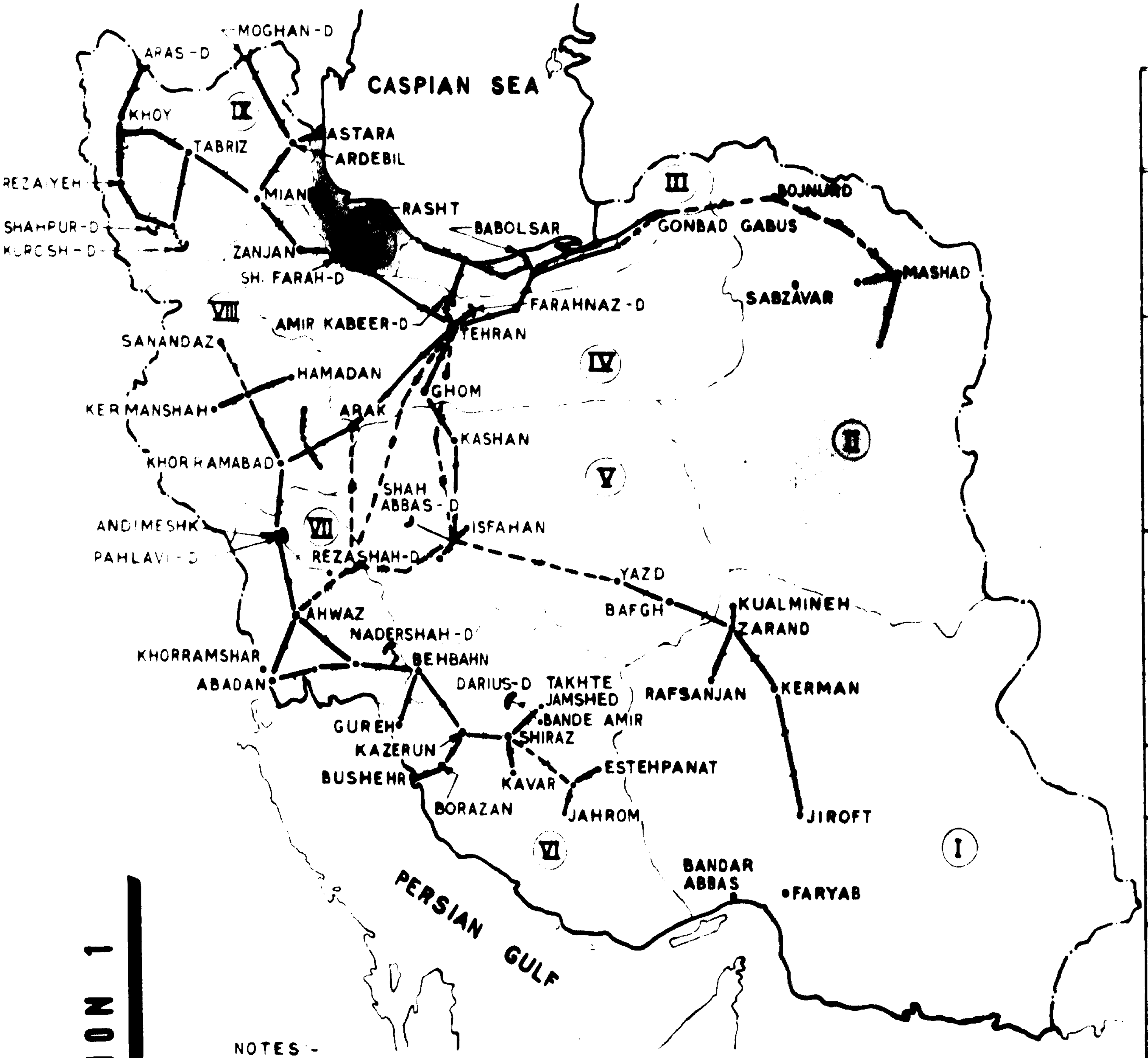
Plant capacity

21. The installation of an export-oriented ferro-chrome plant is envisaged in this study. Alternative processes of ferro-chrome production are reviewed and the "Perrin process" selected as the most suitable. Keeping in view recent trends in equipment size, a smelting furnace of 12,000 kVA and a slag furnace of 8,000 kVA are recommended. The rated annual capacity of the plant is 10,000 tons of low carbon ferro-chrome and 4,500 tons of high carbon ferro-chrome.

Location

22. Availability of adequate electric power is a major consideration in selection of locations for ferro-alloy plants as production of ferro-alloys involves very high power consumption. The development of generating capacity till 1982 as envisaged by the Ministry of Water and Power, Imperial Government of Iran, is given in Table 2-4. The planning for the national power grid is shown in Drawing 5131-III-1. Locations for the proposed plants have been selected on the basis of power development.

SECTION 1



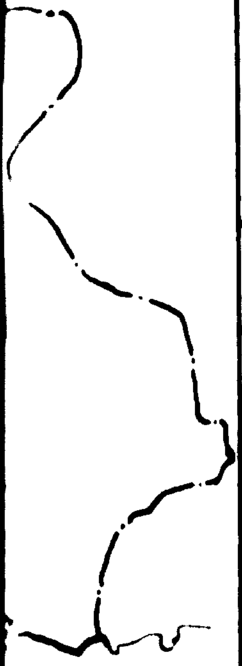
NOTES -

1. THIS DRAWING IS PREPARED ON THE BASIS OF INFORMATION FURNISHED BY MINISTRY OF WATER AND POWER.
2. THE MAP SHOWS INTERCONNECTED TRANSMISSION SYSTEM IN 1972. FUTURE EXPANSION FOR 1972-77 IS SHOWN IN DOTTED.
3. REGIONAL ELECTRIC SUPPLY Co.

(I) KERMAN
(II) KHORASSAN
(III) MAZAN DARAN
(IV) TEHRAN
(V) ISFAHAN
(VI) FARS
(VII) KWPA
(VIII) KHORDESTAN
(IX) AZERBAIJAN
(X) GILAN

TABLE OF INSTALLED GENERATING CAPACITY FOR SELECTED AREAS

REGION	NAME OF GENERATING STN	TOTAL GENERATING CAPACITY IN Mw								
		1972			1977			1982		
		STEAM	HYDRO	GAS	STEAM	HYDRO	GAS	STEAM	HYDRO	GAS
ISFAHAN	ISFAHAN	175	-	70	195	-	105	315	-	105
	SHAH ABBAS KABEER DAM	-	53	-	-	53	-	-	53	-
	STEEL MILL	-	-	15	-	-	15	-	-	15
TEHRAN	FARAHNAZ DAM	-	22	-	-	22	-	-	22	-
	AMIR KABEER DAM	-	84	-	-	84	-	-	84	-
	KARAJ	236·5	-	-	300	-	-	300	-	-
	FARAH ABAD	250	-	-	250	-	-	250	-	-
	TARASHT	50	-	95	-	-	165	-	-	305
	MANZIL	-	-	-	240	-	-	-	-	-
KWPA	AHWAZ	150	-	-	350	-	-	400	-	-
	PAHLAVI DAM	-	500	-	-	500	-	-	500	-
	REZA SHAH DAM	-	-	-	-	1000	-	-	1000	-
	KARUN DAM	-	-	-	-	420	-	-	870	-
	RIVERS POWER	-	-	-	-	-	-	-	-	1200
KERMAN	ZARAND	60	-	-	120	-	-	120	-	-
	BANDAR ABBAS	-	-	30	-	-	60	-	-	120
FARS	SHIRAZ	-	-	52	-	-	52	-	-	52
	DARIUSH KABEER DAM	-	8	-	-	8	-	-	8	-
AZERBAIJAN	TABRIZ	12	-	30	-	-	30	-	-	30
	ARAS DAM	-	21	-	-	21	-	-	21	-
	SHAHPUR DAM	-	6	-	-	6	-	-	6	-
	KUROSH KABEER DAM	-	10	-	-	10	-	-	10	-
KHORDESTAN	SANANDAZ	-	-	-	-	-	10	-	-	-



SECTION 2

FOR

IRA

DRA

APACITY FOR SELECTED AREAS

	GENERATING CAPACITY IN MW					
	977			982		
AS	STEAM	HYDRO	GAS	STEAM	HYDRO	GAS
[illegible]	195	–	105	315	–	105
–	–	53	–	–	53	–
[illegible]	–	–	15	–	–	15
–	–	22	–	–	22	–
–	–	84	–	–	84	–
–	300	–	–	300	–	–
–	250	–	–	250	–	–
35	–	–	165	–	–	305
–	240	–	–	–	–	–
–	350	–	–	400	–	–
–	–	500	–	–	500	–
–	–	1000	–	–	1000	–
–	–	420	–	–	870	–
–	–	–	–	–	–	1200
–	120	–	–	120	–	–
30	–	–	60	–	–	120
52	–	–	52	–	–	52
–	–	8	–	–	8	–
30	–	–	30	–	–	30
–	–	21	–	–	21	–
–	–	6	–	–	6	–
–	–	10	–	–	10	–
–	–	–	10	–	–	–

LEGEND

63 KV TRANSMISSION LINE	─┼─┼─
132 KV TRANSMISSION LINE	─┼─┼─
230 KV TRANSMISSION LINE	─┼─┼─
400 KV TRANSMISSION LINE	─┼─┼─
FUTURE EXPANSION 1972-1977	- - - - -
DAMS (D)	◡
TOWNS & CITYS	●
AREA COVERED BY REGIONAL ELECTRIC SUPPLY Co	(I)

TOTAL INSTALLED GENERATING CAPACITY IN IRAN

PLAN PERIOD	GENERATING CAPACITY IN MW.	ADDED CAPACITY IN MW.
4TH PLAN PERIOD ENDING IN 1972	2581	
5TH. PLAN PERIOD ENDING IN 1977	4441	1860
6TH. PLAN PERIOD ENDING IN 1982	6876	2431
7TH. PLAN PERIOD ENDING IN 1987	9576	2700

SECTION 3

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
POWER GRID MAP OF IRAN

DRAWN	K.Basu	14.11.69	No. 5131-III-1
APPROVED			

Table 2-4

DEVELOPMENT OF GENERATING CAPACITY FOR SELECTED AREAS

Region & generating station	Total generating capacity in MW								
	1972			1977			1988		
	Steam	Hydro	Gas	Steam	Hydro	Gas	Steam	Hydro	Gas
ISFAHAN									
Isfahan ..	175	-	70	195	-	105	315	-	105
Shah Abbas Kabeer Dam ..	-	53	-	-	53	-	-	53	-
Steel Mill ..	-	-	15	-	-	15	-	-	15
TEHERAN									
Farahnaz Dam ..	-	22	-	-	22	-	-	22	-
Amir Kabeer Dam	-	84	-	-	84	-	-	84	-
Karaj ..	236.5	-	-	300	-	-	300	-	-
Farah Abad ..	250	-	-	250	-	-	250	-	-
Tarasht ..	50	-	95	-	-	165	-	-	305
Manjil ..				240					
KWPA									
Ahwaz ..	150	-	-	350	-	-	400	-	-
Pahlavi Dam ..	-	500	-	-	500	-	-	500	-
Reza Shah Dam ..	-	-	-	-	1000	-	-	1000	-
Karun Dam ..	-	-	-	-	420	-	-	870	-
Rivers Power ..	-	-	-	-	-	-	-	-	1200
KERMAN									
Zarand ..	60	-	-	120	-	-	120	-	-
Bandar Abbas ..	-	-	30	-	-	60	-	-	120
FARS									
Shiraz ..	-	-	52	-	-	52	-	-	52
Dariush Kabeer Dam	-	8	-	-	8	-	-	8	-
AZERBAIJAN									
Tabriz ..	12	-	30	-	-	30	-	-	30
Aras Dam ..	-	21	-	-	21	-	-	21	-
Shahpur Dam ..	-	6	-	-	6	-	-	6	-
Kurosh Kabeer Dam	-	10	-	-	10	-	-	10	-
KHORDESTAN									
Sanandaz ..	-	-	-	-	-	10	-	-	-

Faryab location suggested

23. Three locations for the plant - Ahwaz, Bandar Abbas and Faryab - have been evaluated. The installation of the ferro-chrome plant at Faryab, near the chromite mines, is proposed in view of the favourable operating economics and availability of water supply. This is also in keeping with the Government policy of developing the south-eastern part of the country.

24. It must be emphasised that setting up the ferro-chrome plant in this area is entirely dependent on the timely development of the power supply system. The Ministry of Water and Power has given us to understand that if Faryab-Bandar Abbas region is selected as a suitable location for siting the plant, adequate supply of power could be assured within a period of three years from the date of decision. Depending on the time schedule, the power could be supplied either by extending the national grid or by installation of a power plant at Bandar Abbas.

Infra-structure development

25. It is suggested that in order to speed up the installation of the plant, immediate steps be taken for:

(i) developing power supply;

(ii) prospecting for quartzite and limestone in Faryab area;

(iii) developing the chromite mines as well as the selected sources of quartzite and limestone;

(iv) investigating the availability of water in required quality and quantities from river Minab; and

(v) improving the road linking the mines to the metalled highway to Bandar Abbas.

Major facilities

26. The general layout of the ferro-chrome plant has provision for future expansion. The major equipment and facilities have been selected and the requirements of water, power and other utilities estimated. The plant flow sheet is given in Drawing 5131-III-5.

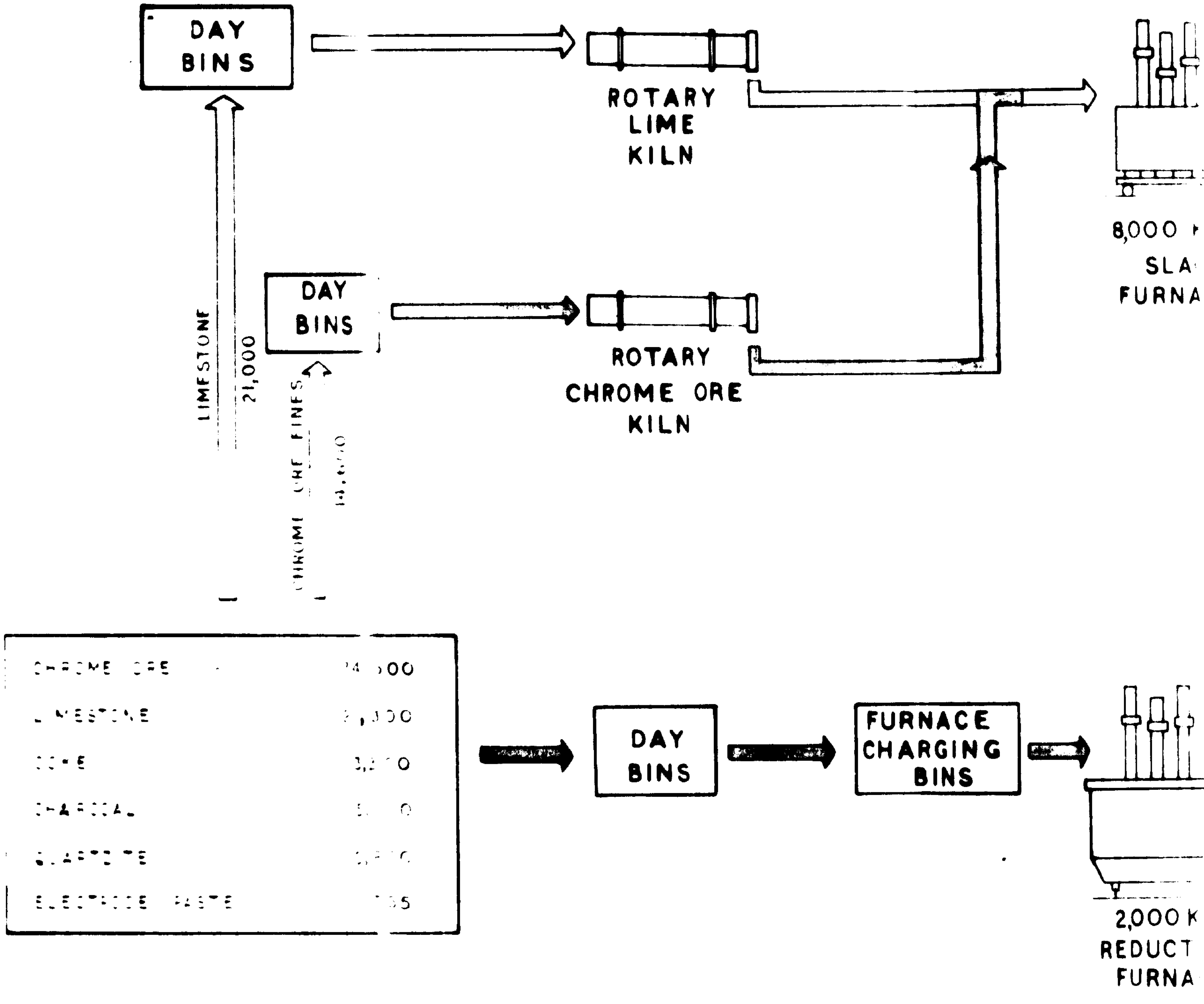
Construction schedule

27. The construction schedule and network planning indicate that the plant could be completed in about 30 months.

Cost estimates

Project cost

28. The total project cost is estimated at $ 11 million as given in Table 2-5. Of this the capital cost for plant and facilities within the plant boundary is estimated at $ 10 million (Table 12-1, Appendix 12-1, Volume III).


DAY BINS
ROTARY LIME KILN
8,000
SLA
FURNA
LIMESTONE
21,000
DAY BINS
ROTARY CHROME ORE KILN
CHROME ORE FINES
13,6?0
CHROME ORE 24,500
LIMESTONE 21,000
COKE 3,2?0
CHARCOAL 5 0
QUARTZITE 3,? 0
ELECTRODE PASTE ?55
DAY BINS
FURNACE CHARGING BINS
2,000 K
REDUCT
FURNA

SECTION 1

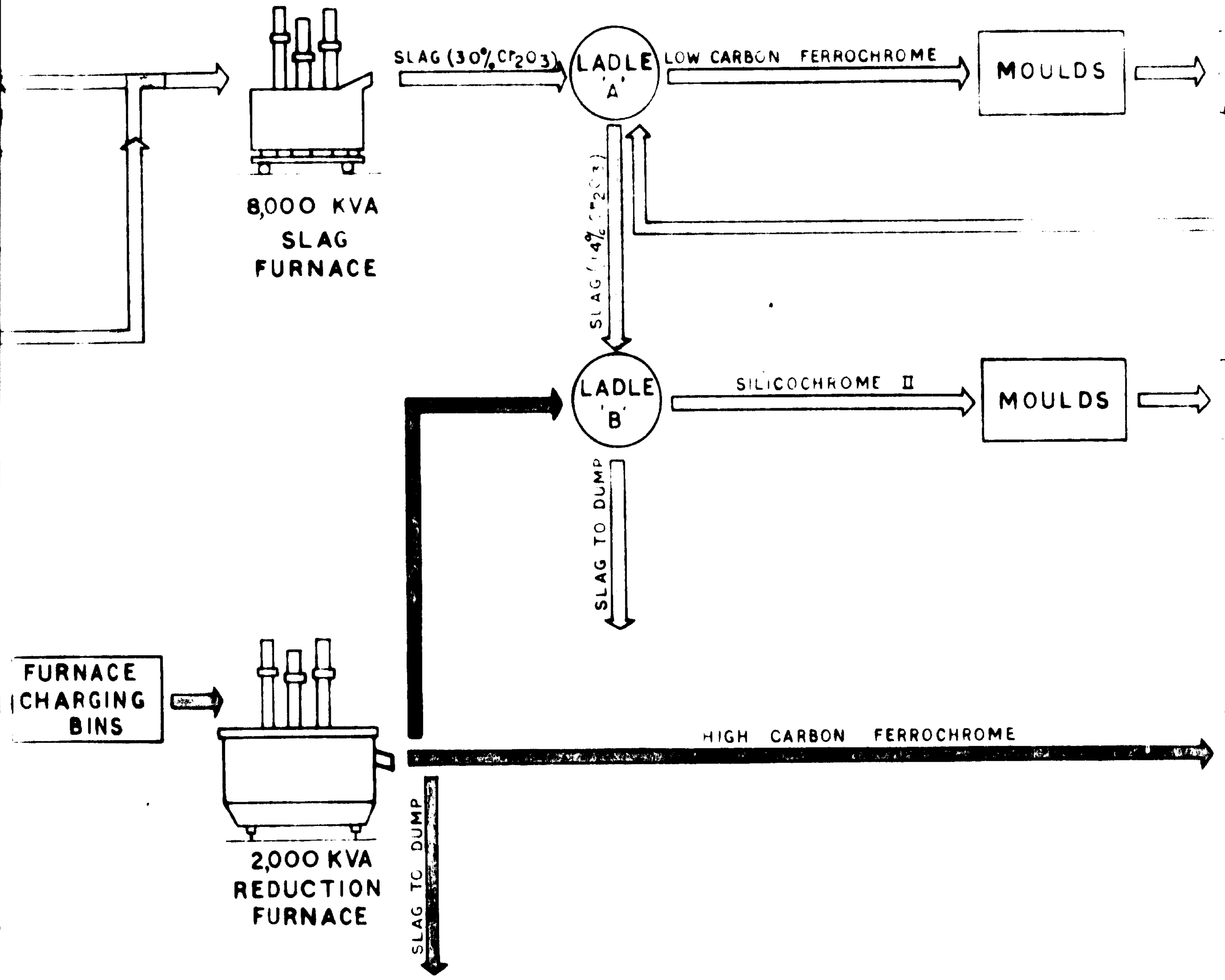
corollary to this development is the setting up of ferro-alloy capacity to process Iran's mineral resources into exportable higher-cost products and to provide the alloying ingredients for the growing mild steel and alloy steel industries.

Teams of the Consulting Engineers visited major raw material deposits and possible plant locations in Iran. Series of detailed discussions were held with the Ministry of Water and Power, the Ministry of Economy and the Plan Organization of the Imperial Government of Iran and with a number of public and private enterprises to determine the various local factors (such as costs of power, raw materials, construction materials, and labour and supervision) which form the base of the financial analyses in the report.

The proposed ferro-chrome plant would be export-oriented, and could be located at Faryab which is close both to Iran's major chromite deposits as well as to the port of Bandar-Abbas. However, this requires infra-structural development; for instance, the decision to extend the power system to this area has to be made and work undertaken on further development of the chromite mines as well as sources for quartzite and limestone.

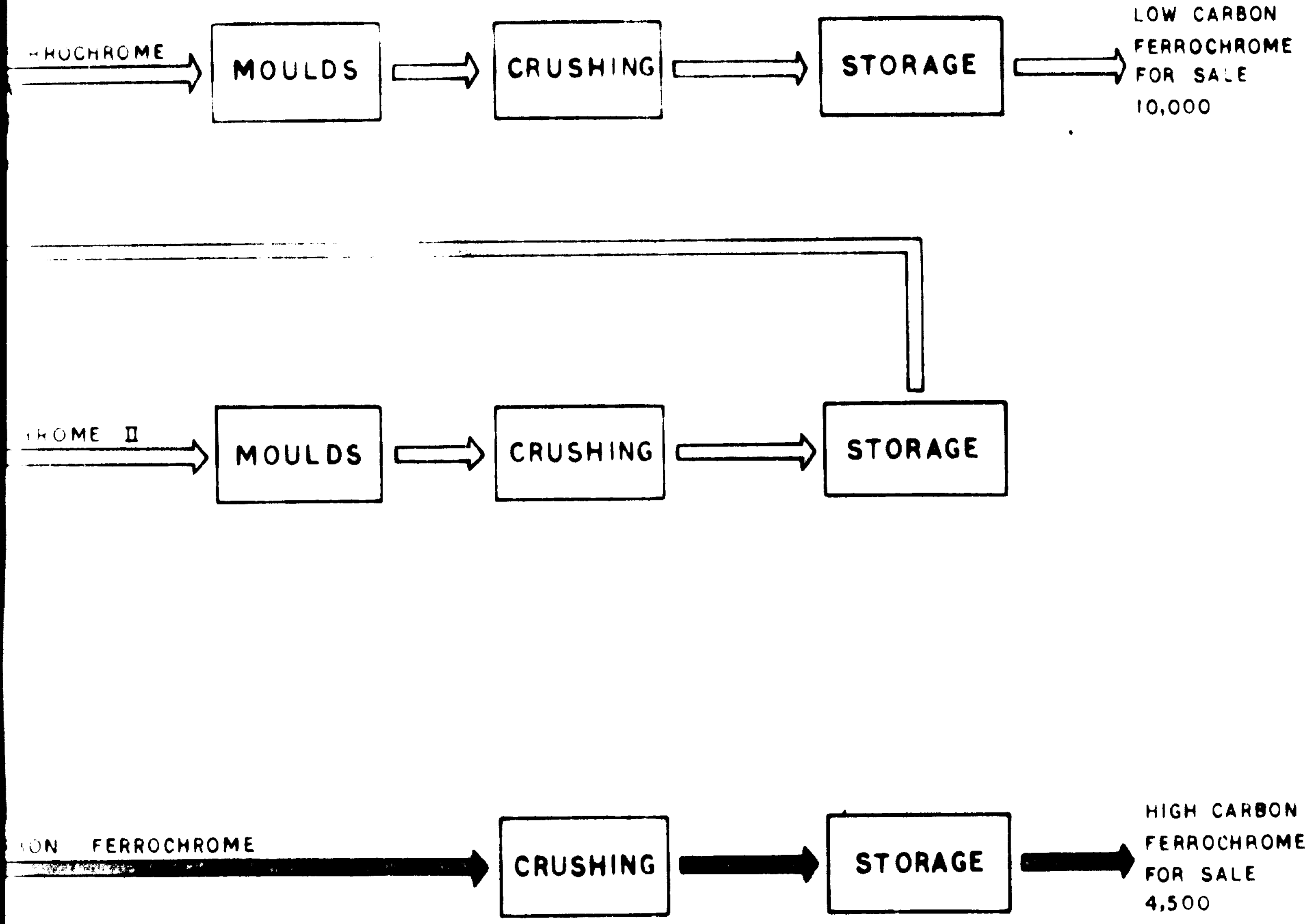
This study indicates that the ferro-chrome project would not be commercially viable on the basis of the raw material and power costs assumed and the international selling prices obtaining at the end of 1969. However, the economics of the project show considerable improvement if the selling prices prevailing in first quarter of 1970 are taken into consideration, when there has been a general increase in ferro-alloy prices. Also, the project offers important social benefits (such as development of the Bandar-Abbas area) and good foreign exchange earnings.

The main consumer of ferro-silicon and ferro-manganese will be the new integrated steelworks at Isfahan. It is proposed that the production of these two ferro-alloys be combined in a single plant, which could be advantageously located adjacent to the Isfahan steelworks. This would reduce overall capital investment by the sharing of facilities between the two products as well as sharing utility supplies with Isfahan itself.



NOTE:
QUANTITIES ARE IN TONS/YEAR.

SECTION 2



IN TONS/YEAR.

SECTION 3

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FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PPOJECTS
FERROCHROME PLANT — FLOW SHEET

DRAWN		21.11.69	No. 5131-III-5
APPROVED	P.K.Bose	27.11.69	

2

Table 2-5

FERRO-CHROME PLANT: PROJECT COST ESTIMATE

(Thousand dollars)

	Foreign currency	Local currency	Total
1. Plant cost ..	6 298	3 753	10 051
2. Promotional expenses	-	50	50
3. Start-up expenses ..	-	41	41
4. Training expenses ..	38	72	110
5. Technical assistance	-	100	100
6. Know-how ..	100	-	100
7. Interest on loan during construction ..	445	-	445
Total ..	6 881	4 016	10 897

Say $ 11 million

Manpower requirement

29. A typical organization chart is developed. The total manpower requirement would be 312, including executives, supervisors and operation, maintenance, administration staff.

Know-how requirements and training

30. Technical know-how for production process and initial assistance for operating the plant and exporting products will have to be obtained from abroad. It will also be essential to train key personnel abroad for periods of 3 to 6 months.

Cost of electric power

31. No published electric power tariff exists at present for electro-metallurgical industries in Iran and it is understood that this is now under preparation.

The Ministry of Water and Power has indicated that the power rates applicable to such industries are normally negotiated. Considering the large quantity of power required (22,000 kVA) at high load factor and high power factor by the ferro-chrome plant - an ideal consumer from the viewpoint of the supply company - an average rate of 5 mills per kWh has been considered for this feasibility study.

Production cost

32. On this basis the works production costs are estimated at:

$ 156.5 per ton of high carbon ferro-chrome,
$ 198.2 per ton of silico-chrome, and
$ 245.5 per ton of low carbon ferro-chrome.

Financial analysis

Sales price

33. The ex-works sales prices realisable by this project are considered to be as follows:

		$/ton
High-carbon ferro-chrome	..	216
Silico-chrome	..	253
Low-carbon ferro-chrome	..	316

Profit & loss statement

34. The profit and loss analysis is presented in Table 2-6. It will be observed that the plant incurs heavy losses upto the 11th year (the cumulative losses upto this year come to about $ 5 million).

Table 2-6

PROFIT AND LOSS STATEME

(Thousand dollars)

	I	II	III	IV	V	VI	VII
A. Income							
Total sales receipts (Ex-works)	2 066	3 342	4 132	4 132	4 132	4 132	4 1
B. Manufacturing expenses							
1. Raw materials ..	756	1 167	1 432	1 432	1 432	1 432	1 4
2. Electric power @ 5 mills..	368	452	563	563	563	563	56
3. Labour and supervision ..	494	494	494	494	494	494	4
4. General plant and overhead	507	507	507	507	507	507	50
5. Other costs a/ ..	80	108	140	140	140	140	1
Total (B) ..	2 175	2 728	3 136	3 136	3 136	3 136	3 1
C. Gross profit/loss (A - B) ..	-109	614	996	996	996	996	9
D. Other expenses							
1. Depreciation @ 8% ..	803	803	803	803	803	803	80
2. Interest on working capital	66	84	96	96	96	96	9
3. Interest on loan capital	480	480	480	432	384	336	2 3
4. Deferred charges ..	94	94	94	94	94	94	9
5. Sales expenses ..	21	34	42	42	42	42	
Total (D) ..	1 464	1 495	1 515	1 467	1 419	1 371	1 3
E. Net profit/loss (C - D)							
Current ..	-1 573	-881	-519	-471	-423	-375	-3
Cumulative ..	-1 573	-2 454	-2 973	-3 411	-3 867	-4 242	-4 5

a/ Other costs comprise expenses incurred on utilities, consumables, repair and maintenance and r

SECTION 1

Table 2-6

OFIT AND LOSS STATEMENT

Table 2-6

(Thousand dollars)

Year of operation										
V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
4 132	4 132	4 132	4 132	4 132	4 132	4 132	4 132	4 132	4 132	4 132
1 432	1 432	1 432	1 432	1 432	1 432	1 432	1 432	1 432	1 432	1 432
563	563	563	563	563	563	563	563	563	563	563
494	494	494	494	494	494	494	494	494	494	494
507	507	507	507	507	507	507	507	507	507	507
140	140	140	140	140	140	140	140	140	140	140
3 136	3 136	3 136	3 136	3 136	3 136	3 136	3 136	3 136	3 136	3 136
996	996	996	996	996	996	996	996	996	996	996
803	803	803	803	803	803	803	803	399	-	-
96	96	96	96	96	96	96	96	96	96	96
384	336	288	240	192	144	96	48	-	-	-
94	94	94	94	94	94	-	-	-	-	-
42	42	42	42	42	42	42	42	42	42	42
1 419	1 371	1 323	1 275	1 227	1 179	1 037	989	537	138	138
-423	-375	-327	-279	-231	-183	-41	7	459	858	858
-3 867	-4 242	-4 569	-4 848	-5 079	-5 262	-5 305	-5 296	-4 837	-3 979	-3 121

air and maintenance and relining reserve.

From the 12th to the 15th year the plant is estimated to make a profit of about $ 2 million leaving a cumulative net loss of about $ 3 million by the end of the 15th year.

Cash flow

35. The cash flow statement is presented in Table 2-7. To make good the heavy cash deficit arising out of losses in operation, additional funds to the tune of $ 1,350,000 are required. If interest charges are to be paid on these additional funds, the cash deficits again appear and to avoid this vicious circle it has been assumed for this exercise that such additional funds are provided free of interest charges. It will be observed that the net surplus at the end of 15th year will be $ 3.20 million and after providing for repayment of additional funds of $ 1.35 million, the net surplus will amount to $ 1.85 million as against the equity capital of $ 5 million.

Effect of higher prices

36. International market prices for ferro-alloys have recorded an upward trend and prices in the first quarter of 1970 were 10 to 20 per cent higher than those assumed for the profit and loss analysis (based on prices prevailing in the last quarter of 1969). The effect of the higher sales realisation, assuming the same manufacturing and other expenses as given in Table 2-6, is shown graphically in Fig. III-2.

2 - Summary and recommendations (cont'd)

T

CASH F

(Thou

	I	II	III	IV	V	V
Sources of cash						
Net profit/loss ..	-1 573	-881	-519	-471	-423	-37
Add: depreciation ..	803	803	803	803	803	80
deferred charges ..	94	94	94	94	94	9
Operating surplus/deficit ..	-676	16	378	426	474	57
Additional funds (interest free) ..	700	-	200	200	100	15
Total sources of cash ..	24	16	578	626	574	67
Disposition of cash						
Loan repayment ..	-	-	600	600	600	60
Estimated cash balance/deficiency - current	24	16	-22	26	-26	7
- cumulative	24	40	18	44	18	9

SECTION 1

Table 2-7

Table 2-7

CASH FLOW STATEMENT

(Thousand dollars)

Year of operation											
IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
-471	-423	-375	-327	-279	-231	-183	-41	7	459	858	858
803	803	803	803	803	803	803	803	803	399	-	-
94	94	94	94	94	94	94	-	-	-	-	-
426	474	522	570	618	666	714	762	810	858	858	858
200	100	150	-	-	-	-	-	-	-	-	-
626	574	672	570	618	666	714	762	810	858	858	858
600	600	600	600	600	600	600	600	600	-	-	-
26	-26	72	-30	18	66	114	162	210	858	858	858
44	18	90	60	78	144	258	420	630	1 488	2 346	3 204

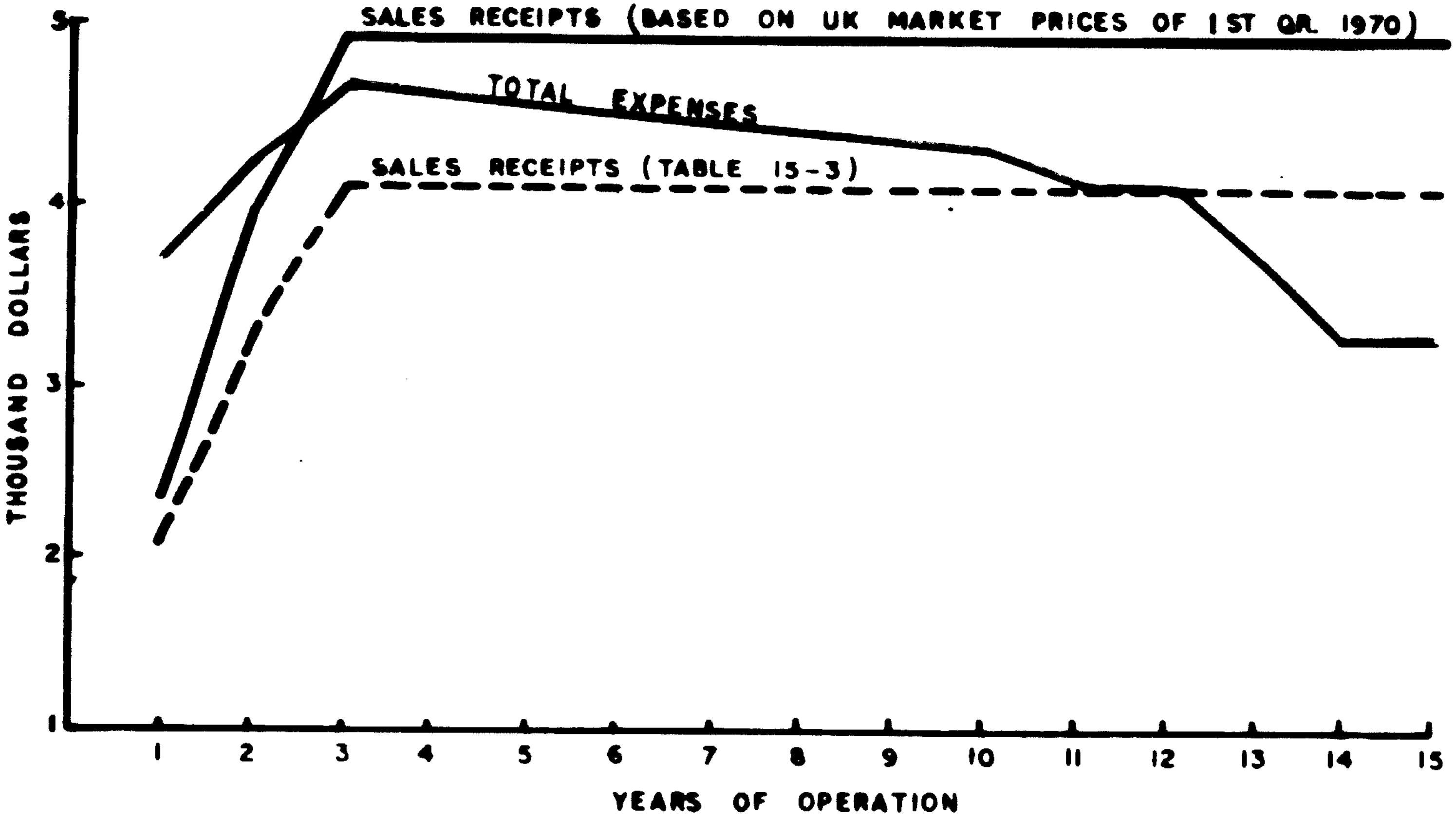


FIG. III — 2. EFFECT OF SALES REALISATION ON PROFITABILITY

The indigenous demand and export potential for ferro-silicon and ferro-manganese warrant installation of a good sized plant.

For the <u>alloy steel plant</u>, of the various locations considered Ahwaz and Arak are considered suitable. Ahwaz has the advantages of better access to imported and local scrap and better water availability. Based on the 1977/78 alloy steel demand, an optimum-sized plant has been proposed.

The alloy steel plant and the ferro-alloy plants incorporate modern and proven processes in order to be able to produce quality products at competitive costs. Provision has been made in the plant layout designs for substantial expansion in future. While this does not add to initial investment, it does allow the plants to take advantage of substantial economies of scale as the demand increases.

The report indicates areas where foreign collaboration arrangements would be needed for the purpose of plant engineering, training of Iranian personnel and technical assistance during initial operations.

The financial analyses of each project over a 15-year period show that the plants for production of ferro-silicon and ferro-manganese as well as alloy steels would be commercially viable. The ferro-chrome plant though not commercially attractive, may still be given consideration in view of the rising trend in world ferro-chrome prices and the social benefits which would accrue.

The salient features of the projects are summarised on the next page.

This is considered to be the appropriate time for Iran to take the decisions and concrete steps leading to construction of the projects under study. For instance, considerable detailed prospecting and development work is required on the manganese ore, chromite, quartzite and limestone deposits; power, water and transportation systems have to be developed at the locations; and decisions are required on the plant locations themselves as well as on financing and know-how arrangements.

Contributory margin

37. The contributory margin at full production level (based on the financial analysis in Table 2-6) works out to about $ 2 million. This corresponds to a contributory margin : sales receipt ratio of 0.48.

Internal rate of return & present value analysis

38. The internal rate of return before tax is about 1.4 per cent, as given in Table 2-8. The present value analysis indicates a deficit of about $ 5 million.

Foreign exchange earnings

39. The foreign exchange earnings of the project are estimated at about $ 3.5 million in the third year of operation (first year of full operation) gradually rising to a little over $ 4 million in the 14th year. If the chrome ore utilised in the project which could otherwise be exported is also considered, the effective net foreign exchange earnings would be $ 2.6 million in the third year of operation gradually rising to $ 3.2 million in the 14th year. The rate of return of foreign exchange is about 34 per cent per annum as worked out in Table 2-9.

Social benefits

40. The direct employment potential of the project is about 300. In addition, substantial indirect employment would be created due to the development of mining, transport and other activities. The location of the ferro-chrome plant in Faryab-Bandar Abbas region would also assist the process of development and industrialization of this area.

2 - Summary and recommendations (cont'd)

Table 2-8

INTERNAL RATE OF RETURN

(Thousand dollars)

	Cash outflows			Cash inflows		
	Estimate for the period	Discounted at		Estimate for the period a/	Discounted at	
		1%	2%		1%	2%
Construction period						
0 to 12 months	2 000	2 050	2 102			
13 to 24 months	5 700	5 786	5 872			
25 to 30 months	2 800	2 814	2 828			
Year of operation						
I ..	1 250	1 250	1 250	-130	-129	-127
II ..	150	149	147	580	568	557
III ..	300	294	283	954	926	907
IV ..	200	194	185	954	917	881
V ..	100	95	91	954	907	864
VI ..	150	141	133	954	899	847
VII ..				954	890	831
VIII ..				954	881	814
IX ..				954	872	798
X ..				954	863	782
XI ..				954	855	767
XII ..				954	846	752
XIII ..				954	838	737
XIV ..				954	830	723
XV ..				2 758	2 375	2 049
Total ..	12 650	12 891	12 773	14 656	13 338	12 182

Average rate of return:

Excess at lower trial rate (1%) = 13 338 - 12 773 = 565
Deficit at higher trial rate (2%) = 12 891 - 12 182 = 709

$$\text{Average rate of return} = 1 + 1\frac{565}{(565 + 709)} = 1.44\%$$

a/ Real cash surplus Table 15-5

Table 2-9

RATE OF RETURN OF FOREIGN EXCHANGE

(Thousands of dollars)

		Cash outflows (capital expenditure)				Cash inflows (net surplus)			
		Estimate for the period	Compounded at			Estimate for the year	Discounted at		
			25%	30%	35%		25%	30%	35%
Construction period									
0 to 12 months	..	1 300	2 285	2 527	2 784				
13 to 24 months	..	3 700	5 203	5 532	5 869				
25 to 30 months	..	1 400	1 575	1 610	1 645				
Commencement of operation									
1 year	..					2 060	1 648	1 584	1 526
2 year	..					3 330	2 131	1 971	1 828
3 to 15 years	..					53 534	9 966	7 853	6 321
Total	..	6 400	9 063	9 669	10 298	58 924	13 745	11 408	9 675

Computation of averate rate of return

Excess at lower trial rate (30%) = 11 408 - 9 669 = 1 739

Deficit at higher trial rate (35%) = 10 298 - 9 675 = 623

Average rate of return $= 30 + 5 \frac{(1\ 739)}{(1\ 739 + 623)}$ = 33.68%

FERRO-SILICON AND FERRO-MANGANESE PLANT (VOL. IV)

Plant capacity

41. Ferro-silicon and ferro-manganese capacities are being installed primarily to meet the local demand, particularly that of the Isfahan steel plant. Keeping in view the requirements in 1977 and 1982, it is suggested that a plant with capacity of 17,000 tons ferro-silicon (75% grade) and 38,000 tons ferro-manganese per year be installed.

Process selection

42. Taking into consideration the grades of ferro-alloys to be produced, the comparative cost of alternative processes and availability of coke and electric power, the adoption of the electric smelting process is proposed for the production of both ferro-alloys.

Location

43. Two alternative locations for the ferro-silicon and ferro-manganese plants - Ahwaz and Isfahan - are discussed. Evaluation of the sites indicates that setting up a single ferro-alloy plant to produce both ferro-silicon and ferro-manganese at Isfahan would be advantageous, and this site is therefore suggested.

Major facilities

44. A plant general layout has been developed which has provision for substantial expansion in future. The major production facilities include a 24,000 kVA furnace for ferro-silicon and a 20,000 kVA furnace for ferro-manganese smelting. The plant flow sheet is given in Drawing No. 5131-IV-3.

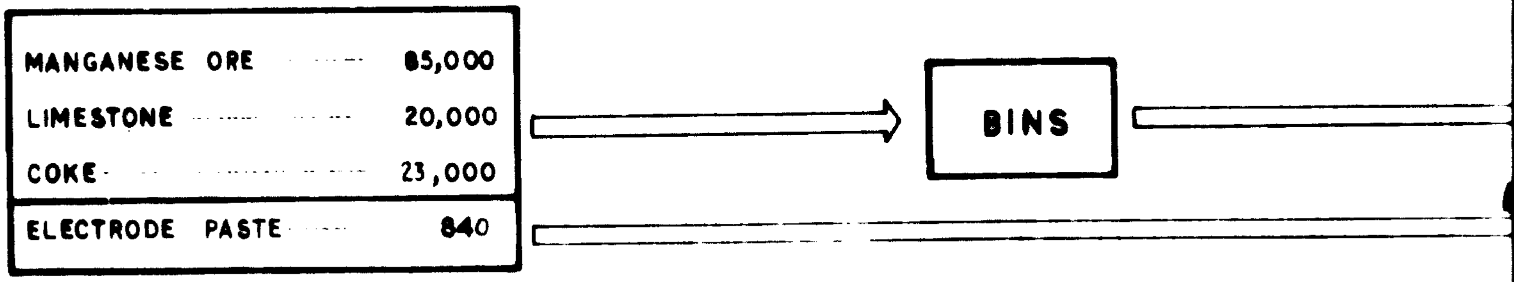
45. In order to minimise capital investment, the maximum possible integration of utility and service facilities for the ferro-alloy plant with the Isfahan steel plant is proposed.

46. The construction schedule visualises that this ferro-alloy plant could be completed in 24 months after preliminary work such as finalisation of the plant site and infra-structure development.

Cost estimate

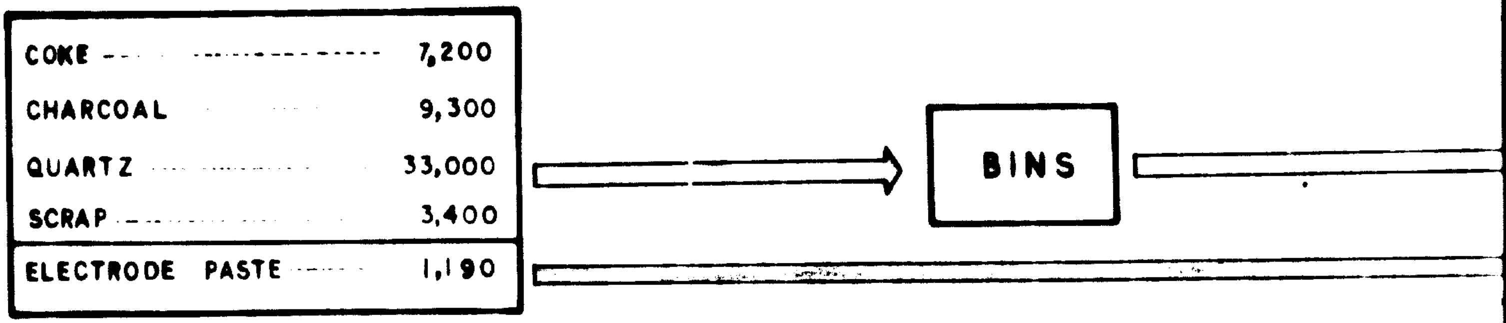
47. The estimate of total project cost is $ 10.5 million including foreign exchange of $ 6.6 million as given in Table 2-10.

Project cost



MANGANESE ORE	85,000
LIMESTONE	20,000
COKE	23,000
ELECTRODE PASTE	840

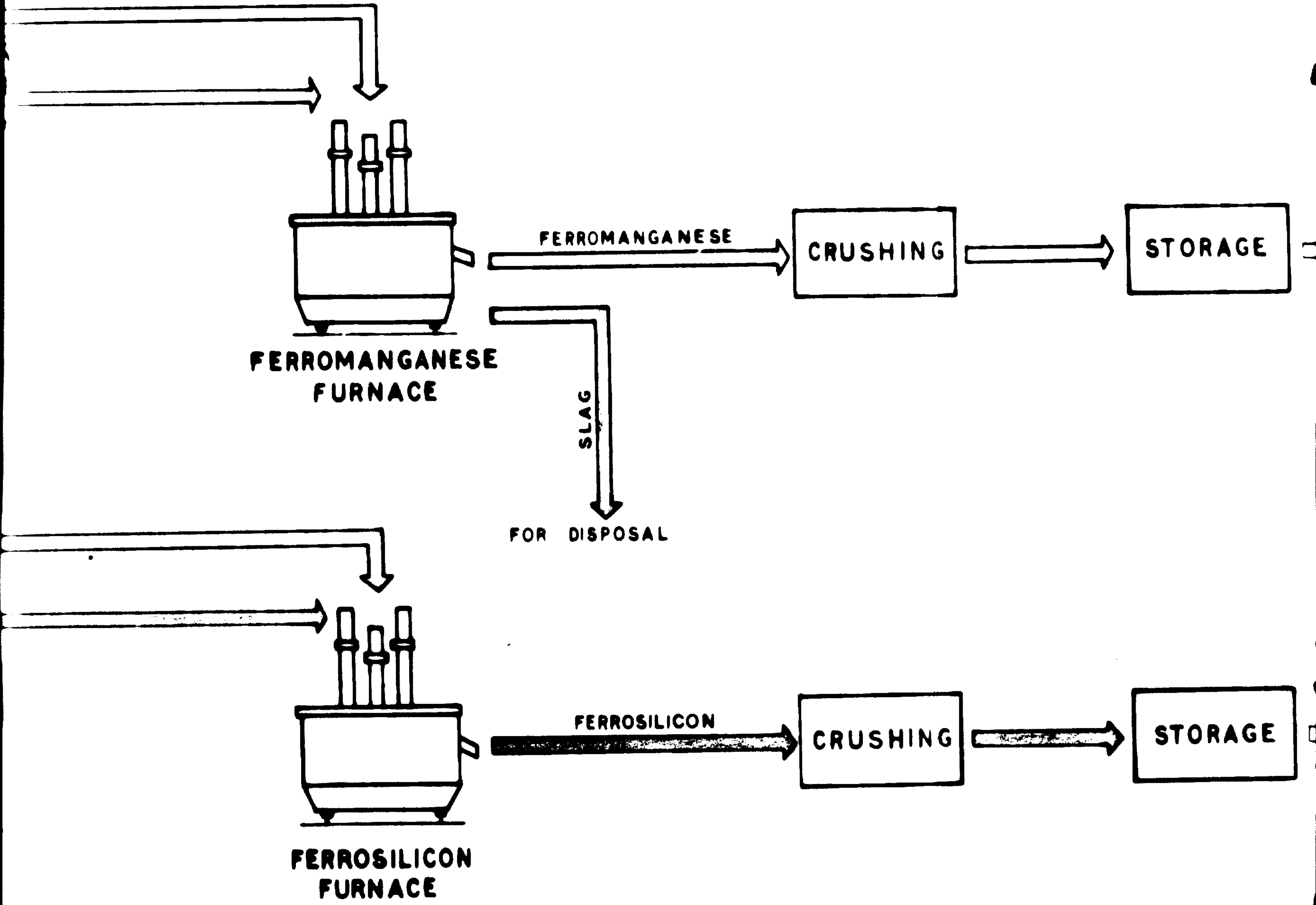
RAW MATERIALS FOR FERROMANGANESE PRODUCTION



COKE	7,200
CHARCOAL	9,300
QUARTZ	33,000
SCRAP	3,400
ELECTRODE PASTE	1,190

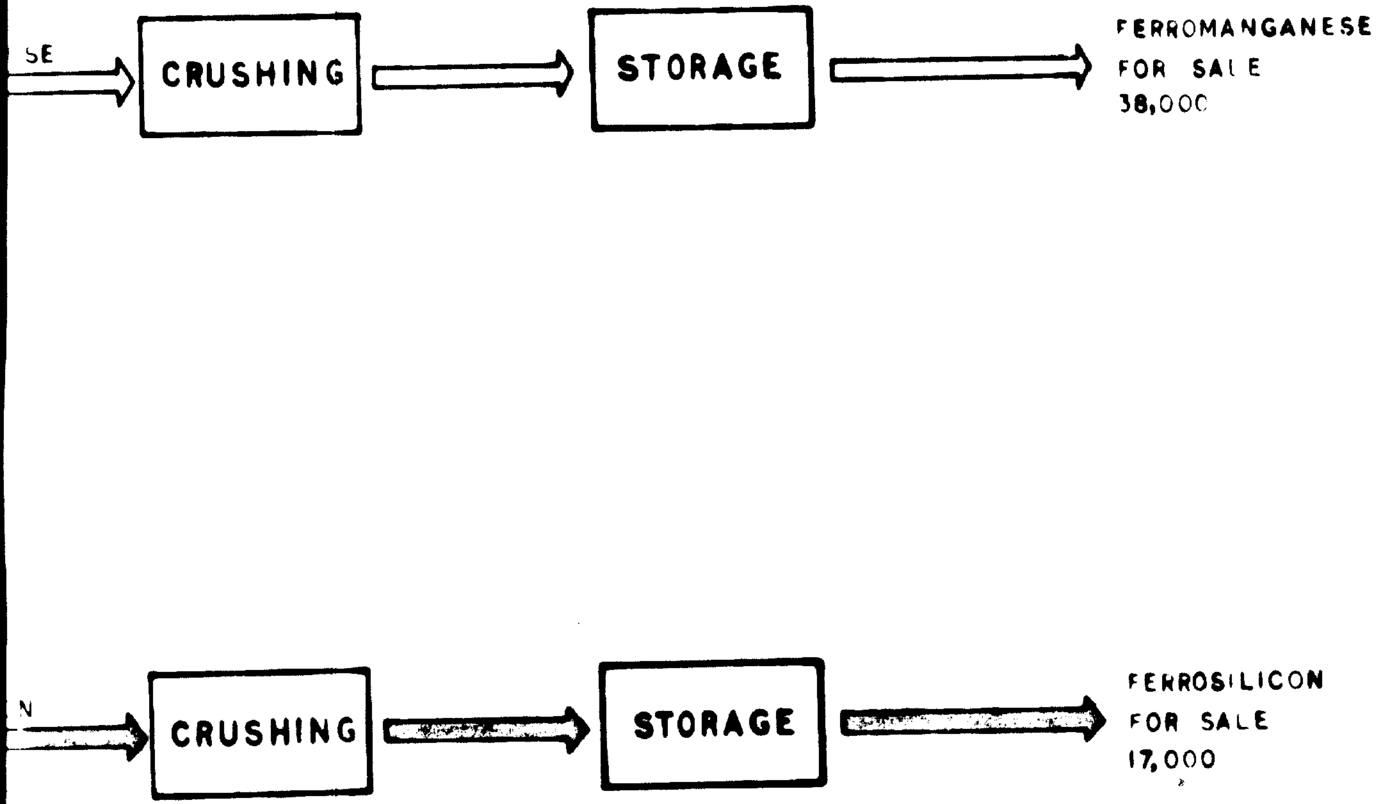
RAW MATERIALS FOR FERROSILICON PRODUCTION

SECTION 1



SECTION 2

NOTE:
QUANTITIES ARE IN TONS/YEAR



E IN TONS/YEAR

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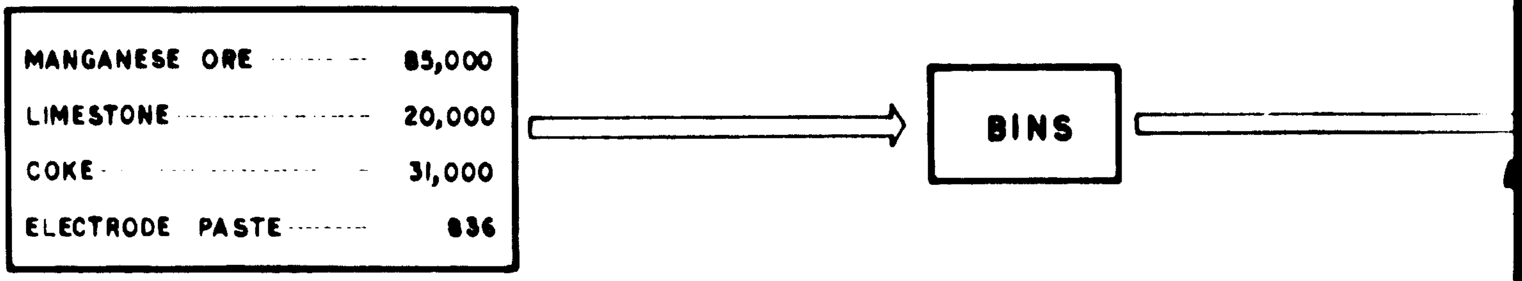
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROALLOYS PLANT — FLOW SHEET

DRAWN		28.11.69	No.5131-IV-3
APPROVED	PLBose	4.12.70	



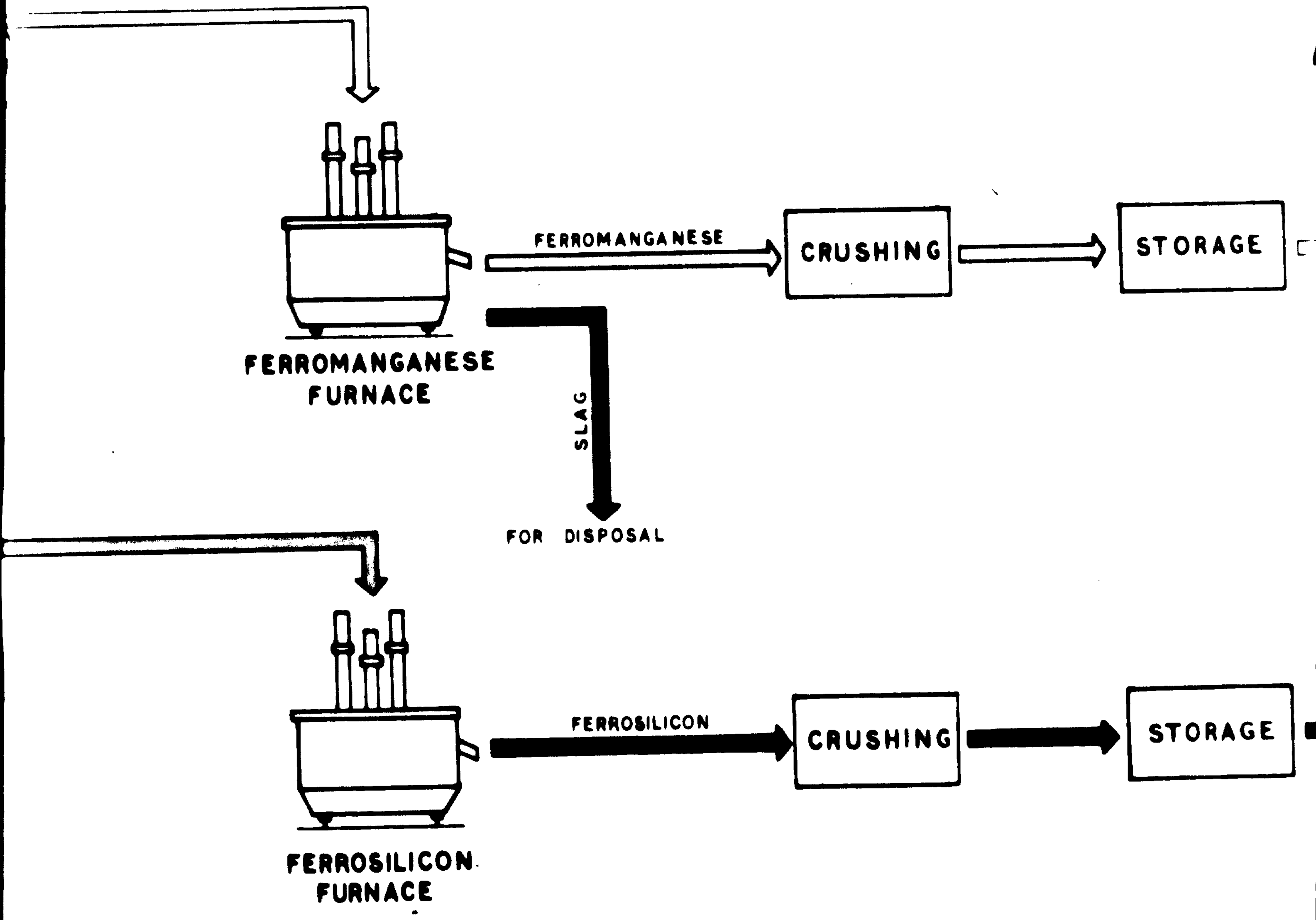
MANGANESE ORE	85,000
LIMESTONE	20,000
COKE	31,000
ELECTRODE PASTE	836

RAW MATERIALS FOR FERROMANGANESE PRODUCTION

CHARCOAL	9,300
QUARTZ	33,000
SCRAP	3,400
ELECTRODE PASTE	1,190

RAW MATERIALS FOR FERROSILICON PRODUCTION

SECTION 1



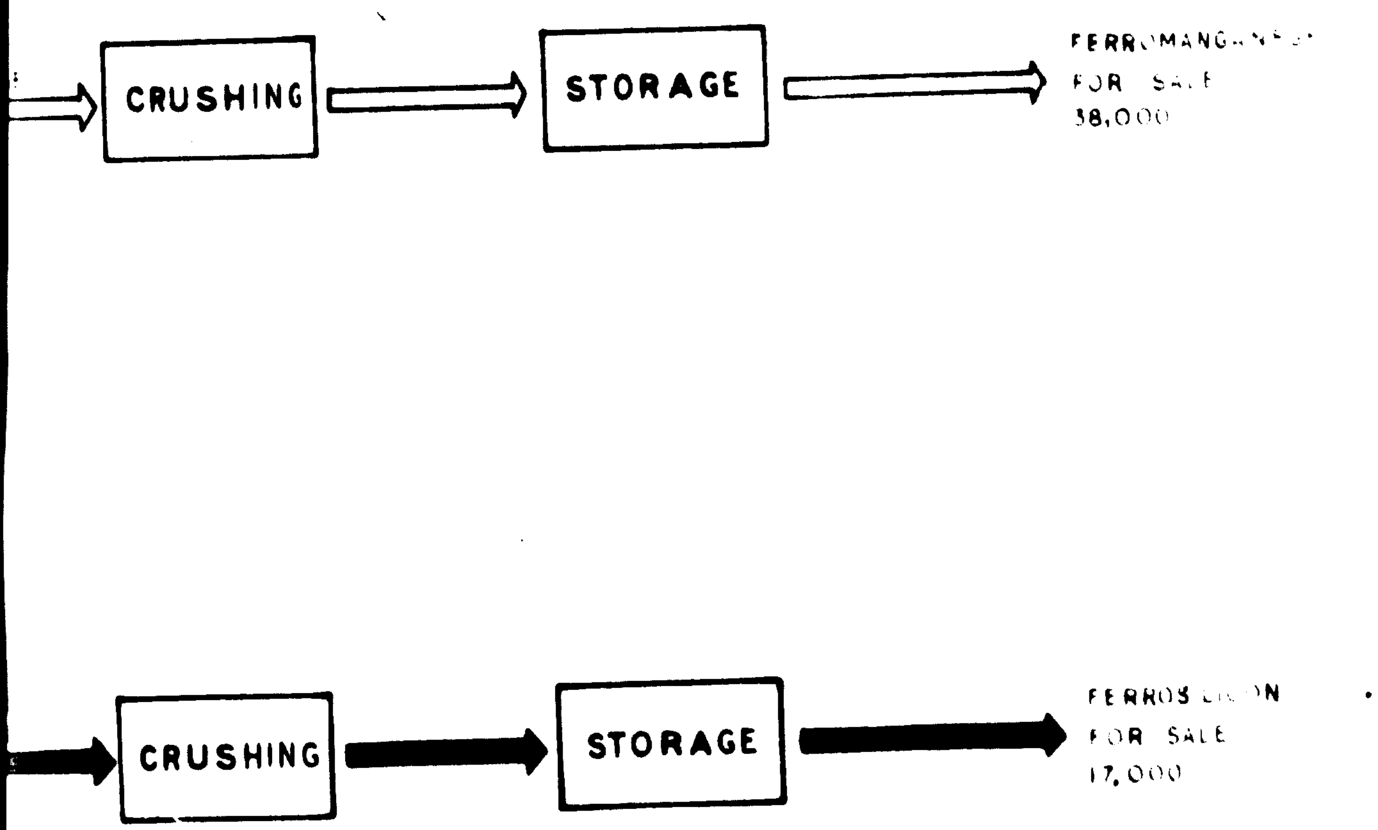
SECTION 2

NOTE:
QUANTITIES ARE IN TONS/YEAR

IRAN: PROPOSED FERRO-ALLOYS AND ALLOY STEEL PROJECTS - SALIENT FEATURES

		Ferro-chrome plant	Ferro-silicon and ferro-manganese plant	Alloy steel plant
Suggested location		Faryab or Bandar-Abbas	Isfahan	Ahwaz or Arak
Capacity	tons/yr	Low C 10 000 High C 4 500	FeSi 17 000 FeMn 38 000	50 000
Project cost (incl foreign currency \$ mill)	\$ mill	11.0 (6.9)	10.5 (6.6)	52.0 (29.3)
Manufacturing and other expenses a/	\$ mill	4.7	9.4	24.1
Sales receipt a/	\$ mill	4.1	11.9	29.1
Internal rate of return	%	1.4	14.3	10.0
Rate of return on foreign exchange	%	34.0	43.7	10.0
Excess present value (at 8% rate)	\$ mill	-6.3	8.0	12.5
Pay-back period b/	years	-	7.2	8.5

a/ In first year of full production
b/ By traditional method



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IN TONS/YEAR

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IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROALLOYS PLANT — FLOW SHEET

DRAWN 28 11 69
APPROVED 4 12 70

No. 5131 - IV - 3

Table 2-10

ESTIMATED TOTAL PROJECT COST

(Thousand dollars)

	Foreign currency	Local currency	Total
1. Plant cost	6 139	3 719	9 858
2. Promotional expenses	-	50	50
3. Start-up expenses	-	32	32
4. Training expenses	42	78	120
5. Technical assistance	-	80	80
7. Interest on loan during construction	400	-	400
Total	6 581	3 959	10 540

Manpower

48. The plant would require a total staff of 317. It is essential that key personnel receive training abroad. Foreign assistance for the operation of the plant during the initial period is suggested.

Production cost

49. As mentioned earlier, an average power rate of 5 mills per kWh has been assumed for this electro-metallurgical industry. Works production cost is estimated at:

$ 149 per ton of ferro-silicon (75% grade),
$ 92 per ton of ferro-silicon (45% grade), and
$ 147 per ton of ferro-manganese.

Financial analysis

Sales price

50. The sales prices realisable by this project, domestic as well as export are estimated as follows:

Market	Basis	Ferro-silicon (75% grade) $/ton	Ferro-manganese $/ton
Domestic	f.o.r. Isfahan	280	200
Export	f.o.r. Isfahan	135	85
Export	f.o.r. Persian Gulf port	160	105

Profit and loss

51. The statement of estimated profit and loss after tax resulting from the operation of the plant over a period of 15 years is given in Table 2-11. The annual average net profit after tax is estimated at $ 1.4 million, representing a return of about 13.3 per cent on the total investment of $ 10.5 million.

Taxation

52. Under the Inland Revenue Act 1967, the ferro-alloys industry is likely to get substantial tax exemptions. It is assumed that profits during the first 5 years of operation will be totally exempt from tax; from the 6th year onwards an adhoc tax rate of 33% of the total income from the project has been assumed after taking into account various exemptions.

Table 2-11

PROFIT AND LOSS STATE

(Thousand dollars

	I	II	III	IV	V	VI	V
A. Income							
Sales receipt - Ferro-silicon							
- domestic @ $ 230	1 260	1 680	2 100	2 520	2 300	3 080	3
- export @ $ 135	608	1 215	1 283	1 080	945	810	
Ferro-manganese							
- domestic @ $ 200	2 600	3 500	4 400	5 300	5 800	6 300	6
Total (A)	4 468	6 395	7 783	8 900	9 545	10 190	10
B. Manufacturing expenses							
Raw materials ..	2 096	3 036	3 678	4 173	4 448	4 668	4
Electric power ..	616	953	1 118	1 197	1 241	1 276	1
Labour & supervision ..	383	383	383	383	383	383	
General plant expense ..	397	397	397	397	397	397	
Other costs ..	203	301	360	401	423	441	
Total (B) ..	3 695	5 070	5 936	6 551	6 892	7 165	7
C. Gross profit/loss (A - B) ..	773	1 325	1 847	2 349	2 653	3 025	3
D. Other expenses							
Depreciation ..	784	784	784	784	784	784	
Interest on working capital	120	156	180	192	204	216	
Interest on loan capital ..	440	440	440	396	352	308	
Deferred charges ..	70	70	70	70	70	70	
Total (D) ..	1 414	1 450	1 474	1 442	1 410	1 378	1
E. Net profit/loss (C - D) - current	-641	-125	373	907	1 243	1 647	1
F. Tax ..	-	-	-	-	-	544	
G. Profit/loss - current ..	-641	-125	373	907	1 243	1 103	1
(after tax) - cumulative ..	-641	-766	-393	514	1 757	2 860	4

SECTION 1

Table 2-11

PROFIT AND LOSS STATEMENT

(Thousand dollars)

Table 2-11

	Year of operation										
	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
0	2 300	3 080	3 360	3 640	3 920	4 200	4 480	4 760	4 760	4 760	4 760
30	945	810	675	540	405	270	135	-	-	-	-
00	5 800	6 300	6 800	7 300	7 600	7 600	7 600	7 600	7 600	7 600	7 600
00	9 545	10 190	10 855	11 480	11 925	12 070	12 215	12 360	12 360	12 360	12 360
3	4 448	4 668	4 998	5 218	5 438	5 438	5 438	5 438	5 438	5 438	5 438
7	1 241	1 276	1 328	1 365	1 398	1 398	1 398	1 398	1 398	1 398	1 398
3	383	383	383	383	383	383	383	383	383	383	383
7	397	397	397	397	397	397	397	397	397	397	397
01	423	441	468	486	504	504	504	504	504	504	504
1	6 892	7 165	7 574	7 847	8 120	8 120	8 120	8 120	8 120	8 120	8 120
19	2 653	3 025	3 261	3 633	3 805	3 095	4 095	4 240	4 240	4 240	4 240
1	784	784	784	784	784	784	784	784	399	-	-
2	204	216	228	240	240	240	240	240	240	240	240
6	352	308	264	220	176	132	88	44	-	-	-
70	70	70	70	70	70	70	-	-	-	-	-
2	1 410	1 378	1 346	1 314	1 270	1 226	1 112	1 068	639	240	240
07	1 243	1 647	1 915	2 319	2 535	2 724	2 983	3 172	3 601	4 000	4 000
	-	544	632	765	837	899	984	1 047	1 188	1 320	1 320
07	1 243	1 103	1 283	1 554	1 698	1 825	1 999	2 125	2 413	2 680	2 680
14	1 757	2 860	4 143	5 697	7 395	9 220	11 219	13 344	15 757	18 437	21 117

SECTION 2

Cash flow

53. Estimated figures of cash flows are given in Table 2-12. It will be noted that after repayment of long-term loan there is a cumulative net surplus of about $ 26 million at the end of the 15th year against the capital investment of about $ 5 million.

Contributory margin

54. The contributory margin amounts to $ 4.6 million in the 9th year (the first year of production at rated capacity). This corresponds to a contributory margin: sales receipt ratio of 0.39.

Break-even chart

55. The break-even chart is presented on the following page (2-). In the first year of full rated production (ninth year of operation) the plant can be expected to break-even when operating at about 44 per cent of the rated capacity.

Internal rate of return and excess present value.

56. The internal rate of return works out to about 14 per cent as given in Table 2-13. The excess present value analysis indicates an excess of about $ 8 million and the present value index is 1.62.

- Summary and recommendations (cont'd,

Table 2-12

CASH FLOW STATEMENT

(Thousand dollars)

	Year of op							
	I	II	III	IV	V	VI	VII	VIII
Cash inflow								
Profit/loss after tax	-641	-125	373	907	1 243	1 103	1 283	1 554
Add - depreciation	784	784	784	784	784	784	784	784
- deferred charges	70	70	70	70	70	70	70	70
Operating surplus/deficiency	213	729	1 227	1 761	2 097	1 957	2 137	2 408
Cash outflow								
Loan repayment	-	-	550	550	550	550	550	550
Net surplus/deficiency - current ..	213	729	677	1 211	1 547	1 407	1 587	1 858
- cumulative ..	213	942	1 619	2 830	4 377	5 784	7 371	9 229

SECTION 1

Table 2-12

Table 2-12

CASH FLOW STATEMENT

(Thousand dollars)

Year of operation												
II	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
373	907	1 243	1 103	1 283	1 554	1 698	1 825	1 999	2 125	2 413	2 680	2 680
784	784	784	784	784	784	784	784	784	784	399	-	-
70	70	70	70	70	70	70	70	-	-	-	-	-
227	1 761	2 097	1 957	2 137	2 408	2 552	2 679	2 783	2 909	2 812	2 680	2 680
550	550	550	550	550	550	550	550	550	550	-	-	-
677	1 211	1 547	1 407	1 587	1 858	2 002	2 129	2 233	2 359	2 812	2 680	2 680
619	2 830	4 377	5 784	7 371	9 229	11 231	13 360	15 593	17 952	20 764	23 444	26 124

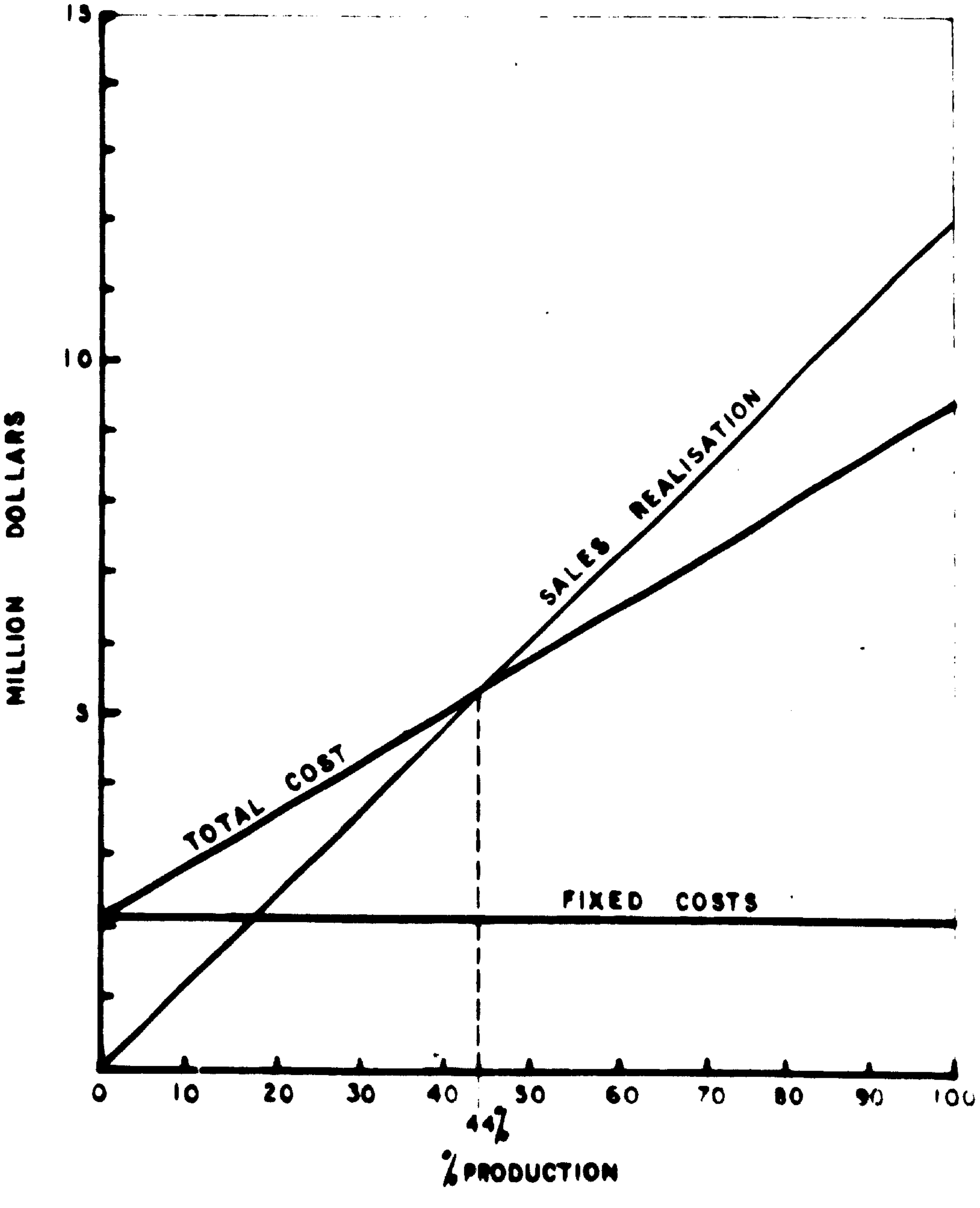


FIG. IV-5. BREAK-EVEN CHART

2 - Summary and recommendations (cont'd)

Table 2-13

INTERNAL RATE OF RETURN

(Thousand dollars)

		Cash outflow			Cash inflow		
		Estimate for the period	Discounted at 14%	Discounted at 15%	Estimate for the period	Discounted at 14%	Discounted at 15%
Construction period							
0-12 months	..	2 500	3 249	3 306			
13-24 months	..	7 600	8 664	8 740			
Year of operation							
I	..	1 000	1 000	1 000	773	678	673
II	..	300	263	261	1 325	1 019	1 002
III	..	200	154	151	1 847	1 247	1 215
IV	..	100	68	66	2 349	1 391	1 344
V	..	100	59	57	2 653	1 377	1 319
VI	..	100	52	50	2 481	1 131	1 072
VII	..	100	46	43	2 629	1 052	989
VIII	..	100	40	38	2 868	1 007	939
IX	..	-	-	-	2 968	914	843
X	..	-	-	-	3 051	824	754
XI	..	-	-	-	3 111	737	669
XII	..	-	-	-	3 193	664	597
XIII	..	-	-	-	3 052	555	497
XIV	..	-	-	-	2 920	467	412
XV	..	-	-	-	5 900	826	726
Total	..	12 100	13 595	13 712	41 120	13 889	13 051

Average rate of return

Excess at lower trial rate (14%) = 13 889 - 13 595 = 294

Deficit at higher trial rate (15%) = 13 712 - 13 051 = 661

$\therefore$ Average rate of return $= 14 + \left(\frac{294}{(294+661)}\right) = 14.31\%$

Say 14.3%

The ferro-silicon, ferro-manganese and alloy steel projects will provide important materials for the country's development and defence efforts as well as assist the export programme. In addition, they will provide the impetus for the development of auxiliary industries - both for feeding materials to the new projects and processing their products.

Respectfully submitted
M.N. DASTUR & COMPANY PRIVATE LTD.
by

M.N. Dastur, Managing Director

cc: Chief, Purchase and Transportation Service
United Nations
New York, NY 10017
USA.

Pay-back period

57. On the traditional basis, the pay-back period is 7.6 years and on discounted basis at 8 per cent it comes to 8.5 years.

Foreign exchange earnings

58. The net savings in foreign exchange increase from about $ 2.2 million in the first year to about 7 million in the 14th year. The rate of return of foreign exchange presented in Table 2-14 is estimated at about 44 per cent.

Effect of ferro-manganese export

59. The financial analysis has not considered export of ferro-manganese, because the works cost of production is estimated at $ 146 against an estimated f.o.b. sales price of $ 105 only.

The foreign exchange component of the works cost of production would depend upon the proportion of the indigenous ore blended with the imported ore. This is estimated at $ 71.5 per ton of ferro-manganese with 100% imported ore. The rate of return of foreign exchange would then work out to 45 per cent

Table 2-14

RATE OF RETURN OF FOREIGN EXCHANGE

(Thousand dollars)

		Foreign exchange outflow			Foreign exchange inflow		
		Estimate for the period	Compounded at		Estimate for the period	Discounted at	
			40%	45%		40%	45%
Construction period							
0-12 months	..	1 600	3 136	3 364			
13-24 months	..	4 800	6 720	6 960			
Commencement of operation							
I	..				2 766	1 975	1 909
II	..				4 149	2 116	1 975
III	..				4 935	1 796	1 613
IV	..				5 423	1 410	1 226
V	..				5 709	1 062	891
VI	..				5 996	797	648
VII	..				6 282	597	465
VIII	..				6 568	447	335
IX	..				6 776	325	237
X	..				6 866	240	165
XI	..				6 956	174	113
XII to XV	..				28 184	324	211
Total	..	6 400	9 856	10 324	90 610	11 263	9 798

Average rate of return:

Excess at lower trial rate (40%) = 11 263 - 9 856 = 1 407

Deficit at higher trial rate (45%) = 10 324 - 9 798 = 526

Average rate of return $= 40 + 5 \left(\frac{1\,407}{(1\,407 + 526)} \right)$

= 43.65%

as indicated in Table 2-15 if excess ferro-manganese produced is exported and even if no local ore is used in the plant.

This ferro-silicon-cum-ferro-manganese plant would have a significant role in Iran's developing steel industry, as it would produce indigenously and at viable costs essential ferro-alloys which would otherwise have to be imported.

2 - Summary and recommendations (cont'd)

Table 2-15

RATE OF RETURN OF FOREIGN EXCHANGE CONSIDERING EXPORT OF FERRO-MANGANESE

(Thousand dollars)

	Foreign exchange outflows			Foreign exchange inflows				
	Estimate for the period a/	Compounded at		Estimate for the period			Discounted at	
		45%	50%	Fe-Mn export	Others a/	Total	45%	50%
Construction period								
0-12 months ..	1 600	3 360	3 600					
13-24 months ..	4 800	6 960	7 200					
Year of operation								
I ..				301	2 766	3 067	2 116	2 046
II ..				335	4 149	4 484	2 134	1 991
III ..				368	4 935	5 303	1 739	1 570
IV ..				368	5 423	5 791	1 309	1 147
V ..				301	5 709	6 010	938	793
VI ..				218	5 996	6 214	671	547
VII ..				134	6 282	6 416	475	379
VIII ..				51	6 568	6 619	338	258
IX to XV ..				-	48 782	48 782	731	502
Total ..	6 400	10 320	10 800	2 076	90 610	92 686	10 451	9 233

Average rate of return

Excess at lower trial rate (45%) = 10 451 - 10 320 = 131

Deficit at higher trial rate (50%) = 10 800 - 9 233 = 1 567

Average rate of return = $45 + 5 \frac{(131)}{(131 + 1\ 567)}$ = 45.4%

a/ Table 23-12

ALLOY STEEL PLANT (VOL V)

Demand for alloy steel

Present consumption

60. Direct import of alloy and special steels in the form of rolled products into Iran was around 10,000 tons in 1968 (including about 3,000 tons of spring steels). The gross consumption including indirect imports in the form of finished metal products, machinery and parts is estimated at 31,000 tons in 1968.

Demand forecast

61. The demand is expected to rise to about 78,300 tons per year by the end of the Fifth Plan. The consumption pattern by sectors is expected to be as given in Table 2-16.

Table 2-16

ESTIMATE OF ALLOY STEELS DEMAND BY SECTORS

	1977 tons	%
Transport equipment	41 460	53.6
Electrical equipment and machinery	7 260	9.4
Industrial and agricultural machinery and equipment	12 700	16.7
Metal products	4 260	3.7
	65 680	
Other miscellaneous users	12 630	16.6
Total	78 310	100.0

2 - Summary and recommendations (cont'd)

62. The consumption pattern by steel types would be as given in Table 2-17.

Table 2-17

ESTIMATE OF ALLOY STEEL DEMAND BY STEEL TYPES

Type of steel	1977 tons	%
Carbon constructional steel ..	8 430	10.70
Free cutting steel	4 180	5.40
Spring steel	25 140	32.40
Alloy and constructional steel ..	27 840	35.00
Stainless steel	6 360	8.32
Electrical sheets	2 340	3.00
Tool steel	3 180	4.10
Die blocks	840	1.08
Total ..	78 310	100.00

Shortfall

63. By 1977, the proportion of alloy steels to total steels would reach only about 3 per cent whereas this figure is in the range of 6 to 10 per cent in developed countries. As there is no indigenous production, the entire demand would represent the shortfall in 1977, to be met through imports and by creating capacity for indigenous manufacture. Generally limited imports would continue as the tonnages required of certain alloy steels would still be too small to justify local manufacture.

Proposed plant capacity and product-mix

Plant capacity

64. Keeping in view the estimated future shortfall and the optimum scale of operation for an alloy steel

2 - Summary and recommendations (cont'd)

plant, it is proposed to start the plant with a capacity of 75,000 tons of ingots per year (50,000 tons of finished alloy steels). The facilities will be installed in two stages - stage I for 45,000 tons of finished alloy steels per year, and stage II to follow continuously with additional 5,000 tons per year.

Product-mix

65. The product-mix proposed is given in Table 2-18 below:

Table 2-18

PROPOSED PRODUCT-MIX

	Finished alloy steel tons/yr
Stage I	
Constructional steels	
Carbon constructional steels	8 000
Low alloy medium tensile steel	8 000
Medium alloy high tensile steel	2 000
Case hardening steel	5 000
Free cutting steel	2 000
Sub-total	25 000
Spring steels	
Carbon spring steel	5 000
Silico-manganese spring steel	12 000
Chrome-vanadium spring steel	3 000
Sub-total	20 000
Total stage I	45 000
Stage II	
Alloy tool and die steels	
High speed steel	200
Hot work die steel	300
Cold work die steel	1 000
Low alloy tool steel	1 000
Die blocks	500
Carbon tool steel	2 000
Total stage II	5 000
Total stage I and II	50 000
	(75 000 ingot tons)

2 - Summary and recommendations (cont'd)

Flow sheets

66. The plant flow sheets for stage I and stage II are shown in Drawing Nos 5131-V-1 and 5131-V-2 respectively.

Process, equipment and facilities

67. Proven modern technology with optimum size equipment has been selected to meet the production and quality requirements.

Arc furnace for steelmaking

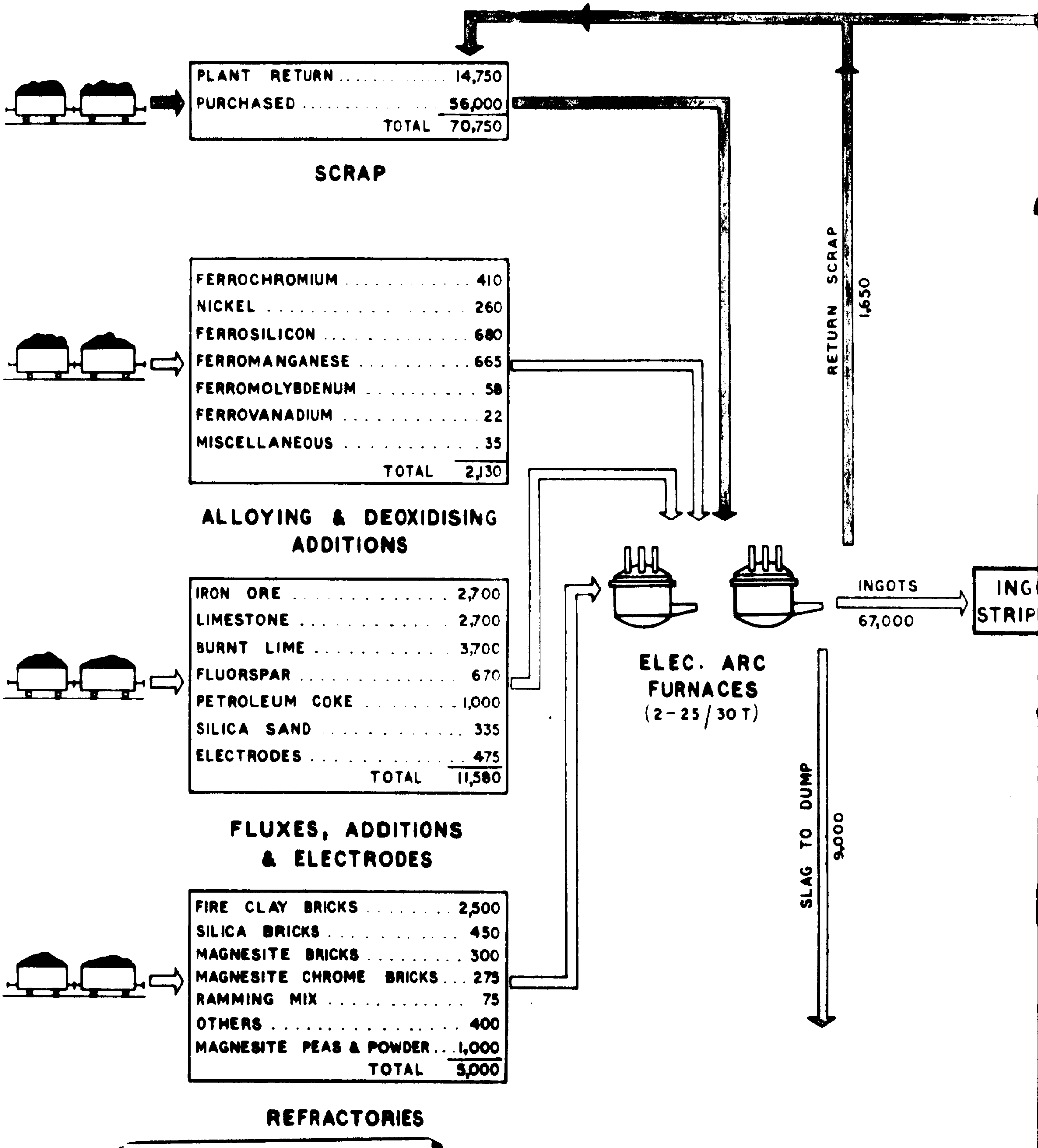
68. Steelmaking will be in electric arc furnaces using 100 per cent steel scrap. Two 20/25-ton arc furnaces have been proposed for stage I, and a 6-ton arc furnace added in stage II.

Ingot casting proposed

69. Consideration was given to 'continuous casting' as well as conventional ingot casting. In view of the variety of steels to be produced and the stringent quality requirements, continuous casting has not been proposed at this stage. All steel will be fully killed and cast in hot-top wide-end-up moulds, to give ingots weighing up to 3 tons.

Gas-fired soaking pits

70. The ingots will be stripped and charged, normally in the hot condition, in one-way gas-fired soaking pits. Facilities for slow cooling and preheating of ingots are also provided.



PLANT RETURN	14,750
PURCHASED	56,000
TOTAL	70,750

SCRAP

FERROCHROMIUM	410
NICKEL	260
FERROSILICON	680
FERROMANGANESE	665
FERROMOLYBDENUM	58
FERROVANADIUM	22
MISCELLANEOUS	35
TOTAL	2,130

ALLOYING & DEOXIDISING ADDITIONS

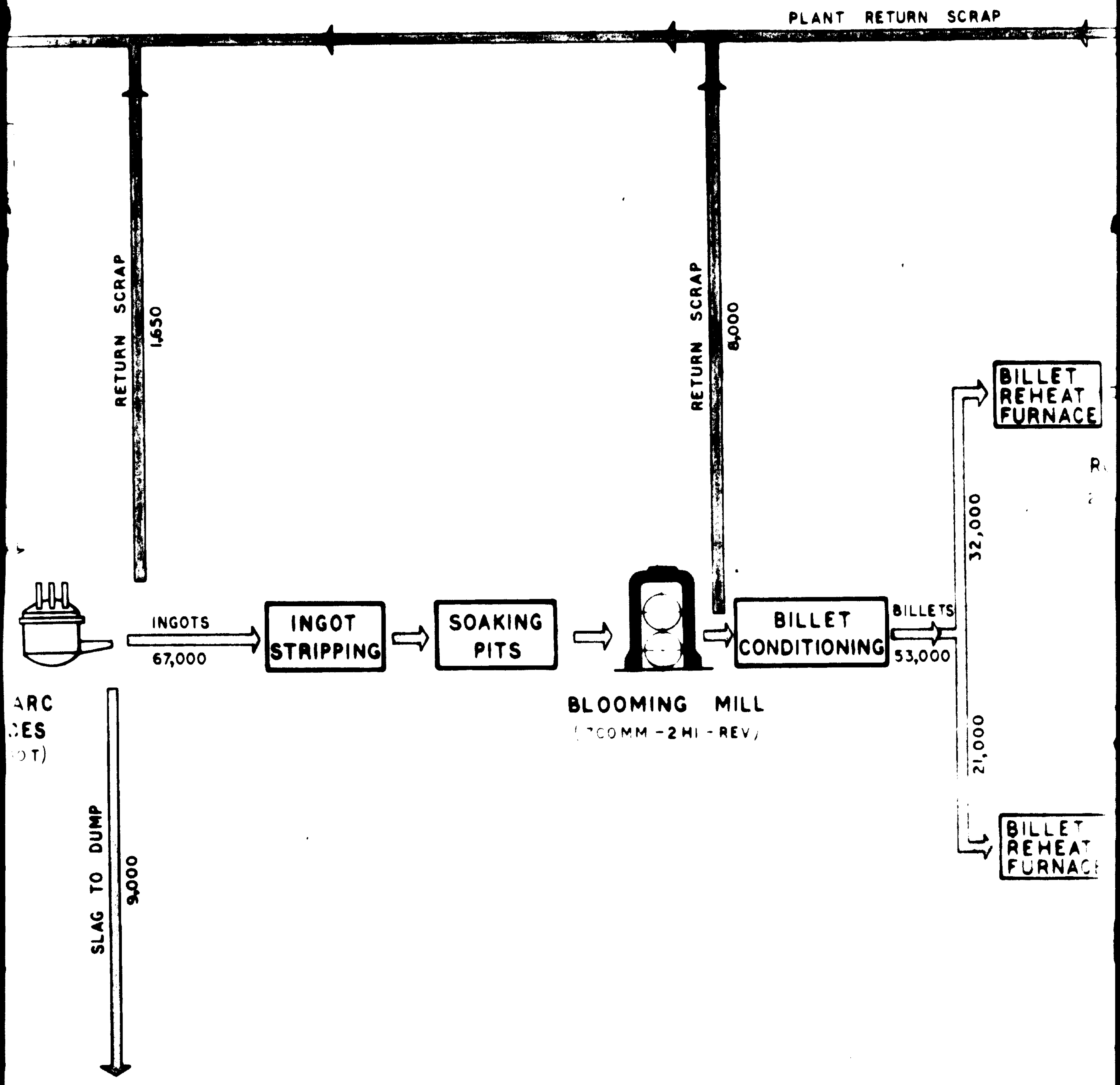
IRON ORE	2,700
LIMESTONE	2,700
BURNT LIME	3,700
FLUORSPAR	670
PETROLEUM COKE	1,000
SILICA SAND	335
ELECTRODES	475
TOTAL	11,580

FLUXES, ADDITIONS & ELECTRODES

FIRE CLAY BRICKS	2,500
SILICA BRICKS	450
MAGNESITE BRICKS	300
MAGNESITE CHROME BRICKS	275
RAMMING MIX	75
OTHERS	400
MAGNESITE PEAS & POWDER	1,000
TOTAL	5,000

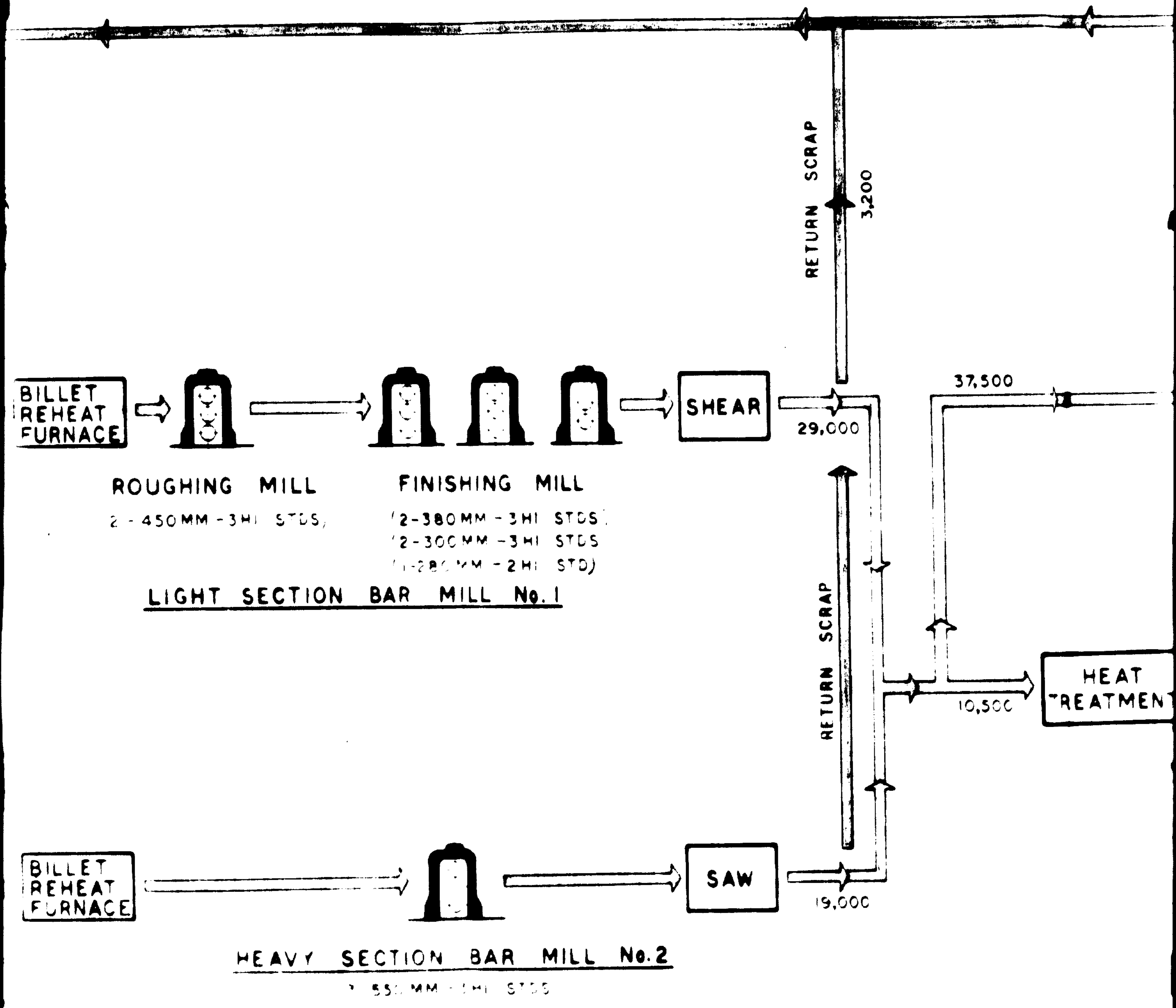
REFRACTORIES

SECTION 1


PLANT RETURN SCRAP
RETURN SCRAP
1,650
RETURN SCRAP
8,000
ARC
CES
OT)
INGOTS
67,000
INGOT STRIPPING
SOAKING PITS
BLOOMING MILL
(700MM - 2HI - REV)
BILLET CONDITIONING
BILLETS
53,000
32,000
21,000
BILLET REHEAT FURNACE
BILLET REHEAT FURNACE
SLAG TO DUMP
9,000
R
2

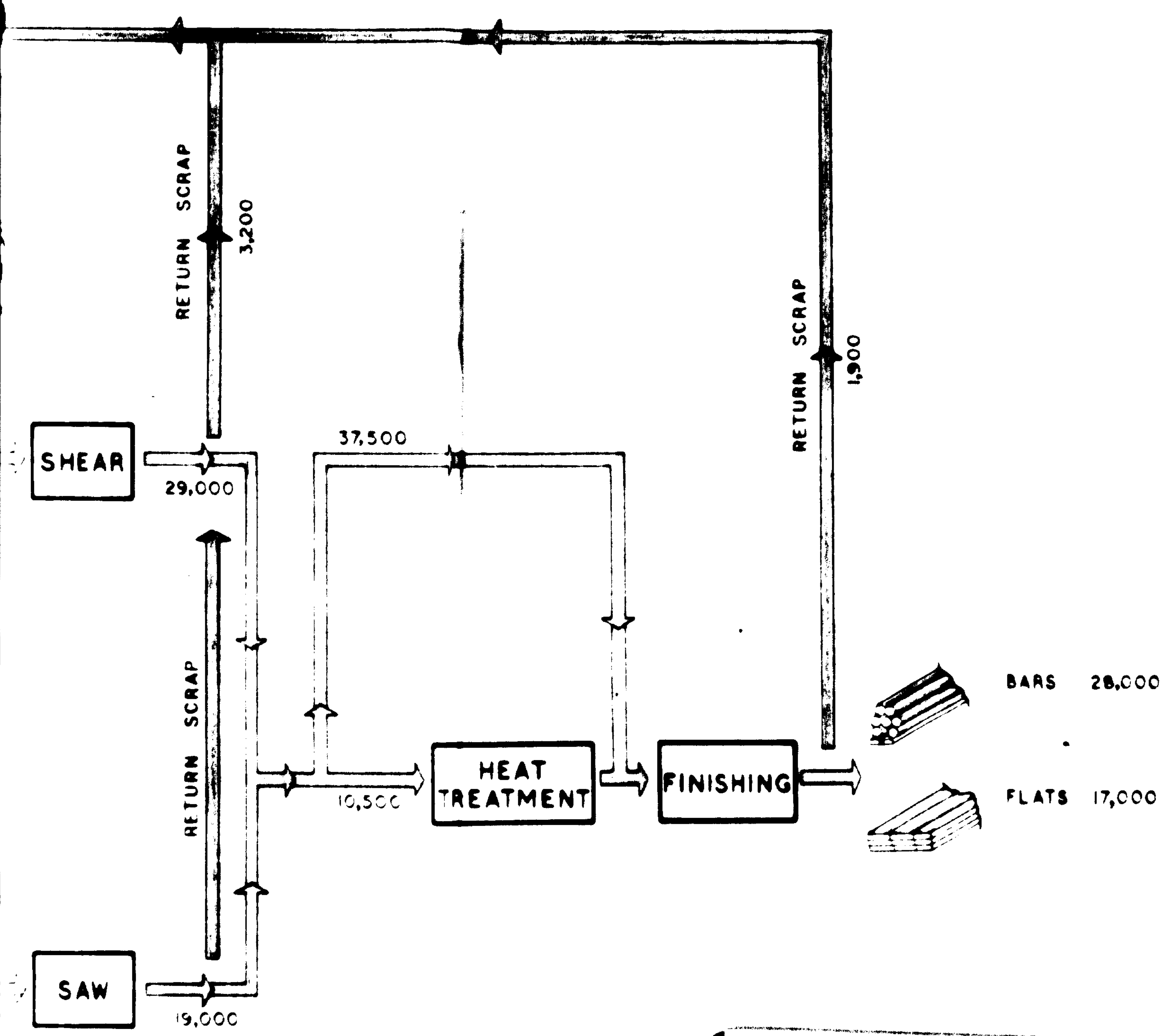
SECTION 2

LIST OF VOLUMES



SECTION 3

NOTE QUANTITIES ARE IN TONS / YEAR.



SECTION 4

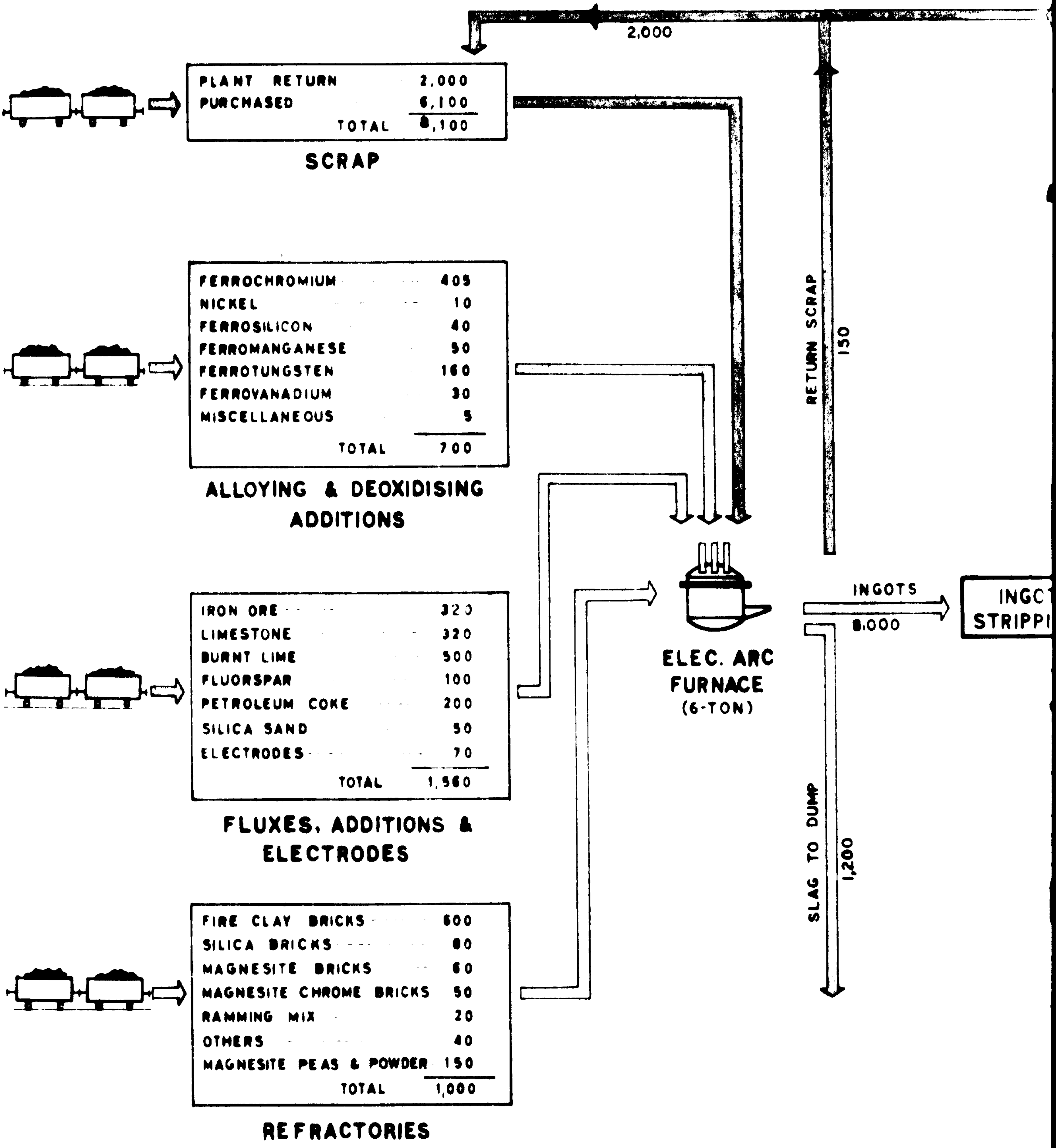
AR.

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT — FLOW SHEET - STAGE I

DRAWN		9.11.69	No. 5131 - V - 1
APPROVED	KSV	7.11.69	



PLANT RETURN	2,000
PURCHASED	6,100
TOTAL	8,100

SCRAP

FERROCHROMIUM	405
NICKEL	10
FERROSILICON	40
FERROMANGANESE	50
FERROTUNGSTEN	160
FERROVANADIUM	30
MISCELLANEOUS	5
TOTAL	700

ALLOYING & DEOXIDISING ADDITIONS

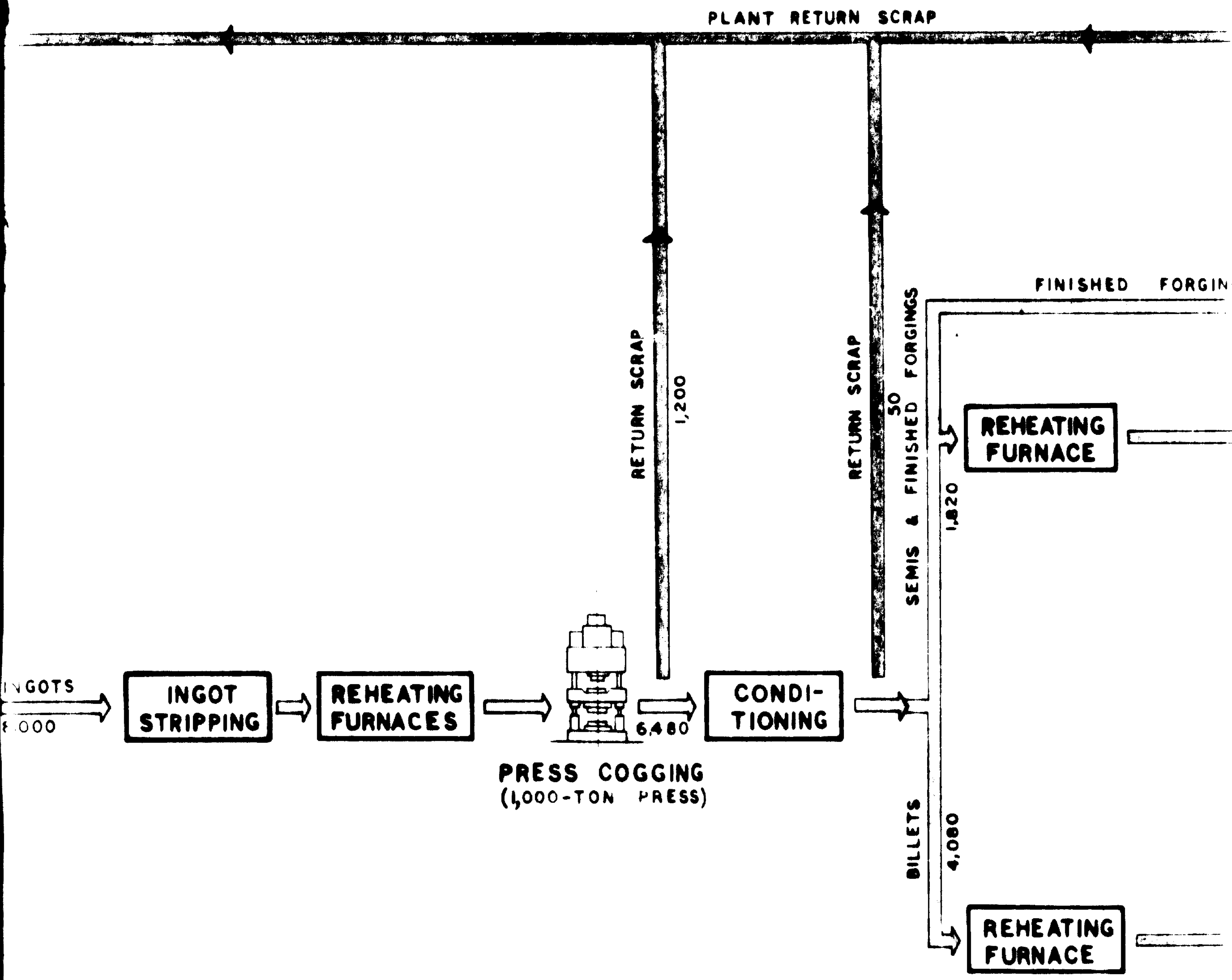
IRON ORE	320
LIMESTONE	320
BURNT LIME	500
FLUORSPAR	100
PETROLEUM COKE	200
SILICA SAND	50
ELECTRODES	70
TOTAL	1,560

FLUXES, ADDITIONS & ELECTRODES

FIRE CLAY BRICKS	600
SILICA BRICKS	80
MAGNESITE BRICKS	60
MAGNESITE CHROME BRICKS	50
RAMMING MIX	20
OTHERS	40
MAGNESITE PEAS & POWDER	150
TOTAL	1,000

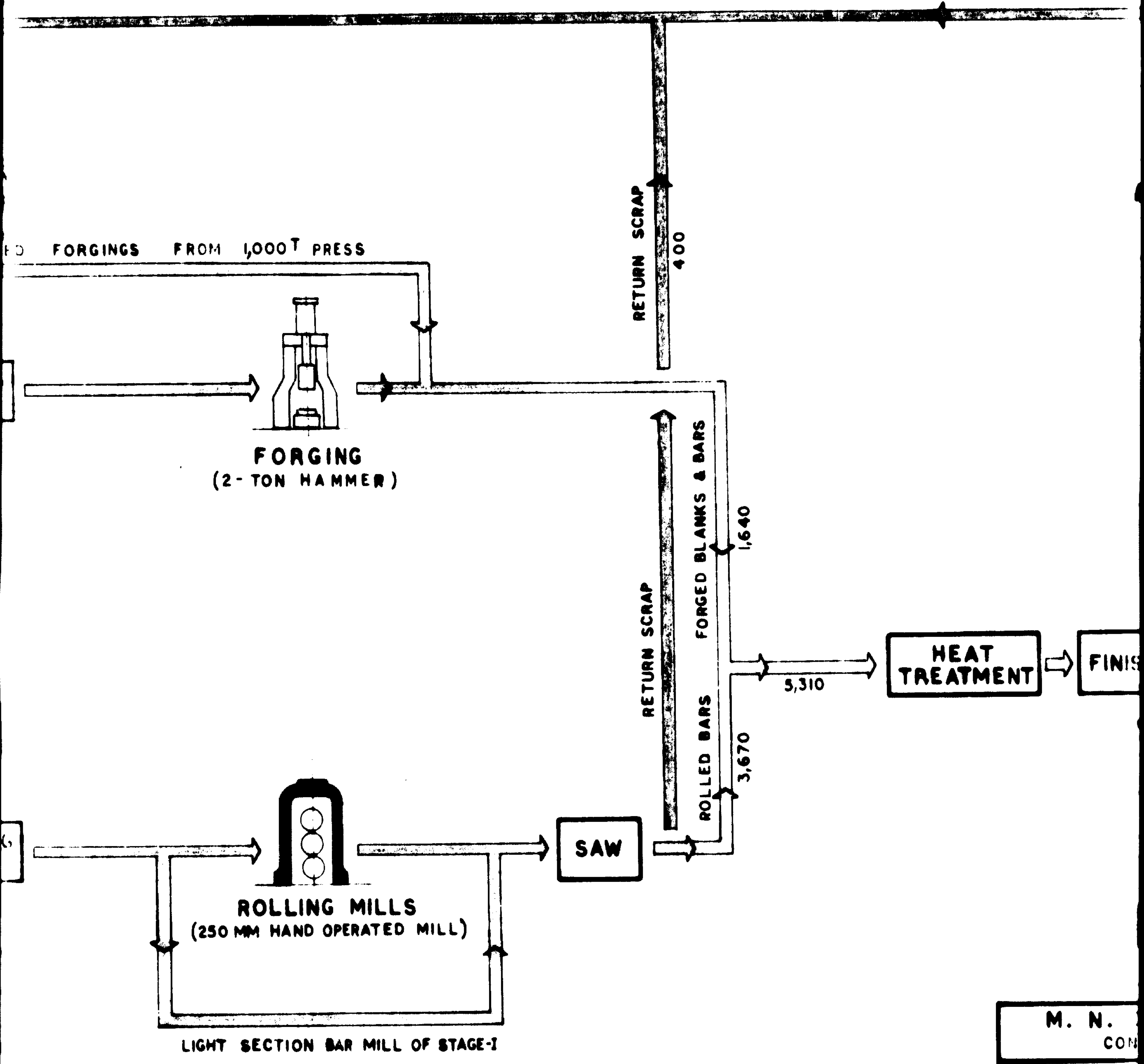
REFRACTORIES

SECTION 1



NOTE: QUANTITIES ARE IN TONS/YEAR.

SECTION 2



SECTION 3

M. N.
CON

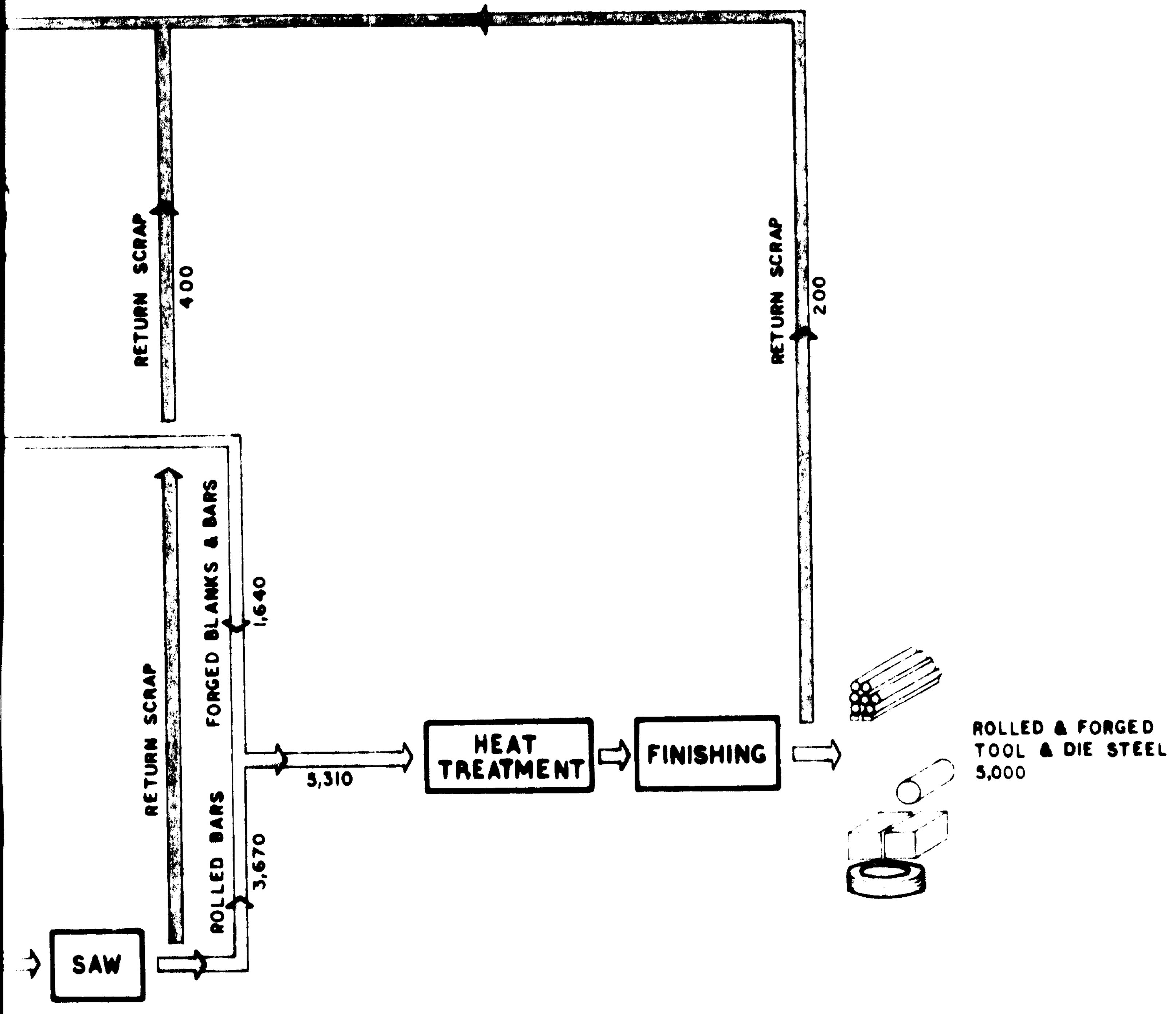
FOR:

INDUSTR

IRAN FERR
ALLOY

DRAWN

APPROVED



SECTION 4

M. N. DASTUR & Co. PRIVATE LTD CONSULTING ENGINEERS, CALCUTTA			
FOR: UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION			
IRAN FERROALLOYS & ALLOY STEELS PROJECTS ALLOY STEELS PLANT—FLOW SHEET-STAGE II			
DRAWN		4.12.69	**No. 5131 - V - 2**
APPROVED		15.12.69	

2 - Summary and recommendations (cont'd)

Blooming mill

71. The cast ingots will be cogged down to blooms or billets in a 700 mm 2-high reversing blooming mill. Initially the mill need to operate only in two 8-hr shifts, but it has in-built capacity to roll about 150,000 tons of ingots/year on 3-shift per day basis.

Conditioning

72. Blooms and billets rolled in the blooming mill will be slow-cooled where required and extensively conditioned by hand scarfing, chipping and grinding. Conditioned billets will be heated in walking beam reheating furnaces for further rolling into finished sections.

Bar mills

73. Two bar mills, one for medium and light sections and the other for heavy sections, are provided for stage I. The medium and light section bar mill consists of a roughing train of two 450 mm 3-high stands; and a finishing mill train of two 380 mm 3-high stands; two 300 mm 3-high stands; and one 280 mm 2-high stand. The mill will operate in three shifts to give an output of 29,000 tons of rolled bars and flats.

74. The heavy bar mill will consist of a 550 mm 3-high, 3-stand mill. This will operate 2-shifts to roll 19,000 tons of heavy sections.

Heat-treatment and finishing

75. About 80 per cent of the total output will be despatched to consumers in the as-rolled condition for forging, machining and fabrication into finished products. The remainder will be supplied in normalised, annealed or heat-treated condition. Appropriate normalising, annealing and heat-treatment equipment are provided.

Other facilities

76. Adequate facilities for storage of raw materials, finished products, spare parts and consumables are provided. A well-equipped laboratory for control purposes and suitable repair shop facilities are also included.

Stage II facilities

77. In stage II, the additional facilities will include a 6-ton arc furnace for steelmaking, one 1000-ton hydraulic press, one 2-ton pneumatic hammer, batch type furnaces for reheating, bogie-hearth furnace for pre-heating and annealing furnaces. One 250 mm 3-high, 4-stand, slow speed, hand operated rolling mill will also be installed.

Site selection

78. Major locational factors considered were freight charges for raw material assembly and finished product distribution, availability of land, water, power, transport facilities, skilled labour etc. The total freight charges

for raw materials assembly and product distribution for the four locations considered - Tabriz, Isfahan, Arak and Ahwaz - are estimated as follows:

Table 2-19

TOTAL FREIGHT FOR RAW MATERIALS ASSEMBLY AND PRODUCT DISTRIBUTION

		Tabriz $/yr	Isfahan $/yr	Arak $/yr	Ahwaz $/yr
Raw materials assembly	..	1 209 150	856 220	476 040	188 930
Finished product distribution	..	540 150	589 150	318 050	690 050
Total	..	1 749 300	1 445 370	794 090	878 980

Ahwaz site suggested

79. Arak and Ahwaz are considered suitable sites for the location of the plant. Ahwaz is better placed than Arak in respect of assured water and stable power supply. Also, Ahwaz will have natural gas whereas Arak is not presently included in this scheme. Further, Ahwaz being near a major port has the advantage of lower transport cost for imported scrap and also for export of alloy steels. The subsequent discussion is based on the Ahwaz site.

Plant layout

80. The plant general layout has been designed with a view to ensure smooth flow of materials; compact and rational arrangement of the production departments, repair shops,

utility and energy networks and auxiliary facilities; and provision for future expansion and diversification. The design provides for introduction of recent technologies such as sponge iron charge for arc furnaces, continuous casting, vacuum degassing, in-line scarfer etc, at a later date when required.

81. The initial plant capacity of 75,000 ingot tons can be doubled with low additional investment by taking advantage of the in-built capacity of the blooming mill (which can roll 150,000 tons of ingots) and certain other facilities. For further expansion, large area is provided adjoining the present complex where a new steelmaking and flat product rolling mill complex can be installed.

Construction schedule

82. It is expected that stage I will be completed in 3½ years from the time the 'green signal' is given. Stage II construction will be taken up one year after commissioning of stage I facilities and completed 2 years thereafter.

Manpower and production cost estimates

Manpower estimate

83. The total manpower requirements for the plant are estimated at 1,270 for stage I and 250 for stage II.

TABLE OF CONTENTS - VOLUME I

1 - INTRODUCTION

2 - SUMMARY AND RECOMMENDATIONS

This includes provision for weekly offs, leave and absenteeism.

Manpower cost

84. Estimated manpower has been suitably classified under categories, and for each category, the average salary has been assumed based on the rates prevailing in Iran. Further, an amount of 50 per cent of the total monthly salary bill, has been provided to cover fringe benefits. The total monthly wage bill (including fringe benefits) for rated production for stage I and stage II are estimated at $ 233,800 and $ 44,000 respectively.

Plant organization and know-how requirements

Organization structure

85. Some of the special features which will have to be given due consideration in the management of this alloy steel plant are production planning, inspection and quality control, research and development, training, sales services. Keeping in view these requirements, a suitable organization structure for the plant has been broadly indicated.

Training

86. This will be the first alloy steel plant in Iran. The production and quality requirements call for experienced and skilled operating and maintenance personnel. It is vital that an effective training programme is initiated, well in advance to ensure that trained personnel would

be available 3 to 4 months before the respective units are ready to be commissioned. While a number of engineers and operatives could be trained in Iran itself in various engineering establishments, it is proposed to train 50 men in alloy steel plants abroad.

Know-how requirements

87. Alloy steel production requires specialised techniques and it is necessary to secure such know-how from foreign collaborators. The know-how arrangement should cover training of Iranian personnel in the collaborator's works, deploying foreign specialists for commissioning and assistance in initial operation of the plant, advice on production of different qualities of steel and supply of related technical documents.

Production cost

88. Based on the current prices of major raw materials and supplies, production costs per ton are estimated for fourteen typical grades of alloy steels as given in Table 2-20.

2 - Summary and recommendations (cont'd)

Table 2-20

ESTIMATE OF PRODUCTION COST

Stage I

Typical steel grade	Production cost per ton Rolled $	 Heat treated $
Carbon constructional (En-8)	261	279
Low alloy constructional (En-19)	290	308
Medium alloy constructional (En-25)	426	444
Case hardening constructional*(En-36)	427	445
High carbon spring steel (En-44)	263	-
Silico-manganese spring (En-45)	270	-
Chrome-vanadium spring (En-47)	291	-
Free cutting steel (En-1A)	261	-

Stage II

Typical steel grade	Hand mill rolled or forged $	Bar mill rolled $
High speed steel (AISI-T1)	2 744	
Hot die steel (AISI-H21)	1 592	
Cold work die steel (AISI-D3)	758	
Low alloy tool steel (AISI-S1)	562	542
Die blocks (1.45 Ni, 0.65 Cr)	564	
Carbon tool steels (AISI-W1)	338	319

Project capital cost

89. The plant capital costs for stages I and II are summarised in Table 2-21.

2 - Summary and recommendations (cont'd)

Table 2-21

PROJECT CAPITAL COST - STAGES I AND II
(Thousand dollars)

	Estimated cost		
	Stage I	Stage II	Stages I and II combined
A. Land	550	-	550
B. Civil and structural work	11 480	1 300	12 780
C. Plant and equipment	17 860	2 200	20 060
D. Other costs			
1. Spares	900	110	1 010
2. Freight and insurance	1 690	220	1 910
3. Port charges and inland transport	600	70	670
4. Equipment erection	2 690	330	3 020
E. Engineering, supervision and construction administration	4 230	520	4 750
F. Contingencies	2 000	250	2 250
Total plant cost	42 000	5 000	47 000
G. Additional funds (for preliminary expenses, start-up, training, know-how and interest during construction	4 000	1 000	5 000
TOTAL PROJECT COST	46 000	6 000	52 000
Foreign currency needed	26 500	2 800	29 300

Financial analysis

Phased programme

90. As given in Fig. V-1 the rated capacity of the plant is expected to be realised in a period of 8½ years from the start of construction. Stage I facilities are scheduled to be completed and commissioned in 3½ years; and stage II construction is proposed to

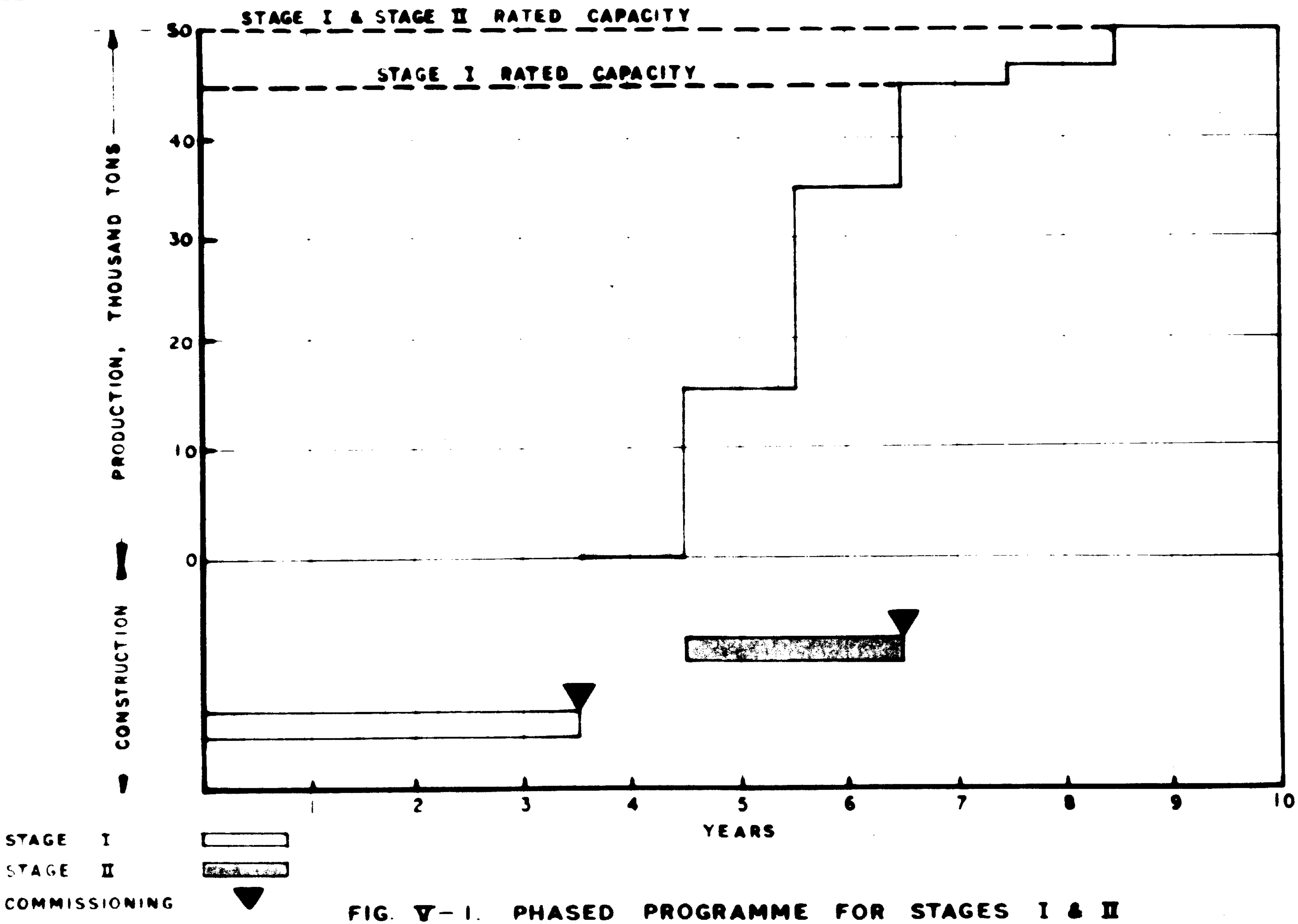


FIG. V-1. PHASED PROGRAMME FOR STAGES I & II

2 - Summary and recommendations (cont'd)

begin one year after commissioning stage I facilities and completed in two years' time.

Financing pattern

91. The financing of total project cost has been envisaged as given in Table 2-22 below:

Table 2-22

FINANCING PATTERN OF TOTAL PROJECT COST
(Thousand dollars)

	1st year	2nd year	3rd year	4th year (first six months)	Total
Stage I					
Equity capital	6 000	12 000	5 000	-	23 000
Loan amount	-	-	17 000	3 800	20 800
Interest on loan during construction at 8%	-	-	-	2 200	2 200
Total	6 000	12 000	22 000	6 000	46 000

	5th year	6th year	7th year	Total	
Stage II					
Loan amount	-	2 400	3 000	5 400	
Interest during construction	-	-	600	600	
Total	-	2 400	3 600	6 000	6 000
				TOTAL	52 000

Working capital requirements

92. Working capital requirement is estimated at $ 4.2 million which is equal to about three months' total manufacturing expenses.

2 - Summary and recommendations (cont'd)

Selling prices

93. The prevailing selling prices of imported alloy steels and the selling prices assumed for the financial analysis in this study are given in Table 2-23 below:

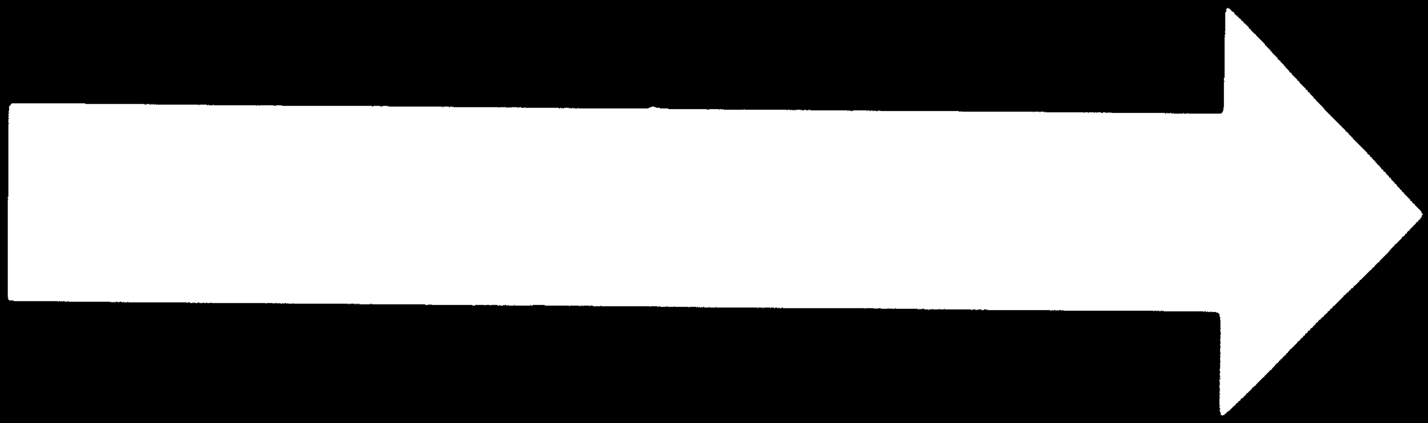
Table 2-23

SELLING PRICES FOR PROPOSED PLANT AND PREVAILING
ALLOY STEEL PRICES IN IRAN

	Iran prices $/ton	Assumed selling prices a/ $/ton
Stage I		
Constructional		
Carbon (En-8)	600	400
Low alloy (En-19)	1 000	550
Medium alloy (En-25)	1 000	700
Case hardening (En-36B).. ..	1 000	700
Free cutting (En-1A)	-	400
Spring steel		
High carbon (En-44)	-	450
Silico-manganese (En-45) ..	1 350	500
Chrome-vanadium (En-47).. ..	-	550
Stage II		
Alloy tool and die steel		
High speed steel (AISI-T1) ..	5 500	4 000
Hot die steel (AISI-H21) ..	3 500	2 500
Coldwork die steel (AISI-D3) ..	1 860	1 500
Low alloy tool steel (AISI-S1) ..	1 500	1 000
Die blocks (1.45% Ni, 0.65% Cr)..	-	900
Carbon tool steel (AISI-W1) ..	930	700

a/ Ex-works Ahwaz

G-388



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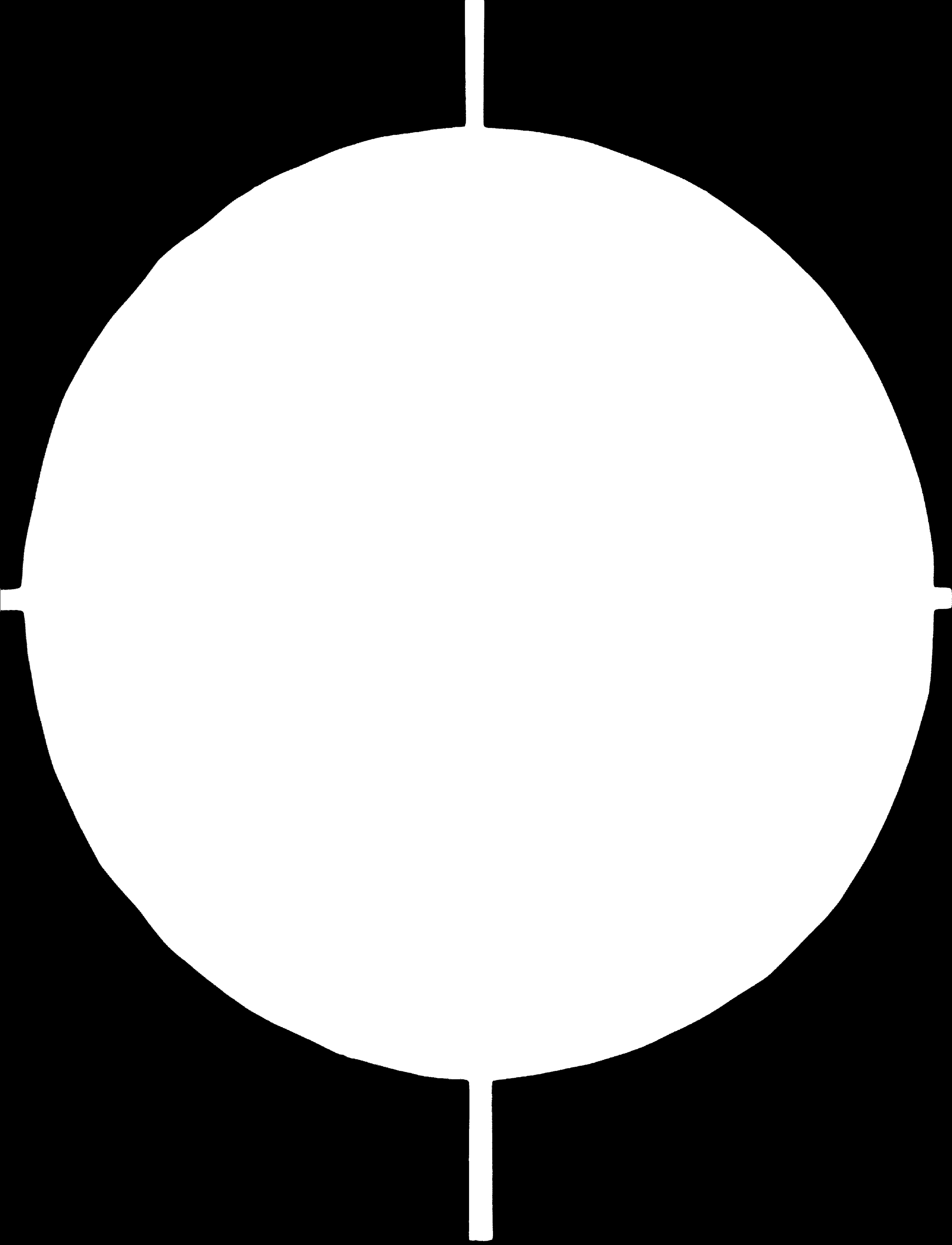

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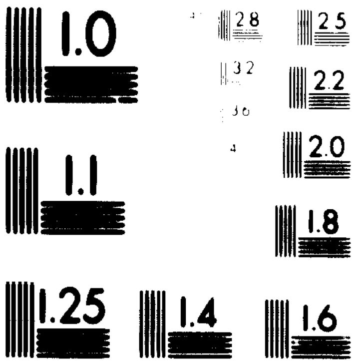

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

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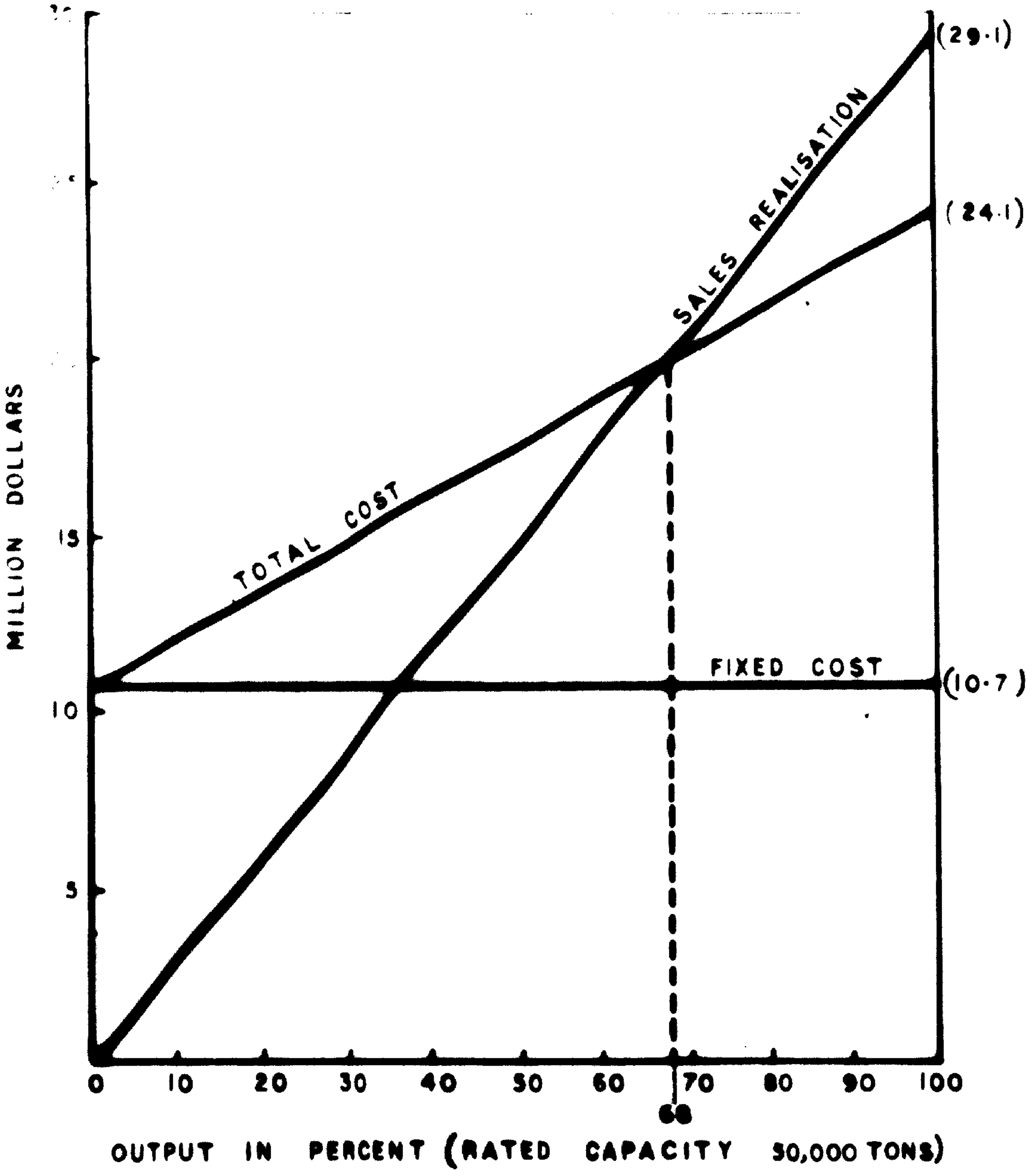


FIG. V-2. BREAK-EVEN CHART

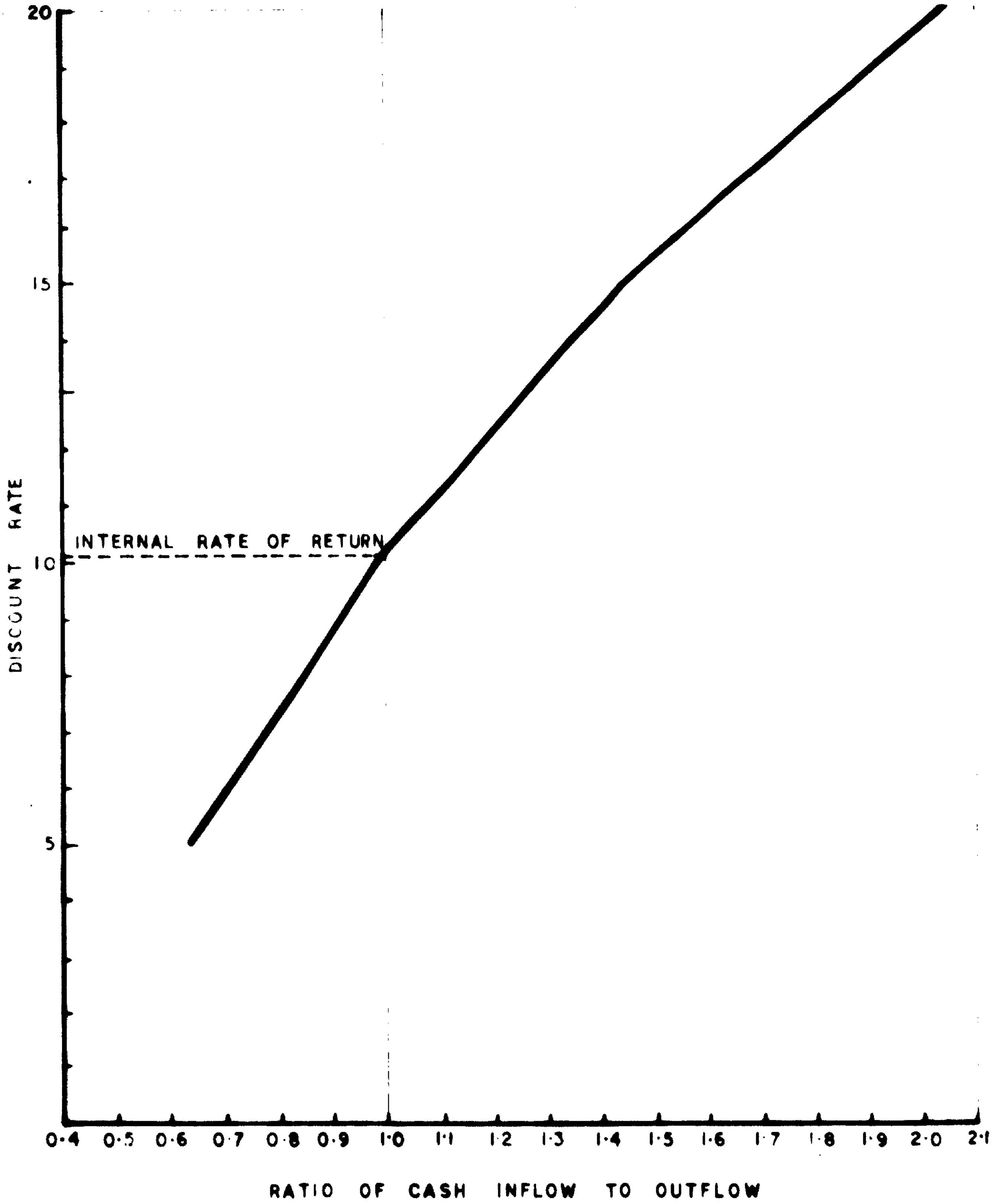


FIG. V-3. INTERPOLATION CHART FOR INTERNAL RATE OF RETURN

2 - Summary and recommendations (cont'd)

Table 2-27

INTERNAL RATE OF RETURN

	Fixed investment million $	Working capital million $	Present value				Internal rate of return(see interpolation chart)
			5%	10%	15%	20%	10%
A. Cash outflow							
Construction period							
Year I	6.0		7.11	8.39	9.81	11.41	8.39
II	12.0		13.56	15.25	17.06	19.01	15.25
III	22.0		23.68	25.41	27.80	29.04	25.41
IV (six months)	3.8		3.90	3.99	4.09	4.18	3.99
Operation period (zero point)							
Year I	-	2.0	2.00	2.00	2.00	2.00	2.00
II	2.4	1.0	3.24	3.09	2.96	2.83	3.09
III	3.0	1.2	3.81	3.47	3.18	2.91	3.47
Total (A)			57.30	61.60	66.30	71.38	61.60

	Operating adjusted cash surplus million $ a/	5%	10%	15%	20%	10%
B. Cash inflow						
Year I	(-) 0.29	(-)0.28	(-)0.26	(-)0.25	(-)0.24	(-)0.26
II	5.93	5.38	4.90	4.48	4.12	4.90
III	9.25	8.00	6.95	6.09	5.36	6.95
IV	9.65	7.94	6.59	5.52	4.65	6.59
V	11.69	9.16	7.26	5.81	4.70	7.26
VI	9.85	7.35	5.56	4.26	3.30	5.56
VII	9.77	6.95	5.01	3.67	2.73	5.01
VIII	9.69	6.56	4.53	3.17	2.26	4.53
IX	9.61	6.20	4.07	2.73	1.86	4.07
X	9.53	5.85	3.68	2.35	1.54	3.68
XI	9.31	5.45	3.26	2.00	1.26	3.26
XII	9.23	5.14	2.94	1.73	1.03	2.94
XIII	8.57	4.54	2.49	1.40	0.80	2.49
XIV	7.93	4.00	2.09	1.12	0.62	2.09
XV	17.12	8.23	4.09	2.11	1.11	4.09
Total (B)		90.47	63.16	46.19	35.10	63.16
Ratios (A/B)		0.63	0.98	1.44	2.03	

a/ From Table 34-7

2 - Summary and recommendations (cont'd)

Pay-back period

107. The pay-back period is estimated at 8.5 years on the traditional basis and at 11.3 years on discounted basis at 8 per cent per annum.

Savings in foreign exchange

108. The total foreign exchange required for the establishment of the project is estimated at $ 29.3 million. As against this, Iran will be self-sufficient to a fair extent in respect of its requirements of alloy steels. Besides, there will be a foreign exchange saving of about $ 0.73 million from the third year of operations rising to about $ 1.8 million in the 5th year of operation. From the 13th year of operation, the net savings rise to over $ 4 million as charges on account of depreciation and deferred charges have been almost fully recovered. The total savings in foreign exchange in the first 15 years of operation are estimated at about $ 28 million.

Import substitution

109. Expenses on import of materials (namely steel, ferro-alloys, electrodes, refractories, rolls etc) are estimated at $ 8.23 million. When imported scrap is substituted by local scrap/sponge iron and when some imported ferro-alloys (such as ferro-chrome, ferro-manganese and ferro-silicon are supplied from the proposed indigenous plant) the expenditure on

imported materials would decrease with corresponding increase in foreign exchange savings each year.

Rate of return of foreign exchange

110. The rate of return of foreign exchange as worked out in Table 2-26 amounts to about 10 per cent.

Social benefits to the national economy

111. Apart from the commercial gains, important strategic materials - alloy and special steels - will be available indigenously for development and defence needs. This in turn would accelerate the indigenous production of engineering goods, transport equipment, consumer durables etc. It would also help in the export of such engineering goods.

112. The establishment of the alloy steel plant would provide the impetus for the installation of various ancillary and auxiliary industries - both for feeding the plant with supplies and services as well as for processing the products and by-products. The plant would thus create direct employment and indirect employment for a large number of people. It would also contribute to government revenues year after year and by way of corporate taxes and other levies on materials and supplies.

2 - Summary and recommendations (cont'd)

Table 2-28

RATE OF RETURN OF FOREIGN EXCHANGE

(Thousand dollars)

	Cash outflows (capital expenditure)			Cash inflows (operating surplus)		
	Estimated for the period	Compounded/discounted at 10%	Compounded/discounted - 15%	Estimated a/ for the year	Discounted at 10%	Discounted at 15%
Construction period						
0 to 12 months	Nil					
13 to 24 months	Nil					
25 to 36 months	17 000	19 635	21 016			
37 to 42 months	3 800	3 990	4 085			
Year of operation						
I	Nil	-	-	968	880	842
II	300	248	227	2 259	1 866	1 708
III	1 900	1 427	1 250	2 905	2 182	1 911
IV				3 430	2 343	1 962
V				4 223	2 622	2 099
VI				4 223	2 382	1 824
VII				4 223	2 166	1 588
VIII				4 223	1 972	1 381
IX				4 223	1 791	1 199
X				4 223	1 630	1 043
XI				4 223	1 478	908
XII				4 223	1 347	790
XIII				4 223	1 225	688
XIV				4 223	1 111	595
XV				4 223	1 009	519
Total	23 000	25 300	26 578	56 015	26 004	19 057

a/ Including foreign exchange amount of depreciation, and deferred charges.

Computation of average rate of return:

Excess at lower trial rate (10%) = 26 004 - 25 300 = 704
Deficit at higher trial rate (15%) = 26 578 - 19 057 = 7 521

$$\text{Average rate of return} = 10 + 5 \left(\frac{704}{(704 + 7\,521)} \right) = \underline{10.43\%}$$

APPENDICES - VOLUME I

Appendix 1-1

TERMS OF REFERENCE

The Consultant shall prepare a Feasibility Study for Ferro-alloy and Special Alloy Steels manufacture in Iran comprising:

a) Ferro-chrome
b) Ferro-manganese
c) Ferro-silicon
d) Special Steels, Alloy and tool steels.

Separate plants or the possibility of including two or more products in a single complex, shall be given consideration.

The subject Feasibility Study shall include but not necessarily be limited to:

a) Raw materials

Chrome ore, manganese ore, quartz, steel scrap, reductant and flux resources of Iran shall be generally reviewed and based on available information, suitable sources of raw materials for producing ferro-alloys and special alloy steels shall be indicated. Further work with regard to proving and developing of raw material sources shall be suggested.

b) Selection of process and plant capacity

Different processes of making ferro-alloys shall be reviewed and suitable processes suggested for the required grade. Based on probable demand for ferro-manganese, ferro-silicon, ferro-chrome and special alloy steels in Iran and the possibility of exporting ferro-chrome, suitable production capacities shall be determined. In appraising the demand for ferro-alloys, the proposed installation programme of the Isfahan steel plant and the probable additional steel capacities in future, shall be given due consideration.

Appendix 1-1 (continued)

c) Selection of sites

Suitable site/sites from a few alternative locations shall be indicated. In selecting the sites due consideration shall be given to availability of electric power, water, transport facilities and other pertinent factors.

d) Plant general layouts

General layouts for the plant indicating the relative disposition of production and ancillary facilities shall be prepared, with provision made for future expansion.

e) Major production facilities

Based on the selected process and recommended plant capacities, suitable production facilities shall be recommended. A list of major equipment shall be included.

f) Ancillary facilities

The requirements of ancillary facilities like transport, materials handling, maintenance shop, laboratory etc. shall be indicated.

g) Capital cost estimate

Preliminary engineering estimates of plant capital costs including production and ancillary facilities within the plant boundary shall be prepared.

h) Production cost estimate

Preliminary estimates of manpower requirements of the plants shall be made. Based on unit costs of raw materials, power, water, production cost estimates for ferro-alloys shall be developed. Based upon the landed cost of the corresponding imported ferro-alloy in Iran, the viability of producing these materials indigenously shall be broadly indicated.

Appendix 1-2

ITINERARY OF VISITS MADE BY CONSULTING ENGINEERS TO MINES, PLANTS AND POSSIBLE LOCATIONS IN IRAN (OUTSIDE TEHERAN)

Date (1969)	Visit	Accompanied by
24th July	Isfahan - steel plant site	-
28th July	Bandar Abbas - port	Mr Hamidi
29th July	Shaahin and Shahriar chromite mines	-do-
30th July	Ahwaz - Iranian Rolling Mills Company	-
30th July	Amir - chromite mines	Mr Hamidi
31st July	Faryab and Bandar Abbas - possible sites	-do-
31st July	Ahwaz - pipe plant	-
3rd August	Shahrokh - manganese ore mines, and Ghom - possible location	Mr Hamidi
7th August	Gaft chromite mines	-do-
8th August	Gaft chromite mines	-do-
	Azadvar - possible location	-do-
12th August	Ghasvin - quartzite deposit	-do-
13th August	Latian area - quartzite deposit	-do-
16th August	Ghom - possible locations	Mr Sohanaki
	Arak - machine building plant site	-do-
17th August	Arak - possible locations	-do-
18th August	Isfahan - steel plant site and possible locations	-do-
19th August	Ahwaz - pipe plant and Iranian Rolling Mills Company	-do-
20th August	Ahwaz - possible locations	
21st August	Khorramshahr, Abadan and Bandar Mashur	-do-
23rd August	Tabriz - Metallurgy and Engineering Company, plant site	-do-
24th August	Tabriz - possible locations	-do-

2 - Summary and recommendations (cont'd)

94. It is to be noted that the selling prices assumed are lower than present prices in the Iran market which are considered high. The main reason for such high prices is the very small current consumption with corresponding high expenses for selling, warehousing, credit arrangements etc.

95. The selling prices assumed for this plant, however, are higher than international prices because major raw materials such as scrap, ferro-alloys, refractories, electrodes, rolls etc will have to be imported initially.

96. According to the present structure of customs tariffs, the duties on mild steel range from $ 50 to $ 100 per ton for different categories, whereas the duties on the more valuable alloy steels are around $ 27 per ton. The selling prices of ordinary steels are high in Iran and this in turn also raises the prices of alloy steels (in spite of the lower customs duties).

Rationalisation of customs duties

97. When the new alloy steel plant goes into production the customs duty tariff would need to be rationalised. It is suggested that duties on imported low alloy steels (whose ci.f. values are under $ 300 per ton) be raised

Appendix 1-3

ACKNOWLEDGEMENT

The Consulting Engineers gratefully acknowledge the co-operation and help extended by all agencies and particularly the following in connection with the feasibility studies on the ferro-alloys and alloy-steel plants in Iran.

TEHERAN

1. UN Experts - Dr A. Nagaraja Rao
Dr R.A. Abuelhadj
Mr J. Semsch
Mr Bier
Mr Kavaguchi

2. Ministry of Economy - Dr M. Yeganegh
Dr J. Ashrafi
Dr J. Vafa
Mr K. Shirzad
Mr S. Shaheen
Mr H. Chafai
Mr C. Showgi
Mr Sultani
Mr M.H. Mohseni
Mr A. Sohanaki
Mr S. Rao
Mr Reza Assefi
Mr F. Khareghani
Mr G. Hamidi
Mr Montazar
Mr A. Sairafi
Mr F. Bazarghani
Mr H. Moadi
Dr Gannadian
Mr I. Moinzade

3. Plan Organisation - Mr N. Hakimi
Mr Noban
Mr Atafi
Mr Vahidi
Mr Simi

Appendix 1-3 (continued)

TEHERAN (continued)

4. Ministry of Water and Power - Mr Abul Fathi
Mr Kutchepur
Mr Parvizi
Mr Ghazi Noori
Mr D. Hariri
Mr Hadizad
Mr Pooya
Mr Hashami
Mr F.J. Bellevance

5. Industrial Development and Renovation Organisation of Iran - Mr Niazmand
Mr R. Badokshar

6. Arak Machine Building Plant - Mr DaCosta
Mr N. Satarawala

7. Metallurgy & Engineering Company (Tabriz Tractor Plant and Machine Tool Plant) - Mr H. Foulladioun

8. Iranian Aluminium Company - Mr M. Faily

9. Geological Survey of Iran - Mr Khadem
Dr J. Stocklin
Dr Williams
Dr G. Aletan
Mr Alipur

10. Metallurgical Company of Iran - Mr Reza Zand

Appendix 1-3 (continued)

TEHERAN (continued)

11. National Iranian Steel Company - Dr A.A. Sheibani
Mr K.H. Kutar
Mr Akbari
Mr Auslander
Mr Valkov
Dr Duinianinov
Mr Kozlov
Dr J. Mehta

12. National Iranian Oil Company - Mr Farkhan
Mr Shahadadi
Mr A. Aghdaye

13. National Iranian Gas Company - Mr M. Shirazi

14. National Petro Chemical Company - Dr Bahari

15. Directorate of Small Scale Industries and Industrial Estates - Dr Ansari
Dr Khosla

16. Industrial and Mining Development Bank of Iran - Mr F. Mahdavi
Mr Azarm

17. Bank Markazi - Dr Hamayam
Mr Ekhatani
Mr Farhang

18. Credit Bank - Dr K. Iravani

19. Rezai Brothers - Mr Mohammed Rezai
Mr Wakil
Mr Dabari

Appendix 1-3 (continued)

TEHERAN (continued)

20. Sangraoud Coal Mines - Dr Shabang
21. Foundry Malleable Company - Mr Noshervani
22. Pars Metal Company - Mr Pourghobady
23. Iranian Rolling Mills Company - Mr Ali Rezai
24. Khoshkeh & Fouland S.A. - Mr H. Khajeh Nouri
    Mr Khoshkeh
25. Keyanco Trading Company - Mr Laghaee
26. Seimens - Mr H. Abkai
    Mr Satayesh
    Mr Shade
27. English Electric Company - Mr Buckroyd
28. Sinkaf - Mr F.R. Kermani
29. Nassehi Rouschesh Sharkate - Mr Rouschesh
    Mr Nassehi
30. K. Barekat and Company - Mr K. Barekat
31. Savom Company Limited - Mr I. Passeur
32. Arya Shipping Company - Mr Kleine

BANDAR-ABBAS - FARYAB

33. Faryab Mining Company - Mr Ardeshi
    Mr M. Aliabadi
    Mr Ostovar
    Mr Fazelli
34. Commercial Bank - Mr Pezeshki
35. - Mr Yavari

Appendix 1-3 (continued)

AZADVAR

36. Qaft Chromite Mines - Mr. A. Faseli

37. Station Master
Asadvar Railway Station

QHOM

38. Town Municipality - Mr Saberi

39. Shahrok Mining Company - Mr M. Athari

40. Town Works Department - Mr. Lajevardisadeh

41. Town Water Supply - Mr H. Ghofrani
Mr Mishoksai

42. Baktar Textile Mill - Mr Rasakpur

ARAK

43. Machine Building Plant - Mr Alavi

44. Lowshen and Company Ltd - Mr Safai

ISFAHAN

45. Arayamehr Steel Company - Mr Sheibani
Mr Mantashi
Mr Movahedi
Mr Tulu
Mr Shahin
Mr Babai
Mr Mikhalits
Mr Romanov
Mr Karbosium
Mr Eghbali
Chief Chemist

Appendix 1-3 (continued)

AHWAZ

46. Iranian Rolling Mills Company - Mr Sethmacher
Mr A. Hamiasdeh
Mr Abbasi

47. Ahwas Pipe Mill Company - Mr Nikakh
Mr Emam
Mr Adibpour
Mr Ali Abedi

48. Ministry of Economy - Mr Sorkhdini

49. Water Supply Department - Director

KHORRAMSHAHR

50. Town Municipality - Chairman

51. Water Supply Department - Mr Bagdsariar
Mr Naraghi

52. Khorramshahr Port - Mr Ansari

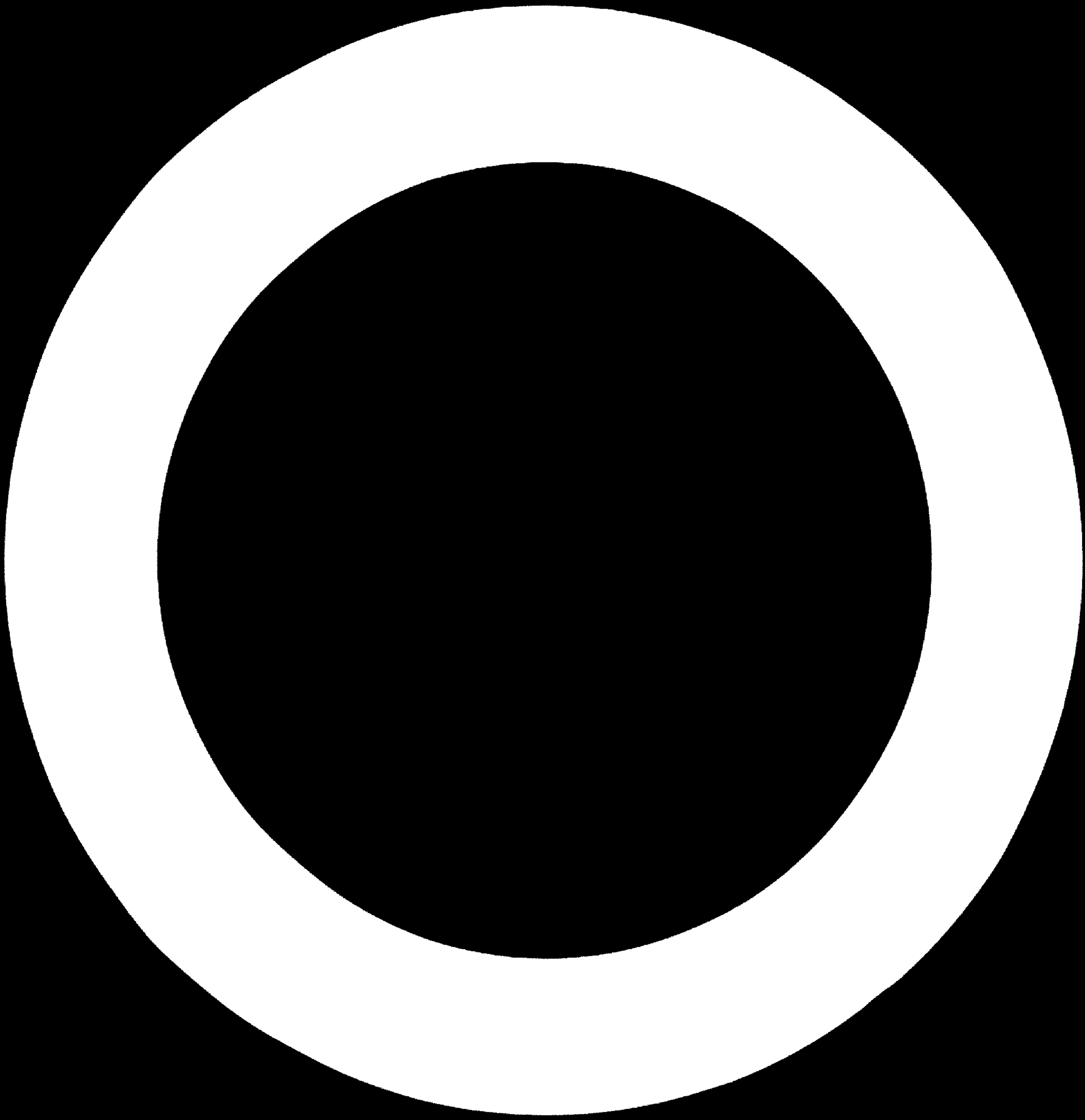
53. Khorramshahr International Hotel - Mr Safai

54. NIOC Petro Chemicals, Bandar Mahshoor - Mr Hassani

TABRIZ

55. Metallurgy & Engineering Company Ltd. - Mr Iravani
Mr Pooya

56. Monaghah and Company - Site Staff



FEASIBILITY REPORT
TO
THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
ON
FERRO-ALLOY PLANTS AND ALLOY STEEL PLANT
FOR
THE MINISTRY OF ECONOMY, IMPERIAL GOVERNMENT OF IRAN

01602
(2 of 5)

VOLUME II
RAW MATERIALS AND MARKET FOR FERRO-ALLOYS AND ALLOY STEELS

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LIST OF VOLUMES

ABSTRACT
(Vol II)

Ferro-alloy raw materials and markets

Till recently no detailed exploration of minerals for ferro-alloy manufacture had been undertaken in Iran. The available data from the existing mines indicate that the chromite deposits of Faryab could adequately sustain a ferro-chrome plant, while the Lachoulleh deposits could meet the quartzite requirement of a ferro-silicon plant. The manganese ore required for production of ferro-manganese would have to be imported till such time as the suitability and adequacy of local ores are established and the deposits developed. The reductants required for manufacture of ferro-alloys - coke, charcoal and woodchips - are locally available. The availability of suitable quality limestone is assured in the Isfahan area. Prospecting work is needed in Ahwaz and Faryab areas to identify suitable sources of limestone and quartzite, if the ferro-alloy and alloy steel plants are to be located in these regions.

The ferro-chrome plant would have to be export-oriented as till 1982 the domestic requirements would be negligible. However, indigenous ferro-silicon and ferro-manganese demands from 1977 onwards justify the installation of optimum-sized production units.

There has been a continuous growth of world ferro-alloy demand and also a constant increase in international trade in ferro-alloys. These trends are expected to continue. The East European countries, Iran's RCD partners and UK are considered to be possible markets for ferro-silicon and ferro-manganese. For ferro-chrome, the potential market could also include South East Asia, the Far East and Oceania.

Alloy steel making materials and markets

The main material - steel scrap - is expected to be in short supply and the bulk of the requirements for the new plant would initially have to be imported. Small quantities of alloying additions, fluorspar, graphite electrodes etc would also have to be imported.

The estimated demand for alloy and special steels (about 76,000 tons by 1977) would warrant the setting up of a good sized plant in Iran.

to 30 per cent (against this present duties on ordinary steel are as much as 30 per cent to 60 per cent) and duties on high alloy steels (c.i.f. values over $ 300) to 20 per cent.

98. Protection of this order is required to enable the new plant to sell its products in the Iranian market in the initial years of operation.

Estimate of sales receipt

99. Based on the proposed product-mix and the estimated selling prices, the total sales receipts for stage I and stage II are worked out in Table 2-24.

Profit and loss

100. The statement of estimated profit and loss after tax on a period of 15 years' plant operation is given in Table 2-25. The annual average net profit after tax is estimated at about $ 3.5 million which is equivalent to about 6.5 per cent return on the initial capital investment of $ 52 million or about 15 per cent return on the equity capital of $ 23 million.

Taxation

101. Under the Inland Revenue Act, 1967, the proposed plant is likely to get substantial tax exemptions. It is assumed that profits during the first 5 years of operation will be exempted from tax and from 6th year onwards, an adhoc tax rate of 35 per cent of the total income from the project has been assumed after taking into account various exemptions.

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EXPLANATION OF SYMBOLS

Three dots (...) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A blank space ( ) in a table means that the item is not applicable.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A space is used to distinguish thousands and millions (1 346 849).

A full stop (.) is used to indicate decimals.

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954.

An asterisk (*) is used to indicate figures partially or wholly estimated.

Use of a hyphen (-) between dates representing years, e.g. 1960-1964, normally signifies an annual average for the calendar years involved, including the beginning and end years. 'To' between the years indicates the full period, e.g. 1960 to 1964 means 1960 to 1964, inclusive.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

3 - RAW MATERIALS FOR FERRO-ALLOYS

This chapter examines the availability and suitability of raw materials in Iran for the manufacture of ferro-chrome, ferro-manganese and ferro-silicon. The review is based on available information, data collected during visits to the different mines, and discussions held with officials at Teheran and at mine sites.

The major raw materials required for production of the proposed ferro-alloys are chromite, manganese ore, quartz, coke, limestone, dolomite and electrode paste.

Specifications

Specifications of raw materials used for ferro-alloys production vary from country to country depending upon the local availability. The materials however should generally conform to the major chemical and physical characteristics indicated in Table 3-1. For efficient operation of electric smelting furnaces the proportion of fines (generally below 5 mm) should be minimum and, therefore, the physical characteristics of the ore should be such that excessive fines are not generated due to decrepitation in the furnace.

3 - Raw materials for ferro-alloys (cont'd)

Table 3-1

MAJOR CHARACTERISTICS OF RAW MATERIALS

	Physical	Chemical	
Chromite ore	hard and lumpy	Cr_2O_3 Cr/Fe	48% and above 2.5:1
Manganese ore	hard	Mn Mn/Fe	46% (minimum) 7:1
Limestone	non-crystalline	CaO SiO_2	48% less than 6%
Quartzites	hard and dense	SiO_2	96% (minimum)

Status of mining industry

In Iran, till recently no systematic appraisal of the mineral deposits (excepting petroleum) has been carried out to arrive at realistic estimates of the reserves and to assess their quality. The production of ores has been export-oriented, as for instance chromite and manganese ores which have been mined exclusively for export. Since 1962, however, with the creation of the Geological Survey of Iran, efforts are being made to assess and evaluate the mineral deposits.

Even in respect of limestone and quartzites, little work has been done in the past. It is only recently that the National Iranian Steel Company is carrying out detailed assessment of the deposits of limestone and quartzites around Isfahan to meet the requirements of the steel plant.

Likewise, the coal deposits in the Kerman area are also being explored to determine their suitability for conversion into coke principally to meet the requirements of the Isfahan steel plant. It is assumed that adequate quantities of coke will be available for ferro-alloy manufacture.

Chromite deposits

Chrome ore occurs in various parts of Iran but the notable occurrences are in the northern and southern parts of the country (Drawing No. 5131-II-1).

Geology

The chromite deposits in Iran are believed to have been formed as a result of magmatic segregations in ultrabasic rocks such as dunite, peridotite, pyroxenite, and very rarely gabbro.

Chromite is predominantly associated with serpentine in the ultrabasic rock formations stretching from north to south in a crescentic manner. The serpentines show signs of alteration and at places show effects of tectonic movements.

In the northern deposits, chromites occur in lenticular form but in the southern deposits, the occurrences are tabular as also sometimes lenticular.

Chromite is sometimes associated with kamererite, uvarovite, stitchite and fuchsite. In the southern deposits the chromites are associated with magnesite which occur as bands within the chromite body, as well as in the form of small crystals in vug-like fissures in the chromite.

Northern deposits

The northern group of workings extend from the north-west of the town of Sabzevar to the south of Meshod, the headquarters of Khorasan province. The various deposits occurring at Miandast, Firuzabad, Froumad, Sudhkar, Shurab, Shuriab, Fariman and Mirmahmud have been exploited in varying degree from time to time in the past, but the Gaft mines have been in production since 1954.

Gaft mines

The Gaft mines are located 80 km west of Sabzevar town, and about 20 km from the Sankhast railway station on Meshed-Teheran railway line.

The ore body which covers an area of more than 2,000 sq m is lenticular in shape and pitch at an angle of 45°. On the basis of the present workings, the length of the ore body varies from 38 m to 53 m with width ranging from 15 m to 25 m, and average thickness of about 45 m.

On the basis of data obtained from tunnels and cross-cuts, it is estimated that the reserves of Gaft deposit would be between 150,000 tons to 250,000 tons. It is reported that the possible reserves of other deposits in the area may

2 - Summary and recommendations (cont'd)

Table 2-24

ESTIMATED SALES RECEIPT

	Quantity Tons/year	Selling price $/ton	Total value '000 $
A. Stage I			
Constructional			
Carbon (En-8)	8 000	400	3 200
Low alloy (En-19)	8 000	550	4 400
Medium alloy (En-25)	2 000	700	1 400
Case hardening (En-36B)	5 000	700	3 500
Free cutting (En-1A)	2 000	400	800
Spring steel			
High carbon (En-44)	5 000.	450	2 250
Silico-Mn (En-45)	12 000	500	6 000
Chrome-V (En-47)	3 000	550	1 650
Total	45 000		23 200
B. Stage II			
High speed steel (AISI-T1)	200	4 000	800
Hot die steel (AISI-H21)	300	2 500	750
Cold work die steel (AISI-D3)	1 000	1 500	1 500
Low alloy tool steel (AISI-S1)	1 000	1 000	1 000
Die blocks (1.45% Ni, 0.45% Cr)	500	900	450
Carbon tool steel	2 000	700	1 400
Total	5 000		5 900
Total (A + B)	50 000		29 100

Cash flow

102. From Table 2-26, it will be noted that after repayment of long-term loan, there is a cumulative net surplus of

be of the order of 1,000,000 tons, though no accurate information is available in this respect.

Ore characteristics

The chromite in these mines is dark coloured, consisting of hard lumpy and soft types. The soft type occurring in a disseminated form is found to occupy the zone between the hard lumpy types. The chromite is often spotted, banded or irregularly mixed with serpentine. At times, a variety locally known as 'leopard-type' is found to occur in which the chromite grains are haphazardly mixed with the serpentine mass.

It is reported that the northern deposits are characterised by variable grades in close proximity to one another. The quality of the ore exported from the Gaft mines is on an average less than 47 per cent Cr_2O_3 with Cr/Fe ratio of 3:1. These ores are exported as refractory grade.

Concentration

An earlier attempt was made by Kanira Mining Company operating in the area of Sabsevar to upgrade ore assaying under 40 per cent Cr_2O_3. It is reported that the test results indicated the possibility of upgrading the ore to 48 per cent Cr_2O_3 by means of crushing and jigging.

Laboratory scale beneficiation tests were carried out on the ores from Gaft mines by the Geological Survey of Iran and the results of the tests are discussed below. The chemical analysis of the head sample of the ore tested was 46.62 per cent Cr_2O_3 and 11.28 per cent Fe. The sample was crushed in a jaw crusher to minus 3/8 in and it was found that the minus 10 mesh fraction accounting for 67 per cent of the total weight contained about 70 per cent of chromium.

The crushed ore was screened into four fractions by gravity methods and each fraction was separately subjected to jigging and tabling. It was found that the total recovery after jigging and tabling was 84.9 per cent with the concentrate assaying over 53.3 per cent Cr_2O_3 and the tailings assaying 30.4 per cent Cr_2O_3. But in the case of only jigging the recovery was 79.1 per cent with the concentrate assaying 53.3 per cent Cr_2O_3 and the tailings assaying 34.4 per cent Cr_2O_3. The screen analysis of the concentrate shows that almost all of the chromite concentrate was minus 10 mesh.

Mining

In the past some quantity of chromite was mined from the Gaft mines by open pit method. This was abandoned in view of the instability of the faces. At present, the ore body is followed by means of tunnels and cross-cuts and the mining is done by cut-and-fill method.

In the ore body three main tunnels, called Dabari, Vakiel and Watts, have been driven at 30 m vertical intervals, the top tunnel being 30 m below the top of the hill. One of the tunnels, the Watts tunnel, is at present being used for prospecting.

The ore is being mined by cut-and-fill stoping above Dabari and Vakiel tunnels from the hanging wall side. The broken ore is transferred by wheel barrows to ore passes and discharged through chutes to tubs. The fill rock is mined by open cast method and transported by face loaders and wheel barrows.

The ores are carried in ore tubs by tram line through the Vakiel tunnel outside and are stockpiled. The ore is sorted out manually, the fines are stockpiled and waste thrown out.

The ore sorted at the pithead is transported by rear dump trucks of 7-ton and 12-ton capacity to the railway station at Sankhast and loaded manually into 20-ton and 50-ton wagons and transported to Khorramshahr port.

The mines operate for 300 days in a year. The daily production is 100 tons including fines. In 1968 the total production was 30,000 tons out of which 18,000 tons were of exportable grade.

Southern deposits

There are two groups of operating chromite mines in the southern part of the country. One of the groups is known as Abdasht mines comprising of Abdasht and Soughan mines situated at a distance of 300 km from the port of Bandar-Abbas. These mines are being operated by the Esfandegeh Mining Company.

The other group of mines comprising of Shariar, Amir, Shahine and Ebrahim mines is situated at a distance of 140 km from Bandar-Abbas. These mines are being operated by the Faryab Mining Company.

The Abdasht group of mines is in operation since 1950, while the Faryab group of mines started production between 1960 and 1962.

Abdasht mines

The two mines in the Abdasht group, Abdasht and Soughan, are separated by a distance of 15 km. The intervening area is occupied by a number of small deposits.

The Abdasht ore body has a length of about 400 m along the strike and the thickness varies from 5 m to 8 m. The chromite layer has an average dip of 48°. The layer has been explored up to a depth of 130 m and further exploration is in progress.

The Soughan ore body has a lateral extension of 120 m with an average thickness of 7 m. The dip of the layer is 80° and the layer has been explored up to a depth of 100 m and further exploration is in progress.

Ore characteristics

The ore is of both hard lumpy and friable varieties. A characteristic feature of the ore is the occurrence of magnesite veins, sometimes as bands or in the form of small crystals in vug-like fissures in the chromite.

The chromite from the Abdasht mines is considered to be of a very superior quality compared to the ores from other mines. The hard and lumpy variety known as super grade analyses 52 per cent Cr_2O_3, 2 to 4 per cent SiO_2 (sometimes even less) having Cr/Fe ratio as 3.4:1. The general range of Cr_2O_3 content varies from 48 per cent to 52 per cent. The average Cr_2O_3 content of chromite from the Soughan mines is 47 per cent to 48 per cent with Cr/Fe ratio as 3:1.

Concentration

The upgrading of the ore and concentration of the ore fines assaying 40 per cent Cr_2O_3 are being done at

Abdasht. Hand-sorting is being employed for coarse-grained ores down to 2 cm and jigging of the material minus 20 mm plus 8 mm producing a grade better than 48 per cent Cr_2O_3. The present concentration mill production is 20 tons per day with the concentrate analysing 49 per cent to 50 per cent Cr_2O_3.

Mining

The mining is being carried out by cut-and-fill method. Since the back filling was not tight before the stope was mined out, caving had been induced. The ore which was tied up in the floor pillar has been recovered by square setting. At present the ores at the bottom level are being extracted by top slicing method.

The production from the Abdasht mines in 1968 was 42,000 tons and from the Soughan mines was 20,000 tons, giving a total production of 62,000 tons.

The transportation of ore from the Abdasht mines is by 35-ton diesel trucks to Hajiabad and from there to Bandar-Abbas on an asphalt highway, a total distance of about 300 km.

Faryab mines

The Faryab group of mines are composed of openings at Shahine, Shariar, Amir, Ebrahim, Resa and Duvase. At the time of the visit, all the mines excepting those of Resa and Duvase were under production.

Ore body

In these deposits the ore bodies are both tabular and lenticular. The structural analysis of the various ore bodies are shown in Drawing No. 5131-II-2. The ore bodies show various degrees of inclination towards the north-east, the inclination varying from 10° to 15° in Shahine, more than 15° in Shariar and between 45° to 57° in the case of Amir mines. The ore bodies have been faulted and the type of faults are normal, cross and diagonal.

The length of the ore bodies varies from 60 m to 400 m with the width varying from 25 m to 150 m, while the average thickness varies from 1.8 m to 12 m. The dimensions of the different ore bodies are shown in Table 3-2.

Table 3-2

DIMENSIONS OF THE ORE BODIES

Ore body		Length m	Width m	Average thickness m
Shahine	..	100	60 to 70	3.0
Shariar	..	400	150	7.0
Amir	..	300	100	12.0
Ebrahim	..	60	25	1.8

Source: Faryab Mining Company.

The possible reserves of the chromite deposits in the entire Faryab area have been estimated at 50 million tons. The reserves estimated and partly proved for Shahine, Shariar, Amir and Reza mines are given in Table 3-3.

Table 3-3

RESERVES OF FARYAB DEPOSITS

		Proved tons	Probable tons
Shahine	..	60 000	40 000
Shariar	..	1 200 000	100 000
Amir	..	900 000	200 000
Ebrahim	..	1 500	1 000
Total	..	2 161 500	341 000

Source: Faryab Mining Company, Teheran.

Ore characteristics

The ores, both hard lumpy and friable, varies in colour from dark grey to black with submetallic to metallic lustre. The ore is occasionally extremely fine-grained and contains thin veins, as well as white and greenish-white areas.

The commonly associated minerals are chrome diopside, uvarovite, kammererite and stichite. Along with the chromite, sometimes picotite may be found, in which the chrome oxide content ranges from 30 per cent to 50 per cent.

The quality of the ore shows a wide range of variation from deposit to deposit. The ore from the Shahine mines contains 40 per cent Cr_2O_3, that of Shariar and Amir mines more than 49 per cent and that of Ebrahim mines 53 per cent. The chromite ores exported from Shariar and Amir mines have a Cr/Fe ratio of 3:1 and that from Ebrahim mine has a ratio of 3.6:1.

Concentration

A concentration plant with a capacity of 15 tons per hour is being installed to upgrade the ores by means of jigging and tabling. Earlier, attempts were made to beneficiate the low grade ores by hand cobbing and panning, and it was found that a 35 per cent Cr_2O_3 could be upgraded to 51 per cent by this method.

Mining

Various methods have been employed, for mining of the ores, depending upon the nature of the ore body. For instance, the Shariar ore body was mined by open cut method in the early stages, but later this method was abandoned and square-set method was adopted. This was also given up in favour of the cut-and-fill method as the square-set method did not allow complete winning of the ore and entailed an excessive use of costly timber needed for roof-support which resulted in unfavourable economics.

The entry to the ore body is by means of tunnels, and the extraction is done in 2 m lifts. The back packing is by waste fill obtained by surface blasting and transported in wheel barrows to the stopes. The stope is laid out in a rectangular panel system to obtain complete extraction.

The ores mined are transported in wheel barrows to the ore passes which are flat dipping at about 30° and are delivered into wooden loading chutes.

The ore is loaded into rocker dump cars which are hauled by 3 h.p. mini locos over the tram line through the main haulage tunnel over a distance of 50 m to the portal.

In 1968/69, this group of mines became the major producer of chrome ore, with a total production of 77,030 tons which was exported. The productions of individual mines are given in Table 3-4.

Table 3-4

PRODUCTION OF FARYAB MINES, 1968/69

(tons)

Shariar	..	36 729
Amir	..	32 351
Ebrahim	..	2 245
Shahine	..	5 705
Total	..	77 030

The transportation is by means of 11-ton trucks over a distance of 140 km to the port of Bandar-Abbas.

Other deposits

There is also a group of deposits of chromite around Khaje Jamali, 300 km north-east of Shiraj, near Bhaktigan

Table 2-28

PROFIT AND LOSS STATEMENT
(Thousand dollars)

							Year of
	I	II	III	IV	V	VI	VII
Production (tons)	15 000	35 000	45 000	47 000	50 000	50 000	50 000
A. Income							
Sales receipt	7 733	18 044	23 200	25 560	29 100	29 100	29 100
B. Manufacturing expenses							
Raw materials	1 832	4 082	5 000	5 800	6 817	6 817	6 817
Labour and supervision ..	1 855	1 855	1 855	2 355	2 355	2 355	2 355
Power, fuel and utilities ..	345	806	1 037	1 116	1 235	1 235	1 235
Refractories, rolls, electrodes and supplies	438	1 023	1 315	1 416	1 567	1 567	1 567
Repair and maintenance ..	1 400	1 400	1 400	1 663	1 663	1 663	1 663
Other miscellaneous expenses	367	855	1 100	1 170	1 275	1 275	1 275
General plant expenses ..	1 550	1 550	1 550	1 622	1 622	1 622	1 622
Total (B)	7 787	11 571	13 257	15 142	16 534	16 534	16 534
C. Gross profit (A-B)	-54	6 473	9 943	10 418	12 566	12 566	12 566
D. Other expenses							
Depreciation	3 316	3 316	3 316	3 716	3 716	3 716	3 716
Interest on working capital ..	240	360	396	456	504	504	504
Interest on loan capital ..	1 840	1 840	1 840	2 136	1 952	1 720	1 488
Deferred charges	400	400	400	500	500	500	500
Selling expenses	232	541	696	767	873	873	873
Total (D)	6 028	6 457	6 648	7 575	7 545	7 313	7 081
E. Net profit or loss before tax (C-D)	-6 082	16	3 295	2 843	5 021	5 253	5 485
F. Income tax a/	-	-	-	-	-	1 839	1 920
G. Net profit or loss after tax							
- current (E-F)	-6 082	16	3 295	2 843	5 021	3 414	3 565
- cumulative	-6 082	-6 066	-2 771	72	5 093	8 507	12 072

a/ Tax - first five years exempted. From 6th year 35% of net profit paid as tax.

SECTION 1

3 - Raw materials for ferro-alloys (cont'd)

salt lake. These deposits have been investigated by Mr Roger Van Vloten along with Engineer N. Taghizadah. According to their findings only the Chasme Bid and Yazdani Dotu deposits present possibilities of exploitation. The other two deposits at Rajune and Barendas are not considered suitable for development.

General observation

It would be seen from the foregoing that the chromite deposits are mainly concentrated in the northern and southern parts of Iran. The chromite mining has been intensified during the last two decades for export.

Since the mining is export-oriented, 75 per cent of the chromite has been of metallurgical grade. The shipment analysis in respect of 129,729 tons exported during the period 1962 to 1968 is given in Appendix 3-1.

Possible reserves

Although no systematic exploration has been undertaken to arrive at an overall estimate of the reserves, available data from the existing mines indicate very large reserves of various grades of chromite ore. This is particularly true of the southern deposits in the Faryab area where the possible reserves have been estimated at 50 million tons.

Annual ore requirements

The proposed ferro-chrome plant will have a capacity for the production of 10,000 tons of low carbon and 4,500 tons of high carbon ferro-chrome. The annual requirements of ore will be of the order of 35,000 tons. In order to sustain a plant of that size, the proved reserves of specific grade of ore should be 700,000 tons, which would ensure adequate supplies to the plant for a period of 20 years.

Since the ore production has so far been related exclusively to export, the requirements of the proposed ferro-chrome plant will have to be met either by additional production or by diversion of supplies meant for export. It is, however, certain that the magnitude of the occurrences of chromite in the country indicate that the requirements of the proposed ferro-chrome plant would be adequately met.

Manganese deposits

Occurrences of manganese in Iran have been reported in Sabzevar, Robat Karim, Ghom and Ardestan areas in the north and north central Iran. The major occurrences are shown in Drawing No. 5131-II-1. At present only Shahrokh mines in the Ghom area are in operation.

Geology

Geologically, the manganese occurrences have not been investigated in detail. There are some occurrences of ferruginous manganese with very low manganese content varying from 1 per cent to 3 per cent. The major occurrences are, however, believed to be related to lower tertiary volcanics. The ore bodies are both in the form of lenses and bedded and are associated with andesitic tuffs, pillow-lavas and jasperoid rocks.

Sabzevar deposit

There are two small manganese occurrences in Benesporte and Assad, the former at a distance of 87 km and the latter at a distance of 96 km towards the south by south-west of the city of Sabzevar.

According to Routhier, the occurrences are as thin bedded deposits varying in thickness from 4 m to 5 m. The ores are associated with tuffs, lavas and jaspers in a sequential form. On the basis of surface examination, Routhier has estimated reserves of 20,000 tons for Benesporte and 50,000 tons for Assad deposits. No information is available on the quality of the deposits.

Robat Karim deposit

The occurrences of manganese ore at Robat Karim south-west of Teheran at an altitude of 1,650 m close to the road to Saveh. The strike of the ore body is north-westerly and the dip is 60° towards the north-east. The length of the ore body is 120 m with an average thickness of 8 m.

The reserves had been estimated at 15,000 tons by Ladame who however thought there is little hope of extending the reserves as the lode wedges at depth.

Ladame's analysis of the ore is as follows:

Mn %	Fe_2O_3 %	CaO %	MgO %	SiO_2 %	Al_2O_3 %
44.5	4.8	2.1	4.3	7.0	8.7
46.1	3.7	1.6	5.5	6.4	10.3
46.5	12.6	3.9	4.7	1.8	8.4

The mines are at present defunct though they were in production since 1939; but no data are available regarding the quantity of production.

Shahrokh deposit

The Shahrokh deposit which is being mined by Resai Brothers is located about 20 km south-west of Ghom on the Teheran-Khorramshahr railway, 150 km south of Teheran.

This group of deposits consist of the mine openings at Jalal, Sake, Doctor, Darband, Mosafferi and Athari, over a distance of 10 km. The extension of the ore body further east of Athari has been observed. At the time of the visit, only Mosafferi mines were in operation as the demand for manganese ores had fallen.

Ore body

The attitude of the various ore bodies indicates that they have been separated by a number of faults, the most prominent is the fault running in a north-east by south-west direction. This fault is separating the Doctor mines from the Darband mines. Apart from the major faults, there are a multiple faults in various directions within the ore bodies. Due to the faulted nature of the ore bodies and concealment, the continuation is difficult to detect.

The lateral extent of the ore bodies varies from 120 m to 500 m with the width varying from 1.5 m to 7 m, but the thickness has not been properly determined. The data on various ore bodies are summarised in Table 3-5.

The deposits have been explored by trenches and inclined shafts. The proved reserves have been calculated at 200 000 tons with possible reserves of 0.5 million to 1.0 million tons.

Ore characteristics

The ore minerals consist of pyrolusite and sometimes hausmannite associated with both haematite and magnetite. Silica in the form of chert is also commonly found to occur.

Table 3-5

SHAHROKH MANGANESE ORE BODIES, ESTIMATED RESERVES AND AVERAVE MANGANESE CONTENT

Name of deposit	Ore body			Average grade Mn %	Estimated reserves ton	Remarks
	Length m	Width m	Thickness m			
Athari	500 (disconti-nuous)	1.5	1.5	...	...	
Mozafferi	220	5-6	...	42	80 000	1st level 70 m below the surface completely extracted. 2nd level 34 m below 1st level
Doctor	150	7	...	34	50 000	1st level 30 m from the surface, completely extracted. 2nd level 35 m below 1st level
Sake	120	7	15	32	70 000	1st level now being worked
Reza Khan	...	...	...	...	...	Only trenches sunk from which about 1 000 tons of 34% to 36% Mn has been raised
Jalal	100	2	...	34 (occasion-ally 38%)	-	In the form of number of lenses

Source: Rezai Brothers, Teheran.

The grade of the ore varies from 34 per cent to 42 per cent in manganese content. Based on the data available it is not likely that a grade above 44 per cent of manganese content could be obtained.

3 - Raw materials for ferro-alloys (cont'd)

The general range of analyses of manganese ores exported are given in Appendix 3-2. The analyses show that the grade varies from 37 per cent to 43 per cent of manganese, and the Mn:Fe ratio varies from 9:1 to 11:1.

Concentration

In order to meet the export requirements, the run-of-mine ore analysing 32 per cent to 34 per cent of Mn is upgraded by screening and hand-sorting. The ore is fed through a grizzly with 25 mm openings. The over-size material is upgraded to 38 per cent to 40 per cent Mn by hand-sorting and the under-size material containing 27 per cent Mn is separately dumped as low grade. The tailings from hand-sorting contain 24 per cent of Mn.

The ore dressing division of the Geological Survey of Iran carried out beneficiation tests on four samples from Shahrokh group of mines. The analyses of the samples were as follows:

Samples	Mn %	Fe %	SiO2 %
1	34.65	8.60	16.76
2	29.53	5.86	25.32
3	27.55	13.24	19.72
4	24.75	11.67	22.10

The samples were crushed by stages in a roll crusher to pass a minus 10 mesh screen, and the screening tests indicated that there was little or no segregation of manganese in any particular size fraction.

Gravity separation with minus 10 plus 100 mesh fraction indicated that the manganese content cannot be increased more than 4 per cent. The samples at minus 5 mesh by jigging increased the manganese content by 5 per cent to 6.5 per cent with 60 per cent to 85 per cent recovery. The samples were ground to minus 28 plus 65 mesh and were tabled. The tabled products assayed about 8 per cent to 10 per cent higher in manganese content than the feed, with 50 per cent to 60 per cent recovery.

The results of roasting and magnetic separation produced non-magnetic concentrates assaying 37.25 per cent Mn in the case of sample 1 and 27 per cent Mn for sample 4, with 90 per cent recovery.

The floatation tests were not satisfactory as fine grinding produced a considerable amount of slime, an unfavourable condition for flotation. Desliming before flotation resulted in the loss of considerable manganese in the slime.

Mining

The present method of stoping is by the cut-and-fill method. The ore body is now being worked at the 2nd level as the 1st level has been completely exhausted. After the ore is broken from the back of the stope, it is hauled by wheel barrows and brought to the ore passes. It is then discharged through the wooden ore chutes at every 16 m, mainly on the south wall and western cross-cut, into the tubs of 1.2-ton capacity. The tubs are hauled by 6 h.p. locos through the main tunnel to the portal.

The back fillage material is discharged through the fillage chutes at every 32 m interval, and for each ton of ore extracted about 600 kgs of fillage material is required.

The ore after being upgraded by screening and hand-sorting is loaded on to the trucks and transported to Ghom railway station, at a distance of 35 km from the mines. The cost of transportation including loading and unloading, is $ 1.33 per ton.

The total production during the period 1963 to 1968 was about 150,000 tons which was almost entirely exported. The current production is about 12,000 tons per year.

Price of <u>ore</u>

The price of manganese ore with 38 per cent Mn content is $ 13 per ton f.o.b. Khorramshahr. The price is increased by 50 cents per ton for every unit (per cent Mn in ore) up to 42 per cent Mn content, and 70 cents per ton for every unit above 42 per cent Mn content.

Other deposits

Boz Noin

The Boz Noin deposit is situated at an elevation of 2,060 m in north central Iran, 25 km south of Ardestan and 6 km north-east of the village of Bagham.

The wall rock is grey quarts porphyry which is cut by a felsite dyke 3 m wide. The porphyry is highly jointed and also faulted. The most prominent fault strikes north-easterly, dipping 85° towards the south-east. The manganese mineralisation has taken place in the shear sone running parallel to the fault.

The main manganese minerals are manganite associated with some soft pyrolusite and small quantities of rhodochrosite.

The deposit is not being mined at present, and no information is available regarding the grade and reserves.

Sanges

The Sanges deposit is reported to occur at an altitude of 1,800 m, south of Kuh-e-Bahraseman in the Kerman volcanic belt.

The deposit occurs as a bed of 1 m to 2 m thickness striking north-west and dipping at an angle of 25° towards the south-west.

Table 2-28

Table 2-[illegible]

T AND LOSS STATEMENT

housand dollars)

Year of operation										
V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
0 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000
9 100	29 100	29 100	29 100	29 100	29 100	29 100	29 100	29 100	29 100	29 100
6 817	6 817	6 817	6 817	6 817	6 817	6 817	6 817	6 817	6 817	6 817
2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355
1 235	1 235	1 235	1 235	1 235	1 235	1 235	1 235	1 235	1 235	1 235
1 567	1 567	1 567	1 567	1 567	1 567	1 567	1 567	1 567	1 567	1 567
1 663	1 663	1 663	1 663	1 663	1 663	1 633	1 663	1 663	1 663	1 663
1 275	1 275	1 275	1 275	1 275	1 275	1 275	1 275	1 275	1 275	1 275
1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622
16 534	16 534	16 534	16 534	16 534	16 534	16 534	16 534	16 534	16 534	16 534
12 566	12 566	12 566	12 566	12 566	12 566	12 566	12 566	12 566	12 566	12 566
3 716	3 716	3 716	3 716	3 716	3 716	3 716	3 716	2 058	400	400
504	504	504	504	504	504	504	504	504	504	504
1 952	1 720	1 488	1 256	1 024	792	560	328	96	48	-
500	500	500	500	500	500	100	100	100	-	-
873	873	873	873	873	873	873	873	873	873	873
7 545	7 313	7 081	6 849	6 617	6 385	5 753	5 521	3 631	1 825	1 777
5 021	5 253	5 485	5 717	5 949	6 181	6 813	7 045	8 935	10 741	10 789
-	1 839	1 920	2 001	2 082	2 163	2 385	2 466	3 127	3 759	3 776
5 021	3 414	3 565	3 716	3 867	4 018	4 428	4 579	5 808	6 982	7 013
5 093	8 507	12 072	15 788	19 655	23 673	28 101	32 680	38 488	45 470	52 483

tax.

3 - Raw materials for ferro-alloys (cont'd)

No information is available regarding the quality and the reserves of this deposit.

Uband

Mon. Basin (UN expert attached to the Geological Survey of Iran) has recently located a manganese deposit at Uband half way between the villages of Neiriz and Darab, east of Shiraj town.

The manganese occurs in a 5 m thick bed dipping about 70°. The ore is associated with jasperoid rocks of uppermost cretaceous age. The ores occurring at the top 2.8 m show an analysis of 46.2 per cent of Mn, followed by siliceous ore analysing 33.7 per cent of Mn content. The inferred reserves have been estimated at 70,000 tons.

General observation

Manganese ore requirements

It is estimated that for the production of 38,000 tons per year of 75 per cent ferro-manganese, a total quantity of 85,000 tons of manganese ore will be required. Assuming an amortisation period of 20 years for the plant, an assured reserve of about 2 million tons of suitable grade of manganese ore will be required.

Although the production of manganese ore for export had been steadily rising until 1966, no proper geological investigation has been carried out to establish the industrial reserves and grade and to locate new areas of occurrences.

The average manganese content in the exported ores varies from 37 per cent to 43 per cent with low phosphorus and sulphur. Although the ores for export are upgraded by screening and hand-sorting which raises the manganese content by 6 per cent, the rejection during the process amounts to about 50 per cent. The results of the beneficiation tests carried out by the Geological Survey of Iran are also not encouraging for upgrading the ores.

The current production of the operating mines at Shahrokh is 12,000 tons per year. Total installed capacity of all the mines in Ghom area would be of the order of 40,000 tons.

The utilisation of indigenous resources can be considered after detailed investigations to determine the availability of suitable grade with concomitant reserves. It is suggested that the Robat Karim deposit which contains about 46 per cent Mn should be carefully explored. The possibility of blending Shahrokh ores which has a favourable Mn:Fe ratio after hand-sorting with imported high grade ores to obtain a composite blend containing 46 per cent min.Mn content should also be investigated. There is a possibility of utilising local ores in increasing proportions.

In the present circumstances, it would be necessary to import manganese ores of suitable grade to sustain a ferro-manganese plant of the proposed capacity. The average analyses of manganese ores supplied by major exporting countries in the world are given in Appendix 3-3. In considering the source for import of manganese ore it would be logical to select a country as near to Iran as possible, commensurate with the price and quality of the ore. As the imports are likely to be through the Persian Gulf ports, India, a traditional exporter of high grade manganese ores, is considered a suitable source for meeting the ore requirements of the plant.

Quartsites

The quartsites in Iran are believed to be associated with the Cambrian, Devonian and Mesozoic rock formations.

Ghasvin area

The deposits which are being worked by the Chemical and Metallurgical Corporation of Iran (a Government undertaking), are situated near Yousbaschai village 55 km north of Ghasvin, about 195 km north-west of Teheran. The quartsites are white, brown and light grey coloured and are medium coarse to fine grained. In the western part, the deposit is found to be kaolinised. The analysis of the quartsites are given below:

	Samples	
	(1)	(2)
	%	%
SiO_2	95.8	97.96
Al_2O_3	1.13	0.55
Fe_2O_3	0.17	Trace
CaO	0.51	Trace
MgO	Trace	Trace
Loss on ignition	1.44	0.70

It is estimated that the reserves will be of the order of 3 million tons of 95 per cent SiO_2 in this area. The quarrying is being done by open cut method and is being developed to augment the production. The average production from this deposit is about 2,000 tons per month and in 1968 the production was 25,065 tons. The total production is consumed locally by Ghazvin Sheet Glass Factory, Iran Glass Factory and other miscellaneous industries.

The pithead price of the quartsite is $ 3.3 per ton, and the price delivered at Teheran varies from $ 4.6 to 5.3 per ton.

Other deposits

There are other quarries of quartsites belonging to the Iran Silica Company, 6 km south of Yousbaschai, and in

Ghasemabad-Latian area near Latian dam, 45 km north-east of Teheran. The quarrying of these deposits is not being done systematically and the production is negligible.

Isfahan-Lachoulleh area

Geological investigations by the National Iranian Steel Company are in progress to locate suitable deposits of quarts and quartzites for the proposed steel plant in Isfahan. As a result of these efforts, quartzite deposits have been located around Tabas, Zefreh and Lachoulleh near Isfahan. In the Lachoulleh deposit the quartzite band is steeply dipping having a thickness of 35 m to 40 m and is overlapped by dolomite. The reserves estimated are 3 million tons. The chemical analysis of the quartzites from Tabas and Lachoulleh deposits is given below:

		Tabas deposit	Lachoulleh deposit		
		(1) %	(1) %	(2) %	(3) %
SiO_2	..	81.27	97.0	96.3	93.3
Al_2O_3	..	3.75	2.8 (R_2O_3)	2.0 (R_2O_3)	-
Fe_2O_3	..	2.50	-	-	4.6
CaO	..	6.35	-	-	1.1
MgO	..	0.20	-	-	-

Sources: National Iranian Steel Company, Isfahan.

General observation

Quartzite requirements

The results of the investigations by the National Iranian Steel Company indicate the suitability of the quartzites of Lachoulleh deposits for steelmaking and ferro-alloy production. It is estimated that total requirements of quartzites for the ferro-silicon and ferro-chrome plant would be 44,000 tons per year.

The quartzite requirements for the production of ferro-chrome are about 11,000 tons per year. It is learnt that suitable deposits of quartz and quartzite may be found in Bandar-Abbas/Faryab area. Appropriate steps need to be taken early to locate and develop such deposits. These deposits, if located, can meet the requirements of the proposed ferro-chrome plant.

Limestone

Limestones are widespread in their occurrence in Iran, particularly in Zagross belt and in the north-eastern part of the country. Stratigraphically, the limestones are associated with rock formations of Palaeozoic and Mesozoic age. They are the host rock for the lead-zinc mineralisation in the central part of Iran and are the reservoir rocks for the most productive oil fields in Iran. Although the limestones occur abundantly and are being utilised for cement manufacture and lime burning, no systematic attempt has been made to determine their reserves and grade.

Isfahan area

In the Isfahan area, however, limestone deposits are now being investigated in detail to assess the suitability of the limestones for supply to the Isfahan steel plant.

Pirbakram deposit

In the Pirbakram deposit located 18 km south-west of Isfahan town, limestones of cretaceous age are overlain by more than 500 m thick shales, quartzitic sandstone and shales of Jurassic age. The limestone formation is divided into two horizons, upper and lower. The upper formation is light grey in colour and the lower dark grey in colour, fine grained and blocky. The limestones at places are fissured, with the fissures filled with coarse crystalline calcite, and are sometimes silicified as well as intercalated with argillo-calcareous materials. The thickness of the cretaceous limestone-sandstone formation is estimated between 400 m and 500 m. The reserves of blast furnace and flux grade limestones in Pirbakram area are estimated at 41 million tons.

Mobaraka deposit

The limestone deposits located at 8 km north by north-west of Mobaraka town and 20 km south-east of Isfahan city, are believed to be of upper cretaceous age. The limestones which appear to vary from 50 m to 100 m in thickness, are massive, dark grey in colour, medium to fine grained and slightly metamorphosed. In some parts of the limestone beds, remnants of shells infilled with dark grey calcite can be seen. The reserves of this deposit are not known.

Quality

The chemical analysis of the limestones from the Mobaraka area is given below:

		Sample		
		(1) %	(2) %	(3) %
CaO	..	53.18	53.40	54.14
MgO	..	1.44	1.55	0.70
Insol.	..	1.39	0.91	1.28
R_2O_3	..	0.31	0.24	0.26
SO_3	..	0.0221	0.0183	0.1122
P_2O_5	..	Trace		0.0235
Loss on ignition	..	43.40	43.61	43.24

Source: National Iranian Steel Company, Isfahan.

Other areas

Bandar-Abbas

In the Bandar-Abbas area, the limestone deposits around Tsorikh, 20 to 25 km from Bandar-Abbas on the road to Kerman, may be considered. Earlier a cement plant was proposed to be set up based on this deposit.

Ahwaz

In Ahwaz area, the Asmari deposits which are located north-east of Ahwas, are not uniform in quality. Therefore, the deposits at Andimeskh, 300 km from Ahwas, might be a better source. The deposits however should be investigated to assess the reserves and grade.

General observation

Limestone requirements

It has been estimated that the total quantity of flux grade limestones required would be about 53,000 tons annually. The investigations carried out by the National Iranian Steel Company around Isfahan indicate considerable reserves of blast furnace and flux grade limestones. For a Isfahan-based ferro-manganese plant the requirements of flux grade limestones can be met from the deposits around Isfahan. For a ferro-chrome plant to be based in the Bandar-Abbas/Faryab area, investigations will have to be carried out to locate suitable deposits close to Faryab area to meet the requirements of flux grade limestones.

Reductants

The carbonaceous materials suitable for use as reductants in the manufacture of ferro-alloys are coal, coke, woodchips, charcoal and petroleum coke. The choice of the reductants is dependent upon their chemical, physical and electrical properties, and their availability.

3 - Raw materials for ferro-alloys (cont'd)

Coal

The main coal bearing regions of Iran are:

1) The Northern Elburz regions
2) The Southern Elburz regions
3) The Khorasan region
4) The Kerman regions
5) The Central region

Geologically, the coal formations in Iran belong to lower and middle Jurassic age, and no permo-carboniferous occurrences of coal have yet been found.

Kerman coal deposit

The coal belt in Kerman area is being explored extensively by the National Iranian Steel Company for the steel plant at Isfahan. The coal formations in the Kerman region extend over an area 150 km long and 25 km wide. The formations have been divided into 4 (four) series, a, b, c and d. The d series has been fully investigated and the most important seam, No.2 in d series, varies in thickness from 1.3 m to 12.0 m.

Coke

It has been proposed by the National Iranian Steel Company to utilise coal from the Kerman field for conversion into coke, principally to meet the requirements of the Isfahan steel plant.

The National Iranian Steel Company have carried out a series of tests on cokability of the coals from Kerman

Table 2-[illegible]

CASH FLOW STATEMENT

(Thousand dollars)

								Year
	I	II	III	IV	V	VI	VII	VIII
Sources of cash								
Net profit or loss after tax	-6 082	16	3 295	2 843	5 021	3 414	3 565	3 71
Add - depreciation	3 316	3 316	3 316	3 716	3 716	3 716	3 716	3 71
- deferred charges	400	400	400	500	500	500	500	50
Surplus/deficiency from operation	-2 366	3 732	7 011	7 059	9 237	7 630	7 781	7 93
Disposition of cash								
Repayment of loan	-	-	2 300	2 300	2 900	2 900	2 900	2 90
Estimated cash balance/deficiency								
- current	-2 366	3 732	4 711	4 759	6 337	4 730	4 881	5 03
- cumulative	-2 366	1 366	6 077	10 836	17 173	21 903	26 784	31 81

SECTION 1

coal belt. The analysis of coke from Kerman coal is as follows:

Ash	..	13 to 14%
Sulphur	..	1.3 to 1.4%
Volatile	..	1.0%
Calorific value	..	4 400 Kcal/kg
	..	

This coke is suitable for ferro-manganese and ferro-silicon (45 per cent grade) and would be available as a by-product from the Isfahan steel plant.

Charcoal

For technical reasons the use of coke alone as a reductant is not considered suitable for the manufacture of ferro-chrome and ferro-silicon (75 per cent grade). It is, therefore, proposed to use charcoal as a reductant along with coke. The estimated requirement of charcoal for ferro-chrome is 4,550 tons per year and that for ferro-silicon is 9,350 tons per year. Availability of adequate quantity of charcoal needs to be investigated.

The charcoal requirements for a ferro-silicon plant at Isfahan location can be met locally, but in the case of the ferro-chrome plant located at Bandar-Abbas/Faryab area the charcoal will have to be transported to that area. No data on the quality of charcoal is available.

3 - Raw materials for ferro-alloys (cont'd)

Scrap

Production of ferro-silicon also requires a small quantity of steel scrap to the extent of about 200 kg per ton. The annual scrap requirement of about 3,400 tons is expected to be met from local sources.

Cost of raw materials

The cost of raw materials estimated for the feasibility study are given in Table 3-6.

Table 3-6

COST OF RAW MATERIALS

Raw materials	Cost ex-source $/ton
Chromite	17.0
Manganese	29.8 a/
Quartzite	3.4
Limestone	0.9
Coke	22.6
Charcoal	59.5
Electrode paste	138.0 b/
Scrap	30.0

a/ c.i.f. Khorramshahr including port and handling charges.
b/ f.o.r. ferro-alloy plants.

4 - RAW MATERIALS FOR ALLOY STEELS

The major raw materials required for alloy steels production are steel scrap, ferro-alloys, fluxes such as limestone, burnt lime and fluorspar and graphite electrodes. The availability and sources of supply for these materials are discussed in this Chapter.

Steel scrap

Present availability

Current availability of steel scrap in Iran may be estimated at 30,000 to 35,000 tons per year (corresponding to 3 per cent to 4 per cent of present steel consumption in the country). About half the scrap is generated in the engineering industries located around Teheran. Fair quantities are also available at Ahwaz from the existing rolling mills of the Iranian Rolling Mill Company and the pipe plant of the National Iranian Oil Company. The availability of scrap from these plants at Ahwaz is estimated at about 17,000 tons per annum as given in Table 4-1.

Table 4-1

AVAILABILITY OF SCRAP AT AHWAZ

		Present production tons	Scrap generation tons
Iranian Rolling Mill Company	..	100 000	7 000
Pipe plant - National Iranian Oil Company	..	150 000	10 000
Total	..		17 000

4 - Raw materials for alloy steels (cont'd)

With the increased industrial consumption of steel, the scrap generation and availability will also rise.

At present, the iron foundries are the major users of large quantities of scrap because of the substantial difference in price between imported pig iron (\$ 80 to 85 per ton) and local scrap (\$ 15 to 25 per ton). If pig iron is made available (together with foundry coke) from indigenous production, the pressure to use steel scrap would reduce.

Export and import of scrap

Iran has also been trading in scrap as given in Table 4-2.

Table 4-2

EXPORT AND IMPORT OF SCRAP a/

Year		Export tons/yr	Import tons/yr
1962/63	..	716	2 944
1963/64	..	3 365	5 092
1964/65	..	6 178	5 376
1965/66	..	5 200	6 067
1966/67	..	7 241	9 376
1967/68	..	3 524	5 170
1968/69	..	25 833	6 029

a/ Tariff Code No. 698 - scrap, chips, iron, steel and cast iron.

Source: Year Book - Foreign Trade Statistics of Iran, 1962/63 to 1968/69.

It will be noted that except in the year 1968/69, Iran has been a net importer of scrap. Up to 1966/67, the export of scrap has been mostly to Japan and some quantity to neighbouring countries such as Iraq, Kuwait, Oman etc. In 1967/68, about 3,000 tons of scrap was exported to Nationalist China and in 1968/69 all the scrap (that is about 25, 833 tons) was exported to Nationalist China.

As no data regarding the present consumption of scrap is readily available, it is difficult to develop the current national scrap balance.

A broad indication of overall national picture of possible future scrap availability and demand by 1977/78 and 1982/83 has been developed to identify the import requirements, especially for the proposed alloy steel project.

Future scrap <u>availability</u>

The availability of melting scrap in Iran is estimated on the basis that the total consumption of steel in Iran will be about 2.4 million tons by 1977/78 and 3.5 million tons by 1982/83. It is also assumed that the scrap trade will get organised and the effective scrap collection will be about 80 per cent of the total scrap arisings in the country. Accordingly the scrap availability for melting purposes after allowing about 15 per cent for industrial and re-rollable users, is conservatively estimated at about 105,000 tons per

4 - Raw materials for alloy steels (cont'd)

per year by 1977/78 and about 185,000 tons per year by 1982/83 as given in Table 4-3.

Table 4-3

ESTIMATED SCRAP AVAILABILITY IN IRAN, 1977/78 AND 1982/83

	Basis		Scrap quantity	
Scrap	1977/78	1982/83	1977/78 tons	1982/83 tons
Process scrap a/ as related to finished steel consumption	5% of 2.4 million tons	6% of 3.5 million tons	120 000	210 000
Capital scrap b/ as related to process scrap	30% of process scrap		36 000	63 000
Total scrap arisings ..			156 000	273 000
Total scrap availability (at 80% of total arisings)			124 800	218 400
Availability of melting scrap c/ (at 85% of total availability)			106 080	185 640
Say			105 000	185 000

a/ The current process scrap generation is estimated to be about 3%. For a developing economy of Iran, where the consumption of steel for construction purposes is expected to be higher in 1977/78 and 1982/83, the process scrap generation is estimated on a low side as against about 10% for countries such as USA, Japan, UK, West Germany etc.

b/ Capital scrap arising is based on the figure currently obtained in India.

c/ There are at present no scrap re-rollers in Iran. Hence scrap diversion for industrial and re-rollable uses is assumed at about 15% as against about 30% to 40% of total scrap availability in countries such as India. However, if the demand of scrap for industrial and re-rollable uses increases above 15% in Iran, the availability of scrap for melting purposes will correspondingly decrease.

4 - Raw materials for alloy steels (cont'd)

Future scrap demand

Based on the likely steel and alloy steel production as well as development of foundry and forge industries the demand for melting scrap in Iran is estimated at about 350,000 tons per year by 1977/78 and 535,000 tons per year by 1982/83 as given in Table 4-4.

Table 4-4

ESTIMATED DEMAND OF SCRAP IN IRAN, 1977/78 AND 1982/83

	Consumer	Likely production		Estimated scrap demand	
		1977/78 tons	1982/83 tons	1977/78 tons	1982/83 tons
1.	Ore based steel plants - Isfahan and others ..	2 300 000 a/	3 100 000 a/	25 000 b/	34 000 b/
2.	Scrap based steel plants - IRMCO and others ..	200 000 a/	300 000 a/	220 000 c/	330 000 c/
3.	Alloy steel plants ..	50 000 a/	80 000 a/	55 000 c/	88 000 c/
4.	Steel foundries ..	15 000	30 000	16 500 c/	33 000 c/
	Sub-total (1 to 4)		..	316 500	485 000
5	Miscellaneous uses @ 10% of (5)		..	31 650	48 500
	Total ..		..	348 150	533 500
			Say	350 000	535 000

a/ Production of ingots or semis.
b/ Based on Isfahan steelworks norm of purchased scrap - 6,000 tons per year for 0.55 million ton output.
c/ Based on 1.1 ton scrap per ton of production.

It will be noted that there may be a scrap deficit in 1977/78 and 1982/83 of the order of 245,000 tons and

350,000 tons respectively. Considering the availability of natural gas, there is a possibility of producing sponge iron in future to meet at least a part of this shortfall in melting stock. The Imperial Government of Iran is already examining the feasibility of such a proposition.

Imported scrap for alloy steel plant

In view of the deficit national scrap balance, and also because the cost of imported scrap ($ 50 per ton) is considerably higher than present prices of local scrap (say $ 25 per ton), this study has on a conservative basis assumed use of imported scrap. The use of metallics (scrap or sponge iron) from local sources in the proposed alloy steel plant would result in improved profitability than that indicated in this report.

Ferro-alloys and additives

A wide range of ferro-alloys and additives are necessary for producing alloy and special steels. The types, grades and quantities of these materials depend on the product-mix of an alloy steel plant. This study assumes that all alloying and de-oxidizing will have to be imported. The possibility of installing capacities for production of ferro-chrome, ferro-silicon and ferro-manganese is under investigation and forms a part of this study. As and when these plants are installed, the requirement of these ferro-alloys could be met from indigenous sources.

Small quantities of iron ore and petroleum coke are also required for steelmaking in arc furnaces. The iron ore could be supplied from local sources. The petroleum coke would have to be imported.

Fluxes

Limestone

The fluxes required for steelmaking are limestone, burnt lime and fluorspar. The availability of limestone in different parts of the country has been discussed in Chapter 3. It may be recapitulated that adequate availability of flux grade stone is ensured in the Isfahan area where considerable prospecting work has already been conducted by the National Iranian Steel Company. However, appropriate investigations would have to be undertaken for locating and proving limestone deposits in other areas such as Ahwaz, Arak and Tabriz, if one of these locations is finally found suitable for an alloy steel plant. It may be mentioned, however, that in view of the wide prevalence of limestone in the country locating suitable deposits in the vicinity of the selected plant site may present no problems.

Burnt lime

Burnt lime required for steelmaking is proposed to be produced in the calcining facilities provided in the alloy steel plant itself.

Fluorspar

No geological investigations have so far been conducted for locating fluorspar deposits in Iran. The entire requirement of fluorspar is, therefore, to be met through imports. It is suggested that availability of fluorspar in the country should be investigated.

Graphite electrodes

An important consumable item for arc furnace steelmaking is graphite electrodes, which is not produced locally. The requirement of graphite electrodes and nipples would, therefore, have to be met through imports.

Cost of raw materials

The cost of major raw materials considered for this feasibility study are given in Table 4-5.

Table 2-[illegible]

CASH FLOW STATEMENT

(Thousand dollars)

Table 2-[illegible]

Year of operation											
IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
843	5 021	3 414	3 565	3 716	3 867	4 018	4 428	4 579	5 808	6 982	7 013
716	3 716	3 716	3 716	3 716	3 716	3 716	3 716	3 716	2 058	400	400
500	500	500	500	500	500	500	100	100	100	-	-
059	9 237	7 630	7 781	7 952	8 083	8 234	8 244	8 395	7 966	7 382	7 413
300	2 900	2 900	2 900	2 900	2 300	2 900	2 900	2 900	600	600	-
759	6 337	4 730	4 881	5 032	5 183	5 334	5 344	5 495	7 366	6 782	7 413
836	17 173	21 903	26 784	31 816	36 999	42 333	47 677	53 172	60 538	67 320	74 733

4 - Raw materials for alloy steels (cont'd)

Table 4-5

PRICES OF RAW MATERIALS FOR ALLOY STEEL PLANT

Raw materials		Price at plant a/ $/unit
Steel scrap		
Imported	..	50.00/ton
Alloying and deoxidizing additions		
High-carbon ferro-chrome	..	370.00/ton
Low-carbon ferro-chrome (0.1% C)	..	0.67/kg
Ferro-tungsten (70% W)	..	8.10/kg
Ferro-vanadium (50% V)	..	6.67/kg
Ferro-molybdenum (70% Mo)	..	6.00/kg
Nickel pellets (99.8% Ni)	..	4.00/kg
Ferro-manganese (standard grade)	..	215.00/ton
Ferro-silicon (74% Si)	..	240.00/ton
Aluminium shots	..	800.00/ton
Fluxes and electrodes		
Iron ore (60% Fe)	..	15.00/ton
Limestone (flux grade)	..	5.40/ton
Burnt lime	..	13.50/ton
Fluorspar	..	120.00/ton
Petroleum coke	..	100.00/ton
Silica sand	..	10.00/ton
Graphite electrodes	..	700.00/ton

a/ Includes the freight cost of transporting from source to plant site.

The prices of limestone, burnt lime, silica sand and iron ore are based on the current prices of these materials in Iran and of other materials on the basis of prevailing international prices.

5 - FERRO-ALLOY REQUIREMENTS OF IRAN

The specification and uses of ferro-alloys under study are reviewed and an assessment is made of future requirements within the country. The possibilities of exporting ferro-alloys are discussed in the following Chapter.

Ferro-alloys and their uses

Alloy additions are made to iron and steel mainly for two purposes, namely, (i) for 'scavenging' and deoxidation, and (ii) for imparting special properties such as control of grain size, improvement in mechanical properties, increase in hardenability, enhanced corrosion resistance, or for achieving other specific results like scaling resistance or high temperature strength.

Manganese, chromium, tungsten, molybdenum, vanadium and titanium are generally added to the molten steel in the form of ferro-alloys, as it is more economical to produce them and in some cases also more advantageous to utilise them in this form rather than in the iron-free metallic state. Nickel, cobalt, copper and aluminium are, however, used as iron-free metals. Specially prepared alloys like nitrogen-bearing ferro-alloys and complex deoxidisers like silico-manganese, alsifer, ferro-silico-zirconium are required only to a limited extent.

Ferro-alloys are produced in different grades, containing varying proportions of the alloying element and carbon. The grade selected depends on the end-uses, as discussed below. Typical standard specifications of ferro-manganese, ferro-silicon and ferro-chrome are given in Appendices 5-1, 5-2 and 5-3.

Ferro-manganese

Manganese is an essential constituent of all steels, plain carbon as well as alloy. The presence of manganese in steel, to the extent of at least seven times the sulphur content, is necessary to nullify the harmful effect of sulphur in rendering the steel 'red-short'. It is also effective as a deoxidiser. In larger percentages it functions as a regular alloying element for improving hardenability, strength and toughness. Manganese is present to the extent of 12 to 14 per cent in 'Hadfield' manganese steel which is extensively used for wear-resistant castings.

High-carbon ferro-manganese is used for additions to plain carbon as well as alloy steels, while the low-carbon variety is used only for alloy steel where carbon content has to be kept low, for instance, in low-nickel and nickel-free substitute stainless steels.

Ferro-silicon

Ferro-silicon is mainly used as a deoxidiser in the steel industry. High-grade ferro-silicon is also required for the production of electrical steels.

Ferro-chrome

Chromium is added to most alloy steels in the form of either low-carbon or high-carbon ferro-chrome, depending upon the type of steel and manufacturing process adopted.

Chromium is a carbide stabiliser. It contributes effectively towards increasing the hardenability of steel and is therefore added in amounts up to 3 per cent in constructional alloy steels. It markedly increases abrasion resistance of high-carbon compositions, and is used in amounts varying from 1 per cent to 18 per cent in ball bearing steels, high speed steels, shear blade and die steels and hard, wear resistant cast irons. It increases resistance to corrosion and oxidation, and is the chief alloying element, in percentages varying from 12 to 28, in stainless irons and steels with or without nickel.

Because of its mild carbide effect in tempering to resist softening, its marked effect in conferring oxidation and scaling resistance at high temperatures, and its contribution to high temperature strength, ferro-chrome is used in percentages varying from 2 to 35 in hot work die steels, heat resisting steels and high temperature strength steels. In short, no other alloying element in iron and steel confers as extended a range of useful properties and therefore finds as wide a use as chromium.

Past consumption in Iran

Currently the major consumers of ferro-alloys in Iran are the foundries and the entire requirements have been met through imports, as a start has yet to be made in the production of ferro-alloys. The available information regarding total imports and sources of supply is given in Appendix 5-4.

Import statistics do not, however, indicate the different types of ferro-alloys and their grades. As no separate statistics of ferro-alloys actually consumed are available, the imported quantity may be assumed to indicate the apparent consumption. The available information on production of iron castings and apparent consumption rate of ferro-alloys is given in Table 5-1.

Table 5-1

PRODUCTION OF IRON CASTINGS AND APPARENT CONSUMPTION OF FERRO-ALLOYS IN FOUNDRIES

	Production of iron castings tons	Import of ferro-alloys tons	Apparent consumption of ferro-alloys kg/ton castings
1964/1965 ..	3 916	114.7	29.2
1965/1966 ..	3 206	107.5	33.5
1966/1967 ..	12 258	326.1	26.5
1967/1968 ..	20 460	1 028.0	50.5
1968/1969 ..	25 602	802.0	31.5
1969/1970 a/ ..	...	614.0	...

a/ For nine months, March to November.

It is noted from Table 5-1 that the estimated consumption rate shows considerable variation in different years. This may be attributed to variation in proportion of pig iron to scrap used and changes in inventories.

In order to study the present trends in the use of ferro-alloys, therefore, selected foundry practices were studied. A foundry producing pipe fittings from scrap as the metallic charge in mains frequency furnace reported the use of 40 kg of ferro-silicon (75 per cent grade) per ton of metal. The same foundry, however, does not require any ferro-alloys for production of cast iron pipes for which pig iron is melted in the cupola. Another foundry producing malleable castings utilises varying proportion of scrap and pig iron depending on their availability and therefore the ferro-alloy additions also vary. The average consumption is reported to be 10 kg ferro-silicon (75 per cent grade) and 4 kg ferro-manganese (75 per cent grade) per ton of castings.

The present annual requirement of ferro-alloys as reported by some major foundries is given in Table 5-2.

Table 5-2

ANNUAL REQUIREMENT OF MAJOR FOUNDRIES

Name of foundry		Capacity tons	Annual ferro-alloy requirement	
			Ferro-silicon tons	Ferro-manganese tons
Pars Metal Co	..	10 000	500	-
Machine Sazi Iran	..	20 000	750	-
Foundry Malleable Co	..	4 000	100	40
Total	..	34 000	1 300	40

It is observed that the bulk of the ferro-alloys consumed in the foundry industry is ferro-silicon. The annual requirement of ferro-silicon indicated by the major foundries corresponds to about 38 kg of ferro-silicon (75 per cent grade) per ton of casting. The annual requirement of all ferro-alloys by major foundries corresponds to 39.5 kg per ton of casting. This is in agreement with the average national consumption rate for 1967/68 and 1968/69 taken together.

In estimating the future ferro-alloys demand by the foundry industry, however, these consumption rates would not be applicable because with the completion of the Isfahan Steel Plant, the supply of pig iron would improve. At the same time, the availability of scrap to the foundry industry would decrease with the installation of additional scrap-based electric furnace steelmaking facilities.

Future demand

Tonnage steels

The major future consumption of ferro-alloys will be for production of mild and alloy steels. The first integrated steel plant now under construction at Isfahan has an initial capacity of 0.55 million tons per year and is designed for expansion to 1.2 million tons as onvisaged in the Soviet Detailed Project Report (DPR). From discussions with the National Iranian Steel Company (NISC), it is understood that expansion to a larger capacity (say, 2 to 3 million tons) is being contemplated. As mentioned earlier, the Iranian Rolling Mills Company is installing an arc furnace/continuous casting plant of about 65 000 tons per year capacity, with provision for future expansion. The installation of an integrated complex based on direct reduction process with an annual capacity of 0.5 million tons is also under consideration. No time schedule is yet available for the installation of these additional steel capacities.

Alloy and special steels

In addition, consideration is presently being given to the installation of an alloy steel plant, which also forms a part of this study. Alloy steels production capacity would have to increase in future.

Iron and steel foundries

Plans for the expansion of the foundry industry have so far not been drawn up, but with the growth of the heavy machine building industry in Iran, and increased demand for steel castings, the capacity of the foundry industry is bound to expand. Part of this capacity would be set up as 'captive foundries' in the steelworks and machine building plants. The captive foundry capacity now under construction corresponds to about 14,000 tons of steel castings and about 27,000 tons of iron castings. In addition, about 39,000 tons of iron founding capacity already exists.

5 - Ferro-alloy requirements of Iran (cont'd)

Future iron and steel production

In order to project the future demand of ferro-alloys, it is necessary to have a broad picture of the possible expansion of the steel plants and foundry industry. For the purpose of this study, the future production of iron and steel is expected to be generally as indicated in Table 5-3. It may be noted that these figures do not represent the future steel demand (which is the subject of a separate study) but they give a preliminary indication of the likely future production in Iran.

Table 5-3

PROBABLE IRON AND STEEL PRODUCTION,
1972/73, 1977/78 AND 1982/83

	1972/73 tons	1977/78 tons	1982/83 tons
Tonnage steel (ingots/semis)			
Isfahan and other plants	350 000	2 500 000	3 400 000
Alloy and special steels (ingots/semis)			
Alloy and special steels	-	50 000	80 000
Silicon steel	-	-	6 000
Foundries			
Steel foundry	6 000	15 000	30 000
Iron foundry	30 000	40 000	80 000

Consumption of ferro-alloys

The consumption norms of ferro-alloys for the different products of the iron and steel industry can be derived from past production (if such products are already being produced), otherwise these have to be estimated from the production practices followed in these industries in other countries.

The ferro-alloys requirement for the Isfahan Steel Plant as envisaged in the Soviet DPR is given in Table 5-4.

Table 5-4

FERRO-ALLOYS REQUIREMENT OF ISFAHAN STEEL PLANT a/
(AS ENVISAGED IN SOVIET DPR)

		Ferro-silicon (45% grade)	Ferro-manganese (80% grade)
Annual requirement, tons	..	3 800	4 700
Average requirement, kg/ton	..	6.9	8.7

a/ At 550,000 tons per year capacity.

The ferro-silicon consumption indicated above on 45 per cent grade basis is equivalent to about 4.2 kg on 75 per cent grade basis. This is considerably in excess of that normally required for production of tonnage steels in other countries, and the NISC authorities concerned were not able to give any clarification of this. For this study, in estimating the ferro-alloy requirements for the Isfahan Steel Plant, the DPR figure has not been utilised.

Ferro-alloy consumption rates as obtaining in international practice have been considered and are given in Table 5-5.

about $ 75 million at the end of the 15th year, as against the equity capital of about $ 23 million.

Contributory margin

103. The contributory margin amounts to about $ 19.5 million in the fifth year when the rated production of integrated operations of stage I and stage II is expected to be achieved. This corresponds to a contributory margin to sales ratio of about 0.67.

Break-even point

104. The break-even chart (Fig.V-2) is given on the following page. It will be noted that the break-even point is reached when the plant operates at about 68 per cent of the rated capacity.

Internal rate of return

105. Computing the present values of total outflows and inflows at different trial rates, the internal rate of return comes to about 10 per cent as given in Table 2-27, seen in conjunction with Fig. V-3 (which is the interpolation chart).

Excess present value

106. For determining the excess present value, the present values of total inflows and outflows at 8 per cent rate are worked out as $ 72.5 million and $ 60 million respectively. The excess present value at 8 per cent is therefore $ 12.5 million and the present value index is 1.21.

, 5 - Ferro-alloy requirements of Iran (cont'd)

Table 5-5

FERRO-ALLOYS CONSUMPTION RATES

		Ferro-silicon (75% grade) kg/ton	Ferro-manganese (75% grade) kg/ton	Ferro-chrome (all grades) kg/ton
Tonnage steel plants	..	3.0	10.0	-
Alloy and special steels	..	9.0	10.0	6.0
Silicon steel	..	40.0	-	-
Steel castings	..	7.0	10.0	-
Iron foundries	..	7.0	-	-

Requirement of ferro-alloys

Based on the above consumption rates, the probable indigenous requirements of ferro-alloys are estimated in Table 5-6. The estimates include a provision for contingencies of 10 per cent for ferro-silicon and 5 per cent for ferro-manganese.

Table 5-6

FUTURE FERRO-ALLOY REQUIREMENTS,
1972/73, 1977/78 AND 1982/83

		1972/73 tons	1977/78 tons	1982/83 tons
Ferro-silicon (75% grade)	..	1 400	9 000	13 000
Ferro-manganese	..	4 000	26 500	38 000
Ferro-chrome	..	-	300	500

It will be noted that the ferro-alloy requirements increase rapidly between 1972 to 1977. In planning new ferro-alloy (ferro-manganese and ferro-silicon) capacity, therefore, due consideration has to be given to the demand in about 1977/78 and thereafter as the low demand in 1972/73 would not sustain economic operations and as any new capacity may not come into operation before 4 or 5 years from now. The local demand for ferro-chrome till 1982/83 is too small to justify installation of a plant, and therefore, such a plant has to be initially export-oriented.

6 - FERRO-ALLOY EXPORT POSSIBILITIES

The world demand for ferro-alloys is rising not only because of continuing growth of tonnage steel production but also because of the increasingly higher ratio of alloy steels to tonnage steel. If steel is to maintain its dominant position in materials technology, the production of steels with greater strength and higher corrosion resistance is imperative, which in turn calls for greater use of ferro-alloys.

Ferro-alloy situation in selected countries

No other activity in the steel industry is so dependent on international trade as ferro-alloys. As both ferro-alloys and the raw materials needed for their manufacture are international commodities, the major steel producing countries are sensitive to ferro-alloy developments elsewhere. In this context it would be relevant to review briefly the situation of ferro-alloys in selected countries.

Canada

Canada produces and exports ferro-silicon, ferro-chrome and ferro-manganese, though the exports of the latter two are rather limited. Canada's trade in ferro-alloys during 1964, 1965 and 1966 is given in Table 6-1.

Table 6-1

CANADA: TRADE IN FERRO-ALLOYS, 1964 to 1966

		1964 tons	1965 tons	1966 tons
Exports				
Ferro-chrome	..	156	186	31
Ferro-manganese	..	3 047	3 463	5 109
Ferro-silicon	..	41 718	42 118	33 949
Imports				
Ferro-manganese	..	19 804	31 354	48 855
Ferro-silicon	..	3 114	5 679	5 247

U.S.A.

The United States of America is the largest user of high alloyed steels and as such of ferro-alloys. The average consumption of all ferro-alloys is about 20 kg per ton steel. In terms of world production of ferro-alloys, approximately one-third is accounted for by this country. The production, import and exports of ferro-chrome, ferro-silicon and ferro-manganese in USA for 1966 are given in Table 6-2.

Table 6-2

USA: PRODUCTION, IMPORT AND EXPORT
OF FERRO-ALLOYS, 1966

		Ferro-chrome tons	Ferro-silicon tons	Ferro-manganese tons
Production	..	281 000	463 400	816 100
Imports	..	59 200	11 7[illegible]	230 270
Exports	..	6 950	5 [illegible]9	487

6 - Ferro-alloy export possibilities (cont'd)

It will be observed that USA is a net importer of ferro-alloys. This factor has had a tremendous impact on the ferro-alloy industry, as indicated by the happenings of fifties. The big strategic stockpile of USA in 1950's resulted in an increased growth rate of ferro-alloy industry, faster than the steel industry, the major consumer. As a result, when in 1958 the steel production and alloy requirements suddenly dropped in USA, the ferro-alloy industry was badly hit.

In 1968 production of low-carbon as well as high-carbon ferro-chrome in USA declined mainly because of decreased production of high chrome bearing steels such as high speed and stainless steels. The total quantity of low carbon ferro-chrome imported was about 52,000 tons (of which 25,000 tons was from South Africa) and the local production was 95,000 tons. The high-carbon ferro-chrome and charge chrome production was higher than the domestic requirements, and therefore a part was exported to Europe, while the imports were around 8,000 tons.

In some countries such as USA, where prices of some imported ferro-alloys are lower than locally produced ones, the Government has provided protection to the local industries in the form of levies for imports etc. The competitive position of importers in the meanwhile is improving through the 5-year tariff reductions agreed to at the Kennedy round of GATT tariff negotiations and the first stage of the 50 per cent reduction came into effect from 1968. Several major domestic ferro-alloy producers have approached the Office of Emergency Preparedness to start investigating the effect of imports on the local industry and have suggested cut in imports - for standard grade ferro-manganese from 42 per cent to 27 per cent of local production and for medium carbon refined variety from 26 per cent to 20.3 per cent of local production. The chances of the present administration fixing import quotas in the immediate future on ferro-alloys are reported to be slim.

Latin America

Mexico, Brasil, Argentina and Chile are the leading producers of ferro-alloys in Latin America. Production figures of ferro-chrome, ferro-silicon and ferro-manganese for 1967 are given in Table 6-3. The figures do not include the small quantities produced in Colombia, Peru, Uruguay and Venezuela.

6 - Ferro-alloy export possibilities (cont'd)

Table 6-3

LATIN AMERICA: PRODUCTION OF
FERRO-ALLOYS, 1967

		Ferro-chrome tons	Ferro-silicon tons	Ferro-manganese tons
Argentina	..	1 665	6 369	10 117
Brasil	..	-	15 707	29 830
Chile	..	1 074	3 842	3 887
Mexico	..	-	11 160	35 540
Total	..	2 739	37 078	79 374

The surplus of ferro-alloys available is exported to USA and to other Latin American countries.

United Kingdom

UK, the fifth largest steel producer in the world, is also the largest importer of ferro-alloys. The prohibitive cost of electric power has prevented indigenous production of ferro-alloys, except high carbon ferro-manganese produced in blast furnaces, which is also exported. The export of ferro-manganese was 22,000 tons in 1968 but less than 2 500 tons in the first five months (January to May), 1969. The import of ferro-alloys in 1968 and during January to May 1969 are given in Table 6-4. The total imports of ferro-alloys in the first six months of 1969 was 165 642 tons.

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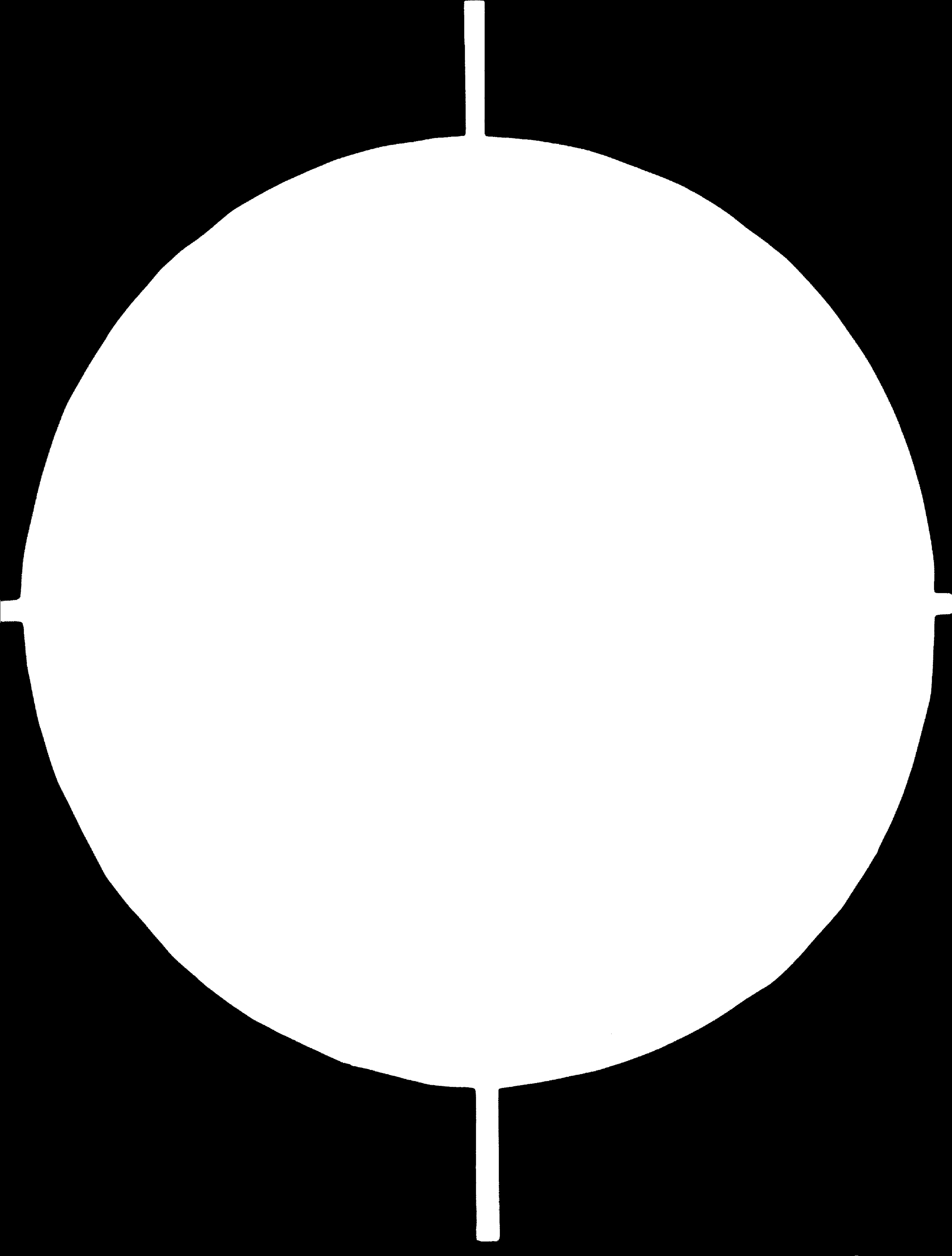

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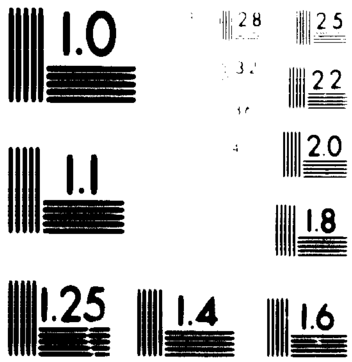

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STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

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6 - Ferro-alloy export possibilities (cont'd)

East Germany Steel production in East Germany in 1966 was about 4.1 million ingot tons. The consumption of ferro-alloys was substantial, but separate statistics of production, export and imports of ferro-alloys are not available. However, it is understood that the entire quantity of ferro-alloys is imported from the USSR.

Hungary Ferro-alloy production of Hungary recorded a downward trend and declined from 19,000 tons in 1962 to 6,000 tons in 1964 and remained at this level till 1966. The country has, therefore, become more dependent on imports. In 1965, total imports were 25,000 tons of which 23,000 tons were supplied by USSR.

Bulgaria Bulgaria is also an importer of ferro-alloy, though some quantities are locally produced. Imports are mainly from USSR.

USSR USSR has a major influence on the world ferro-alloy industry, as it is the second largest steel producing country, a major supplier of manganese and chrome ores, and also an important exporter of ferro-alloys. The ferro-alloy usage in USSR and USA is almost identical. It must, however, be mentioned that such a comparison is not meaningful as reliable statistics on the grade of ferro-alloys used is not readily available.

6 - Ferro-alloy export possibilities (cont'd)

Exports of ferro-alloys from USSR for 1966 and 1967 are given in Table 6-14.

Table 6-14

USSR: EXPORTS OF FERRO-ALLOYS, 1966 AND 1967
(tons)

		1966	1967
Ferro-chrome	..	29 800	31 000
Ferro-silicon	..	91 400	100 400
Ferro-manganese	..	87 400	87 000
Total	..	208 600	218 400

South Africa

South Africa has a large export-oriented ferro-alloy industry sustained by its own vast mineral resources. Production and trade in ferro-alloys during 1964 and 1965 are given in Table 6-15.

Table 6-15

SOUTH AFRICA: PRODUCTION AND TRADE IN FERRO-ALLOYS, 1964 AND 1965
(tons)

	Production		Exports		Imports	
	1964	1965	1964	1965	1964	1965
Ferro-chrome	...	...	28 559	62 933	36	16
Ferro-manganese	...	...	122 240	157 598	7	4
Ferro-silicon	...	...	20 740	16 202	1 863	1 356
Others	...	...	4 575	302	195	249
Total	230 000	332 000	176 114	237 035	2 101	1 625

6 - Ferro-alloy export possibilities (cont'd)

South Africa is the largest ferro-chrome exporter in the world. The factors which have favoured this position are: i) establishment of super thermal stations with captive sources; and ii) a strong infra-structure in the form of mining and transport system.

Research and development have also played a significant role in the progress of South Africa's ferro-chrome industry. The metallurgical problems confronting the fast growing ferro-alloy industry and increasing competition in the market, have been responsible for stepping up research and development efforts, which have resulted in improved processes and quality, and also lowered costs - a trend which will continue. The high iron-content South African chrome ores with Cr:Fe ratio of 1.6 to 1.8 : 1 are being used to produce low carbon ferro-chrome containing 53 to 56 per cent Cr. The product is being exported on the basis that the user gets 15 per cent low carbon iron at no cost.

The major ferro-chrome consumer in the country is a stainless steel plant commissioned in 1967, which is expected to produce 25,000 tons in 1970.

Rhodesia

The ferro-alloy industry in Rhodesia is limited to production of chrome based alloys. In addition to export of chrome ore, almost the entire production of the two

6 - Ferro-alloy export possibilities (cont'd)

ferro-chrome plants in the country was exported till recently. In 1964, ferro-chrome production was 23,000 tons and exports were 22,700 tons, main destinations being UK, Australia and Sweden. In 1965, plans for trebling the capacity of Rhodesian Alloys (P) Ltd were announced. However, in view of the political developments since then, these are reported to be frozen.

<u>Middle East countries</u>

Geographically speaking, the Middle East and Persian Gulf countries would have a significant bearing on the ferro-alloys trade of Iran.

Algeria

Algeria's new steel plant has recently come into operation and the entire quantity of ferro-alloys requirements is at present imported.

Cyprus

Cyprus does not produce any steel. The ferro-alloy requirements of Cyprus are negligible, being only 10 to 15 tons per year.

Iraq

It is understood that the Iraqi Ministry of Industries is studying a project for installation of a 350,000 tons per year steel mill at Umma Quasir, based on the use of scrap. The imports of ferro-alloys hitherto have been insignificant.

6 - Ferro-alloy export possibilities (cont'd)

Lebanon

Lebanon has also plans to install steelmaking capacity based on the use of scrap. At present, the National Iron and Steel Manufacturing Co, produce cast iron pipes based on imported pig iron and coke. The ferro-alloy requirements are met by imports which have varied from about 300 to 1,300 tons per year between 1961 and 1964.

Morocco

Till 1966, Morocco's iron and steel requirements were met entirely by imports. But now, the setting up of the country's first steel project at Mador with an annual production of about 0.25 million tons, based on the use of local iron ore and imported coke, is under consideration. The import of ferro-alloys has been about 300 tons per annum.

Syria

Syria is presently installing a rolling mill at Hamma which is expected to start operation by the end of this year (1970). It is also planning to install an integrated iron and steel plant based on local ores. The current ferro-alloys requirements have been insignificant, about 15 tons only in 1961 which have been met through imports.

Tunisia

Tunisia's steel production in 1966 was 45,000 ingot tons. The ferro-alloy requirements of about 500 tons per anuum are met through imports.

6 - Ferro-alloy export possibilities (cont'd)

UAR United Arab Republic's steel production was about 179,000 ingot tons in 1965 which is expected to be raised to 2.25 million ingot tons in 1975. A ferro-manganese plant was installed at Sinai for utilising the local manganese ores, but did not go into production till 1969. It is reported that UAR proposes to be self-sufficient in ferro-alloys by 1975.

RCD countries

Turkey Steel production of Turkey was under one million ingot tons in 1966. The ferro-alloy industry is practically restricted to the manufacture of ferro-chrome at Anthalia in the south-western part of the country. The bulk of the production of this two-furnace plant with a rated annual capacity of 8,000 tons of ferro-chrome, is exported. Exports of ferro-chrome during the years 1964 to 1968 are given in Table 6-16.

Table 6-16

TURKEY: EXPORT OF FERRO-CHROME AND OTHER FERRO-ALLOYS, 1964 TO 1968
(tons)

	1964	1965	1966	1967	1968
Ferro-chrome ..	5 863	5 946	7 367	5 206	6 933
Silico-chrome ..	-	-	-	-	1 061
Others ..	-	-	-	70	-

6 - Ferro-alloy export possibilities (cont'd)

The ferro-manganese and ferro-silicon requirements are met through imports, the main source of supply being Norway, USA and USSR. The imports of ferro-manganese and ferro-silicon for the period 1964 to 1968 are given in Table 6-17.

Table 6-17

TURKEY: FERRO-SILICON AND FERRO-MANGANESE IMPORTS, 1964 TO 1968
(tons)

	Ferro-manganese	Ferro-silicon	Total
1964 ..	5 058	1 229	6 287
1965 ..	7 089	1 367	8 456
1966 ..	8 644	1 322	9 966
1967 ..	5 566	1 598	7 164
1968 ..	4 885	1 963	6 848

In addition, small quantities of ferro-chrome (about 20 to 25 tons per year) were also imported between 1966 and 1968. Imports of other ferro-alloys were about 550 tons in 1967 and 1,900 tons in 1968.

Pakistan

The iron and steel industry in Pakistan has made a beginning with a 180,000 tons per year capacity plant which is to be expanded to 250,000 tons per year by 1970. The production is based on steel scrap and was 12,000 tons of ingot steel in 1964. Pakistan has no ferro-alloy industry and the entire requirements are imported. The imports of ferro-alloys in 1965-66 are given in Table 6-18.

6 - Ferro-alloy export possibilities (cont'd)

Table 6-18

PAKISTAN: IMPORTS OF FERRO-ALLOYS,
JULY 1965 TO JUNE 1966

		Value Rs
Ferro-chrome	..	117 616
Ferro-silicon	..	460 691
Other ferro-alloys	..	243 412
Total	..	821 719

India

India is a leading exporter of both ferro-alloys and its ores, mainly chrome and manganese ores and ferro-manganese and ferro-silicon. Till very recently the ferro-alloys produced were limited to ferro-manganese and ferro-silicon but in 1969 two ferro-chrome plants went into production and a part of ferro-chrome produced is being exported. Production and trade of ferro-alloys are given in Table 6-19.

Table 6-19

INDIA: PRODUCTION AND TRADE IN FERRO-ALLOYS
(tons)

	Production		Exports		Imports		
	FeMn	FeSi	FeMn	FeSi	FeCr	FeSi	FeMn
1965/66 a/	155 900	20 300	56 423	4 763	875		543
1966/67	134 400	19 500	10 020	904	527		548
1967/68	138 500	18 400	29 296	950	1 204		322
1968/69	132 280 b/	15 770 b/	70 260	3 672	466		116

a/ Fiscal years commencing 1st April
b/ For 11 months ending February 1969.

6 - Ferro-alloy export possibilities (cont'd)

Considerable capacity of ferro-manganese was established mainly for export. But at the very inception the industry was hard hit because of the sudden fall in world demand in 1958 - an after effect of the US strategic stock piling policy of 1950. Since then the industry has been subject to low ebbs and high tides of international trading. Currently there is a boom in the export market and the entire surplus available for 1969/70, totalling to about 75 000 tons was booked up within the first six months of the year. The increase in exports over last year is largely due to increased demand from Japan.

The ferro-silicon industry was installed mainly to meet the increasing internal demand and any surplus available after meeting local requirements was exported. The entire surplus expected to be available during the current year has been already booked up for exports and orders are being entertained for 1970-71 only. The expansion of ferro-silicon capacity for export is currently under consideration.

One of the ferro-chrome plants is also considering further expansion in view of the present world market situation.

Japan

The ferro-alloy industry in Japan has grown along with the steel industry. There has been marginal trade mainly to meet small imbalances. For example, in 1969 for the first time in two years, Japan negotiated with India for 12 000 tons of ferro-manganese, owing to a fall in indigenous production of ferro-manganese, occasioned mainly due to furnace troubles. The production of ferro-silicon and ferro-chrome has also been affected by drought, necessitating imports of some quantities of these alloys.

The estimated production and requirement of ferro-alloys for 1969/70 is given in Table 6-20.

Table 6-20

JAPAN: ESTIMATED REQUIREMENT OF FERRO-CHROME, 1969/70

	Production tons	Requirements tons
Ferro-chrome		
High C	180 000	158 000
Low C	90 000	89 000
Ferro-silicon	220 000	237 000
Ferro-manganese		
High C	370 000	316 000
Low C	81 000	68 000
Total	**941 000**	**868 000**

It is noted that only a marginal shortfall in ferro-silicon requirement is expected in 1969/70. With

6 - Ferro-alloy export possibilities (cont'd)

Table 6-4

UK: IMPORTS OF FERRO-ALLOYS, 1968 AND 1969

	Ferro-chrome tons	Ferro-silicon a/ tons	Ferro-manganese tons
1968	58 474	115 296	66 389
1969 (Jan to May)	24 431	46 790	38 292

a/ Includes silico-chrome

UK, possibly the most open market for ferro-alloys, influences the world market considerably by its purchasing policies such as centralised buying by the British Steel Corporation. To keep prices down, UK recognises certain suppliers as 'traditional' who enjoy a price advantage over 'non-traditional' suppliers. Ferro-alloy prices in UK are generally lower than in other markets. The favourable prices which UK enjoys for Norwegian ferro-silicon in comparison with other European countries, is mainly due to historical reasons as UK in turn supplies metallurgical coke to Norway.

Norway

Norway is a major ferro-alloy producer because of abundant availability of cheap power. It is the largest exporter of ferro-silicon. Manganese ore and chrome ore

6 - Ferro-alloy export possibilities (cont'd)

continuing expansion of steel production, however, the requirements will increase in coming years, but various measures are already being thought of to bridge the gap. It has been estimated that the ferro-silicon requirements in 1972/73 will be about 307,000 tons as against the availability of around 200,000 tons. To make up this deficit of 100 000 tons, calcium carbide producers have entered the field of ferro-silicon production and between April 1969 to June 1971 some 13 furnaces with a total rating of 140,000 kVA will switch over to ferro-silicon production which would add about 80,000 tons per year to the existing capacity.

The local pricing is adjusted to international prices. In the case of silico-manganese, for example, the local prices were recently increased by $ 2.80 per ton (*Metal Bulletin*, 18 Apr 1969), as it was lower than international prices. Similarly, in order to lower the prices of certain ferro-alloys, mergers of a number of companies to form bigger units are in the offing. For example, Japan Metals and Chemicals Co. Ltd, with a total capacity of 200,000 tons per year is being formed by the merger of Japan Ferro-Alloys Co and Asuma Kako K.K.

6 - Ferro-alloy export possibilities (cont'd)

Australia

Australia meets her ferro-alloys requirements by indigenous production supplemented by imports in (Table 6-21). No ferro-alloys are exported.

Table 6-21

AUSTRALIA: PRODUCTION AND IMPORTS OF FERRO-ALLOYS, 1965 AND 1966

	1965		1966	
	Production tons	Imports tons	Production tons	Imports tons
Ferro-chrome	1 358	3 238	...	...
Ferro and silico-manganese	56 901	9 728	...	11 122
Ferro-silicon	4 475	8 727	...	7 500
Total	62 734	21 693		18 622

Price trends

International trade in ferro-alloys and ores is influenced by political, technical, economic and commercial developments in the world as a whole.

Chrome ore

Increasing prices

A development which has had a far reaching effect on the ferro-alloy industry was the UN economic sanctions against Rhodesia, one of the major exporters of high grade lumpy chrome ores. The economic boycott of Rhodesia forced up chrome ore prices from $ 20 to around $ 24 per ton and created not only favourable circumstances for exporters like USSR and Turkey, but gave new life to the chromite industry of countries like Iran. Prices of Soviet ore have increased by 50 per cent, while Turkish ore prices have gone up by about 15 per cent. South African Transvaal ore prices have, however, remained fairly steady. The trend of world prices of chrome ore is given in Table 6-22.

Reserves enhanced

If the upward trend in prices of Soviet chrome were to continue, it is likely that the South African (Transvaal) ore will be in increased demand. In this context, it is interesting to note that technological innovations have led to the reappraisal of the natural distribution of metallurgical chrome ores. For example, till 1964 it was believed that the 300 million tons of metallurgical grade ore occurring in Rhodesia constituted 75 per cent of the total world reserves of this grade (excluding USSR). However, with the successful utilisation of Transvaal ore (which was regarded as chemical grade) for ferro-chrome production, world chromite reserves (excluding USSR) have been re-estimated at 2,660 million tons, 75 per cent of which occurs in Bushveld igneous complex of South Africa. Similarly, Yawata Steel of Japan claims to have developed a suitable process for utilising Mindane Island (Philippines) chromite which was not exploited earlier due to smelting difficulty.

4 - Ferro-alloy export possibilities (cont'd)

Table 6-22

WORLD PRICE TREND OF CHROMITE ORES

Source	Type	Grade Cr_2O_3 %	Grade Cr:Fe	Basis	Price $/ton 1964	1965	1966	1969	1970
Soviet	Lumpy	48	3.5:1	c.i.f.	-	-	-	34.4 to 41.3	42.2 to 44.2
		54 to 56	4:1	c.i.f.	-	30.0 to 32.4	30.0 to 32.4	44.5 to 48.2	-
Pakistan	Friable Lumpy	48	3:1	f.o.b.	-	-	-	29.4 to 32.4	29.4 to 32.4
Turkey	Lumpy	48	3:1	c.i.f.	29.4 to 31.4	29.0 to 30.9	29.0 to 32.9	30.4 to a/ 33.4	32.4 to a/ 39.3
	Concentrate	48	3:1	f.o.b.	-	-	-	27.5 to 30.4	30.4 to 33.4
Transvaal	Friable Lumpy	44	-	c.i.f.	17.7 to 18.7	19.7 to 21.1	17.7 to 21.1	22.6 to 25.5	22.6 to 25.5
Southern Rhodesia	Lumpy	48 to 50	3:1	c.i.f.	29.4 to 34.4	30.4 to 34.4	30.4 to 34.4	Nominal	Nominal
Iran	Hard lumpy	48 to 50	3:1	c.i.f.	-	-	20 a/	34.4 to 36.4	41.2 to 43.2

a/ f.o.b.

6 - Ferro-alloy export possibilities (cont'd)

Manganese ore

Manganese ore industry is characterised by supplies in excess of demand, which has been responsible for the downward trend in prices in recent years as indicated in Table 6-23.

Table 6-23

PRICE TREND OF MANGANESE ORE, 1967 TO 1969
(cents/ton unit of Mn)

Grade	1967	1968	1969
c.i.f. European ports			
46 to 48% Mn, 0.1% max P	58 to 77	57 to 73 a/	...
46 to 48% Mn, other grades	54 to 71	54 to 71	...
48 to 50% Mn	...	53 to 58 b/	50 to 55
c.i.f. USA ports			
46% min Mn	69 to 72	...	49
48% min Mn, low impurities	73 to 77	...	52 to 56

a/ Prices upto October
b/ Prices from October

Increased competition

In addition, there is a continuous trend towards marketing richer ores and exploration is being vigerously pursued to discover and locate new deposits. The discovery and development of rich new deposits and ample supplies of high grade Brazilian and African ores at lower prices are even bringing about closure of uneconomic units. For example, towards the end of 1968 Union Carbide Corporation discontinued their manganese mining operations at Mathews Ridge, Guiana, which had been supplying ore to the Corporation's metallurgical operations in USA and Norway since 1960.

Ferro-alloys

Ferro-alloy prices have been affected by the developments in the ore industry, demand and supply position of ferro-alloys in world market and technological trends in ferro-alloy production.

In UK ferro-chrome prices are quoted on the basis of a scale of 4 to 6 per cent carbon and over 6 per cent carbon qualities, while 2 per cent and lower carbon content grades are quoted on per pound of metal content basis. Ferro-silicon of 75 per cent grade is quoted for bulk delivery which is not yet widely practised in other grades. The Norwegian Association has introduced flat price basis for bulk supply while scale basis for packed alloys continues. Standard grade ferro-manganese is quoted on flat basis and the refined grade on scale basis. Ferro-alloys are negotiated and priced on a quarterly basis.

UK market

The price trends may best be reviewed by studying the UK market, the biggest importer of ferro-alloys. The price trends of ferro-chrome, ferro-manganese and ferro-

6 - Ferro-alloy export possibilities (cont'd)

silicon in UK are shown in Figure II-1. For the last three years there has been a fairly continuous increase in prices of ferro-alloys, particularly ferro-chrome.

The recent trend of prices of selected ferro-alloys in UK market is given in Table 6-24.

Table 6-24

RECENT IMPORTED FERRO-ALLOY PRICES IN UK MARKET

		Price £/ton		
		1969		1970
Material	Basis	3rd Quarter	4th Quarter	1st Quarter
Ferro-chrome High carbon	67% Cr Packed	221 to 237	230 to 244	244 to 263
	Bulk	214 to 230	228 to 240	241 to 258
Low carbon	68% Cr Packed	307 to 333	325 to 344	374 to 419
	Bulk	297 to 316	314 to 329	367 to 410
Ferro-silicon	75% Si Packed	170 to 177	177 to 184	196 to 224
	Bulk	165 to 170	170 to 179	186 to 196
Ferro-manganese	Standard grade	120	123	133

Iran - Ferro-alloy export possibilities

Ferro-alloys present good export possibilities for Iran, in view of the increasing world trade in this commodity. The potential of the country in establishing and sustaining fairly large sized industry specially for ferro-chrome and ferro-silicon is good considering the raw materials availability and power resources. As and when adequate availability of local manganese ores of suitable quality is assured, export of ferro-manganese also might be possible.

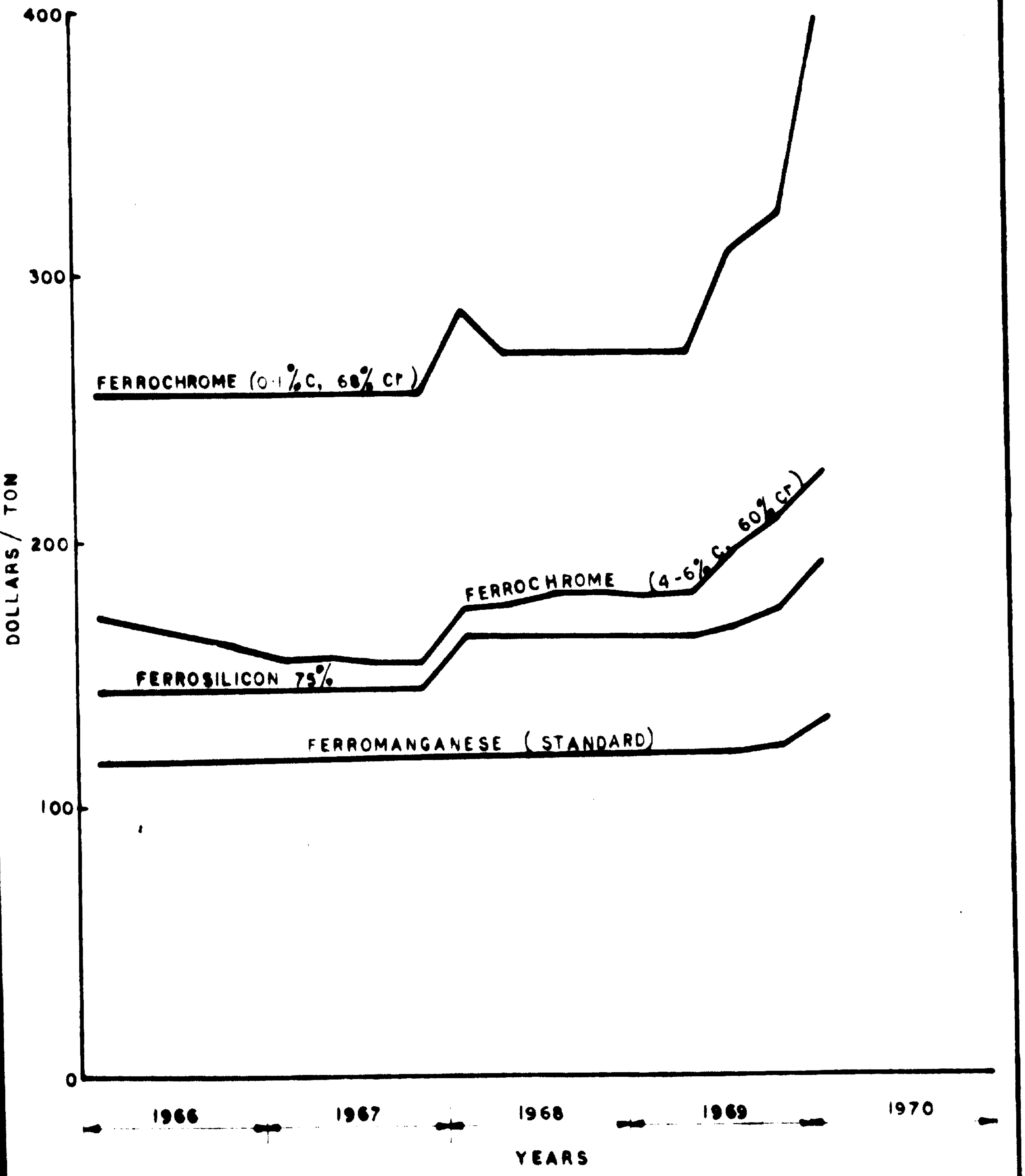


FIG. II – 1. UK FERROALLOYS PRICE TREND

6 - Ferro-alloy export possibilities (cont'd)

The direction of trade with some selected countries who are ferro-alloy importers is given in Table 6-25.

Table 6-25

EXTERNAL TRADE a/ BY PRINCIPAL
COUNTRIES, 1967 AND 1968

($ million)

	1967		1968	
	Export	Import	Export	Import
Canada ..	0.6	2.4	0.5	2.8
USA ..	22.3	189.8	20.6	212.4
UK ..	10.1	121.7	9.7	139.4
W. Germany ..	22.4	206.1	27.4	275.3
Italy ..	6.8	48.3	3.4	60.1
Austria ..	0.8	13.8	0.7	17.2
Czechoslovakia ..	5.5	7.6	7.3	13.5
Rumania ..	3.1	7.0	4.4	13.7
Poland ..	3.3	7.3	5.5	4.9
Hungary ..	3.7	4.1	2.5	7.1
Bulgaria ..	-	5.1	1.0	2.7
Turkey ..	0.1	0.1	-	0.1
Pakistan ..	1.6	2.7	1.0	4.1
Japan ..	4.9	73.0	3.6	91.6
Australia ..	0.5	12.1	0.2	9.4

a/ Excluding oil.

Export diversification

The export policy of the Government during the current Plan is the continuation of the policy initiated during the Third Plan, namely the diversification of exports and transition of the country from exporter of raw materials to exporter of finished goods, which would make the country less dependent on oil revenues. It is envisaged that the Fifth Plan will be significantly export-oriented.

6 - Ferro-alloy export possibilities (cont'd)

Potential countries for export

Potential customers

Amongst the European countries, Rumania, Czechoslovakia and Poland are ferro-alloy importers. Though USSR is the major exporter tp these countries, it may be reasonably expected that in view of good trade relations between USSR and Iran, a part of the increased demand of ferro-alloys of these countries may be met by Iran.

West Germany is another potential buyer, whose exports to Iran are almost ten times that of imports. However, trading in ferro-alloys with West Germany has to keep in view the trade relations amongst EEC member countries and the third country import quota.

UK is the largest importer of ferro-alloys in the world and exports goods worth about 14 times more than its imports for Iran. The entry into the UK market would, however, depend on how competitive Iranian ferro-alloys would be and, as a new comer, Iran has to be initially content with the position of 'non-traditional supplier'.

Geographically, the countries with maximum export interest would be Iran's RCD partners and Persian Gulf countries. Turkey imports its total requirement of ferro-silicon and ferromanganese, while Pakistan may continue importing all ferroalloys for some years to come.

6 - Ferro-alloy export possibilities (cont'd)

are imported, while quartsite is available indigenously. The bulk of ferro-alloy production (about 95 per cent) is exported mainly to UK, West Germany, Sweden and Benelux countries.

In 1966, out of a total production of 232 745 tons of ferro-silicon, 219,684 tons were exported. Ferro-chrome exports amount to 29,259 tons out of a total production of 30,516 tons. Exports have recorded a steady increase as reflected by the export trend of two major items during 1967 and 1968, given in Table 6-5.

Table 6-5

NORWAY: EXPORT OF SILICO-MANGANESE AND FERRO-MANGANESE, 1967 AND 1968

		1967	1968
Silico-manganese	..	112 936	131 872
Ferro-manganese	..	120 514	143 753
Total	..	232 450	275 625

Sweden

The proportion of alloy and special steels to tonnage steel produced is the highest in Sweden, and therefore Sweden is a major ferro-alloy consumer. Ferro-alloy production and trade in 1966 are given in Table 6-6.

6 - Ferro-alloy export possibilities (cont'd)

Turkey (and more recently India) have export-oriented ferro-chrome industry. Turkey is not as favourably located as India for trading with south-east Asia, east Asia and Oceania. Iran also has a good potential to trade in these markets through its southern ports.

It must also be mentioned, that the installation of export-oriented ferro-alloy capacity is continuing in a number of countries. For instance, the expansion of ferro-silicon industry in Norway and India is going ahead due to the increased world-wide interest in ferro-silicon. Costa Rica is planning to set up a ferro-manganese plant with 30,000 tons per year capacity, entirely for exports to USA. In Finland,Outokumps Oy are installing a 30,000 tons per year ferro-chrome plant at Tomio. With regard to ferro-chrome, increasing demand of chrome ore in Europe and Japan and the rising price trend of chromite,are likely to push the ferro-chrome prices upward in the next few years (after 1969).

Probable exports

With the continuing increase in mild and alloy steel production, world ferro-alloy capacity would also have to be stepped up. It is estimated that future requirements of the three major ferro-alloys would be over 8 million tons in 1970 and are expected to rise to about 12 million tons in the next decade (Table 6-26).

6 - Ferro-alloy export possibilities (cont'd)

Table 6-26

WORLD ESTIMATED FERRO-ALLOY REQUIREMENT

	1970 tons	1975 tons	1980 tons
Ferro-chrome	1 700 000	1 960 000	2 300 000
Ferro-silicon (75% gr)	860 000	1 050 000	1 200 000
Ferro-manganese (75% gr)	5 700 000	7 000 000	8 500 000
Total	8 260 000	10 010 000	12 000 000

Iran's share <u>in world trade</u>

Iran's share in this international activity would largely depend on the production of consistent and high quality product at low cost. The tentative export possibilities assumed in this study are given in Table 6-27.

Table 6-27

IRAN: TENTATIVE EXPORT POSSIBILITY OF FERRO-ALLOYS, 1977 AND 1982

	1977 tons		1982 tons	
Ferro-chrome ..	13 000 to	15 000	20 000 to	30 000
Ferro-silicon ..	5 000	7 000	6 000	9 000
Ferro-manganese ..	6 000	8 000	8 000	10 000
Total	24 000	30 000	34 000	49 000

The export targets indicated are a fraction of the increase in world demand and can be reasonably expected to be realised if the supplies are competitive, both in terms of quality and price.

7 - ALLOY STEEL REQUIREMENTS OF IRAN

Alloy and special steels are those which owe their typical properties either to the deliberate addition of certain alloying elements normally not found in ordinary steels or to the presence of larger proportion of elements (like manganese and silicon) than are present in ordinary steels. The precise connotation of alloy and special steels differs from country to country; Appendix 7-1 gives a general note on the classification of alloy steels followed in major steel producing countries.

Role of alloy steels

The importance of alloy steels in the development programme of a country can hardly be over-emphasised. Alloy steel consumption is a fair measure of a country's industrial development. The economic importance of alloy steels arises from the fact that they are prerequisites for the fabrication of all capital goods and consumer durables. They are indispensable in a number of manufacturing industries, such as industrial machinery, transport equipment and metal products. Besides, they are required for a country's defence industries.

There is generally some time lag between the development of the ordinary steel industry and the alloy steel industry in a country. Now that Iran is installing its first integrated steel plant, it is appropriate that it also starts planning its alloy steel industry, so that the demand for such steels could be met to a large extent from indigenous sources.

The future requirement of mild as well as alloy steels is the subject of a separate study now under preparation. The initial findings of this study relating to alloy steels are reviewed in order to determine the capacity and product-mix of the proposed alloy steels plant.

Past consumption

The import of alloy and special steels into Iran during the past few years is given in Table 7-1. As there is no indigenous alloy steels production, the import figures may be assumed to represent the consumption of alloy and special steels in the country.

7 - Alloy steel requirements of Iran (cont'd)

Table 7-1

SPECIAL STEEL IMPORTS, 1962/63 TO 1969/70

(tons)

Categories		1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70[a]
Ingot	..	3	147	-	13	-	33	67	525
Semis	..	77	29	60	62	-	51	611	182
Bars	..	51	270	279	349	461	630	783	761
Wires	..	22	28	240	94	959	6 982	6 747	1 306
Sheets	..	59	9	646	2 667	2 251	27 014	28 559	9 199
Hoops	..	83	142	52	329	301	539	1 727	307
Total	..	295	625	1 277	3 514	3 972	35 249	38 494	12 280

a/ For nine months, March to November 1969.

Source: Foreign Trade Statistics of Iran.

Sudden rise in import figures

The above import statistics are aggregates and do not define the types of steels included under the tariff code of special steels. There is a sudden rise from about 4,000 tons in 1966/67 to about 35,000 tons in the very next year, mainly in sheets (about 25,000 tons) and in wires (about 6,000 tons). Since the nomenclature does not specify the types of steel, it has not been possible to ascertain whether these large imports really consisted of alloy and special steels and, if so, what were the types of steels and where and how they were used.

Past consumption

The past consumption pattern as well as the industrial structure do not warrant the sudden big rise in alloy steel imports. From an analysis of the c.i.f. values it would appear that mild steel sheets imported for automobile body panels and domestic consumer durables, capacity for which was created in recent years, have been included under the import classification for special steels. Therefore, judging from past trends as well as the degree of industrial development, it is reasonable to assume that alloy and special steels imports in 1968/69 may actually have been not more than 7,000 tons. This is also borne out by the fact that in 1968/69 only 12,000 tons of alloy and special steels were imported during the period March to November.

Present direct imports by steel types

The types of steels included in the above import figures would be mainly alloy tool and die steels, alloy constructional steels and some stainless and other steels, but excluding spring steels which have been classified in the official statistics with ordinary iron and steel products. On the basis of field surveys, the approximate break-down of types of alloy steels imported is estimated to be as follows:

	Tons
Tool and die steels ..	2 000
Constructional steels ..	3 500
Stainless and other steels	1 500
Total ..	7 000

7 - Alloy steel requirements of Iran (cont'd)

The bulk of the alloy and special steel imports (about 70 per cent) consisting of constructional, stainless and some tool steels, is directly by the users. A small portion is imported by the local selling agents of foreign alloy steel producers.

Besides the above, about 3,000 tons of spring steel is being imported which is shown in the import statistics under ordinary steel category. Also some quantity of carbon constructional steel for shaftings is imported for which separate import data are not available.

The above direct import figures are based on discussion with importing agents and the consumers who import directly. Current annual imports of the main agents are understood to be as follows:

Firms	Agents for	Current annual imports of alloy and tool steels tons
Khoshkeh & Faulad S.A. Avenue Khayyam Teheran	Böhler Co Austria	1 000 to 1 200
Rena Co Khiabone Ghasvin Teheran	ASSAB Sweden	300 to 400
Pamir & Co 46 Sepand Avenue Teheran	DEW Germany	200 to 300
	Total ..	1 500 to 1 900

7 - Alloy steel requirements of Iran (cont'd)

Indirect imports

The present direct imports of rolled alloy steels as such would not give the complete picture of the total alloy steel consumption in Iran. As in the case of other developing economies, substantial tonnages of alloy steels are imported indirectly in the form of finished metal products, parts and components of machinery and equipment etc. In order to arrive at a realistic estimate of the total alloy steels consumption, these indirect imports need to be taken into account. For this purpose, the total steel content of the various imported items of machinery and equipment, suitably regrouped under major groups such as transport equipment, industrial machinery, electrical machinery etc, was first derived by the application of appropriate norms of consumption for each item, and then alloy steels content arrived at as a percentage of total steel content.

Table 7-2 gives the total consumption of alloy steels, and the proportion of the alloy steels to total (mild and alloy) steel, consumption, including indirect imports.

7 - Alloy steel requirements in Iran (cont'd)

Table 7-2

GROSS CONSUMPTION OF ALLOY STEELS AND TOTAL STEELS

(Thousand tons)

		Total steel a/			Alloy and special steel b/			Proportion of alloy and special steels to total steel
		Direct imports	Indirect imports	Total imports	Direct imports	Indirect imports c/	Total imports	%
1962/63	..	347	146	493	0.29	7.30	7.59	1.59
1963/64	..	355	143	498	0.62	7.15	7.77	1.56
1964/65	..	505	206	711	1.28	10.30	11.58	1.63
1965/66	..	685	245	929	3.51	12.25	15.76	1.70
1966/67	..	720	288	1 007	3.97	14.40	18.37	1.82
1967/68	..	1 216	304	1 519	35.25 (6.0)d/	15.20	21.20	1.39
1968/69	..	1 365	481	1 846	38.49 (7.0)d/	24.05	31.05	1.64

a/ Ordinary steel (including spring steel) plus alloy and special steels, but excluding iron products and castings.
b/ Excluding spring steel.
c/ Assumed to be 5% of indirect steel imports.
d/ Estimated alloy steel import.

Source: Foreign Trade Statistics of Iran.

Current consumption low

It will be seen that alloy steel consumption has been under two per cent of total steel, which is a low figure due mainly to the fact that heavy industries which are major consumers of alloy and special steels have still not been set up. The situation is comparable to that of India in the early fifties when the proportion of alloy steels to total steel was also only about two per cent; this has now risen to about four per cent. With the rapid industrialisation envisaged in the Fourth and subsequent development plans, the proportion of alloy steel consumption in Iran is also bound to increase.

Future alloy and special steels requirements

1977/78 demand considered

The installation of an alloy steel plant is a time-consuming process involving several stages of activities commencing with the feasibility study, through design and engineering, construction, commissioning of plant units and then achieving rated capacity in another 2 to 3 years. Even if the 'green signal' for a major alloy steel project is given now, it could begin to supply products to the market only by 1974/75 and would reach full production some years later. Hence, any plant visualised today should take into account the allov steel requirements by 1977/78 and beyond.

It is no doubt important that a major new project should become profitable at the earliest. However, in installing the first plant in a country to produce a strategic and basic material like alloy and special steels, commercial profitability is not the only criterion - the need for national self-sufficiency to the extent possible would also be an important objective. An equally significant factor is the recurring expense of foreign exchange

6 - Ferro-alloy export possibilities (cont'd)

Table 6-6

SWEDEN: FERRO-ALLOY PRODUCTION, IMPORTS AND EXPORTS, 1966

		Production tons	Imports tons	Exports tons
Ferro-chrome	..	55 200	16 160	22 917
Ferro-silicon	..	28 700	6 871	1 554
Ferro-manganese	..	25 000	22 507	8 157
Total	..	108 900	45 538	32 628

The main sources of imports were Norway and South Africa in 1965.

EEC countries

Major ferro-alloy producers amongst the EEC countries are France, West Germany and Italy, who are also important exporters/importers.

France

France is a leading country in process development and production of ferro-alloys. Its exports are significant while imports are low. In 1965, the imports were 48,000 tons against a total export of 256,000 tons of ferro-alloys. Trade in ferro-alloys in 1966 is given in Table 6-7.

Table 6-7

FRANCE: TRADE IN FERRO-CHROME, FERRO-SILICON AND FERRO-MANGANESE, 1966

		Exports tons	Imports tons
Ferro-chrome	..	23 092	...
Ferro-silicon	..	20 565	834
Ferro-manganese	..	191 821	16 421
Total	..	235 478	17 255

for import of such materials which puts a strain on the developing economy and hence, a basic industry like alloy and special steels needs to be set up at the first appropriate opportunity.

Though some forecasts for total steel requirements are available, no estimates of future alloy steel demand in Iran have so far been made. The preliminary estimate made in this study is based on the production programme of existing industrial units and new units planned to be set up under the Fourth Plan, after due consideration to the type of manufacturing operation and the proportion of imported parts and components to be used. Obviously, mere assembly units would not generate additional alloy steel demand, until they put into effect schemes of progressive indigenous manufacture.

Output forecasts <u>and norms</u>

The future requirements of alloy steels would mainly arise due to increased industrial activity, particularly in the field of steel processing, such as indigenous production of automobiles, wagons, industrial machinery and equipment, structurals, domestic appliances, tools and agricultural implements etc. The output levels of these alloy steel consuming items for 1977/78, the terminal year of the Fifth Plan, have been determined on the basis of development plans and the estimated growth rate of industrial production and import substitution. The norms of alloy steel consumption have been evolved through the end-use method by discussion with various consumers, personally as well as through questionnaires. For items planned for future production for which local data were not available, appropriate norms obtaining for similar items in other countries have been assumed.

Automobile <u>manufacture</u>

There are four major units in Iran engaged in the assembly of passenger cars and commercial vehicles. Their present activity is confined to sheet metal work and the position is not expected to change much during the Fourth Plan, in spite of the increased production envisaged. Only during the Fifth Plan would indigenously made parts and components be used to the extent of about 95 per cent of the total. Taking these factors into account, alloy steel requirements for the automobile sector have been estimated. Other transport requipment likely to generate alloy steel demand by 1977/78 are railway wagons and farm as well as road trailers.

A major sector consuming alloy steels is manufacture of industrial and agricultural machinery. In estimating the total requirement, all major units together with their production plans by 1977/78 have been considered.

7 - Alloy steel requirements of Iran (cont'd)

Demand by sectors

The requirement of alloy steels in 1977/78 by major consuming sectors and according to steel types are estimated in Appendix 7-2. The total requirement of about 72,000 tons includes a provision of 10 per cent for spares and maintenance, two per cent for small scale industries and 1.5 per cent for stocks. This demand excludes the demand of tool steel and die blocks, which are indirectly required in processing steel.

The anticipated consumption pattern for 1977/78 indicates that the transport sector would be generating the largest demand for alloy and special steel, accounting for about 57 per cent of the total. Since a great deal of alloy steels go into transport equipment, the proportion of alloy steel consumption by the transport sector is the largest. In Iran this proportion is even larger due to the relatively well developed transport sector.

The other major sector (accounting for about 18 per cent) is industrial and agricultural machinery, which again is a large consumer of alloy steels all over the world, next only to transport equipment. All other sectors manufacturing different types of equipment, metal products etc account for the remaining 25 per cent.

To arrive at the total demand according to steel types, the requirements of tool steels and die blocks have been estimated and added to the demand of other types indicated in Appendix 7-2. The requirement of tool steel has been estimated at five per cent of the total alloy and special steels required. The die blocks requirement is estimated on the basis of 1.8 per cent of the expected production of the forgings. The requirement of different types of steels including tool steel and die blocks are given in Table 7-3.

TABLE 7-3

ESTIMATED FINISHED ALLOY STEEL REQUIREMENT, 1977/78

Type of steel	Tons	%
Carbon constructional steel	8 453	10.70
Free cutting steel	4 186	5.40
Spring steel	25 137	32.40
Alloy and constructional steel	27 842	35.00
Stainless steel	6 358	8.32
Electrical sheets	2 340	3.00
Tool steel	3 180	4.10
Die blocks	840	1.08
Total	78 316	100.00

Constructional and spring steels

Steel-wise, the maximum demand is expected to be for low and medium alloy constructional steels (about 35 per cent) and for spring steels (about 33 per cent), these being closely related to the development of the transport sector. Demand for carbon constructional steels (about 11 per cent), though not strictly alloy steels, has also been included in this category, because the stringent quality requirements and production facilities needed for their manufacture are akin to alloy steels.

Electrical steel

Electrical steel sheets required for electrical equipment like transformers, generators etc come to about three per cent and have not been taken into consideration in the product-mix of the proposed plant as these are normally produced in integrated steel plants with facilities for sheet or strip rolling.

Stainless steel

The requirement of stainless steel is fairly low due to the fact that projects to manufacture stainless steel consuming items (such as chemical machinery, fertiliser plants, nuclear equipment, domestic utensils, kitchen-ware, cutlery etc) are still in the planning stage. The small current requirement is for razor blades, domestic appliances etc.

Ball bearing steel

The estimates do not include the requirement of ball bearing steels, though the Swedish firm SKF has plans to set up a unit in Iran to manufacture ball bearings. It is expected that this plant would initially

7 - Alloy steel requirements of Iran (cont'd)

import the ball bearing steels, as there is currently no proposal to install by 1977/78 intermediate facilities to supply the requirements from domestic sources.

Demand by product categories

In terms of product categories, the demand would be mostly for non-flat products (except for small quantities of flat products for razor and hacksaw blades and stainless steel sheets for equipment and appliances). More than 90 per cent of the demand would be in non-flat products of different sizes and finishes. The precise size and finish would depend on the facilities available at the consumers end.

It is estimated that about 20 per cent of carbon and alloy constructional steel would be needed as billets for forgings and the balance as rolled bars such as rounds, squares, flats and hexagons of different sizes, for drop forging as well as direct machining into finished parts.

Spring steels would be required in the form of wide flats for automobile and wagon leaf springs, rounds and squares for coil springs togethor with a small quantity of wires. Free cutting steel would be required mostly in the form of round bars of different sizes.

7 - Alloy steel requirements of Iran (cont'd)

Tool steels would be needed as forged blanks and bars of heavy section, forged die blocks, as well as hot rolled bars of different sections and sizes.

Overall demand

The demand pattern indicates that even by 1977/78 the proportion of alloy steels to total steel would be about three per cent indicating the need for a faster growth rate in alloy steels in future when the industrial production base would be expanded. The proportion of alloy and special steels in total steel consumption varies widely from country to country. For instance, in 1966 this proportion was 9.16 per cent in USA, 7.71 per cent in Japan, 6.50 per cent in UK and 3.79 per cent in India.

Future availability and shortfall

As estimated above, there would be a demand for about 76,000 tons of alloy and special steels by the end of Iran's Fifth Plan. Since there is no scheme in hand for the production of such steels, the demand has to be met either through imports or by creating some capacity for indigenous manufacture to meet at least a part of the demand by 1977/78. If steps are not taken now to create some indigenous capacity to meet the demand, the larger shortfalls in the Sixth Plan beyond 1977/78 would be far more difficult to meet.

7 - Alloy steel requirements of Iran (cont'd)

Two major factors which can influence the demand for alloy steels are structural changes in the economy of the country as a whole and the development of substitute materials.

Structural changes

The above estimates have taken into account the structural changes that have been visualised up to 1977/78 on the basis of Plans in hand. Beyond 1977/78 it has been assumed that the same pattern would continue in the next Plan.

Substitute materials

Substitute materials such as aluminium, plastics, glass, timber, paper etc are cutting into the field of iron and steel in certain areas. The threat of competition is mainly to ordinary steel in the field of flat products and primarily for containers, building construction, water supply, and to a lesser extent in the manufacture of equipment and metal products. The challenge of these materials is considerably less in case of alloy steels which are developed and used specifically for obtaining enhanced properties combining high strength, high toughness, resistance to high temperature, corrosion, wear etc.

While there is no sizeable replacement of alloy steel by these substitutes, some new materials have been developed for certain applications, e.g. carbide tip tools to replace high speed steel tools, titanium and its alloys in the place of creep resistant steels for aero-engineering. However, the impact of this substitution has not yet been significant.

Though alloy steels do not face much of a challenge from other materials, there is constant substitution within the family. Thus, alloy constructional steels of some grades can be expected to be replaced by superior alloy steels of other grades, or nickel bearing stainless steel can be substituted by nickel free types due to nickel shortage etc.

APPENDICES - VOLUME II

6 - Ferro-alloy export possibilities (cont'd)

West Germany

West Germany produces the most varied range of ferro-alloys. The ferro-alloy industry is located along the navigable Rhine which is a cheap transport route for imported raw materials assembly and also for export. The high power cost is, however, a major handicap. Ferro-alloys trade in 1967 and 1968 is givon in Table 6-8.

Table 6-8

WEST GERMANY: TRADE IN FERRO-CHROME, FERRO-SILICON AND FERRO-MANGANESE, 1967 AND 1968

(tons)

		Imports		Exports	
		1967	1968	1967	1968
Ferro-chrome	..	37 628	53 063	12 537	18 212
Ferro-silicon	..	81 884	114 249	8 418	11 175
Ferro-manganese	..	72 754	110 869	40 491	75 500
Total	..	192 266	278 181	61 446	104 887

Italy

Ferro-alloy production in Italy has increased from 122 000 tons to 153,000 tons between 1962 and 1966. Production and trade statistics for 1966 are given in Table 6-9.

Table 6-9

ITALY: FERRO-ALLOY PRODUCTION AND TRADE, 1966

		Production tons	Exports tons	Imports tons
Ferro-chrome	..	29 200	8 068	13 734
Ferro-silicon	..	60 000	1 884	14 180
Ferro-manganese	..	11 700	8 901	77 882
Total	..	100 900	18 853	105 796

Appendix 3-1

AVERAGE ANALYSIS OF CHROMITE ORE EXPORTED DURING 1962/1968

Year of shipment	Quantity exported tons	Average chemical analysis				
		Cr_2O_3 %	Cr:Fe ratio	SiO_2 %	Al_2O_3 %	MgO %
1962	2 530	47.08	3.12	6.75	...	...
	833	48.08	3.15	...	...	...
	2 061	49.02	3.22	...	...	...
	5 424					
1963	5 366	48.22	...	...	...	...
	5 166	48.00	3.00	6.00	...	...
	10 532					
1964	2 000	48.00	3.00	5.00	...	...
	900	48.00	3.00	5.00	...	...
	2 100	49.88	3.40	5.35	...	...
	5 000					
1965	2 000	48.59	3.48	...	...	...
	5 000	48.00	3.00	6.00	...	...
	5 000	49.50	3.40	4/5	11/12	11/12
	12 000					
1966	5 080	50.66 (Cr_4O_6)	3.45	4.45	...	...
	9 300	48.00	3.00	6.00	...	...
	24 600	48.00	3.00	6.00	...	...
	38 980					
1967	3 500	48.96	3.54	...	...	...
	2 000	48.00	3.00	4.00	...	...
	7 000	48.60	3.54	5.89	...	...
	24 600	48.00	3.00	4.00	...	...
	37 100					
1968	2 480	48.62	3.30	0.95	...	...
	4 457	48.21	3.35	6.20	...	...
	4 500	49.68	3.56	5.59	...	...
	8 369	47.66	3.40	6.60	7.60	21.36
	19 806					

Source: Mining and Research Division, Ministry of Economy, Teheran.

Appendix 3-2

CHEMICAL COMPOSITION OF MANGANESE EXPORTED DURING 1964 TO 1969

Year of shipment	Quantity exported tons	Chemical analysis								
		Mn %	Fe %	SiO_2 %	Al_2O_3 %	CaO %	MgO %	P %	S %	H_2O %
1964	2 500	43.00	...	18.00	...	...	...	0.05	...	...
	3 300	42.05	3.35	16.94	3.30	...	...	0.04	0.01	...
	1 500	40.35	3.48	15.90	3.45	...	...	0.05	...	...
	1 109	39.37	3.40	16.45	...	...	...	0.04	...	...
	1 188	39.98	3.40	16.23	...	...	...	0.05	...	...
	841	39.37	3.40	16.45	...	...	...	0.04	...	...
1965	2 636	39.39	4.00	16.00	...	9.79	...	0.04	...	...
	6 880	40.18	3.60	15.88	...	...	...	...	0.44	...
	3 012	40.05	4.00	15.82	...	...	...	0.04	...	...
	6 348	39.29	4.00	16.30	...	...	...	...	...	0.86
1966	59 062	38.65	3.70	...	...	...	...	0.04	...	...
	3 041	37.95	4.07	16.05	...	...	...	...	...	...
	9 500	39.48	4.16	15.69	4.00	10.30	0.88	0.04	...	...
	4 334	38.85	...	...	...	...	...	...	...	0.81
1967	855	37.22	4.40	17.10	...	12.02	...	0.04	...	...
	4 100	38.78	3.75	16.42	...	11.64	...	0.05	...	...
	4 000	37.68	3.92	16.18	...	...	...	...	...	...
	4 139	...	...	...	...	...	...	...	...	0.48
1968	7 872	38.90	3.50	16.14	...	...	...	...	...	0.61
	3 211	37.23	3.73	16.51	...	...	...	0.05	...	0.61
	5 400	38.70	4.00	16.20	...	11.12	...	0.03	...	...
1969	6 462	38.35	3.95	15.74	...	8.31	...	0.05	...	...

Source: Mining and Research Division, Ministry of Economy, Tehran.

Appendix 3-3

AVERAGE ANALYSIS OF MANGANESE ORES OF MAJOR EXPORTING COUNTRIES

Country	Mn %	Fe %	SiO_2 %	Al_2O_3 %	P %
Soviet Union - Chiaturi	48 to 49	0.0 to 1.8	6 to 10	...	0.15 to 0.18
- Nikopol	48 to 51	0.7 to 1.2	7.5 to 10.5	...	0.16 to 0.22
Brazil - Minas Geraes	50	...	1.0	...	0.03 to 0.05
India	50.19	4.09	1.67	1.74	0.07
Mexico	47.59	2.04	8.01	1.10	0.03
South Africa	56 to 60 (combined with Fe)	...	Less than 8	...	0.02 to 0.15

Source: Material Survey : Manganese, U.S. Bureau of Mines, 1952.

Appendix 5-1

TYPICAL STANDARD SPECIFICATIONS OF FERRO-MANGANESE

A. India (IS 1171-1964)

Grade	Chemical composition				
	Mn %	C %	Si max %	S max %	P max %
Fe Mn 80	78 to 82	6.0 to 8.0	1.50	0.050	0.35
Fe Mn 76	74 to 78	6.0 to 8.0	1.50	0.050	0.35
Fe Mn 72	70 to 74	6.0 to 8.0	1.50	0.050	0.35
Fe Mn 68	65 to 70	6.0 to 8.0	1.50	0.050	0.35
Fe Mn 70 P5	65 to 75	6.0 to 8.0	1.50	0.050	0.50

B. Soviet Russia (GOST 4755-49)

Grade	Chemical composition				
	Mn min %	C max %	Si max %	P max %	S max %
Low carbon Mn 0	80	0.5	2.0	0.30	0.03
Medium carbon Mn 1	80	1.0	2.0	0.30	0.03
Medium carbon Mn 2	80	1.5	1.5	0.30	0.03
Carbon Mn 3	78	7.0	2.0	0.33	0.03
Carbon Mn 4	76	7.0	2.0	0.38	0.03

C. Japan

Grade	Chemical composition				
	Mn %	C max %	Si max %	P max %	S max %
Fe Mn H 0	78 to 82	7.5	1.2	0.40	0.02
Fe Mn H 1	73 to 78	7.3	1.2	0.40	0.02
Fe Mn H 2	73 to 78	7.0	3.0	0.40	0.02
Fe Mn 0	80 to 85	1.5	1.5	0.40	0.02
Fe Mn 2	75 to 80	2.0	2.0	0.40	0.02
Fe Mn L 0	80 to 85	1.0	1.5	0.35	0.02
Fe Mn L 1	75 to 80	1.0	1.5	0.40	0.02

Appendix 5-2

TYPICAL STANDARD SPECIFICATIONS OF FERRO-SILICON

A. India (IS 1110-1964)

Grade	Chemical composition				
	Si %	C max %	S max %	P max %	Al max %
FeSi 80	75 min	0.15	0.05	0.05	1.0
FeSi 73	70 to 75	0.15	0.05	0.05	1.0
FeSi 73P10	70 to 75	0.15	0.05	0.10	1.0
FeSi 65	60 to 70	0.15	0.05	0.05	1.0
FeSi 55	50 to 60	0.15	0.05	0.05	1.0
FeSi 20P15	15 to 25	1.50	0.05	0.15	1.0

B. Soviet Russia

Grade	Chemical composition				
	Si %	Mn %	Cr %	P %	S %
GOST (805-41)					
FS 1	13.10 and above	3.00		0.15	0.04
FS 2	9.00 to 13	3.00		0.15	0.04
GOST (1415-49 with modifications)					
Si 90	87 to 95	0.5	0.2	0.04	0.04
Si 75	74 to 80	0.7	0.5	0.05	0.04
Si 45	40 to 47	0.8	0.5	0.05	0.04

C. Japan

Grade	Chemical composition			
	Si %	C max %	P max %	S max %
FeSi 1	88 to 93	0.2	0.05	0.02
FeSi 2	75 to 80	0.2	0.05	0.02
FeSi 3	40 to 45	0.2	0.05	0.02
FeSi 4	25 to 30	0.8	0.10	0.10
FeSi 6	14 to 20	1.3	0.05	0.06

Appendix 5-3

TYPICAL STANDARD SPECIFICATION OF FERRO-CHROME

A. India (IS 1170-1967)

Grade	Chemical composition					
	Cr %	C %	Si %	S max %	P max %	N %
a) High-carbon ferro-chromium						
7FeCr65	60 to 70	6 to 8	1.5 max	0.05	0.05	
	60 to 70	6 to 8	1.5 to 5	0.05	0.05	
	60 to 70	6 to 8	4 to 6	0.05	0.05	
	60 to 70	6 to 8	6 to 10	0.05	0.05	
5FeCr65	60 to 70	4 to 6	1.5 max	0.05	0.05	
	60 to 70	4 to 6	1.5 to 4	0.05	0.05	
	60 to 70	4 to 6	4 to 6	0.05	0.05	
	60 to 70	4 to 6	6 to 10	0.05	0.05	
7FeCr58	55 to 60	6 to 8	4 to 6	0.05	0.05	
	55 to 60	6 to 8	6 to 10	0.05	0.05	
5FeCr58	55 to 60	4 to 6	4 to 6	0.05	0.05	
	55 to 60	4 to 6	6 to 10	0.05	0.05	
b) Medium-carbon ferro-chromium						
15FeCr55	60 max	1 to 2	1.5 max	0.05	0.05	
3FeCr55	60 max	2 to 4	1.5 max	0.05	0.05	
15FeCr64	60 to 67	1 to 2	1.5 max	0.06	0.05	
3FeCr64	60 to 67	2 to 4	1.5 max	0.05	0.05	
15FeCr71	67 to 75	1 to 2	1.5 max	0.05	0.05	
3FeCr71	67 to 75	2 to 4	1.5 max	0.05	0.05	
c) Low-carbon ferro-chromium						
002FeCr55	60 max	0.025 max	1.5 max	0.05	0.05	
004FeCr55	60 max	0.025 to 0.05	1.5 max	0.05	0.05	
008FeCr55	60 max	0.05 to 0.10	1.5 max	0.05	0.05	
03FeCr55	60 max	0.10 to 0.50	1.5 max	0.05	0.05	
08FeCr55	60 max	0.50 to 1.0	1.5 max	0.05	0.05	
002FeCr64	60 to 67	0.025 max	1.5 max	0.05	0.05	
004FeCr64	60 to 67	0.025 to 0.05	1.5 max	0.05	0.05	
008FeCr64	60 to 67	0.05 to 0.10	1.5 max	0.05	0.05	
03FeCr64	60 to 67	0.10 to 0.50	1.5 max	0.05	0.05	
08FeCr64	60 to 67	0.50 to 1.0	1.5 max	0.05	0.05	
002FeCr71	67 to 75	0.025 max	1.5 max	0.05	0.05	
004FeCr71	67 to 75	0.025 to 0.05	1.5 max	0.05	0.05	
008FeCr71	67 to 75	0.05 to 0.10	1.5 max	0.05	0.05	
03FeCr71	67 to 75	0.10 to 0.50	1.5 max	0.05	0.05	
08FeCr71	67 to 75	0.50 to 1.0	1.5 max	0.05	0.05	

Appendix 5-3 (continued)

A. India (IS 1170-1967) (cont'd)

	Chemical composition					
Grade	Cr %	C %	Si %	S max %	P max %	N %
d) High-nitrogen low-carbon ferro-chromium						
FeCr64N075	60 to 67	0.10 max	1.0 max	0.05	0.05	0.5 to 1.0
FeCR64N125	60 to 67	0.10 max	1.0 max	0.05	0.05	1.0 to 1.5
FeCr64N175	60 to 67	0.10 max	1.0 max	0.05	0.05	1.5 to 2.0
FeCr64N300	60 to 67	0.10 max	1.0 max	0.05	0.05	2.0 to 4.0
e) Carbon-free ferro-chromium a/						
FeCr70	65 to 75	trace		0.05	0.05	

a/ Aluminium content is 1.0% max.

B. Soviet Russia (GOST 4757-49)

	Chemical composition							
			Si (min)					
Grade	Cr min %	C %	low %	medium %	high %	P %	S %	N min %
Carbon-free ferro-chromium								
Khr0000	65	0.06	1.0	1.5		0.06	0.04	
Khr000	65	0.07 to 0.10						
Khr00	60	0.11 to 0.15						
Low-carbon ferro-chromium								
Khr0	60	0.16 to 0.25	1.5	2.0	3.0	0.06	0.04	
Khr01		0.26 to 0.50						
Medium-carbon ferro-chromium								
Khr1	60	0.51 to 1.0		2.5	3.0	0.10	0.04	
Khr2		1.1 to 2.0						
Khr3		2.1 to 4.0						

Appendix 5-3 (continued)

B. Soviet Russia (GOST 4757-49) (cont'd)

	Chemical composition							
	Cr		Si (min)					N
Grade	min %	C %	low %	medium %	high %	P %	S %	min %
High carbon ferro-chromium								
Khr4	65	4.1 to 5.5	2.0	3.0	5.0	0.07	0.04	
Khr6		6.6 to 8.0				0.07	0.04	
Spl. carbon-free ferro-chromium								
Khrb1	70	up to 0.04		0.8		0.02	0.03	
Khrb2		up to 0.04		1.0		0.03	0.03	
Nitrided								
Khrn1	70	up to 0.05		1.0		0.03	0.03	0.90

C. Japan

	Chemical composition				
		C	Si	P	N
Grade	Cr %	max %	max %	max %	max %
High carbon					
FeCrH1	65 to 70	6	1.5	0.04	0.08
H2	60 to 65	6	2.0	0.04	0.08
H3	60 to 65	8	2.0	0.04	0.06
H4	55 to 60	6	4.0	0.04	0.05
H5	55 to 60	8	8.0	0.04	0.05
Medium-carbon					
FeCrM3	60 to 65	4.0	3.5	0.04	0.05
M4	55 to 60	4.0	4.0	0.04	0.05
Low-carbon					
FeCrL1	65 to 70	0.10	1.5	0.04	0.05
L2	60 to 65	0.03	1.0	0.03	0.03
L3	60 to 65	0.06	1.0	0.04	0.03
L4	60 to 65	0.10	1.0	0.04	0.03

Appendix 5-4

FERRO ALLOY IMPORTS OF IRAN

Source	1964/65 tons	1965/66 tons	1966/67 tons	1967/68 tons	1968/69 tons
Japan	65.000	40.431	60.000	59.500	155.000
W. Germany	34.200	39.333	168.838	154.614	360.906
U. Kingdom	.208	4.500	5.280	4.950	-
Sweden	.305	-	0.200	10.900	37.450
Netherland	12.000	0.050	-	-	-
Australia	2.750	-	-	-	-
Italy	-	3.000	-	-	-
Norway	-	20.000	-	49.350	52.076
USA	-	0.227	40.941	11.350	-
Belgium	-	-	50.000	32.000	91.916
Switzerland	-	-	0.508	1.000	1.500
France	-	-	0.300	-	.014
Portugal	-	-	-	25.000	-
USSR	-	-	-	379.384	100.000
S. Leone	-	-	-	-	3.048
Total	114.675	107.541	326.067	1 028.048	801.990

Source: Year Book, Foreign trade of Iran

Appendix 7-1

A NOTE ON CLASSIFICATION OF ALLOY & SPECIAL STEELS

All steels are basically iron-carbon alloys with other elements, some unavoidable in steel production and others intentionally added to effect desired properties. Additions of these alloying elements cause changes in the basic characteristics of the steel and render it more suitable for specific uses, for example, addition of nickel and chromium to obtain heat and corrosion resisting properties, or addition of tungsten to get superior cutting edges in tools, or addition of larger amounts of silicon to produce electrical sheets of low hysterisis losses and better magnetic permeability.

Currently the term 'special steel' is used to indicate such steels which lie between true alloy steels and the so-called mild or ordinary steel. These steels contain more than normal amounts of constituents like manganese, silicon, sulphur or even carbon.

However, there is no universally accepted definition of special steels and each major steel producing country follows its own classification. Consequently steels included under the category of special steels in one country are not included as such in another country. For instance, medium and high carbon constructional steels are considered to be special steels in Japan and West Germany, but not so in U.K. and U.S.A. In Germany all steels requiring

6 - Ferro-alloy export possibilities (cont'd)

Free trade

In EEC countries the free ferro-alloy trade is controlled by fixing up the third country quota. The third country quotas for 1969 are given in Table 6-10.

Table 6-10

EEC - THIRD COUNTRY IMPORT QUOTA, 1969

	Ferro-silicon tons	Silico-manganese tons	Low carbon Ferro-chrome tons
Belgium/Luxembourg ..	11 275	900	130
France ..	50	100	10
West Germany ..	3 900	42 000	170
Italy ..	1 000	1 800	2 630
Netherland ..	3 775	700	60
Reserves ..	-	4 500	-
Total ..	20 000	50 000	3 000

Spain

Manganese and silicon bearing ferro-alloys accounted for 80 per cent of total ferro-alloy production in Spain in 1966 (Table 6-11). The major item of export in 1965 was ferro-manganese when out of a total export of 10,000 tons of ferro-alloys, ferro-manganese accounted for 7,000 tons (of which 6,000 tons were exported to USA). The trade pattern changed considerably in the following year. The figures of ferro-alloy trade in 1966 are given in Table 6-11.

Appendix 7-1 (continued)

any special treatment for controlling the composition, quality or finish are considered to be special steels, e.g. steels with low phosphorus (below 0.035 per cent) and with low sulphur (below 0.035 per cent). Electrical steel sheets are likewise classified as special steels in U.S.A. and India, whereas they are included under tonnage steels in U.K. and Japan.

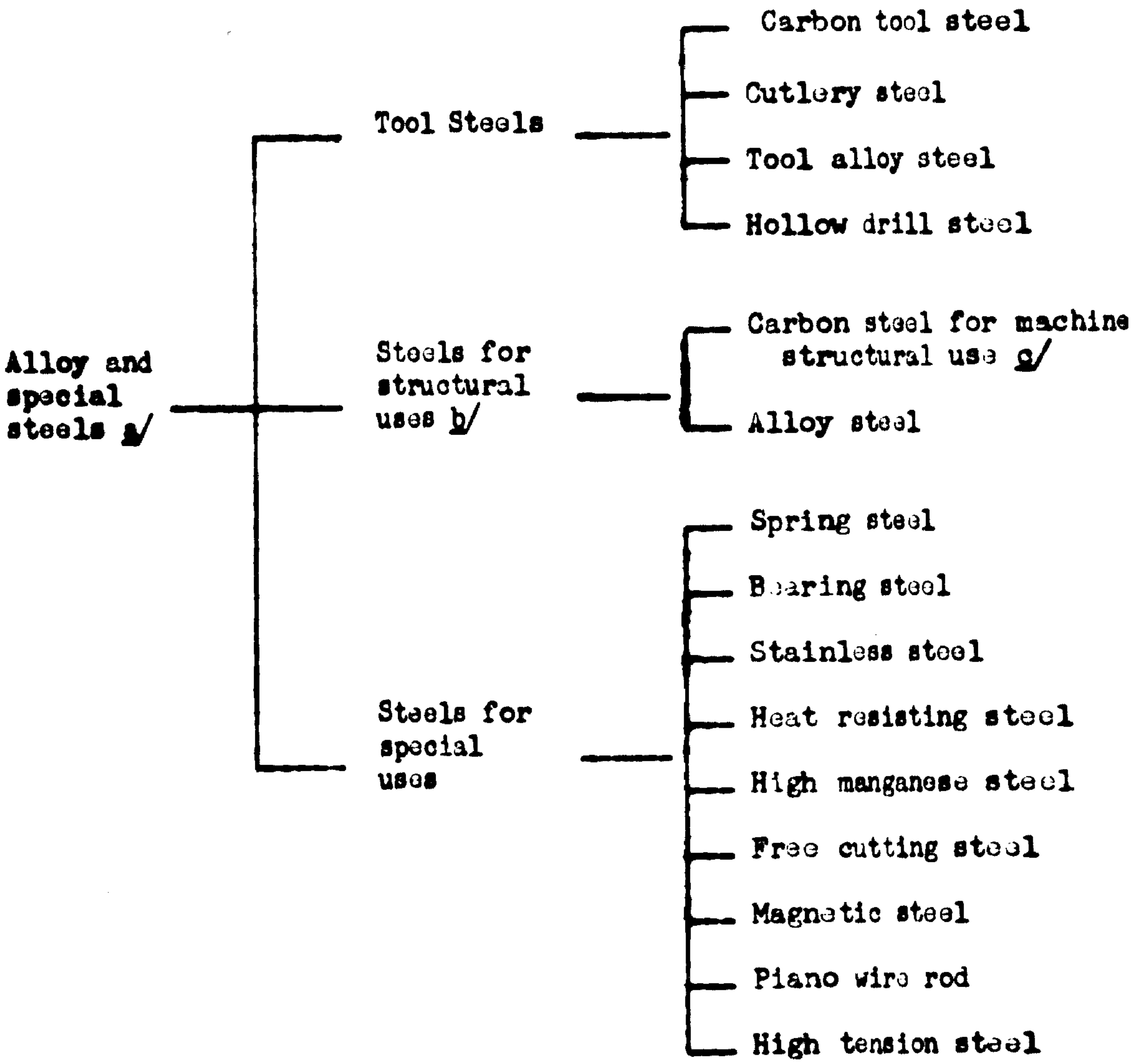
Table 1 gives the broad classification of alloy and special steels in Japan by the Japan Iron and Steel Federation. Table 2 indicates a few types of typical steels which are classified differently in different countries.

Keeping in view the applications of various types of steel for the Iranian economy, the general classification shown in Table 3 is proposed.

Appendix 7-1 (continued)

Table 1

CLASSIFICATION OF ALLOY AND SPECIAL STEELS
(by the Japan Iron and Steel Federation)



a/ Silicon steel is treated as ordinary steel.
b/ Refers to constructional steels.
c/ Refers to carbon constructional steel.

Appendix 7-1 (continued)

Table 2

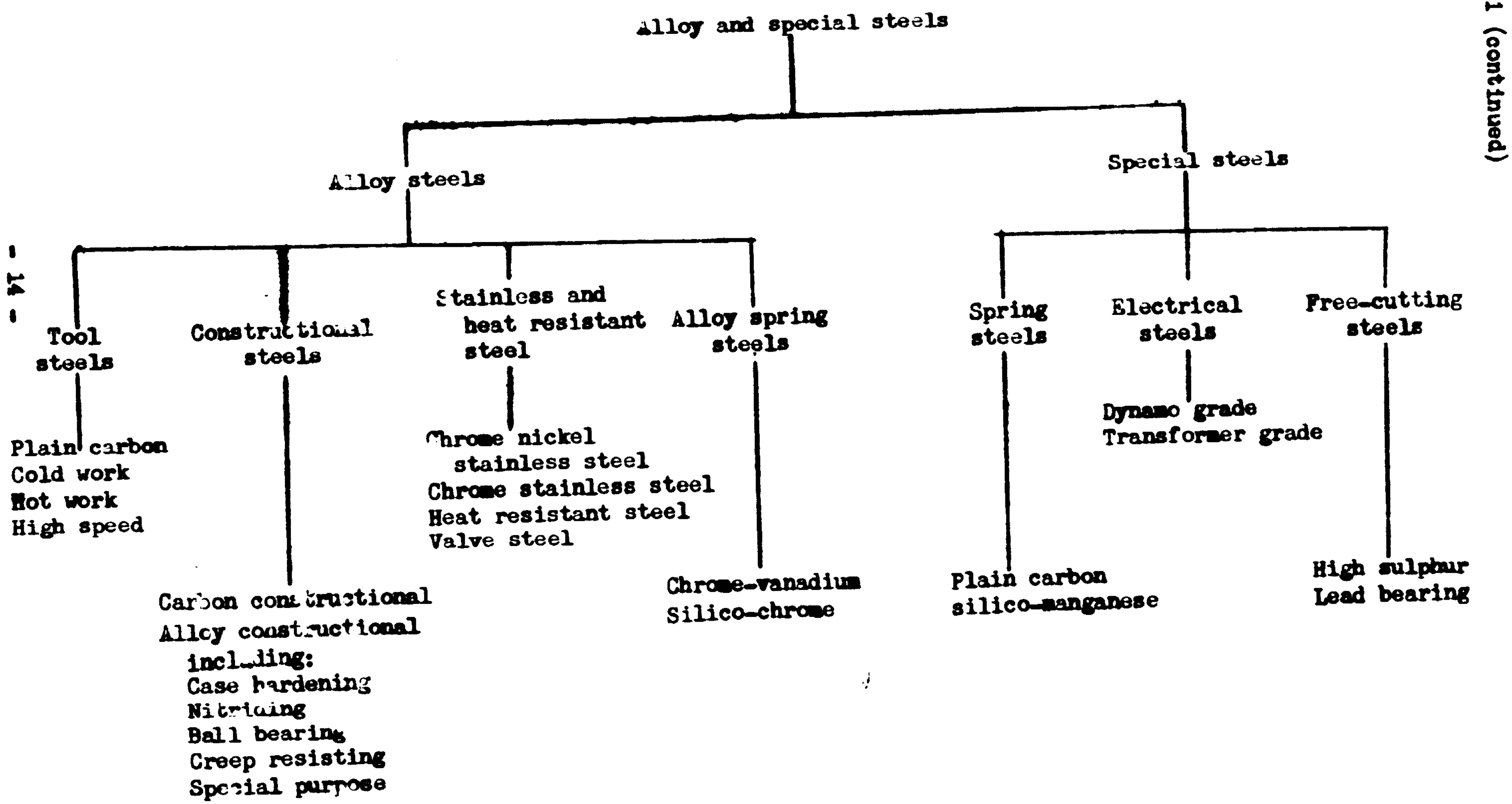
COMPARISON OF TYPICAL STEEL CLASSIFICATION IN SOME COUNTRIES

Countries	Carbon constructional steel	Free cutting steel	Si-Mn spring steel	High carbon steel	Silicon steel sheets
Japan	Special steel	Special steel	Special steel	Special steel	Ordinary steel
U.S.A.	Carbon steel	Carbon steel	Alloy steel	Alloy steel	Alloy steel
U.K.	Carbon steel	Carbon steel	Carbon steel	Carbon steel	Carbon steel
E.C.S.C	Special steel	Special steel	Special steel	Special steel	Special steel
W. Germany	Special steel	Ordinary steel	Ordinary steel	Special steel	Special steel
France	Special steel	Special steel	Special steel	Special steel	Special steel
Italy	Special steel	Special steel	Ordinary steel	Special steel	Special steel
Sweden	Special steel	Special steel	Special steel	Special steel	Special steel
India	Special steel	Special steel	Special steel	Ordinary steel	Special steel

Appendix 7-1 (continued)

Table 3

SUGGESTED CLASSIFICATION OF ALLOY AND SPECIAL STEELS FOR IRAN



Appendix

ALLOY STEEL REQUIRE

Item		Unit of output	Anticipated output	Carbon constl. steel tons	Free-cut stee tons
A. Transport equipment					
1. Railway wagons	..	Nos	800	915.00	-
2. Trailers	..	Nos	4 000	28.80	-
3. Buses and minibuses	..	Nos	25 000	250.00	250.
4. Cars	..	Nos	93 000	2 200.00	790
5. Trucks	..	Nos	12 500	125.00	125
6. Jeeps, station wagons, ambulances and vannets	..	Nos	28 000	840.00	280
7. Motor cycles, scooters and mopeds	..	Nos	13 000	13.00	32
8. Automobile ancillaries	..	Million Rials	1 265	63.00	190
9. Vehicular and diesel engines	..	Nos	13 500	94.50	67
10. Vehicular petrol engines	..	Nos	93 000	140.00	140
11. Bicycles complete	..	'000 Nos	150 000	3.00	-
12. Auto leaf springs (maintenance) a/	..	Tons	5 400	-	-
Total A	..			4 672,30	1 875
B. Electrical equipment					
13. Electric transformers	..	'000 kVA	300	-	-
14. Electric motors	..	'000 kW	150	60.00	60
15. Switch and control gear	..	Million Rials	625	4.80	13
16. House service meters	..	Nos	80 000	-	-
17. Electric fans	..	'000 Nos	250	2.50	-
18. Air conditioners	..	'000 Nos	35	26.00	8
19. Refrigerators (domestic and commercial)		'000 Nos	873	-	-
20. Radio receivers	..	'000 Nos	544	0.55	-
21. P.A. system	..	Million Rials	720	-	-
22. Electric & electronic equipment (relays, switches etc)	..	Million Rials	0,72	-	
Total B	..			93,85	8
C. Industrial & agricultural machinery					
23. Agricultural tractors	..	Nos	5 000	300.00	
24. Agricultural implements	..	Tons	7 500	407.50	15
25. Crawler tractors	..	-	-	-	
26. Building & road construction machinery		Million Rials	50	12.50	
27. Stationary diesel engine	..	Nos	7 500	225.00	
28. Cranes	..	Tons	2 000	10.00	
29. Passenger and industrial lifts	..	Tons	50	-	
30. Fork lifts	..	-	-	-	
31. Other material handling equipment (conveying machinery etc)	..	Million Rials	100	5.00	

SECTION 1

Appendix 7-2

Appendix 7-2

ALLOY STEEL REQUIREMENT 1977/1978

arbon constl. steel tons	Free-cutting steel tons	Spring steel tons	Alloy constl. steel tons	Stainless steel tons	Electrical sheets and electrode quality steel tons	Total tons
915.00	-	1 120.00	-	-	-	1 535.00
28.80	-	100.00	113.60	-	-	242.40
250.00	250.00	5 250.00	2 625.00	-	-	8 375.00
2 200.00	790.00	4 050.00	5 350.00	-	-	12 390.00
125.00	125.00	2 625.00	1 312.50	-	-	4 187.50
840.00	280.00	1 680.00	2 940.00	-	-	5 740.00
13.00	32.50	19.50	156.00	-	-	221.00
63.00	190.00	190.00	250.00	1.80	-	694.80
94.50	67.50	-	337.50	13.50	-	513.00
140.00	140.00	140.00	700.00	-	-	1 120.00
3.00	-	-	-	-	-	3.00
-	-	5 940.00	-	-	-	5 940.00
4 672.30	1 875.00	21 114.50	13 784.60	15.30		41 461.70
-	-	-	-	-	360	360.00
60.00	60.00	-	-	-	1 500	1 620.00
4.80	13.80	9.40	9.40	-	190	227.40
-	-	-	-	-	20	20.00
2.50	-	-	2.50	-	-	5.00
26.00	8.50	3.50	26.00	8.50	-	72.50
-	-	580.00	-	4 367.00	-	4 947.00
0.55	-	1.00	-	10.50	-	12.05
-	-	0.02	-	0.02	-	0.04
-	0.005	0.075	-	-	-	0.08
93.85	82.305	593.995	37.90	4 386.02	2 070	7 264.07
300.00	-	25.00	675.00	-	-	1 000.00
407.50	150.00	182.50	225.00	-	-	963.00
-	-	-	-	-	-	-
12.50	6.00	4.00	12.50	0.50	-	35.50
225.00	-	7.50	52.50	7.50	-	292.50
10.00	5.00	3.00	410.00	-	-	428.00
-	-	2.50	7.50	-	-	10.00
-	-	-	-	-	-	-
5.00	-	-	28.00	2.00	-	35.00

SECTION 2

Item		Unit of output	Anticipated output	Carbon constl. steel tons	Free-cuttin steel tons
C. Industrial & agricultural machinery (cont'd)					
32. Industrial boilers	..	Million Rials	160.00	-	-
33. Air compressors	..	Million Rials	200.00	14.00	200.00
34. Power driven pumps (turbine & centrifugal)		Nos	50 000.00	-	25.00
35. Textile machinery	..	Million Rials	3 000.00	300.00	500.00
36. Sugar machinery	..	Million Rials	300.00	-	340.00
37. Cement machinery	..	Million Rials	325.00	50.00	-
38. Equipment for chemical industry	..	Million Rials	250.00	-	-
39. Heavy plate and vessels	..	Tons	3 300.00	-	-
40. Machine tools	..	Million Rials	350.00	0.50	22.75
41. Machine tool accessories	..	Million Rials	10.00	5.00	4.00
42. Hand tools	..	Tons	3 000.00	-	-
43. Dumpers and scrapers 44. Shovels and excavators	..	Nos	400.00	10.50	3.00
45. Road rollers	..	Nos	250.00	-	135.00
46. Dairy machinery	..	Million Rials	25.00	-	-
47. Weighing machinery	..	Million Rials	165.00	1.60	4.10
48. Tea processing machinery	..	Million Rials	90.00	-	-
Total C	..			1 341.60	1 394.84
D. Metal products					
49. Steel furniture	..	Tons	24 000.00	1 056.00	-
50. Bolts, nuts and rivets b/	..	Tons	10 000.00	285.00	332.00
51. Wire netting and wire products	..	Tons	1 300.00	-	-
52. Sewing machines	..	'000 Nos	100.00	-	2.00
53. Typewriters and office machines	..	Nos	-	-	-
54. Umbrella ribs	..	'000 Nos	250.00	3.50	-
55. Razor blades c/	..	Million Nos	450.00	-	-
56. Hacksaw blades d/	..	'000 Nos	1 110.00	-	-
57. Utensils	..	Tons	1 546.00	-	-
58. Sewing machine needles	..	Tons	1.25	1.50	-
59. Ball and roller bearing	..	Million Nos	2.00	-	-
Total D	..			1 346.00	334.0
E. Other requirements					
60. Spares and maintenance	..	-	-	720.00	370.0
61. Small scale industries	..	-	-	140.00	70.0
62. Stocks	..	-	-	120.00	60.0
63. Tool and die blocks	..	-	-	-	-
Total E	..			980.00	500.0
GRAND TOTAL (A+B+C+D+E)	..			8 433.75	4 186.1

a/ The spring requirement as original equipment is included in the respective norms.
b/ High tensile bolts and special bolts are considered.
c/ 391.50 tons of high carbon tool steel is required in addition to 99 tons of stainless steel.
d/ 222.00 tons of tool steel will be required.

SECTION 1

Appendix 7-2 (continued)

on constl. steel tons	Free-cutting steel tons	Spring steel tons	Alloy constl. steel tons	Stainless steel tons	Electrical sheets and electrode quality steel tons	Total tons
-	-	8.00	320.00	5.00	-	333.00
14.00	200.00	14.00	50.00	2.00	-	280.00
-	25.00	-	25.00	100.00	-	150.00
300.00	500.00	60.00	360.00	120.00	-	1 340.00
-	340.00	8.50	205.00	34.00	-	587.50
50.00	-	100.00	750.00	25.00	-	925.00
-	-	-	50.00	100.00	-	150.00
-	-	-	-	330.00	-	330.00
0.50	22.75	5.25	56.00	0.70	-	85.20
5.00	4.00	0.20	10.00	0.50	-	19.70
-	-	-	750.00	-	-	750.00
10.50	3.00	4.50	4 700.00	-	-	4 718.00
-	135.00	113.50	62.50	-	-	211.00
-	-	-	-	12.00	-	12.00
1.60	4.10	-	3.30	-	-	9.00
-	-	-	32.00	6.00	-	38.00
1 341.60	1 394.84	438.45	8 784.30	745.20		12 704.40
1 056.00	-	-	-	-	-	1 056.00
285.00	332.00	-	475.00	147.00	-	1 239.00
-	-	-	-	5.20	-	5.20
-	2.00	-	-	-	-	2.00
-	-	-	-	-	-	-
3.50	-	-	-	-	-	3.50
-	-	-	-	99.00	-	99.00
-	-	-	-	-	-	-
-	-	-	-	210.00	-	210.00
1.50	-	-	-	-	-	1.50
-	-	-	1 640.00	-	-	1 640.00
1 346.00	334.00		2 115.00	461.20		4 256.20
720.00	370.00	2 220.00	2 310.00	560.00	200.00	6 380.00
140.00	70.00	440.00	460.00	110.00	40.00	1 260.00
120.00	60.00	330.00	350.00	80.00	30.00	970.00
-	-	-	-	-	-	4 020.00
980.00	500.00	2 990.00	3 120.00	750.00	270.00	12 630.00
8 433.75	4 186.16	25 136.95	27 841.80	6 357.72	2 340.00	78 316.37

rms.

stainless steel.

DRAWINGS - VOLUME II


USSR
TURKEY
IRAQ
ZOLFA
CR-6
TABRIZ
SECTION 1
CASPIAN SEA
U S
BANDAR-SHAH
CR
Q-1
TEHRAN
M-1
SANANDADJ
GREAT SALT DES
GHOM
M-2
KERMANSHAH
ARAK
KASHAN
BAD
M-3
Q-2
ISFAHAN
ANDIMESHK
L-1
L-2
GREAT S
YAZD
AHWAZ
KHORRAMSHAHR
ABADAN
BANDAR-SHAHPUR
SHIRAZ
CR-4
CR-
LEGEND
MAIN ROADS
RAIL ROADS (EXISTING)
RAIL ROADS (UNDER CONSTRUCTION)

6 - Ferro-alloy export possibilities (cont'd)

Table 6-11

SPAIN: FERRO-ALLOY TRADE, 1966

		Production tons	Imports tons	Exports tons
Ferro-manganese	..	38 000	1 345	2 750
Ferro-silicon	..	26 000	...	8 537
Others	..	18 000	6 197 a/	146
Total	..	82 000	7 542	11 433

a/ Includes ferro-silicon

Austria

Austria has a limited production of ferro-alloys, about 5,000 tons in 1966. The requirements are met mainly through imports as given in Table 6-12.

Table 6-12

AUSTRIA: FERRO-ALLOY IMPORTS, 1966
(tons)

Ferro-chrome	..	16 310
Ferro-silicon	..	9 276
Ferro-manganese	..	12 289
Total	..	37 875

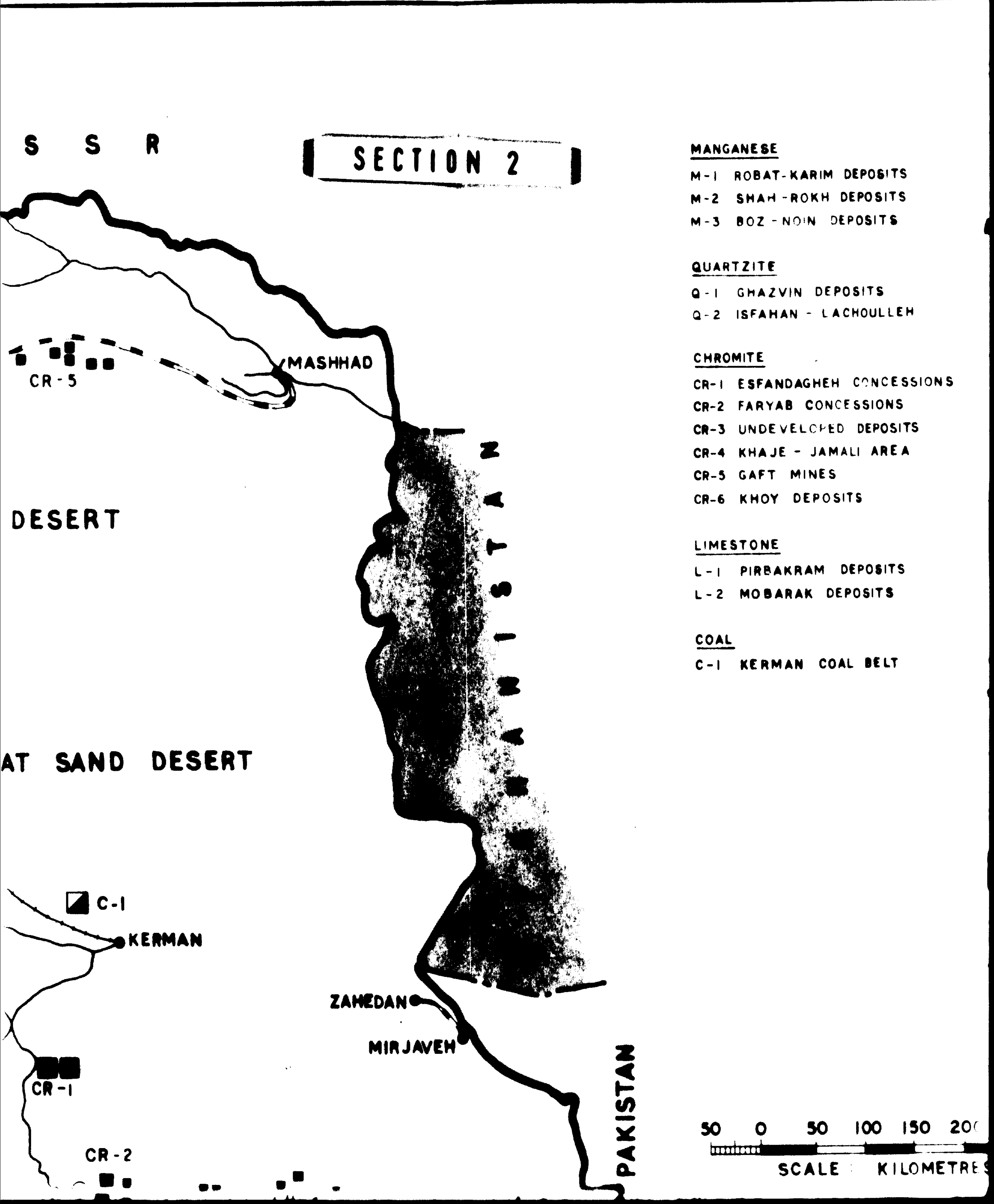
The main sources of supply are USSR, Norway, Czechoslovakia and West Germany.

East European countries

Rumania

Rumania's steel industry has been fast expanding during the last decade and steel production has risen from about 1.8 million tons in 1960 to about 4.8 million tons in 1968.

SECTION 2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AT SAND DESERT
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C-1
KERMAN
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CR-2
PAKISTAN
MANGANESE
M-1 ROBAT-KARIM DEPOSITS
M-2 SHAH-ROKH DEPOSITS
M-3 BOZ-NOIN DEPOSITS
QUARTZITE
Q-1 GHAZVIN DEPOSITS
Q-2 ISFAHAN - LACHOULLEH
CHROMITE
CR-1 ESFANDAGHEH CONCESSIONS
CR-2 FARYAB CONCESSIONS
CR-3 UNDEVELOPED DEPOSITS
CR-4 KHAJE - JAMALI AREA
CR-5 GAFT MINES
CR-6 KHOY DEPOSITS
LIMESTONE
L-1 PIRBAKRAM DEPOSITS
L-2 MOBARAK DEPOSITS
COAL
C-1 KERMAN COAL BELT
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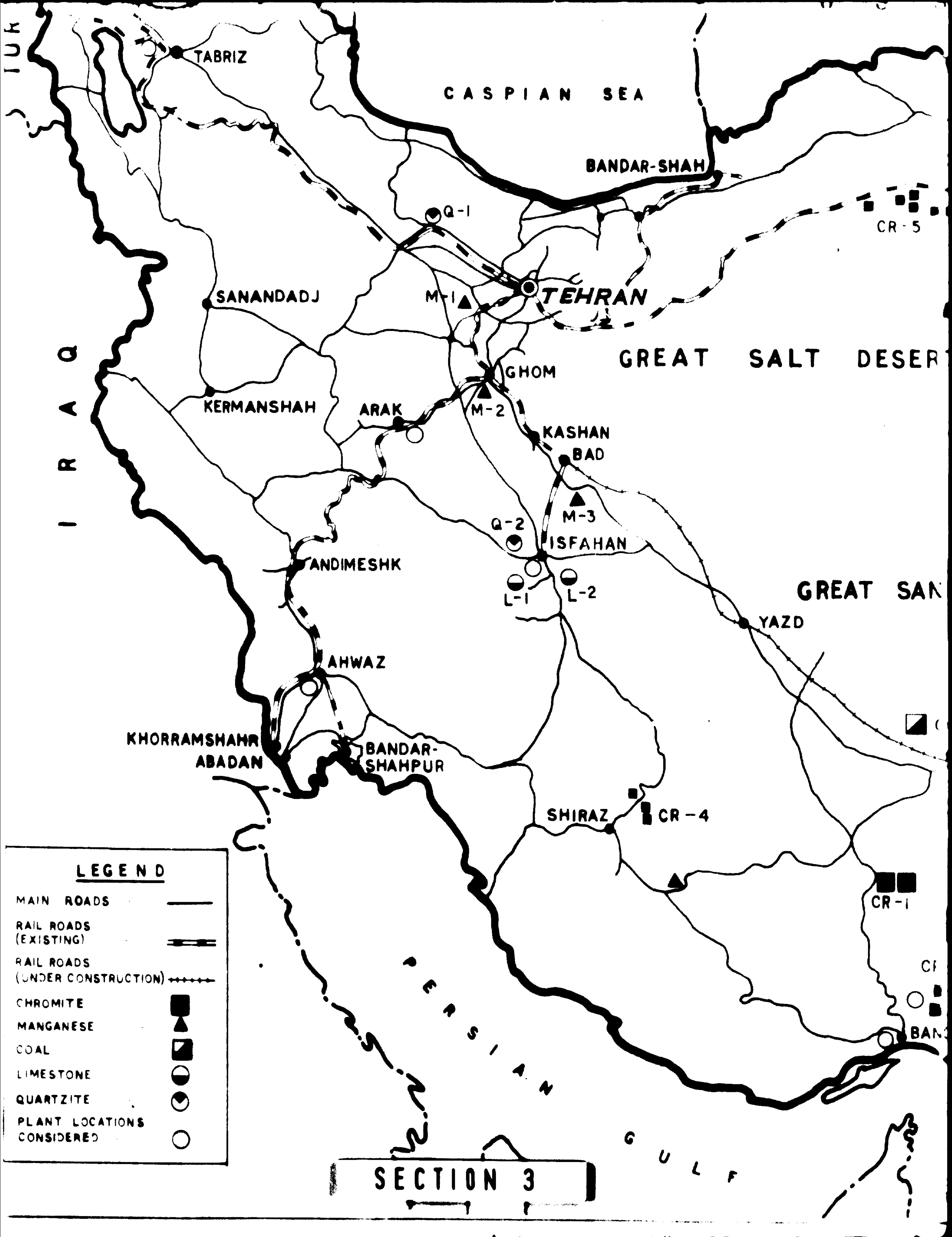
SCALE KILOMETRE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GHOM
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KERMANSHAH
ARAK
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ANDIMESHK
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GREAT SAN
YAZD
AHWAZ
KHORRAMSHAHR
ABADAN
BANDAR-SHAHPUR
SHIRAZ
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CR-1
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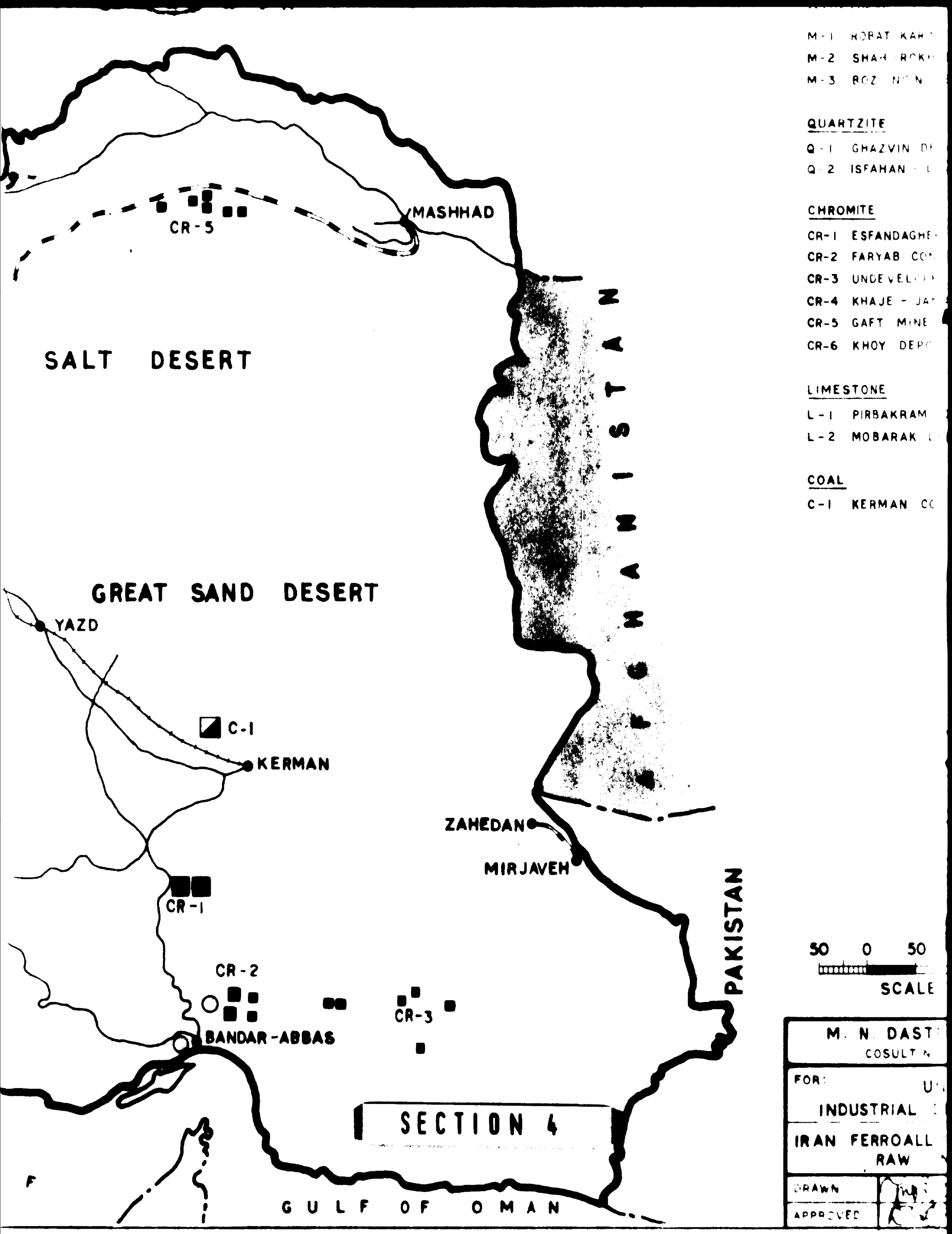
BAN
PERSIAN GULF
LEGEND
MAIN ROADS
RAIL ROADS (EXISTING)
RAIL ROADS (UNDER CONSTRUCTION)
CHROMITE
MANGANESE
COAL
LIMESTONE
QUARTZITE
PLANT LOCATIONS CONSIDERED

SECTION 3


M-1 ROBAT KAR
M-2 SHAH-ROKH
M-3 ROZ N N
QUARTZITE
Q-1 GHAZVIN DE
Q-2 ISFAHAN
CHROMITE
CR-1 ESFANDAGHE
CR-2 FARYAB CO
CR-3 UNDEVEL
CR-4 KHAJE - JA
CR-5 GAFT MINE
CR-6 KHOY DEP
LIMESTONE
L-1 PIRBAKRAM
L-2 MOBARAK
COAL
C-1 KERMAN C
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AFGHANISTAN
GREAT SAND DESERT
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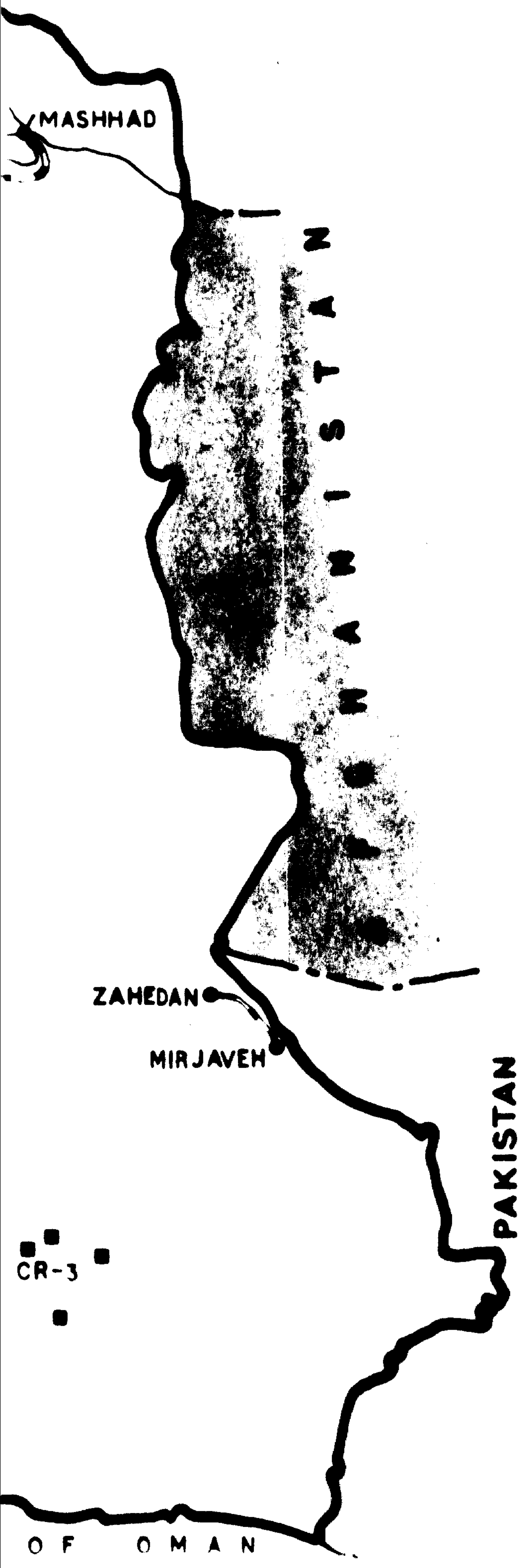
SECTION 4



MANGANESE

M-1 ROBAT-KARIM DEPOSITS
M-2 SHAH-ROKH DEPOSITS
M-3 BOZ-NO N DEPOSITS

QUARTZITE

Q-1 GHAZVIN DEPOSITS
Q-2 ISFAHAN - LACHOULLEH

CHROMITE

CR-1 ESFANDAGHEH CONCESSIONS
CR-2 FARYAB CONCESSIONS
CR-3 UNDEVELOPED DEPOSITS
CR-4 KHAJE - JAMALI AREA
CR-5 GAFT MINES
CR-6 KHOY DEPOSITS

LIMESTONE

L-1 PIRBAKRAM DEPOSITS
L-2 MOBARAK DEPOSITS

COAL

C-1 KERMAN COAL BELT

SECTION 5

50 0 50 100 150 200 250 300

SCALE : KILOMETRES

M. N. DASTUR & Co. PRIVATE LTD
COSULTING ENGINEERS, CALCUTTA

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
RAW MATERIAL DEPOSITS

DRAWN

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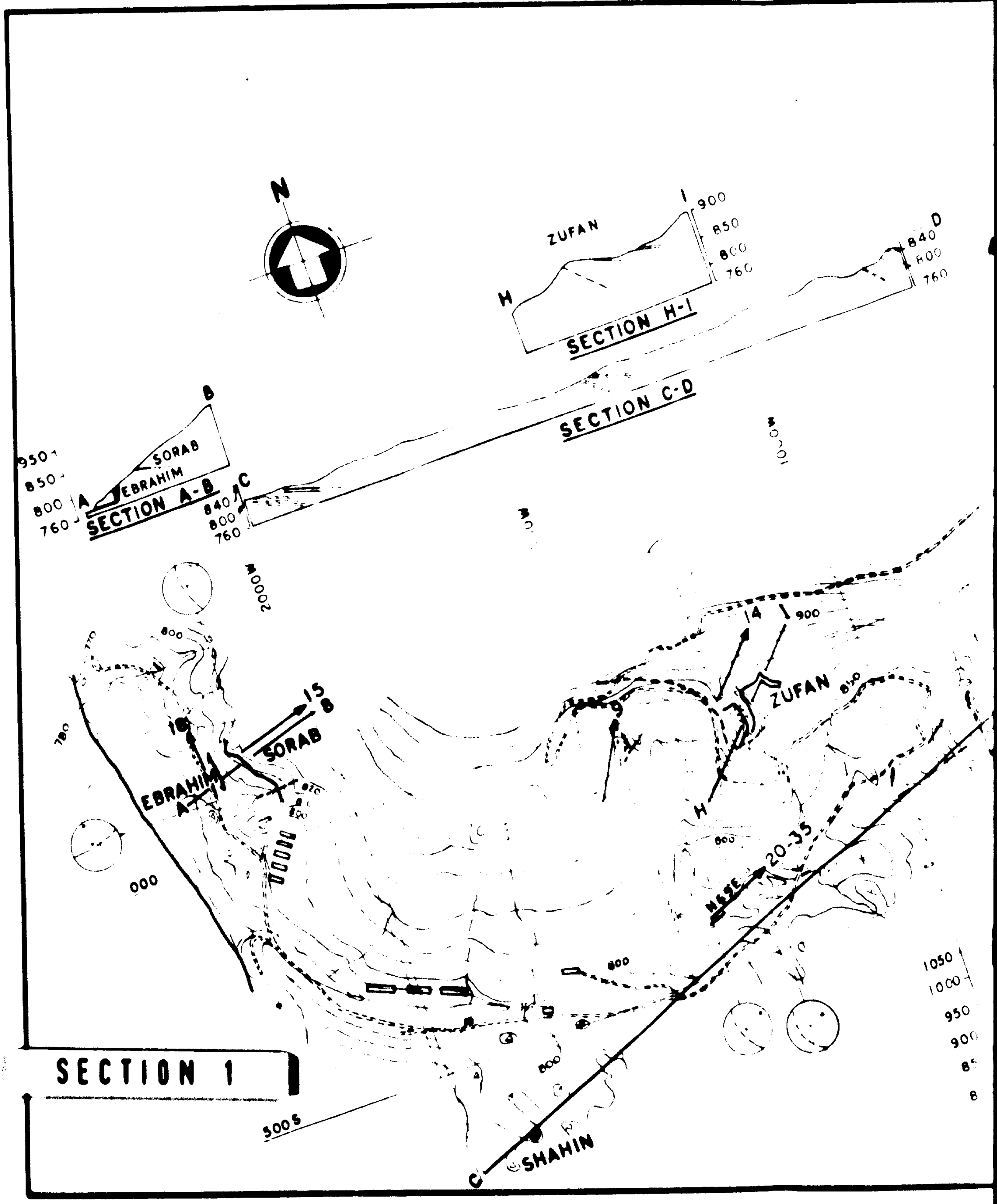
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EBRAHIM
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850
800
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2000M
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770
780
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B
18
SORAB
EBRAHIM
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820
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ZUFAN
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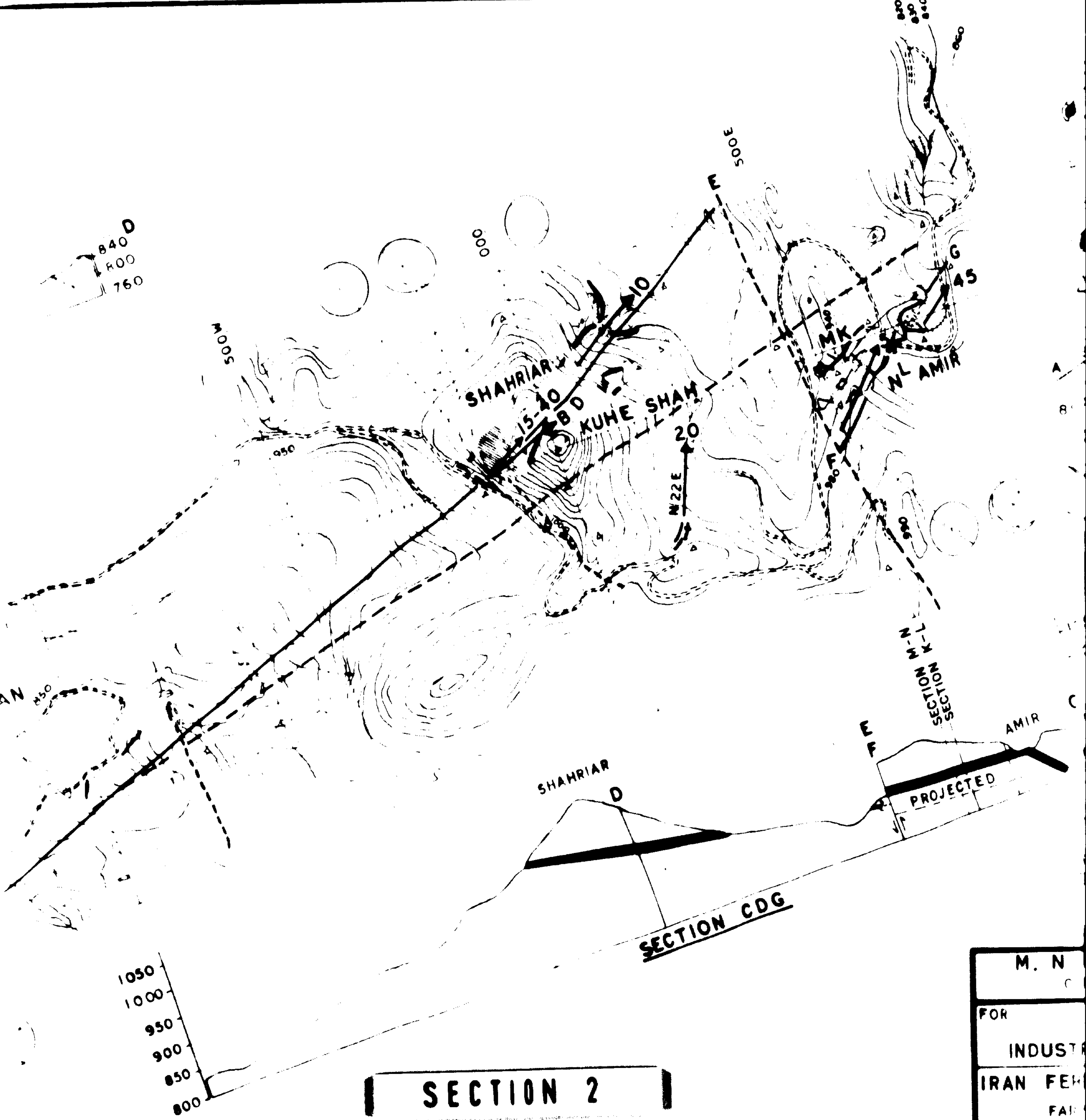
SECTION 1



SECTION 2

SOURCE: GEOLOGICAL SURVEY OF IRAN — UN SPECIAL FUND PROJECT

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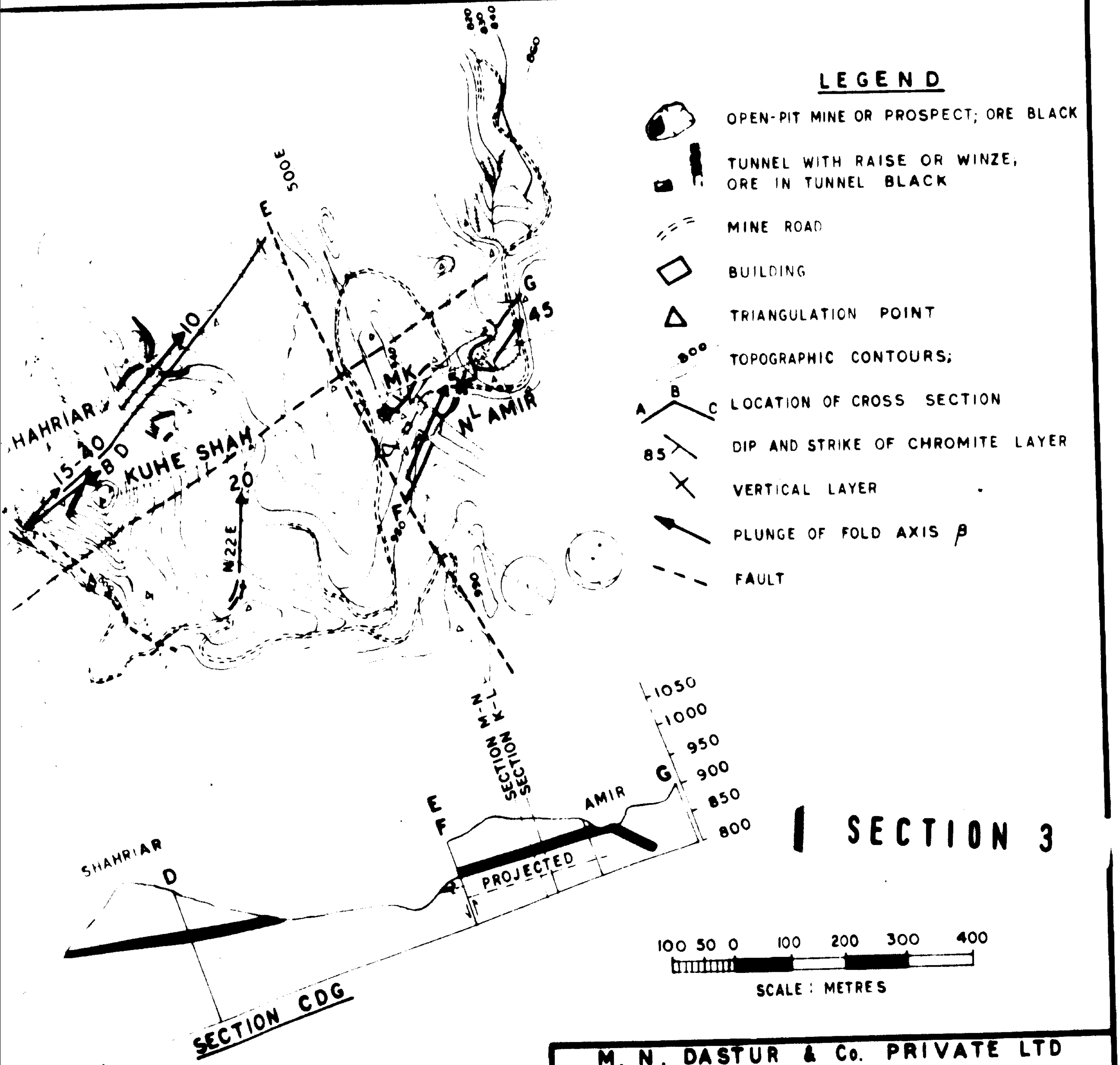

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FARYAB CHROMITE DEPOSIT - STRUCTURAL MAP

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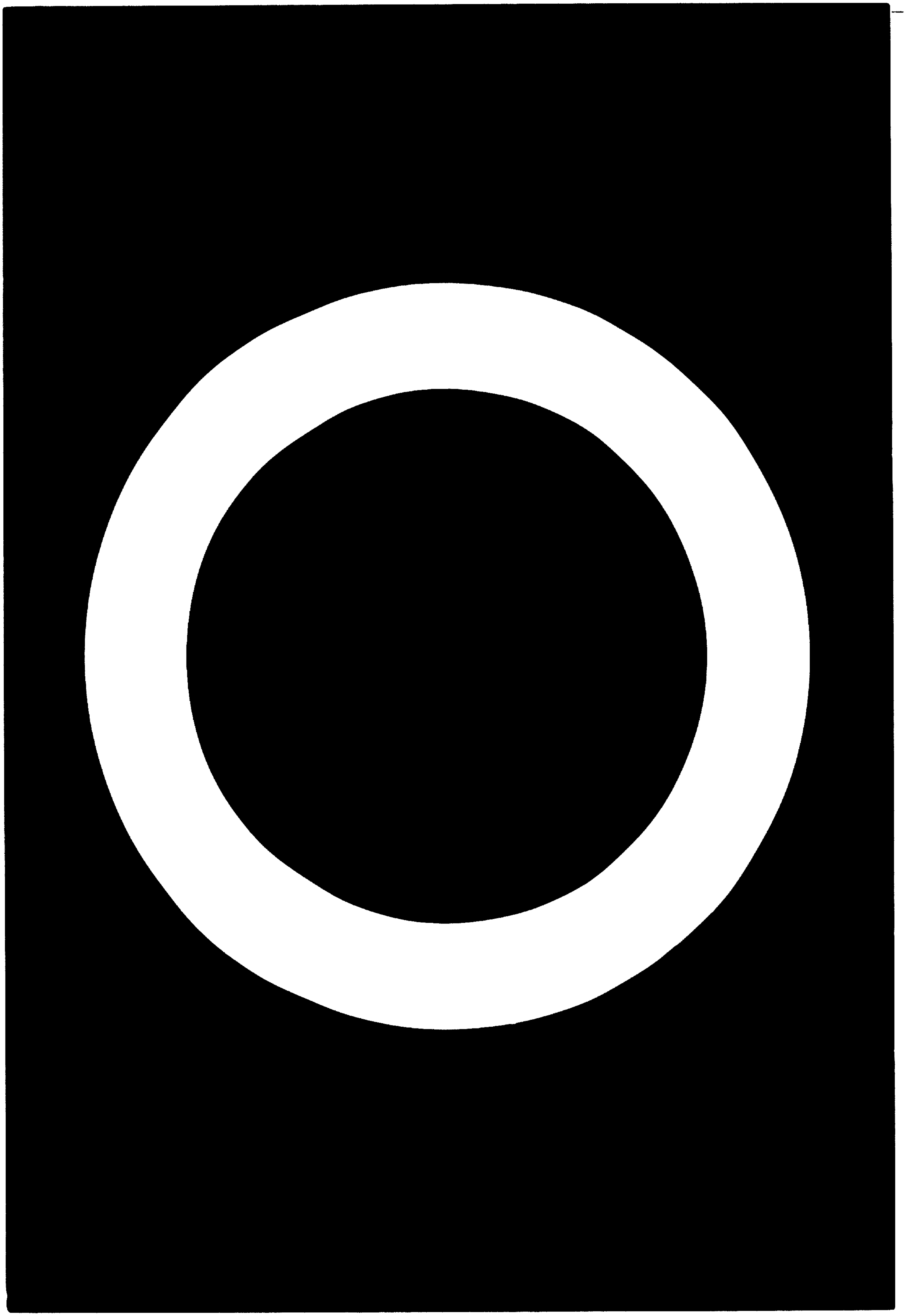
Y OF IRAN — UN SPECIAL FUND PROJECT



FEASIBILITY REPORT
TO
THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
ON
FERRO-ALLOY PLANTS AND ALLOY STEEL PLANT
FOR
THE MINISTRY OF ECONOMY, IMPERIAL GOVERNMENT OF IRAN

01602
(3 of 5)

VOLUME III
FERRO-CHROME PLANT

MAY 1970

M. N. DASTUR & COMPANY PRIVATE LTD. CALCUTTA
DASTUR ENGINEERING INTERNATIONAL GMBH, DUSSELDORF
Consulting Engineers

LIST OF VOLUMES

The planned production for 1969 was about 5.5 million tons which is to be raised to over 10 million tons by 1975. As a result, the demand for ferro-alloys has risen rapidly. The bulk of the ferro-alloy requirements are met by imports which increased from 25 000 tons in 1960 to 69 000 tons in 1967 (Table 6-13).

Table 6-13

RUMANIA: IMPORTS OF FERRO-ALLOYS
(tons)

1960	..	25 000
1965	..	53 000
1966	..	51 000
1967	..	64 000

Czechoslovakia

The steel production of Czechoslovakia increased from about 7.6 million ingot tons in 1962 to about 8.6 million ingot tons in 1965 with corresponding increase in the consumption of ferro-alloys. The ferro-alloy requirements are met partly by indigenous production and partly by imports. Ferro-alloys are produced in blast furnaces as well as in electric furnaces. Electric furnace ferro-alloy production increased from 51,000 tons to 60,000 tons in 1965. Ferro-alloys imported from USSR in 1964 and 1965 were 25,000 tons and 21,000 tons respectively.

ABSTRACT
(Vol III)

This study considers the installation of a ferro-chrome plant with a rated capacity of 10,000 tons of low carbon ferro-chrome and 4,500 tons of high carbon ferro-chrome per annum, specifically for export of the entire production. An evaluation of alternative locations - Ahwaz, Bandar Abbas and Faryab - indicates that the Bandar Abbas-Faryab area to be the most favourable. Installation of a ferro-chrome plant at Faryab will be in keeping with the Government policy of processing minerals before export and of developing the south-eastern part of the country. Setting up a plant in this area depends on the establishment of adequate power supply.

The major production facilities, utilities and services have been selected and a preliminary general layout developed. Estimates of capital cost, manpower requirement and production costs have been derived. The effect of varying electrical energy costs on production cost has been analysed.

On the assumptions that electric power will be made available at 5 mills per kWh and that selling prices would correspond to last quarter 1969 international prices, the project is not commercially viable. However, assuming first quarter 1970 sales prices, the project would earn some profit and generate adequate cash flow for repayment of loan capital.

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EXPLANATION OF SYMBOLS

Three dots (...) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A blank space ( ) in a table means that the item is not applicable.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A space is used to distinguish thousands and millions (1 346 849).

A full stop (.) is used to indicate decimals.

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954.

An asterisk (*) is used to indicate figures partially or wholly estimated.

Use of a hyphen (-) between dates representing years, e.g. 1960-1964, normally signifies an annual average for the calendar years involved, including the beginning and end years. 'To' between the years indicates the full period, e.g. 1960 to 1964 means 1960 to 1964, inclusive.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

8 - FERRO-CHROME PRODUCTION PROCESS AND PLANT CAPACITY

This chapter reviews the different processes of ferro-chrome production and suggests suitable techniques and product-mix for the proposed plant.

Process selection

Two main processes are available for production of ferro-chrome, namely,

alumino-thermic process
electro-thermal process

The choice of process depends upon factors such as the grade of alloy, output, availability and cost of electric power.

Alumino-thermic process

In the alumino-thermic process the chrome ore is reduced by aluminium, which combines with oxygen of the chromic oxide to form alumina, which floats as slag on top of the charge in the reaction vessel. The process is simple and the capital and operating costs are low, but it finds limited application as it is suitable only for small scale production and in locations where aluminium scrap is readily available. This process may not be suitable for Iran.

8 - Ferro-chrome production process and plant capacity (cont'd)

Electro-thermal process

The electro-thermal process is now extensively used for the production of ferro-chrome. Here the chrome ore is reduced by carbon or silicon, with electric power producing the high temperatures necessary for the reaction. The relative merits and limitations of variations of this process for production of ferro-chrome are discussed below, separately for high carbon and low carbon ferro-chrome. The following analyses have been assumed for the intermediate and final products:

	Cr %	C %	Si %	P % max	S % max
High-C ferro-chrome	67.00	6.00	1.50	0.05	0.08
Silico-chrome	40.00	0.04	45.00	0.08	0.05
Low-C ferro-chrome	68.00	0.10 max	0.80	0.08	0.04

High carbon ferro-chrome

Electric smelting

For high carbon ferro-chrome, the accepted process is the use of an open-top submerged arc furnace which is operated on a continuous basis, with the alloy and slag tapped at periodic intervals, generally every two to three hours. Slag and metal are usually tapped from the same taphole into a ladle, which is provided with a lip so that bulk of the slag overflows into a slag pan. As taphole maintenance is often a problem, especially on the five to six per cent carbon alloys, two tapholes, arranged at 30° from each other are generally provided.

The smelting furnace will have a variable pitch circle with a fairly close spacing of the electrodes so as to provide a high power density within the electrode circle. The slags obtained in this process are refractory in nature (as compared with the slags in the silico-chrome operation), necessitating high temperatures for good slag-metal separation. The power density in the electrodes would be about 0.34 kW per sq cm and over the hearth area between 3.5 and 4.0 kW per sq m.

Pre-reduction technique

A recent development in high carbon ferro-chrome practice has been the preparation of the burden and the use of pre-reduction. The process consists of pelletising the chromite ore fines with reductant (coking coal) and pre-reducing in a kiln, followed by hot charging into the smelting furnace. This reduces the power consumption for production of high carbon alloys from 5,000 kWh to say 3,000 kWh per ton. The process has been tried on a 500 kVA pilot plant. Besides the considerable savings in power, electrode consumption would be reduced in proportion to the power consumed. It will also be evident that a much smaller smelting furnace would be needed for a given output. Investment costs, by direct smelting process and the pre-reduction-electric smelting process would be of the same order but overall production may be lower.

6 - Ferro-alloy export possibilities (cont'd)

Poland

Steel production in Poland has increased from about 7.7 million tons in 1957 to about 9.9 million tons in 1966. The country's ferro-alloy requirements are considerable, but as no separate figures of the production of ferro-alloys are available, it is difficult to assess the production capacity of ferro-alloys. A little over 6,000 tons of ferro-alloys was exported in 1964, as against about 2,500 tons of imports. In 1965 imports were reduced to about 1,800 tons. The main sources of imports are USSR, Norway and East Germany.

Yugoslavia

Steel production in Yugoslavia has been fairly steady during the period 1962 through 1966, at about 1.6 million and 1.9 million ingot tons respectively. The ferro-alloys production during these years however increased from about 53,000 tons to 74,000 tons. A little over one-third of ferro-alloys produced in the country is exported and the total quantity exported in 1964 and 1965 was about 21,000 tons and 25,800 tons. Major exports were to Australia, West Germany, Italy, UK, Sweden and USA. Imports of ferro-alloys are rather limited and were only about 1,500 tons in 1964 and 2,000 tons in 1965. The source of imports are USSR, West Germany, USA, France, East Germany, Austria and Sweden.

If this process proves commercially successful, it will be useful for utilisation of fine and friable ores. This report is based on direct electric smelting of sized ore.

Low carbon ferro-chrome

Due to the high affinity of chromium for carbon, low carbon ferro-chrome cannot be produced by the single-step smelting of chrome ore with carbonaceous reductant and fluxes in the electric furnace. The established processes take advantage of the greater affinity of chromium for silicon in relation to carbon. Some of these are briefly discussed below.

Triplex process

The triplex (or so-called 'Swedish') process, consists of making high carbon ferro-chrome from a refining slag containing 20 to 25 per cent Cr_2O_3 and smelting it with quartz to make a silico-chrome with 45 to 46 per cent Si. This silico-chrome is then refined in a tilting furnace with an excess of chrome ore and lime to give the final low carbon alloy plus a chrome rich slag which is then recycled to the first stage.

Perrin process

The Perrin process which gives the highest chrome recovery, consists in melting a chrome-lime slag in a separate tilting furnace and reacting this with silico-chrome made in a regular submerged arc furnace by a single stage process. The reaction between the slag and silico-chrome is carried out in two stages in separate ladles.

Simplex process

The 'simplex' process consists of decarburising high carbon ferro-chrome in the solid state by oxidation in vacuo.

The simplex process involves increased power and refractory consumption. Production of ferro-chrome with carbon contents of less than about 0.06 per cent is difficult. Simplex process also consumes more power than the silico-thermal (Perrin and duplex) processes.

Duplex process

The duplex process is a variation of the Perrin process. It consists of reacting a chrome-lime slag of the same composition as that in the Perrin process in two stages in the same ladle with a 45 to 46 per cent si content in silico-chrome. This is the simplest process of all and is described in detail later.

The duplex process is simpler to manipulate than the perrin process and is easier to control insofar as the silico-chrome entering the reaction is solid, of known composition, and can be accurately measured. There is little difference in power consumption between the two processes, but there is a difference of about two per cent in chrome recovery in favour of the Perrin process. Both the duplex and the Perrin processes are adopted recently in many of the new large ferro-chrome plants. In view of its higher chromium recovery, Perrin process has been recommended for the proposed plant.

Product-mix

Effect of steelmaking practice

The proportion in which the two grades of ferro-chrome will be required, is largely governed by the steelmaking practice which varies considerably from country to country. As regards the high carbon ferro-alloy used for making low alloy and tool steels, the demand pattern is not likely to change much and the quantity required would be proportional to the tonnages of these steels. It is in stainless steel practice, the largest user of ferro-chrome, that variations exist in the mode of charging chromium to steel. With the advent of high speed oxygen blowing, the trend in Japan and USA is towards decreasing use of low carbon ferro-chrome. The possibility of this extending to other countries cannot be ignored.

Consumption trends in ferro-chrome

In USA, low carbon ferro-chrome comprises 50 to 55 per cent of the total ferro-chrome consumed. In UK, the estimated demands is 1970 for high and low carbon ferro-chrome are 21,000 tons and 39,000 tons respectively. In Japan, the estimated requirement during 1969/70 of high and medium carbon ferro-chrome is reported as 158,000 tons and that of low carbon grade about 90,000 tons.

Production trends in <u>ferro-chrome</u>

South Africa, a major exporter of ferro-chrome, concentrates on the production of low carbon grade from the low grade local ores of Transvaal. The ferro-chrome industry in India has also been similarly based on production of larger quantities of low carbon grades. On the other hand, there are examples of countries like Turkey which have set up capacities only for production of high carbon grade for export.

In view of the above conditions obtaining in ferro-chrome producing as well as consuming countries, it may be stated that both grades of ferro-chrome can find market provided they are sold at competitive prices. The proposed plant would mainly produce low carbon ferro-chrome and some high carbon grade.

An open-top submerged arc electric smelting furnace has the flexibility to produce high carbon ferro-chrome and silico-chrome (which is an intermediate product in the production of low carbon ferro-chrome). The plant can start operating with this type of furnace and produce only high carbon variety until the slag furnace for low carbon ferro-chrome is ready, or continue producing exclusively high carbon variety if the demand warrants it.

Plant capacity

The plant capacity in this case is to be based mainly on economic furnace sizes. Recent installations for ferro-chrome production in other countries are for plants with capacities of 10,000 to 35,000 tons per year corresponding to furnace sizes of 7,500 to 15,000 kVA for smelting furnace and 7,500 to 10,000 kVA for the slag furnace.

Recent **installations**

Keeping this trend and the possible export potential in view, it is proposed that the smelting furnace for this plant shall have a rating of 12,000 kVA and the slag furnace 8,000 kVA. These are considered to be optimum sizes.

Proposed furnace **ratings**

A smelting furnace of 12,000 kVA rating operating 330 days a year would be able to produce either

i) about 14,500 tons of high carbon ferro-chrome, or

ii) 9,500 tons of silico-chrome, or

iii) intermediate quantities of the two when producing both the materials.

A slag furnace of 8,000 kVA rating when operating at similar conditions, can produce high chromium slag in quantities adequate to make over 10,000 tons of low carbon ferro-chrome, using about 6,500 tons of silico-chromium from the smelting furnace.

Plant capacity

With both of the above furnaces in operation, the annual plant capacity would be about 10,000 tons of low carbon ferro-chrome and 4,500 tons of high carbon ferro-chrome.

9 - SITE SELECTION

The proposed ferro-chrome plant is to be export-oriented and the possible locations could, therefore, either be port based or raw materials based.

Possible locations

The various locations considered for the ferro-chrome plant are:

Port based	..	Khorramshahr-Ahwaz area Bandar-Abbas area
Raw material based	..	Abbasabad area Faryab area

Port based locations

Khorramshahr-Ahwaz area

The area considered includes Ahwaz as the north apex of a triangle with the Persian Gulf as the base, extending from Khorramshahr in the west to Bandar Shahpur in the east.

The Khorramshahr-Bandar Shahpur region is low lying and gets flooded. The 1969 floods of river Karun inundated a vast area - up to 25 km from Khorramshahr towards Ahwaz. The tidal flat extends 4 to 6 km from the normal shore line at Bandar Shahpur and a plant located close to port would need 2 to 3 m filling to raise above maximum tide level,

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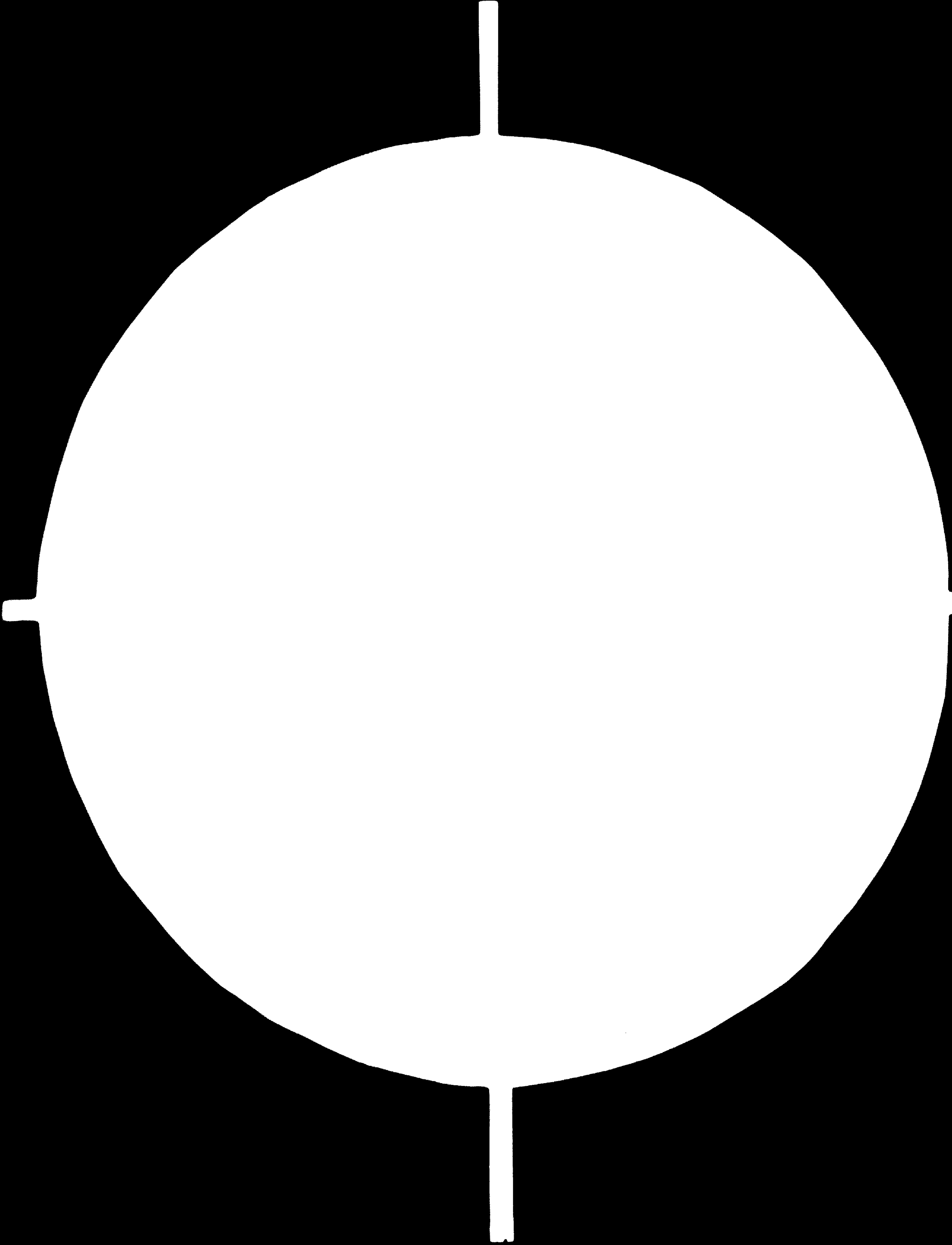

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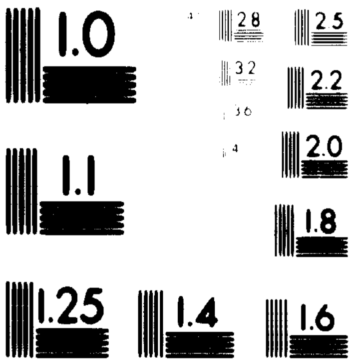

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are restricted. As and when Bandar-Abbas gets connected to the railway network of the country, distribution to domestic consumers would be easier. As the proposed ferro-chrome plant is primarily export-oriented, transport link is not a critical factor in the choice of location. The existing transport links of Bandar-Abbas and Faryab are therefore considered adequate for the purpose.

Township

The choice of Faryab location would require the development of suitable housing facilities and amenities in green field site, as there is no suitable township in the vicinity. Whereas in the case of both Ahwaz and Bandar-Abbas, housing facilities available at the existing townships may be availed of.

Economic considerations

A comparison of capital and operating cost factors for the three units is given in Appendix 9-2. With regard to the capital cost factors, there may not be a significant difference between the three locations.

Operating economics

From the viewpoint of operating costs, it is observed that the incidence of freight for assembly of raw materials and for transport of finished product to the port are the lowest for Faryab. The incidence of freight for the assembly of raw materials and transport of product to the port is given in Table 9-2.

Table 9-2

FREIGHT COST OF RAW MATERIALS ASSEMBLY AND PRODUCT DISTRIBUTION PER TON FERRO-CHROME

	Ahwaz $	Bandar-Abbas $	Faryab $
Raw materials assembly	44.6	31.4	24.7
Product distribution	2.6	1.5	3.6
Total ..	47.2	32.9	28.3

The above comparison indicates that the operating economies are favourable for Faryab, followed by Bandar-Abbas and Ahwaz. It needs to be stressed that the installation of a plant in Faryab or Bandar-Abbas is primarily dependent on the development of the power supply system. The Faryab location has been considered for this study.

10 - PLANT GENERAL LAYOUT AND MAJOR FACILITIES

The plant general layout and major facilities proposed are discussed in this chapter.

Design basis

Product mix

The intermediate and final products would have the following output and chemical analysis:

	Cr %	C %	Si %	P % max	S % max	Rated capacity tons/yr
High C ferro-chrome	67	6	1.5	0.05	0.08	4 500 (in-process material)
Silico-chrome	40	0.04	45	0.08	0.05	
Low C ferro-chrome	68	0.1 max	0.08	0.08	0.04	10 000

Raw materials

Analyses of major raw materials are given in Appendix 10-1. The estimated consumption of raw materials are given in Table 10-1 and plant flow sheet is given in Drawing No. 5131-III-5.

10 - Plant general layout and major facilities (cont'd)

Table 10-1

RAW MATERIALS CONSUMPTION

	Consumption kg/ton		
	High C ferro-chrome	Silico-chrome	Low C ferro-chrome
Chrome ore	2 300	1 450	1 460
Quartzite	145	1 560	
Limestone			2 100
Coke	225	340	
Charcoal	250	590	
Silico-chrome			650
Electrode Paste	35	55	22

Plant general layout

A tentative general layout for the plant is given in Drawing No. 5131-III-6 and a typical section of the furnace building is shown in Drawing No.5131-III-7.

The facilities have been laid out for maximum utilisation of space, without impeding a rational flow of incoming, in-process and outgoing materials.

The main production facilities - raw material stockyard, day bins, and the furnace building - are located in such a way as to ensure rational movement of materials between them or from outside without interference. The raw materials stockyard and the furnace building are laid at right angles to the main high-way allowing for substantial expansion towards one side.

10 - Plant general layout and major facilities (cont'd)

The fuel oil tank and pump house are adjacent to the main road at the eastern end. The incoming water main enters the plant boundary from the east, and the raw water and treated water storage tanks and the water treatment plant, the cooling tower and the pump house are located south of the furnace building, keeping the total run of the big diameter pipes and the pumping costs minimum.

The main receiving station is located at the southern end and the substation is so sited as to enable the best possible connection to the receiving station and the high tension and low tension power consuming units.

All incoming and outgoing materials will be moved by road. The plant is provided with a suitable road network of about 1.5 km length.

Production facilities

Based on the process requirements and materials handled, the equipment and facilities have been determined and given in Appendix 10-2.

Raw material handling

Suitably sized raw materials are proposed to be purchased and received at the plant in dump trucks. Mobile pay loaders will be utilised for stacking and reclaiming these materials.

10 - Plant general layout and major facilities (cont'd)

Two to four weeks storage of major raw materials is proposed. Materials reclaimed from the storage building or from the unloading area by payloaders are belt conveyed to the respective day-bins. Eight day-bins are provided - two for ore, two for coke, two for charcoal, one for quarts and one for other materials. The charging system comprises of vibratory feeders, automatic weighers, belt conveyors and elevator.

Two separate day-bins are provided for chrome ore (concentrates/fines) and limestone in front of the ore drying kiln and the rotary kiln for calcining, respectively. These materials are also carried to the day-bins by payloaders and conveyors/elevators.

Rotary kilns

The chrome ore fines, normally expected to have a moisture content of about 5 per cent are dried in an oil-fired rotary kiln of capacity 3 tons per hour. Dried and preheated ore is stored hot in a refractory lined bin, from where it is charged into the furnace. An oil-fired rotary kiln of 5 tons per hour capacity has been provided for calcining limestone. Calcined product is stored hot in a refractory lined bin from where it is charged into the furnace.

Smelting furnace

The smelting furnace is an open rotating submerged arc furnace served by a 12,000 kVA on-load tap-changing transformer. The furnace operation is controlled from a control room located above the furnace level. A tap hole opening mechanism and mud gun for closing it are provided.

Slag furnace

The 8,000 kVA slag furnace is of travelling-tilting type. It is basic lined and is provided with Soderberg electrodes.

Tapping and finishing equipment

The silico-chrome is tapped into a firebrick lined ladle in the tapping bay. The slag is allowed to overflow and the metal cast into pans to obtain 125 to 200 mm thick slabs, which are then crushed with two jaw crushers and a cone crusher. The crushed silico-chrome is conveyed over a belt to an overhead bin.

The slag from the slag furnace is tapped into a basic refractory-lined ladle up to a third of its volume. The crushed silico-chrome is gradually allowed into this ladle in controlled quantities through a 10-ton capacity weigh-scale and vibratory feeder.

The contents of this ladle are transferred to a basic refractory lined siphon ladle from which the low carbon ferro-chrome is poured into moulds on reciprocating bogies. After solidification,this material which is in slab form is hammered and crushed. The crushed product is transferred to the finished material storage bin.

The slag residue in the siphon ladle has a high chromium content. To recover this, fresh silico-chrome from the smelting furnace is poured into this ladle in weighed quantities with the help of a 15-ton weigh scale, to produce a second variety of silico-chrome with about 25 per cent Si and 60 per cent Cr. This is then used for all subsequent reactions with the high chromium slag for producing low carbon ferro-chrome.

Miscellaneous equipment

Miscellaneous items such as pneumatic breakers and rammers for dismantling refractory linings of furnaces and ladles, for tamping the carbon paste in the reduction furnace, are provided.

Electric power system

Analysis of plant power requirements

On the basis of three-shift operation of furnaces (equalling 7,920 working hours per year) the plant electrical loading conditions are estimated as follows:

Average load based on full calendar year	.. 12,800 kW
Annual energy consumption	.. 112.6 million kWh
Maximum demand on basis of 15-min operation at any one period	.. 17,340 kW
Plant average corrected power factor	.. 0.9
Firm feeder capacity	.. 22,000 kVA

Characteristics of plant load

Power and load factor

The 12 MVA smelting furnace required for initial reduction consumes power at a steady rate throughout the year with high power factor as well as load factor. The 8 MVA slag furnace operates like a steelmelting arc furnace during the initial half hour of its cycle from charge to tap. Consequently, the problem of voltage fluctuations will have to be studied at the engineering stage and the power plant system designed to overcome this problem.

Selection of power system voltages

Power system voltages

Arrangements are required for providing firm power of about 22 MVA for this plant. It is proposed that power be purchased directly at 132 kV, on the basis of the following considerations:

i) With the proposal to locate the plant at a site about 65 km north-east of Bandar-Abbas, power to this plant can be fed by extending the transmission line from Jiroft or by establishing generating station at Bandar-Abbas or by feeding power from the combination of the above two sources.

According to information furnished by Ministry of Water and Power, a 132 kV transmission line network is proposed in this area, and hence power can be taken directly at 132 kV. If, however, a 230 kV line is planned from Jiroft to Bandar-Abbas, then the power to the plant will have to be brought in at 63 kV.

ii) To prevent the voltage disturbance being reflected on the power grid, the system short-circuit level will have to be at least 600 MVA. This may be difficult at lower voltages specially in this industrially undeveloped area.

which has been followed in the case of the petro-chemical complex. The load bearing capacity of the soil being low, it would be necessary to have pile foundations. Industrial quality water would have to be brought from a distance of 60 to 70 km. This area is, therefore, not considered suitable.

Ahwaz
<u>considered</u>

Ahwaz is fast developing as an industrial area. It has adequate supply of water and power and is served by an excellent transport network. Accordingly Ahwaz has been considered as a possible location for the ferro-chrome plant.

<u>Bandar-Abbas</u>

Bandar-Abbas on the Gulf of Oman is being developed into a major port to handle Iran's export trade. A mechanical loading plant for chrome ore has already been installed. At present there is no industrial activity in and around Bandar-Abbas. The Imperial Government of Iran has, however, planned a large scale agricultural and industrial development of this area. In order to promote industrial investment, Government is expected to offer economic incentives in the form of tax relief and financial assistance. This is, therefore considered as a possible location for the plant.

iii) It should be possible to provide a 132/11/6 kV three-winding step-down trensformer to feed power to the plant.
By selection of proper inter-winding transformer reactances, the furnace loads connected to the transformer 11 kV winding could be segregated from the rest of the plant load fed from 6 kV winding.

iv) Selection of a three-winding transformer will also prevent voltage fluctuations being reflected on plant auxiliary loads. 11 kV is selected as one of the secondary voltages since the 8,000 and 12,000 kVA furnace transformers can be designed to operate directly from 11 kV supply.
The third winding of the main transformer is wound for 6 kV for feeding the plant auxiliary loads.

The plant auxiliary loads will be fed from the plant medium voltage distribution system which according to Iranian Standards will be at 380/220 volts.

Plant power distribution system

Power distribution system

Drawing No. 5131-III-8 gives an overall picture of the proposed main system interconnection for the ferro-chrome plant in the form of a single line diagram.

The main features of the distribution system are as follows:

i) Power will be purchased from the power supply company directly at 132 kV over two full capacity feeders. Duplicate feeders are proposed, so that if one of the feeders goes out of service, the other will cater for full load requirements without interrupting the production.

ii) The two feeders will be terminated to the supply company's 132 kV busbars at the plant substation. The 25 MVA 132/11/6 kV power transformer will be connected to the 132 kV bus over a 132 kV outdoor circuit-breaker. The incoming 132 kV circuit-breakers and busbars will be the property of the power supply company whereas the transformer 132 kV circuit-breaker will be the property of plant authority.

iii) The 8 MVA and 12 MVA furnace transformers will be fed from 11 kV winding, over independent 11 kV circuit-breakers.

iv) Plant auxiliary loads will be fed from two 800 kVA, 6/0.4 kV stepdown transformers which are connected to the 6 kV winding over 6 kV circuit-breaker and fuse switches.

v) In case of total power failure, vital services and emergency lighting will be fed from automatic mains failure diesel generating sets provided for the purpose.

Plant power supply equipment

Power supply equipment

It is recommended that except for 132 kV isolating switches and circuit-breakers, all other switchgear should be of indoor, enclosed, sheet steel design, with air or minimum oil circuit-breakers of adequate interrupting rating. The current rating of the circuit-breaker shall be standardised at 400, 630, 1,000, 1,600 and 2,000 amps, depending on the size of the feeder. In selecting current ratings the high ambient temperature conditions will have to be taken into consideration.

For 380/220 volts system, two 800 kVA, 6/0.4 kV transformers with 380 volts switchgear in form of a load centre is proposed to feed auxiliary power to various sections of the plant over motor control centres.

Plant communication system

To provide two-way communication within the plant it is proposed to provide a 50-line internal telephone exchange. This system will have direct dialling facility for person-to-person communication between extensions, as well as conference calling facilities.

10 - Plant general layout and major facilities (cont'd)

A controlled electric clock system is proposed which will indicate synchronised time throughout the plant and will provide impulses to the time recorders from a master clock.

Water supply and distribution

Water is mainly required for cooling the furnaces, transformers, kilns etc and for sanitary purposes. The estimated total water circulation is about 390 cu m per hour as follows:

	Quantity cu m/hr	Remarks
Furnace, transformer etc	330	Recirculated
Kilns and associated equipment	21	
Crushers for ferro-chrome	32	
Drinking and sanitary uses	2	Drained off
Miscellaneous uses	5	
Total	390	

The industrial make-up water requirement is estimated at 20 cu m per hour. A flow diagram of water distribution is given in Drawing No. 5131-III-9.

Water treatment

As the water requirements of the ferro-chrome plant are very small, no difficulty is envisaged as regards the supply of water from the river Minab.

The river water would be pumped to a water storage tank of capacity 500 cu m inside the plant. A settling and water treatment plant of 25 cu m per hour capacity is proposed.

Water distribution

After treatment, the make-up water (20 cu m per hour) is taken to the cold well of the cooling tower. Recirculating water would be cooled in a cooling tower. The high pressure (80 m head) water system is served by two (one standby) pumps of capacity 60 cu m per hour and an overhead tank (at 45 m staging height) floating on the line leading to these consumers. The rest of the water is pumped by three pumps (one standby) of capacity 170 cu m per hour and 50 m head. Another overhead tank at 30 m height floats on the line leading to these consumers. In addition, one diesel operated high pressure pump is provided as emergency standby (to operate during power failure).

Drinking water would be pumped to the different consumers by two pumps (capacity 15 cu m per hour and head 25 m). An overhead tank of height 18 m floats on the line leading to those consumers. Hydrants for fire fighting are provided on the drinking water system.

10 - Plant general layout and major facilities (cont'd)

Compressed air

In addition, compressed air at high pressure (about 40 kg/cm^2) is needed for the electrode hoists of the slag furnace.

Four compressors, each of capacity 500 nm^3 per hour at 7 kg/cm^2 pressure, would be required to supply the compressed sir requirements of the plant. Two standby compressors are also provided. Suitable pressure reducers regulate the pressure at the low pressure air consumption points. A separate compressor would be provided for the high pressure air required for electrode hoists of slag furnace.

Fuel oil

Fuel oil system

The estimated requirements of fuel oil are about 20 tons of fuel oil (based on a calorific value of about 10 000 Kcal/kg) per day for the kilns and the ladles only.

Fuel oil is brought into the plant site by road tankers and unloaded into the storage tanks of total capacity 300 cu m by a pump of 30 cu m per hour capacity. From these tanks, the oil is circulated by a pump of 20 cu m per hour capacity through a ring main leading to the consuming points. Necessary oil preheaters are incorporated to this main. Standby pumps are provided both for unloading from tankers and circulating the oil.

The oil required for operating the emergency power generator and the water pumps would be stored in drums.

Auxiliary facilities

Other facilities

Adequate facilities for repair and maintenance of equipment, stores for the various materials, a laboratory, production and administration offices are provided and furnished with the necessary equipment.

A canteen is provided near the furnace building, where the maximum number of employees are concentrated. A gate house is provided at the main entrance to the plant with separate entrances for vehicles and pedestrians.

The general stores is located near the main road leading to the plant and the repair shops are adjacent to this. The laboratory and production offices are close to the raw material stockyard and the furnace building.

11 - PLANT CONSTRUCTION

The installation of ferro-chrome plant necessitates coordination of various aspects of construction to adhere to a firm time schedule. Basically the overall time taken to execute the project can be divided into two phases, namely

i) preparatory phase, involving investigations of raw materials and finalising the concept of the project. It includes final site selection, land acquisition, soil investigations, establishment of construction facilities at site and initiation of work on off-site facilities; and

ii) construction phase covering the detailed engineering equipment procurement and construction/erection at site.

Preparatory phase

The preliminary or preparatory phase of work is very significant because the infrastructure has to be strengthened and developed for the speedy execution of the project, sources of water and power supply augmented, township built and other related activities taken up.

Infrastructure development

Raw materials

For the ferro-chrome project, investigations specially regarding the source of supply of quartzite and limestone would have to be initiated at an early date. Necessary development of chromite mines as well as quartzite and limestone mines has to be planned and executed. The road connecting the mines to the metalled highway has to be improved.

Power and water

The most important infrastructure development required is for ensuring power supply. Decisions in this regard would have to be made and work taken in hand at an early date.

Advance action would have to be taken to ensure adequate water supply from the river Minab and also to ascertain the quality of water available so that the type and extent of water treatment required may be decided upon.

Land acquisition

After finalising the plant site, immediate steps would have to be taken for acquiring the land for the project. Soil investigations and survey work at site have to be initiated very early to enable site preparation studies, foundation designs and civil work estimates to be prepared.

Authorisation to proceed

In order to finalise the concept of the project and expedite various activities, it is essential that the project authorities take an early decision on the appointment of consulting engineers, production advisers etc. This will facilitate an early start on the engineering of the project.

Construction facilities

Accommodation

Before the main construction work is started, various facilities are necessary for rapid progress. Construction offices will have to be built on the site so that the preliminary work could be expeditiously handled. Construction of residential accommodation has to be taken up simultaneously to provide housing for construction personnel.

Surveys

An initial survey needs to be conducted to fix a grid pattern at the selected site and to locate the main reference towers for a precision survey to be carried out after the site is levelled.

Water and drainage

Temporary drainage and disposal of sewage through the provision of septic tanks will be arranged until permanent drainage and sewerage systems start functioning. Provision will also have to be made for supply of construction water as also drinking water for construction personnel.

Raw material based locations

Abbasabad not suitable

Though adequate land is available around Abbasabad, the availability of water and power may pose problems. A plant in this area would have to be based on the use of underground water. Water for agricultural as well as domestic purposes is at present drawn from deep tube wells. During the field investigation, it was reported that at certain locations there have been problems of drawing water continuously from such wells.

Adequate power supply is not available at present in this area. Even the railway stations have their own diesel generating sets for the railway township and installations. The area is also not likely to be linked up with national grid even in the Sixth Plan. In view of this Abbasabad area is not considered suitable for a power-intensive industry like ferro-chrome in the near future.

Faryab considered

Faryab mine is one of the major sources of chrome ore production of Iran at present. This area falls within 200 km radius of Bandar-Abbas, and it is expected that the necessary facilities, which the Imperial Government of Iran proposes to extend at Bandar-Abbas, would also be available here.

11 - Plant construction (cont'd)

Power

Power supply will also have to be arranged for operating machineries and provide lighting for night work. Keeping in view the 'green-field' conditions of the site, the construction power may have to be supplied from diesel generators.

A central construction campus consisting of open storage areas, covered sheds etc will have to be constructed to receive and store construction material, consumables and incoming equipment. Special provision will have to be made for storage of cement in covered sheds.

Construction phase

Construction schedule

The major activities of plant construction are indicated in Drawing No. 5131-III-10, with durations. The critical path network in Drawing Nos. 5131-III-11 and -12 outlines the major operations in the proper sequence and emphasises the activities that will need special attention for the completion of the project in time. The completion time of the project (excluding the preparatory phase) is expected to be about 30 months.

Procurement and installation of equipment

Equipment procurement and erection

After the capacities and type of major equipment are decided, specifications and tender documents will be prepared for inviting tenders from selected parties on global basis. The issue of the tenders and the placing of orders will be so phased with due thought to their delivery periods as to ensure that the equipment for the various units planned will be received in time, in the order of their completion and the work on the plant construction is expedited. The scope for utilising indigenously manufactured equipment will be fully explored and local supplies will be utilised to the maximum extent.

Erection of all major equipment will have to be entrusted to firms having sufficient experience, finance, tools, tackles and skilled labour. For special equipment, representatives of the equipment manufacturers will supervise the erection.

Structural steelwork

Structural steel requirements which cannot be met from indigenous production are proposed to be imported directly by the project authorities. Fabrication of structural steelwork is to be done at site. Tenders for fabrication and erection of structural steelwork (totalling about 2,500 tons) will be prepared and invited, based on design drawings prepared by the consulting engineers on the project. The selection of the contractors is preferably done on the basis of rate contract (rate per ton) for different categories of steelwork.

Civil work

Construction of ancillary buildings such as administrative office, canteen etc and construction of roads have to be taken up well in advance of the plant buildings. These buildings may be initially utilised as site offices.

Tenders for civil work will be called on item rate basis and quantities for all the major items of work will be indicated in the tender. Approximate total quantity of r.c. work is estimated at 9,000 cu m.

Roads

It will be advisable to take up construction of the main internal roads as early as possible to avoid construction of a number of temporary roads. In the first phase of work, only water-bound macadamised roads should be opened for traffic during plant construction. In the final phase these roads may be repaired as required and wearing surface provided.

Management and supervision of construction

Modern techniques of management control such as CPM and PERT will be followed to anticipate bottlenecks and take advance action. A central coordinating agency or organisation will be necessary to ensure efficient working of the various facets of the construction programme.

12 - CAPITAL COST ESTIMATE

The capital cost estimate of the plant is given in Appendix 12-1 and summarised in Table 12-1.

Table 12-1

PLANT CAPITAL COST ESTIMATE

(thousand dollars)

			Foreign currency	Local currency	Total
A.	Land	..	-	15	15
B.	Civil and structural work and offsite facilities	..	453	1 978	2 431
C.	Plant and equipment	..	4 417	150	4 567
D.	Other costs				
	Spares	..	220	8	228
	Freight and insurance		464	-	464
	Port charges and inland transport	..	-	158	158
	Equipment erection	..	137	548	685
E.	Engineering, supervision and construction administration	..	307	717	1,024
F.	Contingencies	..	300	179	479
	Total	..	6 298	3 753	10 051

The foreign exchange requirement is estimated at $ 6,298,000 which is about 63 per cent of the estimated total capital cost.

Civil and structural cost

The civil work part of the estimate includes costs of all items such as earthwork, foundations for building columns, plant and equipment and masonry and includes r.c. work for buildings, roads and boundary wall. It also comprises off-site facilities including approach road and water supply from river Minab. Electric power connection is assumed to be given by the electric supply authorities at their cost. As no data on soil conditions are available, the designs are based on assumed load bearing capacity. The estimates are on the prevailing prices of cement, sand and gravel obtaining in Faryab area (Table 12-2).

Table 12-2

PRICES OF CONSTRUCTION MATERIALS AT FARYAB

		Unit	Cost $
Cement	..	ton	32.00
Sand	..	cu m	0.67
Gravel	..	cu m	0.67
Bricks	..	1 000	10.67

All civil materials (except timber for shuttering) are expected to be procured from indigenous sources.

The cost estimates of structural steelwork includes structural work involved in the plant building, complete as erected. The technological structurals are included in the cost of equipment.

Cost of structural steel

The local production of steel is at present limited to the production of merchant sections at the Iranian Rolling Mills Co in Ahwaz. However, it may be expected that the integrated steel plant at Isfahan might start production before the work on the construction of the ferro-chrome plant is taken up. Based on a study of the product-mix of these two plants, it is expected that about 25 per cent of the steel required for building construction could be supplied from local sources. In the absence of definite prices for local steel, it is assumed that the indigenous steel costs will be 20 per cent higher than the c.i.f. cost of imported steel including customs duty.

The average price of structural steel delivered to the plant site is estimated at \$ 257 per ton on the basis of f.o.b. price of \$ 140 and adding ocean freight, insurance, port handling charges, customs duty, commercial benefit tax, and inland freight.

It is assumed that fabricating of building structurals will be done at site. The fabrication and erection rate is based on information furnished by local contractors and has been taken at an average of $ 143 per ton. The foreign exchange required for importing structural steel and sheeting is estimated at about $ 343,000.

Plant and equipment

The equipment cost covers production and auxiliary equipment including electricals, EOT cranes, refractories, utilities, material handling and other miscellaneous facilities. The electric smelting furnace and associated equipment cost are based on international prices indicated by equipment manufacturers.

The bulk of the equipment of f.o.b. value of about $ 4.42 million will be imported. The local supply may be restricted to a part of utility and service facilities, estimated at $ 0.15 million. However, at the engineering stage, it may be possible to include a larger component of local supply depending on the availability then, thereby reducing the foreign exchange component correspondingly.

Other costs

Essential capital and commissioning spares will be purchased along with the main plant. The cost of spares has been estimated at five per cent of the cost of equipment.

Freight and insurance

Ocean freight and insurance have been estimated at an average of 10 per cent of f.o.b. cost of equipment and spares. Provision for inland freight of equipment has been made at 3 per cent of c.i.f. cost of imported equipment and ex-works cost of local equipment.

Equipment erection

The erection costs for equipment have been assumed at 15 per cent of the f.o.b. cost of equipment. It has also been assumed that the necessary tools, tackles and erection rigs would be supplied by the erection contractor and ,therefore, no separate provision for these items has been made. In view of the complexity of erection of some equipment, it is envisaged that foreign assistance would be required for erection. A provision for 20 per cent of the total erection expenses in foreign exchange has therefore been made.

No provision has been made for customs duty on plant and equipment as it is expected that these will be exempted from duty, in keeping with Government policy.

Engineering, supervision and construction administration

Provision has been made for expenses for engineering the project, administration and supervision of construction at 12 per cent of the cost of civil and structural work and equipment as erected. Of this, an estimated 30 per cent would be in foreign currency in payment for the consultant's services.

Contingencies

A five per cent provision has been made to cover contingencies.

13 - PLANT ORGANIZATION, MANPOWER AND KNOW-HOW REQUIREMENT

Organization structure

Organization is a vital aspect of planning, concerned with definition of the span of responsibility of the executives, the sub-division of the total management process into functional responsibilities and the establishment of formal inter-relationships. This is of added importance in countries where there is a general shortage of trained and experienced men.

This chapter proposes a typical plant organization structure and indicates the know-how that would have to be imported for this ferro-alloy plant.

Plant organization

Advance action needed

As managerial development is a time consuming process, organization planning and manning programmes should commence early, well ahead of the construction of a project. Arrangements for setting up the plant management structure which would clearly identify the responsibilities of the personnel will have to be worked out at this planning stage. Procedures will have to be evolved for the construction, operation and maintenance of the plant.

Role of the chief executive

Works manager

The title of Works Manager has been suggested for the head of the ferro-alloy plant. It has been assumed that his span of responsibility would cover the works administration, construction, accounts, and sales. The management organization shown in Chart III-1 indicates the framework for carrying out the responsibilities of management, for sub-delegation of such responsibilities and for motivation of the management team with a view to ensuring effective work at all levels.

Management organization

The management organization has been grouped into five different major activities under the direction of the Works Manager. The senior executives directly report to Works Manager and their various responsibilities are indicated in broad terms below:

Plant Superintendent - Construction, production, maintenance, and process and quality control.

Administration Officer - Personnel, labour relations, training, office administration and security

Chief Accounts Officer - General accounts, costs, internal audit, both during construction and operation.

Review of locations

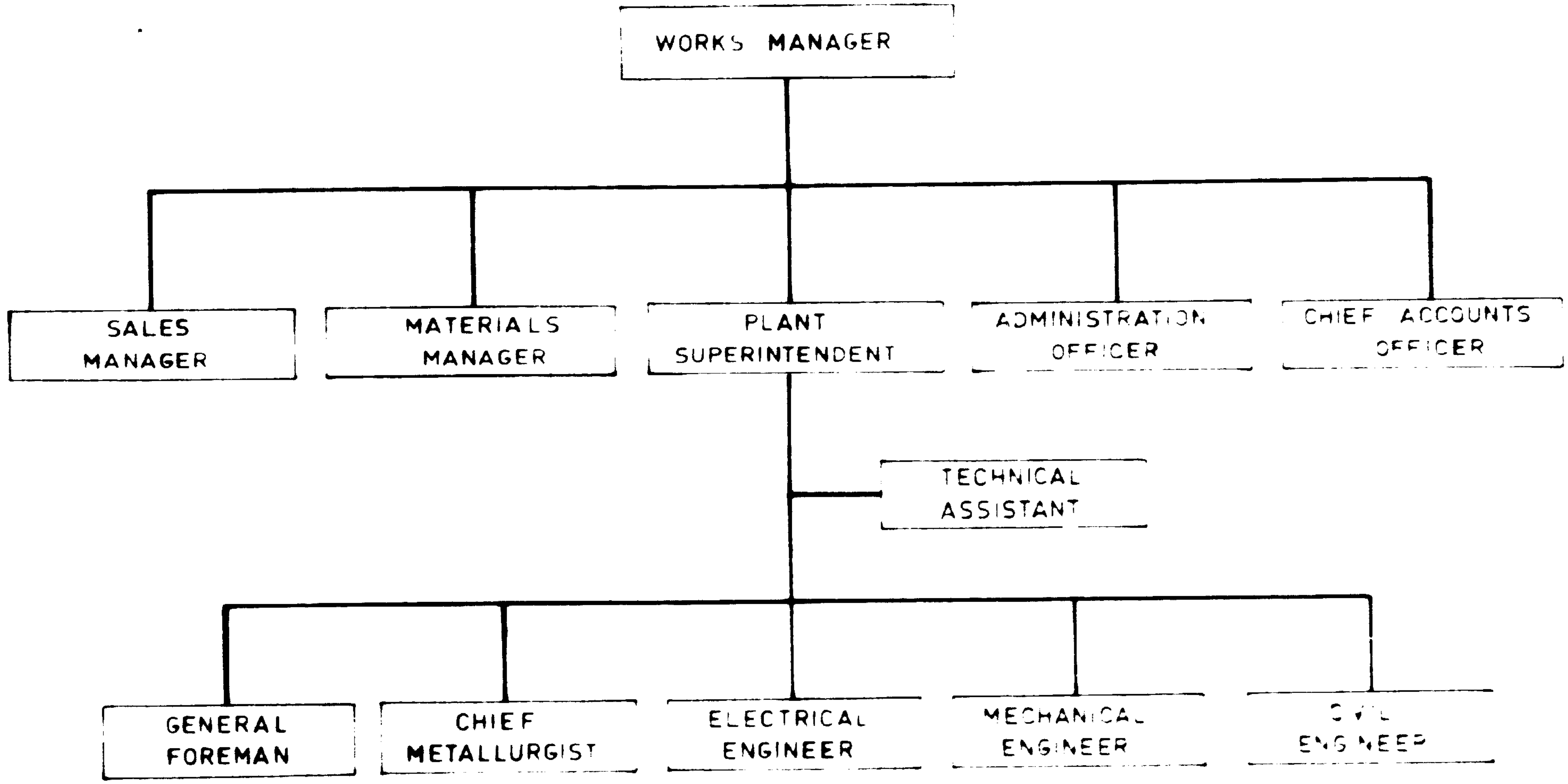
The three areas which need to be considered further for installation of a ferro-chrome plant are Ahwaz in Kuzesthan and Bandar-Abbas and Faryab in Kerman.

Plans for power development

Production of ferro-chrome, like many other ferro-alloys, is a power intensive operation. The ferro-chrome plant would require a firm feeder capacity of 22,000 kVA. The selection of a suitable location has, therefore, necessarily to keep in view adequate availability of electric power.

Present plans for installation of major hydro-electric and thermal power plants during the fourth and fifth plan periods for the regions under study for the ferro-chrome plant location are given in Table 9-1. The proposed national power grid system is shown in Drawing No. 5131-III-1. This information on the development and availability of electric power has been obtained from the Ministry of Water and Power, Imperial Government of Iran.

CHART III-1 – FERROCHROME PLANT – POSSIBLE ORGANIZATION STRUCTURE



Materials Manager	- Purchase and supply of main plant equipment and stores during construction; purchase and supply of stores, spares, consumables and raw materials during operation.
Sales Manager	- Marketing and sales, domestic as well as export.

In developing the organization structure, no provision has been made for management of quarries and mines. It is assumed that there would be no captive source and that the raw materials required for the plant would be purchased.

General arrangement for inter-**relations**

The responsibilities for top planning, coordination and control of activities of the plant are vested in the Works Manager who in consultation with his senior executives and officers and by close and recurrent personal contact among them, would exercise them. The pattern of delegation of responsibility by the Works Manager to the senior executives determines their role and relationships in the organization structure.

Works organization

Plant **superintendent**

The works organization pattern has been developed clearly indicating the responsibility for respective activities for operation as well as maintenance, as shown in Chart 1. The Plant Superintendent, as the head of the works organization, is directly responsible to the Works Manager. The activities under his purview have been grouped under three major divisions, namely,

i) production
ii) production planning and control, and
iii) maintenance and services.

The production division is headed by the General Foreman who is functionally responsible for the technical and supervisory activities of the major production units.

Production planning and control

The production planning and control functions are under Chief Metallurgist. The function of this division comprises planning of production programme, indenting raw materials requirement, and process and quality control.

Maintenance and service

The maintenance and service functions are subdivided into three divisions, namely electrical, mechanical and general plant maintenance. The electrical maintenance would be headed by the Electrical Engineer who would be responsible for the electrical power distribution system as well as maintenance of electrical equipment.

The Mechanical Engineer is functionally responsible for the maintenance of all mechanical equipment involved in production and is in charge of the utilities and service facilities including pump houses, water supply, fuel storage and handling, workshop, and transport equipment.

A Civil Engineer will look after the plant general maintenance including buildings, sewerage, roads, etc.

As production is the primary function of the plant, it is proposed that the delegated responsibility of the Plant Superintendent is to be as composite and comprehensive as possible. He has a vital role to play in the inventory control, as the bulk of the inventory is accounted for by spares and consumables for the plant which are intimately connected with plant operation and maintenance. Although the Materials Manager is directly responsible to the Works Manager, in day to day functioning he would work in close liaison with Plant Superintendent.

Administration and commercial services

The administrative and commercial functions, as indicated in the organization chart, are divided into four groups, headed by four senior executives. The function of each senior executive has been further sub-divided and is looked after by different divisional heads.

Administration The personnel and labour relations, office administration and plant security functions coordinated by the

Administrative Officer are respectively the responsibility of Personnel Officer, Office Superintendent and Plant Security Officer.

Accounts and finance

The functions under the Chief Accounts Officer are sub-divided into three groups - cost accountancy, salaries and wages and general accounts. The Accounts Officer, Costs heads the cost accounts division which looks after the costing of the plant during construction and operation. The Accounts Officer, Salaries and Wages is in charge of the division looking after the time office work, preparation of salary and wage bills and disbursement of the same. The general accounts, costs and internal audit are grouped into one division under Accounts Officer General.

Materials management

In view of the importance of materials management in the scheme of inventory control and cost reduction, a senior executive position of Materials Manager has been proposed to carry out this function. He is assisted by the Purchase Officer and Stores Officer. The Purchase Officer is in charge of purchase of stores, consumables and raw materials, main plant equipment etc as required for the plant operation. The Stores Officer, as the name implies, is in charge of the plant storage facilities for spares and consumables.

13 - Plant organization, manpower and know-how requirement (cont'd)

Sales management

The Sales Manager is responsible for 'sales planning' and to carry out the 'sales policy' decided by a team of executives. As the ferro-chrome plant is primarily export oriented, the sales planning will have to be suitably organised. It is suggested that the activities may be divided into two groups - market research and marketing. Market research mainly comprises identifying and conducting detailed survey of suitable markets, assessing probable demand and price forecasting and is the responsibility of Market Research Officer. The Marketing Officer controls the other sales activities, such as packaging and shipping, customer relations etc.

Supervisory personnel

In planning the management structure for the ferro-chrome plant, the term 'supervisory personnel' has been used to include foreman category and above. The various categories of management personnel both with executive and supervisory cadres required for the ferro-chrome plant are indicated in the manning list discussed.

Manning

The works organization under Plant Superintendent is indicated in Chart 1. The manpower requirement of the plant is discussed below.

The function of manpower planning may be divided into three broad heads - operation manning, maintenance and service manning, and administration and commercial services manning.

Operation manning

Operation manning can be identified under the broad categories of equipment manning, crew manning and helpers. Directing manning positions needed for equipment operation or for attendance on machinery in operation have been identified on the basis of the proposed plant layout, and on the equipment and technology envisaged. In respect of the crew manning, the general operating practices obtaining in ferro-alloy plants in India provided the basis, but the crew size has been suitably modified to allow for the specific technology adopted in the proposed plant.

In addition to the equipment manning and crew manning, provision has also been made for helpers required for manual handling of materials, shop cleaning, and such other activities.

Maintenance manning

A proper evaluation of the requirements of manpower assignment for maintenance work involves a detailed study of the equipment installed, type and extent of preventive maintenance necessary, availability of skill, frequency of breakdowns etc. For the purpose of this report, the maintenance, manning has been developed on the basis of practices followed elsewhere under comparable conditions.

Administrative and commercial manning

The norms for manning of administrative and commercial services vary widely from country to country and also from organization to organization within the same country depending on the administrative and commercial practices in vogue. The manning indicated in this study for these services is primarily for the purpose of estimating the salary and wage bill of the plant. It is emphasised that the manning list is only indicative and would have to be suitably modified.

Relief and leave reserve

In manpower planning due allowance has to be made for relief and reserve to take care of weekly offs, leave and sickness, in addition to the actual number of men to be deployed on a job each day as determined by work study. The standard force which denotes the total number of men on pay roll, includes the working force, reserves for weekly offs, and provision for leave and absenteeism.

For units working on all days of the week, irrespective of the fact whether it operates with one, or two or three shifts per day, the weekly off provision has to be made at 16.6 per cent of the working force, which allows for one day off for seven days for each workman. In estimating the manpower requirements for the proposed plant, similar provision has been made for weekly offs.

The leave reserve has been provided on the basis of following annual leave entitlements:

		Days
Legal holidays	-	10
Earned leave	-	24
Estimated incidence of medical leave and absenteeism	-	14

Earned leave or paid vacation varies in different parts of Iran. In some parts of the country it is 12 days per year, while in others, where the climatic conditions are not so favourable, it is 24 days per year. Taking into account the climatic factors at the proposed location for the ferro-chrome plant, the earned leave entitlement has been assumed as 24 days per year.

Reserve for leave and absenteeism has been provided only for workers. Based on the leave entitlement mentioned earlier, it is estimated at 18.5 per cent of the total payroll of workers.

Manning list

The proposed manning list for the ferro-chrome plant including executives, supervisors, operation and maintenance personnel and administrative and commercial staff is given in Appendix 13-1 and summarised in Table 13-1.

Table 13-1

SUMMARY OF MANNING LIST

Executives	- 6
Supervisors	- 27
Operation and maintenance personnel	- 168
Administrative and commercial staff	- 80
Sub-total	281
Reserve for leave and absenteeism	- 31
Total	312

Salaries and wages

The basic salary of different categories of personnel in the managerial, technical and skilled cadres varies widely in Iran. To a certain extent it depends on the location and type of industry. In the absence of an established wage level for the type of industry under consideration, it has been necessary to assume the salary scale of different categories of personnel, primarily to derive the labour and supervision component of production cost.

Table 9-1

PLANNED POWER GENERATING CAPACITY FOR SELECTED AREAS

Region	Generating station	Total generating capacity in MW								
		1972			1977			1982		
		Steam	Hydro	Gas	Steam	Hydro	Gas	Steam	Hydro	Gas
KWPA	Ahwaz	150	-	-	350	-	-	400	-	-
	Pahalvi Dam	-	500	-	-	500	-	-	500	-
	Reza Shah Dam	-	-	-	-	1 000	-	-	1 000	-
	Karun Dam	-	-	-	-	420	-	-	870	-
	Rivers power	-	-	-	-	-	-	-	-	1 200
Kerman	Zarand	60	-	-	120	-	-	120	-	-
	Bandar-Abbas	-	-	30	-	-	60	-	-	120

Source: Ministry of Water and Power, The Imperial Government of Iran.

Ahwaz

A possible location for a ferro-chrome plant in Ahwaz area is at a distance of about 10/12 km from the town and to its south-west, adjacent to the Ahwaz-Khorramshahr road and rail link. This is shown in Drawing No. 5131-III-2.

Water

The source of water is the perennial revier Karun, flowing at a distance of about 2 km from the plant. It would, however, be necessary to develop a suitable supply system comprising intake works, treatment plant and pipeline.

Power

The Ministry of Water and Power, Imperial Government of Iran, has assumed that adequate power for the ferro-chrome plant would be available at Ahwaz by 1972/73.

Corresponding to the various major groups, the salaries have been classified and identified by a letter code for each job, namely, E- for executives, S- for supervisory grades, W- for workers and A- for administrative and commercial staff as shown in Appendix 13-1.

The average salaries considered for each job category in each major group are given in Table 13-2. The salaries for the executives, supervisors and office staff in administrative and commercial departments are fixed on monthly basis. The prevalent wage rates for workers in Iran is on hourly or daily basis, whereas mechanics and chemists are paid at monthly rates. The average monthly salaries for workers indicated in Table 13-2 have been derived on the basis of the prevailing daily rate and a 30-day month.

It is emphasised that the salary and wage structure should be determined during project finalisation. The quantum and scale of remuneration should have a bearing, among other things, on the job content, experience and qualifications, and a reasonable growth potential.

Table 13-2

BASIC SALARIES AND WAGES FOR DIFFERENT SALARY CLASSIFICATIONS

Salary classification	Average salary per month $
E-1	900
E-2	750
E-3	600
S-1	600
S-2	500
S-3	350
S-4	150
W-1	120
W-2	80
W-3	60
A-1	300
A-2	200
A-3	100
A-4	60

Cost of labour and supervision

The cost of labour and supervision comprises the basic salaries and wages, and other fringe benefits.

Under the labour laws of Iran,health insurance schemes for workers is obligatory, which provides for the medical treatment of the worker and the immediate members of his family, payment of wages during inability/illness, matrimonial allowance, maternity benefit, child allowance, retirement allowance to aged, burial costs to heirs and payment of stipend to heirs. The health insurance premium amounts to 18 per cent of the basic wage of workers, of which five per cent is doducted from the salary and 13 per cent is contributed by the employer. It is understood that it is customary to pay one month bonus to workers during 'Navruji'(Iranian New Year).

Payment of shift premium and night premium for night shifts is in vogue, and this has been taken into account. It is expected that suitable incentive schemes may be introduced.

It is estimated that various legal and extra-legal fringe benefits would increase the total wage bill by an average of about 50 per cent.

Know-how requirement

Imported know-how and assistance will be required for certain specialist services during the construction of the project and operation of the plant for a few years. The know-how required could be broadly grouped as follows:

i) design, engineering and technical assistance during construction,

ii) production know-how, and

iii) sales assistance mainly for exports.

Design, engineering, and construction services

The design and engineering services are required for project planning and selection of appropriate equipment and facilities suited to local requirements and conditions. Any error made at this stage is permanent in nature and has far-reaching effects on the economics of the project.

The requisite consulting engineering services would have to be obtained from reputed organizations having experience in design of ferro-alloy plants. Provision for such engineering services has been made in the capital cost estimate.

Process know-how

Efficient production of ferro-alloys of consistent grade and quality is largely dependent on close metallurgical control of smelting operations. Most ferro-alloy plants experience initial difficulty which has adverse effects on production.

Production know-how would have to be imported for a limited period as there is no expertise available in ferro-alloy smelting in Iran. In order to ensure efficient operation of the plant and also to develop and train up required skills, it is suggested that arrangements be made for obtaining the production know-how from competent foreign sources for the initial years.

Foreign training

The foreign agency should also be entrusted with the training of the key personnel in a similar plant abroad as a part of the know-how agreement. It is envisaged that a total of 21 supervisors and skilled operatives may have to be trained for three to six months' duration (Appendix 13-2). The training expenses will include the home salary, travel to and from training centre, and allowance for staying abroad.

The average expenses of training for shift foreman and above categories are estimated at $ 1,200 per month and that for others at $ 850 per month. On the basis of the training periods suggested in Appendix 13-2, the total expense for training is estimated at about $ 110,000.

The fee payable for know-how will have to be n negotiated. It is expected that this fee including facilities for training and deputing experts for initial periods of operation may be $ 100,000 lumpsum. In addition, expenses for travel and living of experts during an initial period of about six months would amount to $ 100,000.

Sales assistance

Sales assistance is mainly required for exporting ferro-alloys. As discussed earlier in Chapter 7, world trade in ferro-alloys is susceptible to a wide variety of changes including technological developments, economic conditions and political events. In addition, a new exporter seeking an entry into any international market has first to establish his reputation not only for the quality of the product, but on his ability to keep to commitments regarding delivery dates and other terms.

Considerable world trade in mineral and ferro-alloys is done through international selling agencies who have established themselves in those fields. In the initial period, Iran may with advantage utilize such an agency for her ferro-alloy exports. The other alternative is for the ferro-alloy plant to independently establish their export trade. In countries like India, this practice is followed, either independently by the individual producer or jointly through association of ferro-alloy producers. It is also possible that the agency selected for providing the process know-how may provide the assistance for developing export trade.

14 - PRODUCTION COST ESTIMATE

The production cost includes all costs associated with raw materials and processing them through various sections of the plant. The production cost of the finished products comprises cost of materials and cost above materials.

Cost of materials

The quantity of raw materials required for production of one ton of salable products multiplied by their individual unit costs gives the total material cost per ton of product.

The estimated cost of raw materials delivered at site is given in Appendix 14-1 and summarised in Table 14-1. The railway freight for transporting raw materials is based on the existing tariff of Iranian Railways. The freight for transporting raw materials by road has been calculated on a 'telescopic rate' - lower rates for increased haulage.

Table 14-1

COST OF MAJOR RAW MATERIALS

Material		Cost delivered at site/ton $
Chrome ore	..	19
Quartzite	..	5
Coke	..	46
Charcoal	..	83
Limestone	..	3
Electrode paste	..	138

Cost above materials

The cost above materials covers all other items of expenses incurred in the production of finished products such as labour, supervision, water, fuel, power, maintenance, refractories etc.

Operation and maintenance

Based on the manning list and average salaries indicated in Chapter 13, the annual cost for operation and maintenance staff including leave reserves works out to $ 494,000. This estimate includes the provision made for fringe benefits.

In order to estimate the production cost of ferro-alloys separately, it is estimated that 50 per cent of the total salaries would be charged for operation of the reduction furnace and the balance for operation of slag furnace. The labour cost at the reduction furnace is apportioned over the output of silico-chrome and high carbon ferro-chrome comes to $ 22.5 per ton. Considering the production of 10,000 tons of low carbon ferro-chrome per year starting from silico-chrome, the labour cost works out to $ 24.7 per ton.

Fuel oil

The cost of fuel oil delivered to site is estimated at $ 20 per ton. As the oil consumption is almost entirely for the firing of rotary kilns and keeping the reaction ladles hot, the entire requirement is charged to the production of low carbon ferro-chrome.

Water

The cost of water has been taken at the rate of $ 13.3 per thousand cu m on the basis of the price estimated in the detailed project report of the Isfahan steel plant. The total make-up water requirement of the plant is 25 cu m per hour, which is charged entirely to the production of low carbon ferro-chrome.

Maintenance and supplies

The other items of cost above materials includes cost for periodical repairs and maintenance, supplies, consumables, stores, lubricants, etc.

Refractories

Refractories are required during regular operation for ladles, casting pans etc. In addition, the furnaces have to be relieved after a period of operation and a reserve for the same has been provided.

General plant expenses

The general plant expenses cover the salaries and fringe benefits for the executive, administrative and commercial staff, and other expenditure incurred in stationery, postage, telephone and insurance. The total annual expense on this account is estimated at $ 507,000 which has been apportioned between silico-chrome, high carbon ferro-chrome and low carbon ferro-chrome for calculating the production cost. The general administration and overhead expenses per ton of these products come to around $ 24 per ton.

Cost of electric power

Electric power

The manufacturing expenses of the three chrome-alloys, excluding the cost of electric power, have been estimated in Appendices 14-2 to 14-4.

Electric energy consumption in electric smelting furnace excluding auxiliary loads is at a rate of about 5,000 kWh per ton of high carbon ferro-chrome and over 8,700 kWh per ton of low carbon ferro-chrome. Due to this high consumption rate, the cost of energy constitutes a significant portion (about 20 to 25%) of total production cost. No published power tariff exists at present for electro-metallurgical industries in Iran though it is understood that this is now under preparation. On the basis of the tariff published by

9 - Site selection (cont'd)

Transport

Ahwaz is well served by roads, railway and inland water transport. It is learnt that negotiations are underway with the Iranian State Railways for the construction of a suitable rail link between Iranian Rolling Mills Company's plant and the main line of the country's railway network. This rail link may be extended to serve the ferro-chrome plant also. As the suggested location of the ferro-chrome plant is adjacent to Ahwaz-Khorramshahr metalled highway, the plant will also be well connected by road. River Karun which flows in this region is navigable between Ahwaz and Khorramshahr.

Bandar-Abbas

Another suitable location for setting up a ferro-chrome plant is a site about 2 km west of the new port at Bandar-Abbas (Drawing No. 5131-III-3). It is learnt that most of the land in this area is privately owned, and therefore need to be purchased.

Water

The water requirements of the Bandar-Abbas town are at present met from deep tube wells situated at a distance of about 40 [illegible]. It has been proposed that future water requirements of this area would be supplied from the Minab dam located at distance of about 100 km from the town.

Power

So far as power requirements are concerned, it may be noted from Drawing No. 5131-III-1 that there are no plans

Khusestan Water and Power Authority the average power cost for the proposed ferro-chrome plant works out to 7.82 mills (0.591 Rials) per kWh.

As discussed in previous chapters the ferro-alloy plants operate at a much higher load factor compared to other industrial loads currently existing in Iran. This plant would therefore merit special consideration on the basis of quick yearly returns on the initial investment made by the power supply company. Further in case of any temporary power restrictions imposed by the supply company the ferro-chrome plant load could be shed with due notice and this is considered as an added attraction for the power supply company to give special concessional rates.

The power rates enjoyed by the ferrous electro-metallurgical industry in other exporting countries range from 2.5 to 3.5 mills in Norway, 5 mills in South Africa, and 4 to 7 mills in India.

On the above considerations, an average energy rate of 5 mills per kWh has been taken for the financial analysis in this report. (This is approximately double the power rate charged for the Arak aluminium plant). At the same time, the effect of varying energy rates on production costs have also been shown in Fig. III-1 and Table 14-2.

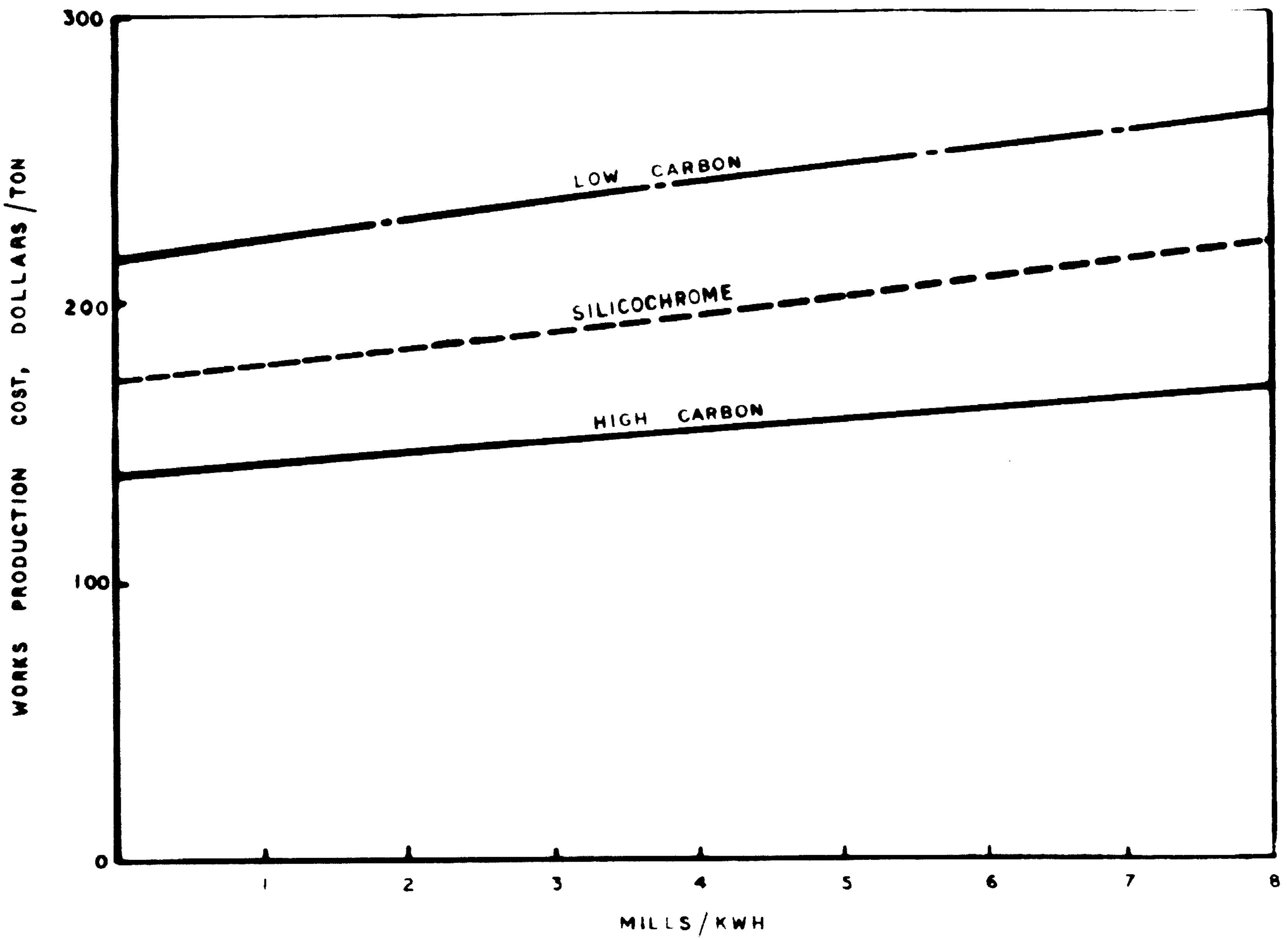


FIG. III – I. VARIATION OF PRODUCTION COST WITH ENERGY CHARGES

14 - Production cost estimate (cont'd)

Table 14-2

PRODUCTION COST ESTIMATES
(Dollars)

			Power at 5 mills/kWh		Power at 7 mills/kWh	
	Material cost/ton	Cost above materials per ton a/	Cost of electric power	Total works production cost/ton	Cost of electric power	Total works production cost/ton
High carbon ferro-chrome	80.4	48.6	26.0	155.0	36.4	165.4
Silico-chrome	107.6	49.6	41.0	198.2	57.4	214.6
Low carbon ferro-chrome	139.1	59.9	44.5	243.5	62.3	261.3

a/ Excludes cost of electric power.

15 - FINANCIAL ANALYSIS

In this chapter the financial implications of the project for the first fifteen years of operation have been discussed.

Estimated project cost

The total project cost comprises cost of the plant as erected, promotional expenses, start-up expenses, training expenses and expenditure incurred on obtaining technical assistance and know-how. The estimated total project cost is given in Table 15-1.

Table 15-1

ESTIMATED TOTAL PROJECT COST
(Thousand dollars)

			Foreign currency	Local currency	Total
1.	Plant cost	..	6 298	3 753	10 051
2.	Promotional expenses	..	-	50	50
3.	Start-up expenses	..	-	41	41
4.	Training expenses	..	38	72	110
5.	Technical assistance	..	-	100	100
6.	Know-how	..	100	-	100
7.	Interest on loan during construction	..	445	-	445
	Total	..	6 881	4 016	10 897

Say $ 11 million

The total project cost is estimated at $ 11 million, of which the cost of the plant as erected is about $ 10.0 million as discussed in chapter 12.

Promotional expenses

The promotional expenses include the expenditure incurred for issue of shares, company floatation, printing of memorandum and articles of association and advertising charges. The entire expenditure of $ 50,000 is expected to be incurred in local currency.

Start-up expenses

Start-up expenses include the cost of materials, utilities, consumables and labour involved in trial runs and in starting the plant. The expenditure estimated at $ 41,000 is assumed to be incurred in local currency.

Training expenses

The expenses for training of key personnel have been discussed in Chapter 13. The expenditure incurred in this connection is partly in local currency and partly in foreign currency. The local expenditure of $ 72,000 covers the salaries and wages of the key personnel during the training period and travel expenses from Iran to the training centre abroad and back. All living expenses at the place of training estimated at $ 38,000 have to be incurred in foreign currency.

Technical assistance

A provision of $ 100,000 in local currency has been made to cover the expenses on foreign experts to provide technical assistance during initial period of operation.

Know-how

A know-how fee of $ 100,000 in foreign currency has been provided.

Interest during construction

The interest on loan capital during construction period is part of the total project cost. It is assumed that no payments against interest accumulations will be made till the plant goes into production. Based on phasing of borrowings, the interest on loan capital computed at 8 per cent per annum during construction period amounts to $ 445,000.

Financing pattern of capital

The capital structure envisaged provides for raising $ 5 million by equity capital and the remaining $ 6 million by loan. The financing pattern has been evolved on the basis of the proposed construction schedule and is given in Table 15-2.

Table 15-2

FINANCING PATTERN OF CAPITAL

(Thousand dollars)

	1st year	2nd year	3rd year	Total
Equity capital	2 000	3 000	-	5 000
Loan amount	-	3 000	2 555	5 555
Interest on loan during construction at 8%	-	-	445	445
Total capital	2 000	6 000	3 000	11 000

15 - Financial analysis (cont'd)

Profit and loss statement

The profit and loss statement has been prepared on the basis of the following assumptions:

i) Production: The annual production of salable ferro-alloys is expected as follows:

	Low carbon ferro-chrome tons	Silico-chrome tons	High carbon ferro-chrome tons
First year ..	2 500	1 200	4 500
Second year ..	7 500	-	4 500
Third year onwards in each year up to fifteenth year ..	10 000	-	4 500

ii) Pattern of sales: As the estimated local demand for ferro-chrome till 1982 is negligible, it is assumed that the entire production will be exported.

iii) Sales price: The sales price has been determined on the basis of the prevailing prices in UK - the largest ferro-alloy market of the world. It may be noted that UK market prices are generally lower than those of USA, West Germany etc. In the last quarter of 1969, high carbon ferro-chrome was quoted in the UK market at an equivalent of $ 230 to $ 244 per ton and low carbon (0.1 per cent C) ferro-chrome at $ 325 to $ 344 per ton. Prices in the first quarter of 1970 are 10 to 20 per cent higher. Prices have been rising since 1967 and this upward trend is likely to be maintained in future. However, for the purpose of this study, selling prices are estimated on the basis of prices prevailing in the last quarter of 1969 as follows:

		c.i.f. price $/ton
High carbon ferro-chrome	..	244
Silico-chrome	..	281
Low carbon ferro-chrome (0.1% C, 68% Cr)	..	344

The above prices are inclusive of packing charges. To arrive at the ex-works prices of the finished products, expenses incurred on ocean freight, port handling charges, inland transport from the plant to the nearest port at Bandar-Abbas and packing charges have to be deducted. These expenses are estimated at about $ 28 per ton. Therefore, the ex-works sales price of the finished product after deduction of $ 28 per ton would be as follows:

		$/ton
High-carbon ferro-chrome	..	216
Silico-chrome	..	253
Low carbon ferro-chrome	..	316

iv) Income: The total annual income of the plant is computed on the basis of the proposed production programme and sales price of different products.

v) Manufacturing expenses: The manufacturing expenses include cost of raw materials, conversion or processing, electric power, labour, supervision, general plant expenses and other costs. The other costs comprise expenses incurred on utilities, consumables, repairs and maintenance and relining reserve. The items of cost entering into manufacturing expenses have been discussed in chapter 14 separately for each chrome alloy.

vi) Depreciation: Depreciation has been calculated on a straight line basis at 8 per cent per annum, on the total plant cost excluding the cost of land.

vii) Working capital: Working capital requirement is estimated as equivalent to 3 months' manufacturing expenses. Interest on working capital is assumed at 12 per cent per annum.

viii) Repayment of loan capital and interest: The plant is expected to operate at the rated capacity from the third year after commencement of operation.

Repayment of loan capital is phased out in 10 equal annual instalments commencing from the third year of operation. Interest on loan capital at 8 per cent per annum is calculated on the balance amount outstanding at the beginning of each year.

ix) Deferred charges: The expenses incurred in commissioning the plant, in obtaining technical assistance, know-how and in payment of interest on loan capital during construction period have been amortized in full in the first 10 years of operation in equal instalments. These charges as worked out amount to $ 846,000 as follows:

		(Thousand dollars)
Promotional expenses	..	50
Start-up expenses	..	41
Training expenses	..	110
Technical assistance	..	100
Know-how	..	100
Interest on loan during construction	..	445
Total	..	846

However, as the project cost has been rounded off from $ 10.897 million to $ 11 million, the resultant difference of $ 0.103 million is merged in deferred charges to cover unforeseen items to give a total at present to connect Bandar-Abbas to the national grid during the Fourth Plan period. The Ministry of Water and Power has, however, proposed to connect Bandar-Abbas to Jiroft at Jahrom over 63 kV and/or 230 kV transmission lines, during the period 1977 to 1982. It is also understood that a gas generating station is to be installed at Bandar-Abbas. The Ministry of Water and Power has further indicated that if the installation of a ferro-chrome plant in this region is economically viable, adequate supply of power can be assured within a period of 3 years from the date of decision.

Transport <u>facilities</u>

Bandar-Abbas is also not on the railway map of Iran, at present though there are proposals to connect it to the Kerman area by standard gauge railway during the Fifth Plan. The area is now served by excellent roads and the present traffic is limited to road transport.

Faryab

Faryab is adjacent to the metalled road connecting Bandar-Abbas to the mines (Drawing No. 5131-III-4). Adequate availability of land is assured at this location.

Water

Adjacent to the site flows a perennial river Minab (locally called Abnehme). Though no data with regard to figure of $ 949,000. The deferred charges are amortised at the rate of $ 94,000 per annum in the first 10 years of operation.

x) Sales expenses: The sales expenses to cover the commission payable to selling agents and other expenses are estimated at 1 per cent of the sales receipts realised by the project and amount to $ 42,000 per annum when the production and sales correspond to the full rated capacity.

xi) Taxation: The basis for company taxation in Iran is the Inland Revenue Act of 1967. Under this Act, profits earned from exports are exempted from tax. As the entire production of ferro-chrome plant is for export, it is assumed that the profits from the project will be exempted from payment of income-tax.

Comments on the profit and loss statement

Based on the above assumptions, a profit and loss statement has been prepared for the first 15 years of plant operation in Table 15-3. From the table it is observed that the plant would be incurring losses up to the 11th year and the cumulative losses upto this year are estimated at about $ 5 million. From the 12th to 15th year the plant is

Table 15-3

PROFIT AND LOSS STATEMEN

(Thousand dollars)

							Y
	I	II	III	IV	V	VI	VII
A. Income							
Total sales receipts (ex works) ..	2 066	3 342	4 132	4 132	4 132	4 132	4 13
B. Manufacturing expenses							
1. Raw materials ..	756	1 167	1 432	1 432	1 432	1 432	1 43
2. Electric power @ 5 mills ..	368	452	563	563	563	563	56
3. Labour and supervision ..	494	494	494	494	494	494	19
4. General plant and overhead ..	507	507	507	507	507	507	50
5. Other costs a/ ..	50	108	140	140	140	140	14
Total (B) ..	2 175	2 728	3 136	3 136	3 136	3 136	3 13
C. Gross profit/loss (A - B) ..	-109	614	996	996	996	996	99
D. Other expenses							
1. Depreciation @ 8% ..	803	803	803	803	803	[illegible]	80
2. Interest on working capital ..	66	84	96	96	96	96	9
3. Interest on loan capital ..	480	480	480	432	384	336	28
4. Deferred charges ..	94	94	94	94	94	94	9
5. Sales expenses ..	21	34	42	42	42	42	1
Total (D) ..	1 464	1 495	1 515	1 467	1 419	1 371	1 3
E. Net profit/loss (C - D)							
Current ..	-1 573	-881	-519	-471	-423	-375	-3
Cumulative ..	-1 573	-2 454	-2 973	-3 444	-3 867	-4 242	-4 56

a/ Other costs comprise expenses incurred on utilities, consumables, repair and maintenance and rel

SECTION 1

Table 15-3

Table 15-3

PROFIT AND LOSS STATEMENT

(Thousand dollars)

Year of operation										
V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
4 132	4 132	4 132	4 132	4 132	4 132	4 132	4 132	4 132	4 132	4 132
1 452	1 452	1 452	1 452	1 452	1 452	1 452	1 452	1 452	1 452	1 452
563	563	563	563	563	563	563	563	563	563	563
494	494	494	494	494	494	494	494	494	494	494
507	507	507	507	507	507	507	507	507	507	507
140	140	140	140	140	140	140	140	140	140	140
3 136	3 136	3 136	3 136	3 136	3 136	3 136	3 136	3 136	3 136	3 136
996	996	996	996	996	996	996	996	996	996	996
805	805	805	805	805	805	805	805	399	-	-
96	96	96	96	96	96	96	96	96	96	96
384	336	288	240	192	144	96	48	-	-	-
94	94	94	94	94	94	-	-	-	-	-
42	42	42	42	42	42	42	42	42	42	42
1 419	1 371	1 323	1 275	1 227	1 179	1 037	989	537	138	138
-423	-375	-327	-279	-231	-183	-41	7	459	858	858
-3 867	-4 242	-4 569	-4 848	-5 079	-5 262	-5 303	-5 296	-4 837	-3 979	-3 121

air and maintenance and relining reserve.

estimated to make a profit of about $ 2 million leaving a cumulative net loss of about $ 3 million by the end of the 15th year.

Cash flow

The cash flow statement is presented in Table 15-4. The total cash resources as generated by the plant are found to be entirely inadequate to meet the operating expenses and commitments in respect of loan repayment. Assuming that the loan is to be repaid in 10 annual equal instalments commencing from the third year of operation, it will become necessary to obtain additional funds to make good the deficits. It is obvious that the additional funds will also attract further interest charges and to pay these interest charges, further additional funds will have to be found. There is thus a vicious circle in which the project becomes financially an impracticable proposition. However, for the purpose of this exercise, it is assumed that the additional funds needed to keep the project going will be provided in the form of assistance by way of interest free loans. The plant requires additional funds to the tune of $ 1,550,000 which are assumed to be provided free of interest charges as per the following schedule:

15 - Financial analysis (cont'd)

Table 15-4

CASH FLOW STATEMENT

(Thousand dollars)

	I	II	III	IV	V	VI	V
Sources of cash							
Net profit/loss ..	-1 575	- 881	- 519	- 471	- 423	- 375	- 7
Add: depreciation ..	803	803	803	803	803	803	
deferred charges ..	94	94	94	94	94	94	
Operating surplus/deficit ..	- 676	16	378	426	474	522	5
Additional funds (interest free).	700	-	200	200	100	150	-
Total sources of cash ..	24	16	578	626	574	672	5
Disposition of cash							
Loan repayment ..	-	-	600	600	600	600	
Estimated cash balance/deficiency - current	24	16	-22	26	-26	72	-
-cumulative	24	40	18	44	18	90	

SECTION 1

Table 15-4

CASH FLOW STATEMENT

(Thousand dollars)

	Year of operation										
	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
71	- 423	- 375	- 327	- 279	- 231	- 183	- 41	7	459	858	858
03	803	803	803	803	803	803	803	803	399	-	-
04	94	94	94	94	94	94	-	-	-	-	-
26	474	522	570	618	666	714	762	810	858	858	858
00	100	150	-	-	-	-	-	-	-	-	-
26	574	672	570	618	666	714	762	810	858	858	858
00	600	600	600	600	600	600	600	600	-	-	-
26	-26	72	-30	18	66	114	162	210	858	858	858
14	18	90	60	78	144	258	420	630	1 488	2 346	3 204

SECTION 2

15 - Financial analysis (cont'd)

(Thousand dollars)

Year of operation	Additional funds required
I	700
II	-
III	200
IV	200
V	100
VI	150
Total:	1 350

It will be observed from the cash flow statement that even after provision for the above additional funds free of interest charges, the cumulative cash resources at the end of the 15th year of operation amount to only about $ 3.2 million. If the additional funds $ 1.35 million are repaid from this surplus, the net surplus will amount to $ 1.85 million only as against the equity capital of $ 5 million.

Appraisal of costs

Competitiveness vis-a-vis foreign producers

It may be useful at this point to review the effect of the various cost components on the total manufacturing cost, and the relative advantage/disadvantage that Iran has vis-a-vis other countries which also have their own deposits and produce ferro-chrome primarily for export (e.g. South Africa, India, Turkey). Other countries - USA, Japan, France, West Germany, UK - import chromite but produce ferro-chrome primarily for their own consumption.

15 - Financial analysis (cont'd)

	Cost/ton low carbon Fe-Cr		Iran project as compared to other ferro-chrome producers
	$	%	
1. Raw materials - chromite ..	46	19	Comparable to foreign costs. Could be reduced if integrated with mining operations, thus lowering overheads, etc.
- coke and others ..	61	25	Cost of coke and charcoal very high - almost double. Also high incidence of freight cost.
2. Electric power (@ 5 mills per kWh) ..	45	19	Generally comparable. A rise of one mill (or fall) would increase (or reduce) cost by over $ 9.
3. Labour and supervision ..	39	16	Iran costs for managerial, technical and skilled personnel considered high.
4. General plant overheads ..	40	16	High costs due to the isolated project. Could be reduced if part of a larger complex.
5. Other operating costs ..	12	5	Generally comparable.
Works cost ..	243	100	
6. Depreciation (@ 8%) ..	55	23	Depreciation charges are a matter of plant policy. Cost here would be comparable to new foreign plants, but much higher than old plants already written down.
Total ..	298	123	

As mentioned earlier, the sales prices realisable on the basis of international prices obtaining in first quarter of 1970 are approximately 10 to 20 per cent higher than those taken for the profit and loss analysis in Table 15-3.

With the higher sales realisations on the basis of 1970 (first quarter prices), and assuming the same manufacturing and other expenses, the plant profitability over the fifteen year period is shown graphically in Fig. III-2.

Contributory margin

The contributory margin, at full production level based on the financial analysis presented in Table 15-3 is worked out as follows:

		Dollars
Annual sales receipts	..	4 132 000
Annual expenses on raw materials, electric power and other costs	..	2 135 000
Contributory margin a/	..	1 997 000

a/ The contributory margin: annual sales receipt ratio corresponds to 0.48

Internal rate of return

For working out the internal rate of return and the present value, the cash flow figures have been adjusted to find out the real cash surplus generated by plant operation and are given in Table 15-5.

For this adjustment, interest on long term loan and working capital have been added back to operating surplus. In the fifteenth year of operation the residual value of the plant estimated at about $ 1 million (10 per cent of the original plant cost) is added back. The working capital requirement of about $ 800,000 is also shown as fully

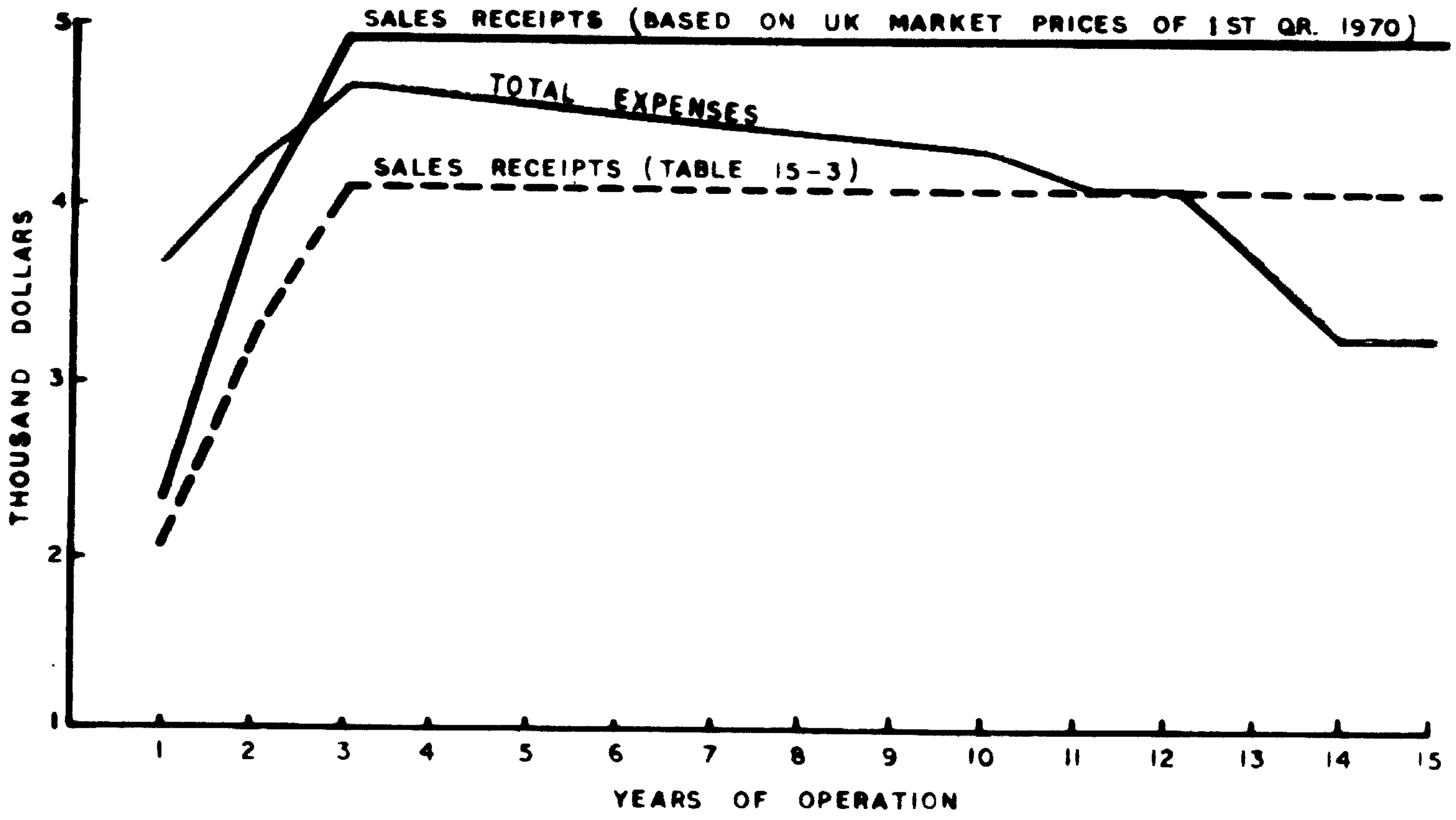


FIG. III — 2. EFFECT OF SALES REALISATION ON PROFITABILITY the minimum flow of this river are available, local sources indicate that adequate quantity of water would be available for a ferro-chrome complex.

Power

The power supply position in this area is rather poor at present and is similar to that at Bandar-Abbas. All mines have their own diesel generating sets for meeting the requirements of mines as well as the township. The Ministry of Water and Power has indicated that adequate power supply for the installation of a ferro-chrome plant could be assured within a period of 3 years from the date of decision, as mentioned earlier for Bandar-Abbas.

Transport

The transport link of the area to the rest of the country is limited to a metalled road, connecting Bandar-Abbas in the south, and with the mines 8 to 10 km to the north.

Evaluation of locations

A comparison of the various locational factors of proposed sites - Ahwaz, Bandar-Abbas and Faryab, is given in Appendix 9-1.

Land

It may be observed that adequate land is available at all locations, though land acquisition at Bandar-Abbas may be difficult and due the private ownership of the selected areas.

15 - Financial analysis (cont'd)

salvaged at the end of 15 years and for the purpose of this exercise shown as an inflow in the fifteenth year.

Table 15-5

ADJUSTED CASH FLOW
(Thousand dollars)

Year of operation	Operating surplus a/	Add interest on b/		Residual value of equipment	Salvaged working capital	Real cash surplus
		Working capital	Loan capital			
I	-676	66	480			-130
II	16	84	480			580
III	378	96	480			954
IV	426	96	432			954
V	474	96	384			954
VI	522	96	336			954
VII	570	96	288			954
VIII	618	96	240			954
IX	666	96	192			954
X	714	96	144			954
XI	762	96	96			954
XII	810	96	48			954
XIII	858	96	-			954
XIV	858	96	-			954
XV	858	96	-	1 004	800	2 758

a/ Refer Table 15-4
b/ Refer Table 15-3

The beginning of the first year of operation is taken as the zero point for the purpose of working out present values and, therefore, all fixed investment outflows during the construction period have been compounded. Outflows by way of working capital during the first three years of operation and all cash inflows representing net operation surplus (Table 15-5) have been discounted. All outflows are assumed to be occurring at the beginning of each year of operation and inflows to accrue at the end of each year. In Table 15-6 the present values of outflows and inflows have been arrived at by adopting two trial rates of discounting, 1 per cent and 2 per cent, and the ratio of capital recovery to original investment is worked out. The internal rate of return on this project works out to about 1.4 per cent.

Present value analysis

The present value analysis has been worked out in Table 15-7 by assuming a discount rate of 8 per cent over a period of 15 years operation of the plant. It is noted that the total present value of net inflows at the end of 15 years amounts to only $ 7.4 million as against a total investment outflow of $ 13.7 million including working capital and additional fund.

Table 15-6

INTERNAL RATE OF RETURN

(Thousand dollars)

		Cash outflows			Cash inflows		
		Estimate for the period	Discounted at		Estimate for the period[a/]	Discounted at	
			1%	2%		1%	2%
Construction period							
0 to 12 months		2 000	2 050	2 102			
13 to 24 months		5 700	5 786	5 872			
25 to 30 months		2 800	2 814	2 828			
Year of operation							
I	..	1 250	1 250	1 250	-130	-129	-127
II	..	150	149	147	580	568	557
III	..	300	294	283	954	926	907
IV	..	200	194	185	954	917	881
V	..	100	95	91	954	907	864
VI	..	150	141	133	954	899	847
VII					954	890	831
VIII	..				954	881	814
IX	..				954	872	798
X	..				954	863	782
XI	..				954	855	767
XII	..				954	846	752
XIII	..				954	838	737
XIV	..				954	830	723
XV	..				2 758	2 375	2 049
Total	..	12 650	12 773	12 891	14 656	13 338	12 182

Average rate of return:

Excess at lower trial rate (1%) = 13 338 - 12 773 = 565

Deficit at higher trial rate (2%) = 12 891 - 12 182 = 709

Average rate of return = $1 + 1\frac{565}{(565 + 709)}$ = 1.44%

---

a/ Real cash surplus Table 15-5

15 - Financial analysis (cont'd)

Table 15-7

PRESENT VALUE ANALYSIS

(Thousand dollars)

Cost of capital - 8%

	Cash outflows		Cash inflows	
	Estimate for the period	Present value at 8%	Estimate for the period a/	Present value at 8%
Construction period				
0 to 12 months ..	2 000	2 426		
13 to 24 months ..	5 700	6 402		
25 to 30 months ..	2 800	2 912		
Year of operation				
I ..	1 250	1 250	-130	-120
II ..	150	139	580	497
III ..	300	257	954	757
IV ..	200	159	954	701
V ..	100	74	954	650
VI ..	150	102	954	601
VII ..			954	556
VIII ..			954	515
IX ..			954	477
X ..			954	442
XI ..			954	409
XII ..			954	379
XIII ..			954	351
XIV ..			954	324
XV ..			2 758	869
Total ..	12 650	13 721	14 656	7 408

Social benefits

The profit and loss analysis indicates that the ferro-chrome plant is not commercially viable. Apart from the commercial aspects, however, there are other considerations of national economy which may be taken into account under specific local conditions for certain projects. These 'social benefits' include foreign exchange earnings, employment potential and regional development.

Foreign exchange earnings

Chrome ore is presently being exported from Iran. The Imperial Government of Iran envisages processing of the minerals before export in order to earn increased foreign exchange from the wasting assets. The price realisable by export of one ton of ferro-chrome is more than ten times that of one ton of chrome ore. In the light of these factors, the foreign exchange implications of installing a chrome ore processing plant are being discussed.

The installation of a ferro-chrome plant would involve a foreign exchange expenditure of about $ 7 million. Recurring foreign exchange expenditure in the course of plant operation for electrode paste, refractories and other consumables such as electrode casing would be $ 130,000 per annum. On export of total production the ex-works earnings in foreign exchange would be $ 4,132,000 per annum when the plant is operated at the rated capacity. The net foreign exchange earnings can be computed by deducting from the f.o.b. earnings the total foreign exchange expenses in the manufacture of ferro-chrome, depreciation on imported equipment and machinery and amortization of deferred charges incurred in foreign exchange. On this basis the year by year net foreign exchange earnings are worked out in Table 15-8.

Table 15-8

FOREIGN EXCHANGE EARNINGS

(Thousand dollars)

Year	F.o.b. earnings (1)	Depreciation a/ (2)	Deferred charges b/ (3)	Manufacturing expenses (4)	Total foreign exchange expenses (5)	Net foreign exchange earnings (1) - (5)
I	2 132	506	68	72	646	1 486
II	3 438	506	68	108	682	2 756
III	4 248	506	68	130	704	3 544
IV	4 248	506	68	130	704	3 544
V	4 248	506	68	130	704	3 544
VI	4 248	506	68	130	704	3 544
VII	4 248	506	68	130	704	3 544
VIII	4 248	506	68	130	704	3 544
IX	4 248	506	68	130	704	3 544
X	4 248	506	68	130	704	3 544
XI	4 248	506	-	130	636	3 612
XII	4 248	506	-	130	636	3 612
XIII	4 248	251	-	130	381	3 867
XIV	4 248	-	-	130	130	4 118
XV	4 248	-	-	130	130	4 118
					Total:	51 921

a/ 65% of depreciation indicated in Table 15-3
b/ 72.5% of deferred charges given in Table 15-3

It will be observed from Table 15-8 that the net foreign exchange earnings increase from about $ 1.5 million in the first year of operation to over $ 4 million in the 15th year. The total earnings during 15 years of operation amount to about $ 52 million.

The chrome ore requirement of the plant has been estimated at 34,375 tons per annum at full capacity. The f.o.b. earnings rate of $ 25 per ton of chrome ore (on the basis of prices obtained in December 1969) would be about $ 860,000 per annum. Therefore, by exporting ferro-chrome instead of chrome ore, the additional foreign exchange earning per annum will be well over $ 2 million to $ 3 million during the 15-year period of operation of the plant.

Rate of return of foreign exchange

For working out the rate of return of foreign exchange, the foreign exchange cash outflows (representing capital investment and deferred charges) and net foreign exchange earnings (as derived from Table 15-8) have been discounted at 2 different trial rates as shown in Table 15-9. The inflows have been obtained by adding back the capital charges (depreciation and deferred charges) to the annual net earnings as derived in Table 15-8. No foreign exchange inflow has been considered on the residual value of the plant.

All outflows are assumed to occur at the beginning of the year and inflows to accrue at the end of the year. The beginning of the first year of operation has been considered as zero point. The analysis in Table 15-8 indicates that the rate of return of foreign exchange is about 34 per cent.

15 - Financial analysis (cont'd)

Table 15-9

RATE OF RETURN OF FOREIGN EXCHANGE

(Thousands of dollars)

	Cash outflows (capital expenditure)				Cash inflows (net surplus)			
	Estimate for the period	Compounded at			Estimate for the year	Discounted at		
		25%	30%	35%		25%	30%	35%
Construction period								
0 to 12 months ..	1 300	2 285	2 527	2 784				
13 to 24 months ..	3 700	5 203	5 532	5 869				
25 to 30 months ..	1 400	1 575	1 610	1 645				
Commencement of Operation								
1 year ..					2 060	1 648	1 584	1 526
2 year ..					3 330	2 131	1 971	1 828
3 to 15 years ..	—	—	—	—	53 534	9 966	7 853	6 321
Total ..	6 400	9 063	9 669	10 298	58 924	13 745	11 408	9 675

Computation of average rate of return

Excess at lower trial rate (30%) = 11 408 - 9 669 = 1 739

Deficit at higher trial rate (35%) = 10 298 - 9 675 = 623

$$\text{Average rate of return} = 30 + 5 \frac{(1\,739)}{(1\,739 + 623)} = 33.68\%$$

Employment potential

The direct employment potential of the ferro-chrome project has been estimated at about 300. In addition, substantial indirect employment would arise due to development of mining, transport and other allied activities.

Regional development

The ferro-chrome project is being considered in the Bandar-Abbas region. The ferro-chrome plant located here could assist the process of economic development and industrialisation of the region.

APPENDICES - VOLUME III

Raw material sources and infrastructure development

Raw material sources

With regard to raw material sources, further investigations are essential to locate and develop suitable limestone and quartzite deposits in all the three areas.

Power

From the viewpoint of power supply Ahwaz has a slight advantage in view of the existing KWPA grid, and is assured of adequate availability by 1972/73. However, as mentioned earlier, the Ministry of Water and Power has indicated that if on techno-economic considerations of Bandar Abbas or Faryab were selected, suitable modifications will be made in the plan priorities to ensure adequate availability of power at the selected site within a period of three years at the maximum. It would therefore follow that adequate power would be available at all locations only by about 1973.

Water

Adequate supplies of water would be available both at Ahwaz and Faryab, but at Bandar-Abbas these may pose problems. Even for the existing town water supply at Bandar-Abbas, the source is located at a distance of about 40 km.

Transport

Regarding transport, Ahwaz has the best connected road and rail links for distribution to domestic consumers as well as to port for export. In comparison, the existing transport links at Bandar-Abbas and Faryab

SECTION 1

Appendix 9-1

COMPARISON OF GENERAL FACTORS AT DIFFERENT LOCATIONS

	Ahwaz	Bandar Abbas	Faryab
1. Area			
a) Location	48°41' E 31°20' N height above sea level 20 m. Site 12 km south-west of Ahwaz, near Iran Rolling Mill Company area	56°17' E 27°11' N on the gulf of Oman. Height above sea level 6 m. Site located about 2 km west of port	Site located 100 km north-east of Bandar Abbas, adjacent to road to Faryab mines
b) Availability of land	Adequate	Adequate	Adequate
c) Acquisition problem	No difficulties envisaged. $ 5 000/ha	Mostly private owners. $ 9 300/ha	No difficulties envisaged. $ 1 300/ha
d) Soil condition	Soil investigations conducted in Iranian Rolling Mill area. Bearing capacity 0.7 to 1.8 kg/sq cm. Sub-soil water 4.2 to 6.7 m below ground level. At some places, soil contains sulphate.	Sandy, generally soft mixed with gravel. Sub-soil water 2.5 to 6 m below ground level.	No data available
2. Raw material sources			
a) Chrome ore	Gaft - 1 427 km by rail	Faryab - 130 km by road	Faryab - 35 km by road
b) Quartzite	To be located, expected within 100 km radius	To be located, expected within 100 km radius	To be located, expected within 50 km radius
c) Limestone	To be located, expected within 100 km radius	To be located, expected within 100 km radius	To be located, expected within 50 km radius
d) Charcoal	Isfahan area - 1 253 km by rail	Isfahan area - 1 290 km by rail and road	Isfahan area - 1 380 km by rail and road
e) Coke	Isfahan - 1 253 km by rail	Isfahan - 1 290 km by rail and road	Isfahan - 1 380 km by rail and road
f) Electrode paste	Through Khorramshahr - 157 km by rail	Through Bandar-Abbas	Through Bandar-Abbas - 100 km by road
3. Power supply	National grid. Adequate	Proposed national grid or	Proposed national grid or

d) Charcoal	Isfahan area - 1 253 km by rail	Isfahan area - 1 290 km by rail and road	Isfahan area - 1 380 km by rail and road
e) Coke	Isfahan - 1 253 km by rail	Isfahan - 1 290 km by rail and road	Isfahan - 1 380 km by rail and road
f) Electrode paste	Through Khorramshahr - 137 km by rail	Through Bandar-Abbas	Through Bandar-Abbas - 100 km by road
3. Power supply	National grid. Adequate availability from about 1973	Proposed national grid or Bandar-Abbas generating station. Can be made available after three years from final decision	Proposed national grid or Bandar-Abbas generating station. Can be made available after three years from final decision
4. Water supply	From river Karun, separate intake, treatment plant and 2 km pipeline	Proposed Minab dam, 92 km away or tube wells, 50 km away	Minab river - adjacent to site
5. Transport link			
a) Road	Ahwas town connected to Teheran, Khorramshahr and Bandar-Shahpur. Site adjacent to Ahwas-Khorramshahr road	Bandar-Abbas linked with Kerman. Site to be connected to Bandar-Abbas by 2 km road	Connected to Bandar-Abbas by metalled road
b) Rail	Nearest rail head Ahwas - 15 km. Ahwas-Khorramshahr rail link passes close to the proposed plant boundary	No rail link	No rail link
c) Waterway	River Karun navigable between Ahwas and Khorramshahr		
d) Port	Khorramshahr - 137 km by rail	Bandar-Abbas	Bandar-Abbas - 100 km by road
6. Climatology	Hot and desert dry, maximum temperature rising to 50°C and possibly higher	One of the hotter towns, maximum temperature rising to 47°C	Summer less severe than Bandar-Abbas. Maximum temperature 43°C, and rainfall 245 mm in 1967 (at mines)

6. Climatology (cont'd)

	Ahwas					Bandar-Abbas					Faryab
	1964	1963	1962	1961	1960	1964	1963	1962	1961	1960	
a) Temperature											
Average max °C	32.3	32.5	33.7	32.6	33.6	30.8	31.8	32.4	31.9	31.7	...
Average min °C	15.6	17.4	17.6	16.7	17.6	21.4	22.9	23.6	22.9	23.6	
Highest max °C	48.0	48.4	49.0	49.0	49.8	42.4	46.5	45.0	45.0	45.5	
Lowest min °C	-7.0	0.6	3.0	1.2	2.0	4.8	5.5	9.5	10.0	9.4	
b) Annual precipitation mm	75.3	157.6	171.3	215.6	116.1	244.5	151.0	1.4	152.7	111.1	...
c) Relative humidity											
Average max %	56	66	67	65	64	72	80	71	74	74	
Average min %	26	35	35	57	37	54	60	57	61	59	...

7. Seismicity

	Ahwas	Bandar-Abbas	Faryab
Modified Mercally earthquake intensity scale	5	5	5

8. Socio-economic factors

	Ahwas	Bandar-Abbas	Faryab
a) Nearest town	Ahwas - population 120 000 12 km distant	Bandar-Abbas - population varies from 45 000 in summer to 75 000 in winter. 2 km distant	Bandar-Abbas. 100 km distant
b) Housing facilities	Not to be built	Not to be built	To be built - essential
c) Educational facilities	University, including an agricultural university 40 km from Ahwas	High school	Bandar-Abbas facilities
d) Hospital	Town facilities may be used	Town facilities may be used	Some facilities will be needed. Advantage of Bandar-Abbas may be taken
e) Industrial Development			
Existing	Pipe Plant. Steel Rolling Mill	None	None

	12 km distant	from 45 000 in summer to 75 000 in winter. 2 km distant	distant
b) Housing facilities	Not to be built	Not to be built	To be built - essential
c) Educational facilities	University, including an agricultural university 40 km from Ahwas	High school	Bandar-Abbas facilities
d) Hospital	Town facilities may be used	Town facilities may be used	Some facilities will be needed. Advantage of Bandar-Abbas may be taken
e) Industrial Development			
Existing	Pipe Plant. Steel Rolling Mill	None	None
Proposed	Arc furnace cum continuous casting plant for billets. Cold Rolling Mill	Possible industrialisation being studied	None
f) Availability of labour	Skilled and unskilled labour	Unskilled; labour rates high	Unskilled
g) Availability of local contractors	Building contractors	Residential building contractors	None
h) Nearest airport	Ahwas	Bandar-Abbas	Bandar-Abbas
i) Tele-communication	Connected to the country network	Connected to the country network	To be established

SECTION 2

Appendix 9-2

COMPARISON OF CAPITAL AND OPERATING COST FACTORS

	Ahwaz	Bandar-Abbas	Faryab
A. Capital cost factors			
1. Site preparation	There may not be any significant difference in the cost of site preparation at different locations		
2. Cost of construction material:			
Cement $/ton	26	28 to 37	28 to 37
Sand $/cu m	4	2	0.67
Gravel $/cu m	4	2.53	0.67
Bricks $/1 000	11.3 to 13.3	12 to 13.3	10.67
3. Cost of construction labour, $/day:			
Unskilled	1.33	1.6	0.87
Welder	4.67	4.67	Same rates as Bandar Abbas
Plastering mason	3.73	4.67	
Mason	5.33	6.0	
Blacksmith) Plumber) Bar bender)	4.00	4.67	
4. Infrastructure development:			
Water	Separate intake, treatment plant and 2 km pipe-line	Long pipeline	Separate intake, treatment plant and 500 m pipeline
Transport	2 km rail link	2 km road	None
Power	None	Power supply system to be developed	
5. Transport of imported equipment and supplies to site	c.i.f. cost plus freight cost to transport about 125 km by road	c.i.f. cost plus freight cost to transport about 2 km by road	c.i.f. cost plus freight cost to transport about 100 km by road
6. Special considerations in design	Buildings to have complete side sheeting for protection against dust storm. Some precautions against soil corrosion	Some piling may be necessary	None
B. Operating cost factors			
1. Freight cost, $/ton product			
Raw materials assembly	44.6	31.4	24.7
Product distribution	2.6	1.5	3.6
Total	47.2	32.9	28.3
2. Tax holiday	'Profits from export exempted from tax' - all locations equally attractive		

Appendix 10-1

ANALYSES OF MAJOR RAW MATERIALS

	Cr_2O_3	Fe	SiO_2	Al_2O_3	CaO	MgO	S	P	F.C.	V.M.	Ash
	%	%	%	%	%	%	%	%	%	%	%
Chromite ore	48	11	6	12	-	12	-	-	-	-	-
Coke	-	-	-	-	-		1.3	-	84.7	1.0	13
Coke ash	-	14	36	28.5	6.5	2.5	-	0.06	-	-	-
Charcoal	-	-	-	-	-	-	-	-	75.3	10.0	4.0
Charcoal ash	-	-	25	-	50	25	-	-	-	-	-
Quartzite	-	-	97	2.8	-	-	-	-	-	-	-
Limestone	-	-	5	1.5	51	0.85	-	-	-	-	-

Appendix 10-2

LIST OF MAJOR EQUIPMENT

Raw materials handling

Three (3) nos.	Mechanical payloaders
Three (3) nos.	Ground hoppers
Two (2) nos.	Bucket elevators
One (1) set	Belt conveyor system for stacking materials and charging day bins
One (1) set	Belt conveyor system for charging reduction furnace bins
One (1) set	Belt conveyor system for feeding chrome ore preheating kiln
One (1) no.	Skip hoist mechanism for charging lime calcining kilns
Ten (10) nos.	Day bins for storing raw materials
Eight (8) nos.	Vibratory feeders with automatic weighing devices
One (1) set	Charging bins
One (1) set	Control mechanism for filling of charging bins

Furnaces and furnace auxiliaries

One (1) no.	12 000 kVA open rotating submerged arc electric reduction furnace
One (1) no.	8 000 kVA open tilting slag melting furnace
One (1) no.	12 000 kVA, 11 kV/170-110 V, onload tap changing transformer for remote control
One (1) no.	8 000 kVA, 11 kV/240-140 V, onload tap changing transformer for remote control
One (1) no.	Chrome ore drying and preheating kiln, with normal and emergency drives
One (1) no.	Limestone calcining kiln, with normal and emergency drives
Two (2) nos.	Hot material charging bins
One (1) no.	Stocking car
Two (2) nos.	Taphole opening devices for reduction furnace
One (1) no.	Pugmill
One (1) no.	Gun for taphole plugging
Two (2) sets	Control panels for furnace operation, together with electrical switchgear
Two (2) sets	Electrode hoists, slipping devices, compressor oil tanks etc with the necessary inter-connecting piping and electrode position indicators

G-388

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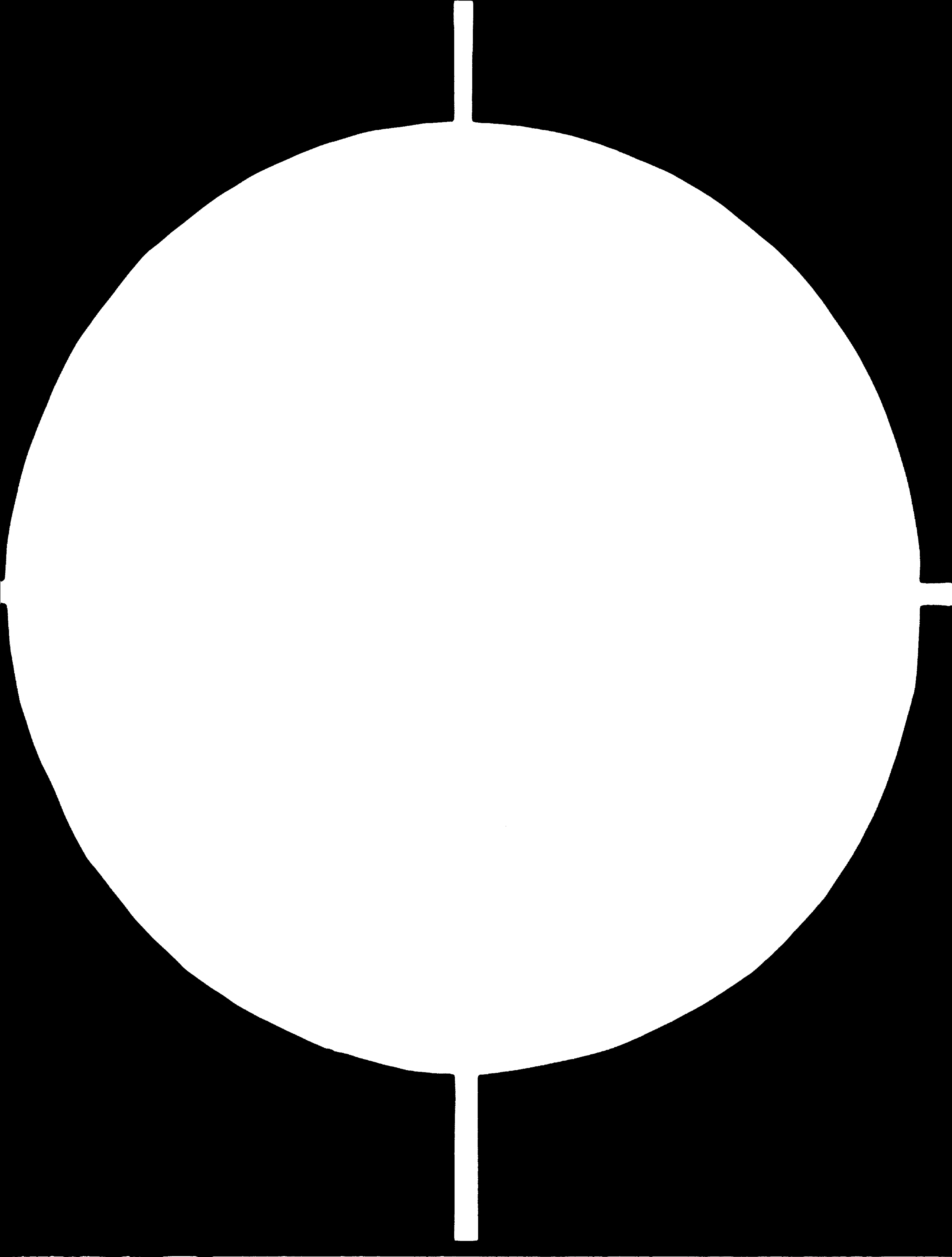
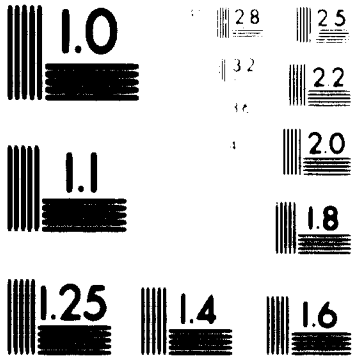


5 OF 10



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
ANSI and ISO TEST CHART No. 2

24x
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Appendix 14-1

COST OF RAW MATERIALS DELIVERED TO SITE

		Transport					
	Cost/ton at source $	Distance km	Mode	Freight rate a/ Rials/ton km	Total freight Rials	Total freight $	Cost/ton at plant site $
Chrome ore ..	17.0	40	Road	3.0	120	1.6	19
Quartzite ..	3.4	50	Road	2.7	135	5.2	5
Coke ..	22.6	700	Rail	0.8	562		
		720	Road	1.7	1 224		
					1 786	23.8	46
Charcoal ..	59.5	700	Rail	0.8			
		720	Road	1.7	1 786	23.8	85
Limestone ..	0.9	50	Road	2.7	135	1.8	3
Electrode paste	-	-	-	-	-	-	138

a/ Railway freight rate as per Iranian railway tariff. Freight rate for road transport computed on the basis of 'telescope rate' - lower rates for higher haulage.

Appendix 14-2

PRELIMINARY PRODUCTION COST ESTIMATE OF HIGH CARBON FERRO-CHROME

Basis: One 12 000 kVA, 3-phase submerged electric arc furnace
Production: 4 500 tons of high carbon ferro-chrome (67% Cr)
6 500 tons of silico-chrome (45% Si, 40% Cr)

	Price/ton material $	Quantity/ton Kg	Cost/ton $
Cost of materials			
Chrome ore	19	2 300	43.70
Coke	46	225	10.35
Charcoal	83	250	20.75
Quartzite	5	145	0.73
Electrode paste	138	35	4.83
Total cost of materials			80.36
Cost above materials			
Labour and supervision	-	-	22.50
Maintenance materials, consumable supplies etc	-	-	1.35
Refractories	-	-	1.35
Reserve for relining	-	-	0.27
General plant expense	-	-	23.10
Total cost above materials excluding power cost			48.57
Total cost of production excluding power cost			128.93

Appendix 14-3

PRELIMINARY PRODUCTION COST ESTIMATE OF SILICO-CHROME

Basis: One 12 000 kVA, 3-phase submerged electric arc furnace

Production: 6 500 tons of silico-chrome (45% Si, 40% Cr)
4 500 tons of high carbon ferro-chrome (67% Cr)

	Price/ton material $	Quantity/ton kg	Cost/ton $
Cost of materials			
Chrome ore	19	1 450	27.55
Coke	46	340	15.64
Charcoal	83	590	48.97
Quartzite	5	1 560	7.80
Electrode paste ..	138	55	7.59
Total cost of materials ..			107.55
Cost above materials			
Labour and supervision ..	-	-	22.50
Maintenance materials, consumable supplies etc ..	-	-	2.00
Refractories	-	-	1.35
Reserve for relining ..	-	-	0.68
General plant expense ..	-	-	23.10
Total cost above materials excluding power cost ..			49.63
Total cost of production excluding power cost			157.18

Appendix 14-4

PRELIMINARY PRODUCTION COST ESTIMATE OF LOW CARBON FERRO-CHROME

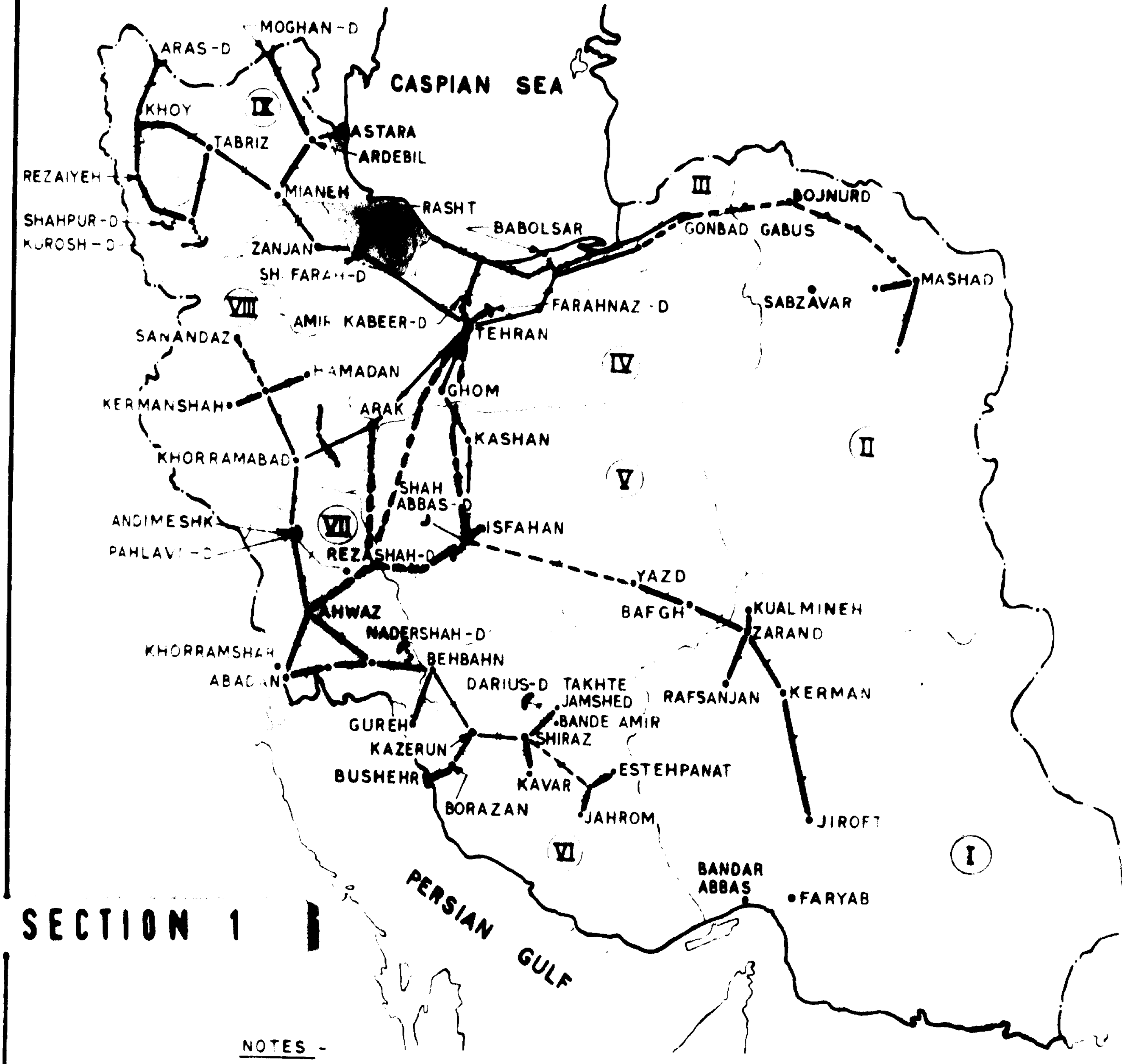
Basis: One 8 000 kVA, 3-phase open tilting electric furnace
Production: 10 000 tons of low carbon ferro-chrome (68% Cr)

	Price/ton material $	Quantity/ton kg	Cost/ton $
Cost of materials			
Chrome ore	19	1 460	27.74
Silico-chrome	157 a/	650	102.05
Limestone	3	2 100	6.30
Electrode paste ..	138	22	3.04
Total cost of materials ..			139.13
Cost above materials			
Labour and supervision ..	-	-	24.70
Fuel oil	20	350	7.00
Maintenance materials, water consumable supplies etc ..	-	-	1.75
Refractories	-	-	0.80
Reserve for relining ..	-	-	0.33
General plant expense ..	-	-	25.30
Total cost above materials excluding power cost ..			59.88
Total cost of production excluding power cost ..			199.01

a/ The price of silico-chrome considered here excludes the cost of electric power necessary to produce it.

DRAWINGS - VOLUME III

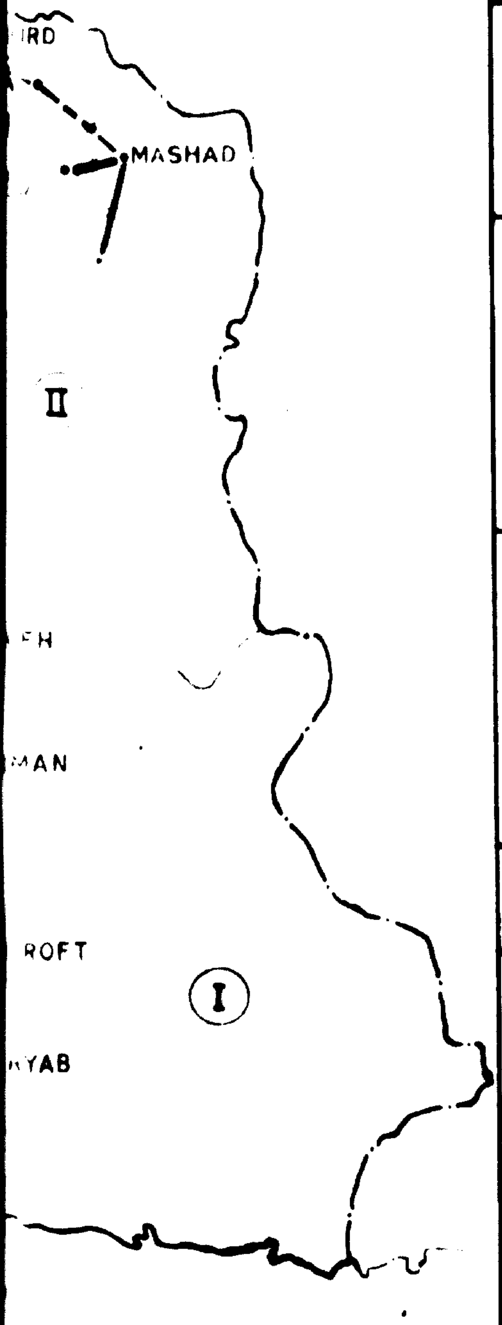
SECTION 1



NOTES -

1. THIS DRAWING IS PREPARED ON THE BASIS OF INFORMATION FURNISHED BY MINISTRY OF WATER AND POWER.
2. THE MA SHOWS INTERCONNECTED TRANSMISSION SYSTEM IN 1972. FUTURE EXPANSION FOR 1972-77 IS SHOWN IN DOTTED.
3. REGIONAL ELECTRIC SUPPLY Co.

Ⅰ	KERMAN
Ⅱ	KHORASSAN
Ⅲ	MAZAN DARAN
Ⅳ	TEHRAN
Ⅴ	ISFAHAN
Ⅵ	FARS
Ⅶ	KWPA
Ⅷ	KHORDESTAN
Ⅸ	AZERBAIJAN
Ⅹ	GILAN



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IN 1972. FUTURE

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TABLE OF INSTALLED GENERATING CAPACITY FOR SELECTED ARE

REGION	NAME OF GENERATING STN.	TOTAL GENERATING CAPACITY IN MW						
		197[illegible]			19[illegible]			
		STEAM	HYDRO	GAS	STEAM	HYDRO	GAS	STEAM
ISFAHAN	ISFAHAN	[illegible]	–		[illegible]			315
	SHAH ABBAS KABEER DAM	–	53	–	–	53	–	
	STEEL MILL	–	–	5	–	–	5	
TEHRAN	FARAHNAZ DAM	–	22	–	–	22	–	
	AMIR KABEER DAM	–	84	–	–	84	–	–
	KARAJ	236·5	–	–	300	–	–	[illegible]
	FARAH ABAD	250	–	–	250	–	–	250
	TARASHT	50	–	95	–	–	165	–
	MANZIL	–	–	–	240	–		
KWPA	AHWAZ	150	–	–	350	–	–	[illegible]
	PAHLAVI DAM	–	500	–	–	500	–	–
	REZA SHAH DAM	–	–	–	–	1000	–	–
	KARUN DAM	–	–	–	–	420	–	–
	RIVERS POWER	–	–	–	–	–	–	
KERMAN	ZARAND	60	–	–	120	–	–	[illegible]
	BANDAR ABBAS	–	–	30	–	–	60	
FARS	SHIRAZ	–	–	52	–	–	52	–
	DARIUSH KABEER DAM	–	8	–	–	8	–	–
AZERBAIJAN	TABRIZ	12	–	30	–	–	30	–
	ARAS DAM	–	21	–	–	21	–	–
	SHAHPUR DAM	–	6	–	–	6	–	–
	KUROSH KABEER DAM	–	10	–	–	10	–	–
KHORDESTAN	SANANDAZ	–	–	–	–	–	10	–

SECTION 2

G CAPACITY FOR SELECTED AREAS

AL GENERATING CAPACITY IN MW						
	[illegible]			1982		
	STEAM	HYDRO	GAS	STEAM	HYDRO	GAS
[illegible]	[illegible]		[illegible]	315	–	[illegible]
–		53	–	–	53	–
[illegible]	–	–	15	–	–	[illegible]
	–	22	–	–	22	–
–	–	84	–	–	84	–
–	300	–	–	300	–	–
–	250	–	–	250	–	–
9[illegible]		–	165	–	–	305
–	24	–		–	–	–
–	350	–	–	400	–	–
–		500	–	–	500	–
–	–	[illegible]	–	–	1000	–
–	–	42	–	–	870	–
–			–	–	–	1200
–	120	–	–	120	–	–
30	–	–	60	–	–	120
52	–	–	52	–	–	52
–	–	8	–	–	8	–
30	–	–	30	–	–	30
–	–	21	–	–	21	–
–	–	6	–	–	6	–
–	–	10	–	–	10	–
–	–	–	10	–	–	–

LEGEND

63 KV TRANSMISSION LINE	━━━━
132 KV TRANSMISSION LINE	━━━━
230 KV TRANSMISSION LINE	━━━━
400 KV TRANSMISSION LINE	━━━━
FUTURE EXPANSION 1972 - 1977	- - - - - -
DAMS (D)	◡
TOWNS & CITYS	●
AREA COVERED BY REGIONAL ELECTRIC SUPPLY Co	Ⓘ

TOTAL INSTALLED GENERATING CAPACITY IN IRAN

PLAN PERIOD	GENERATING CAPACITY IN MW.	ADDED CAPACITY IN MW
4TH PLAN PERIOD ENDING IN 1972	2581	
5TH PLAN PERIOD ENDING IN 1977	4441	1860
6TH PLAN PERIOD ENDING IN 1982	6876	2431
7TH PLAN PERIOD ENDING IN 1987	9576	2700

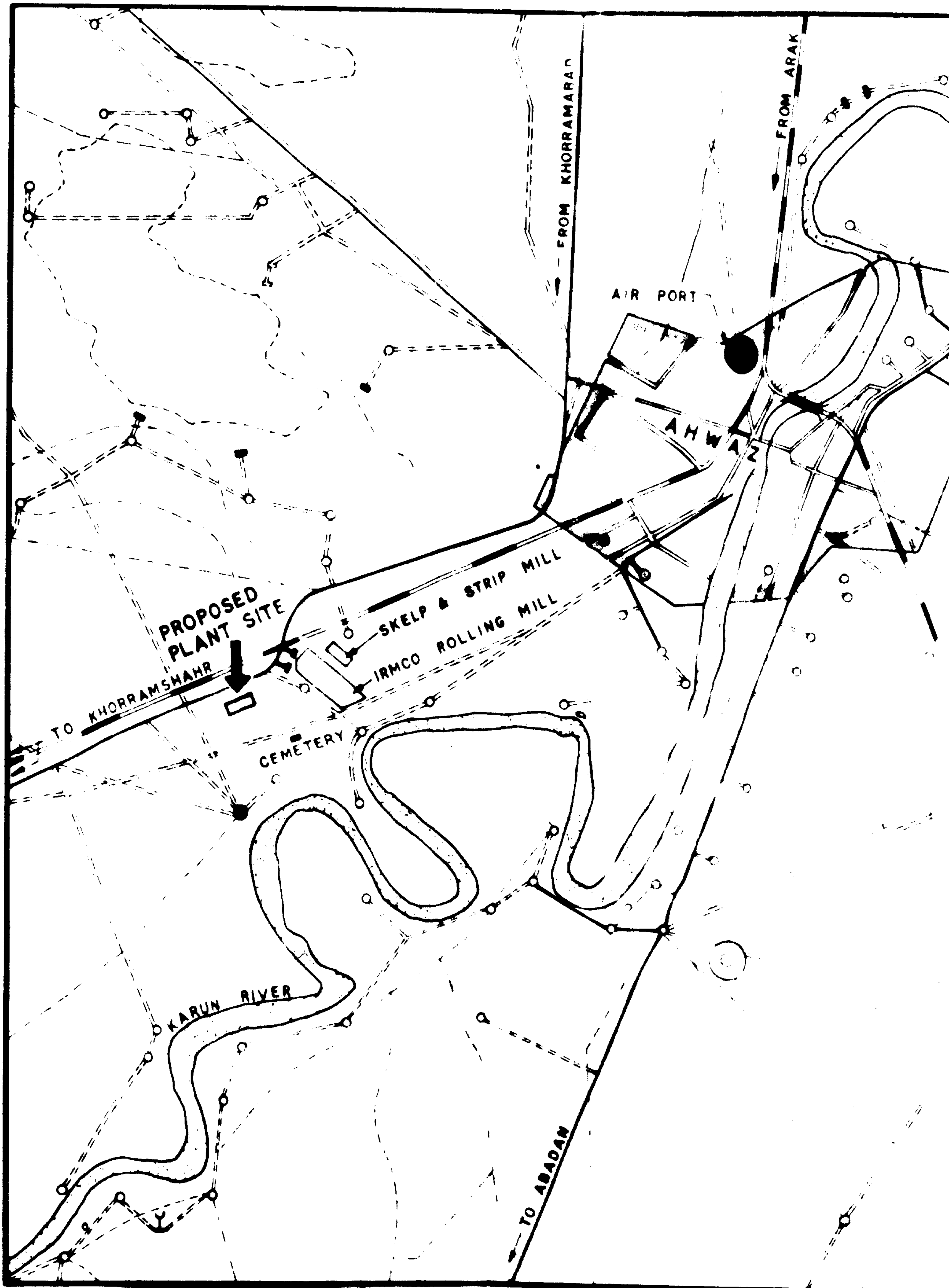
SECTION 3

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

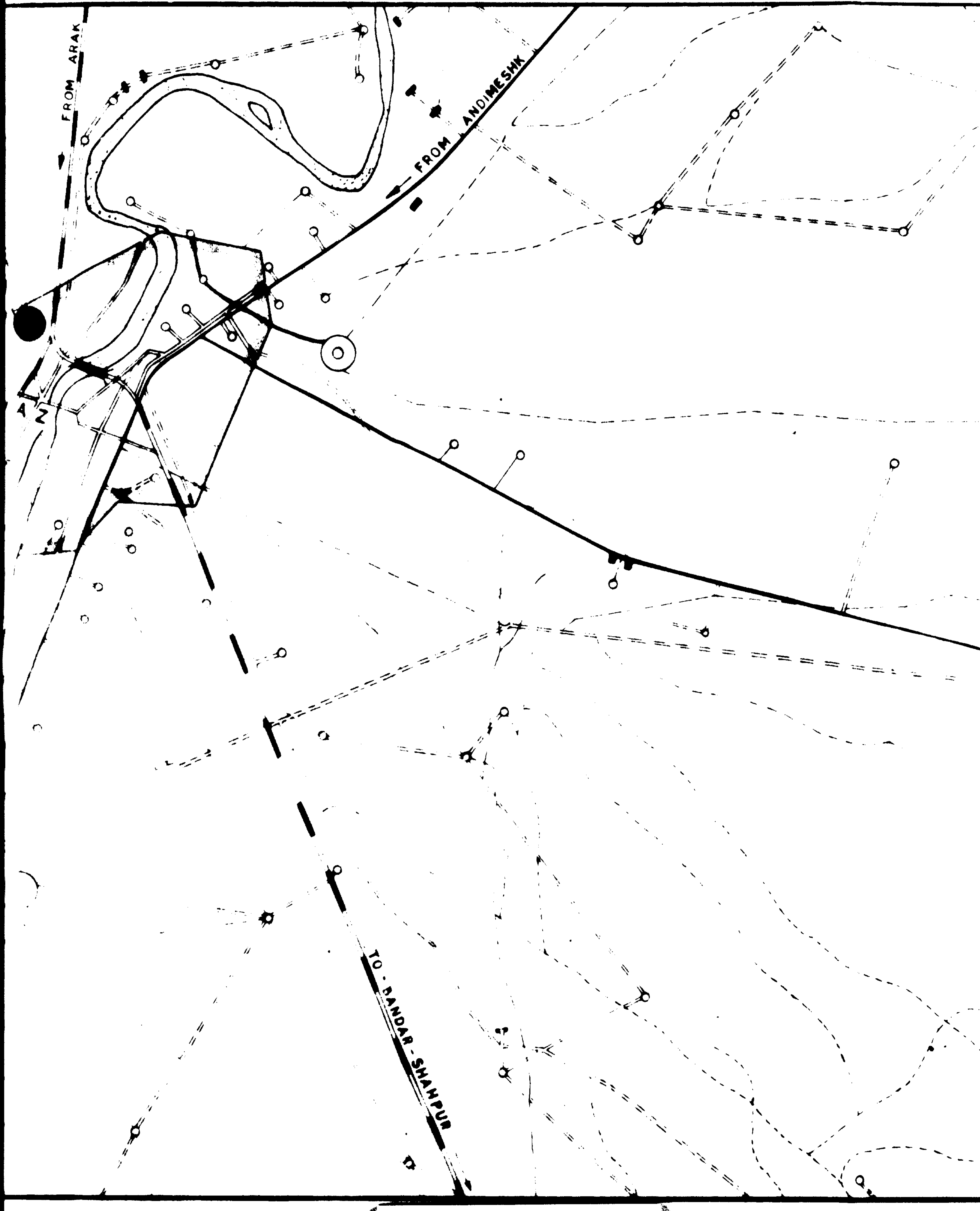
FOR
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
POWER GRID MAP OF IRAN

DRAWN	K. Basu	12.11.69	No. 5131 – III – 1
APPROVED	[illegible]	[illegible]	


FROM KHORRAMABAD
FROM ARAK
AIR PORT
AHWAZ
PROPOSED PLANT SITE
SKELP & STRIP MILL
IRMCO ROLLING MILL
TO KHORRAMSHAHR
CEMETERY
KARUN RIVER
TO ABADAN

SECTION 1



SECTION 2

Appendix 10-2 (continued)

Furnaces and furnace auxiliaries (cont'd)

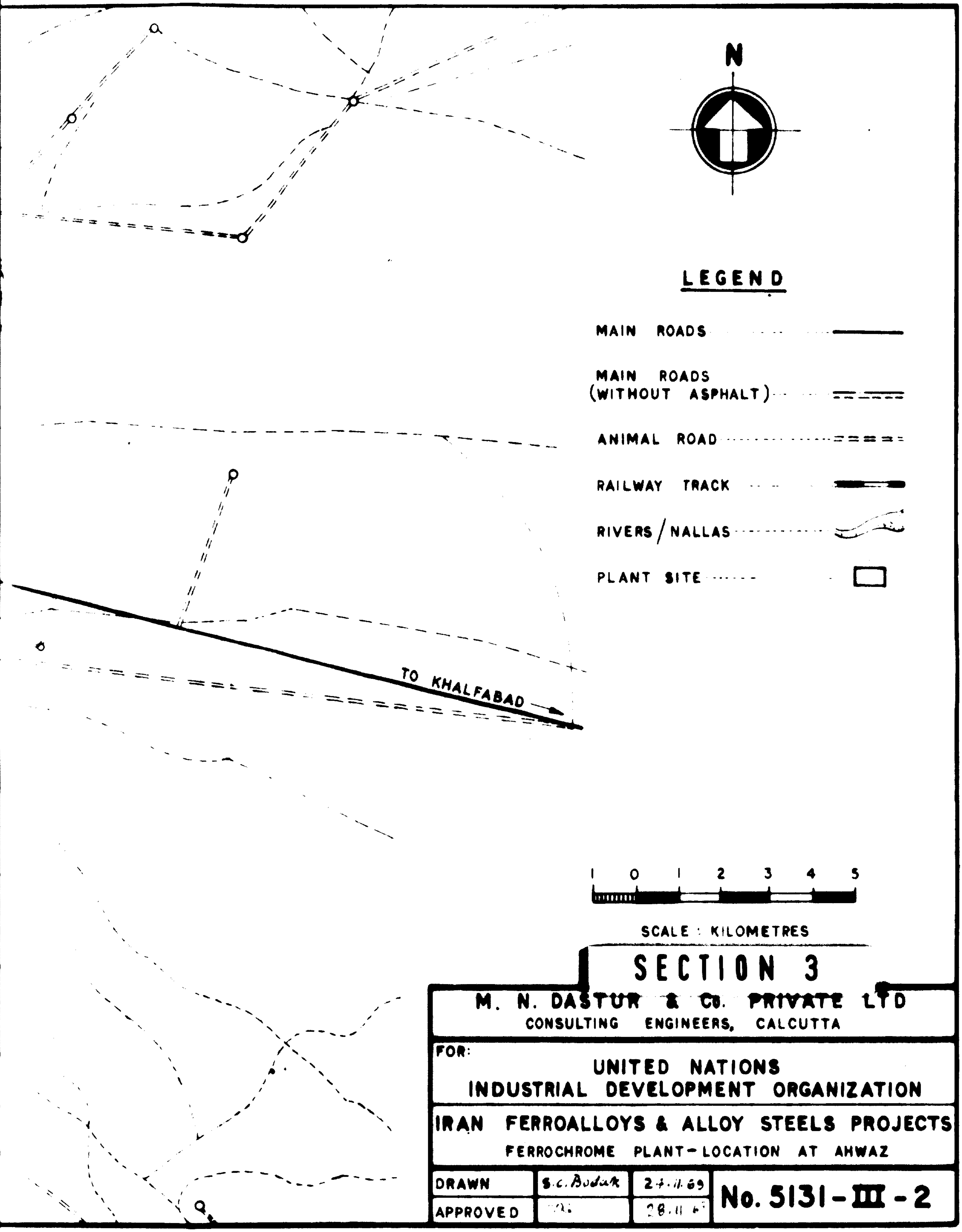
One	(1) set	Rotating machinery for the reduction furnace
One	(1) set	Tilting machinery for the slag furnace
One	(1) set	Furnace carriage for the slag furnace
Two	(2) sets	Smoke hoods and fume exhausting equipment for furnace operation
Two	(2) sets	Smoke hoods, scrubbers etc for dust and fume exhausting for rotary kiln operations
One	(1) no.	5-ton passenger-cum-freight elevator

Tapping and finishing

Two	(2) nos.	Ladles, capacity 9 m^3, with basic lining
Three	(3) nos.	Siphon ladles, capacity 9 m^3, with basic lining
Three	(3) nos.	Ladles, capacity 2 m^3, with firebrick lining
One	(1) no.	Feeder for liquid silico-chrome
One	(1) no.	Weighscale for ladles with liquid silico-chrome
Two	(2) sets	Casting pans for silico-chrome
One	(1) set	Bogies with hydraulic reciprocating mechanism
One	(1) no.	Primary jaw crusher for silico-chrome
One	(1) no.	Secondary jaw crusher for silico-chrome
One	(1) no.	Cone crusher for silico-chrome
One	(1) no.	Feeder for silico-chrome
One	(1) set	Belt conveyors
One	(1) set	Storage bins for silico-chrome
One	(1) no.	Weighing scale for silico-chrome
Two	(2) nos.	Weighing scales for the reaction ladle
Two	(2) sets	Casting pans for ferro-chrome
One	(1) no.	Pneumatic drop hammer for ferro-chrome
One	(1) no.	Primary jaw crusher for ferro-chrome
One	(1) no.	Secondary jaw crusher for ferro-chrome
Two	(2) sets	Storage bins for high carbon and low carbon ferro-chrome
One	(1) no.	Compactor for ferro-chrome
One	(1) no.	Roller conveyor for ferro-chrome drums
Two	(2) nos.	80/25-ton EOT cranes with air-conditioned cabin
One	(1) no.	10/5-ton EOT crane
Two	(2) sets	Smoke exhausting equipment for the ladle reactions
One	(1) set	Slag screening equipment

Power supply

One	(1) no.	132 kV outdoor circuit breaker
Two	(2) nos.	132 kV gang operated isolators



SECTION 3

M. N. DASTUR & Co. PRIVATE LTD
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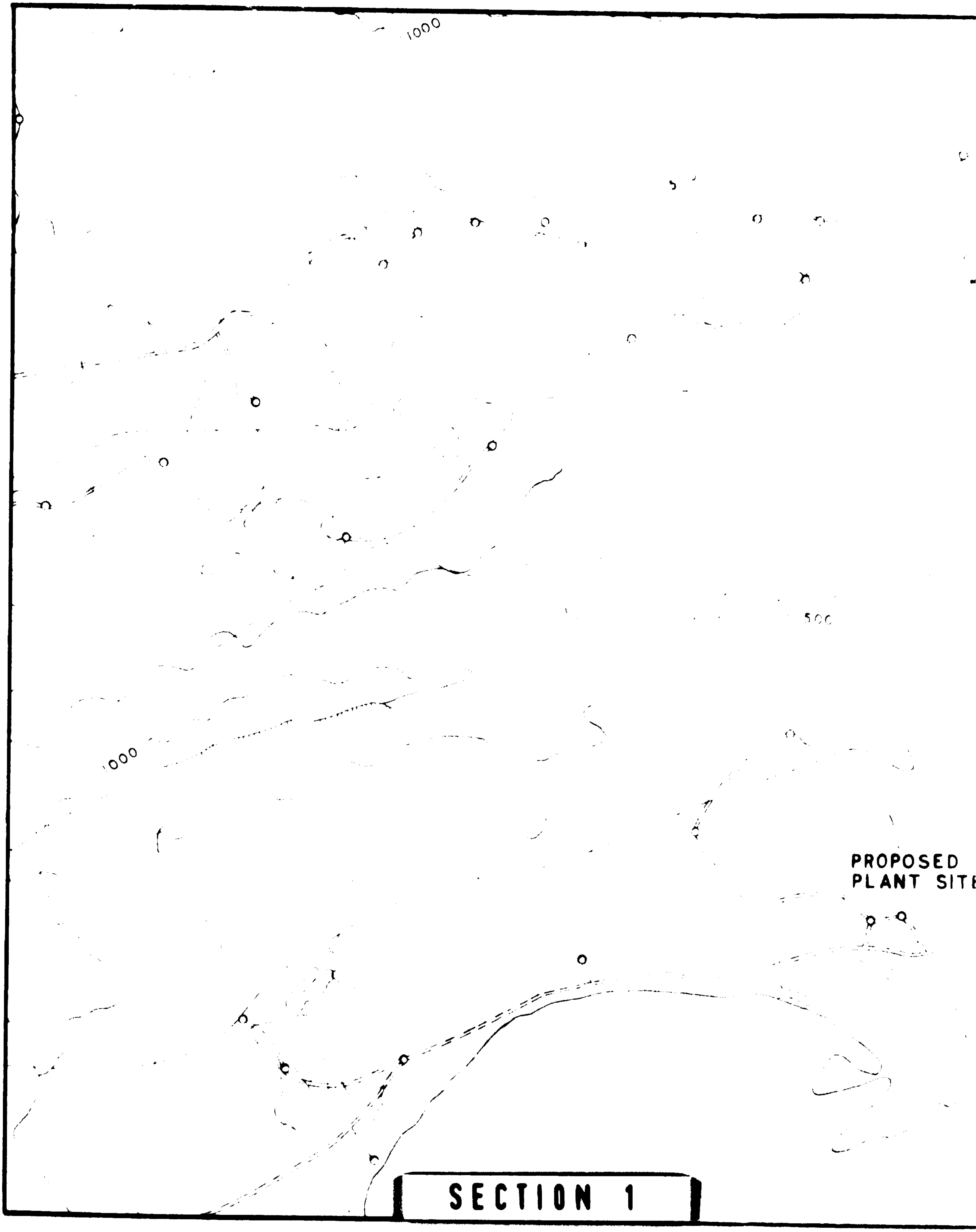
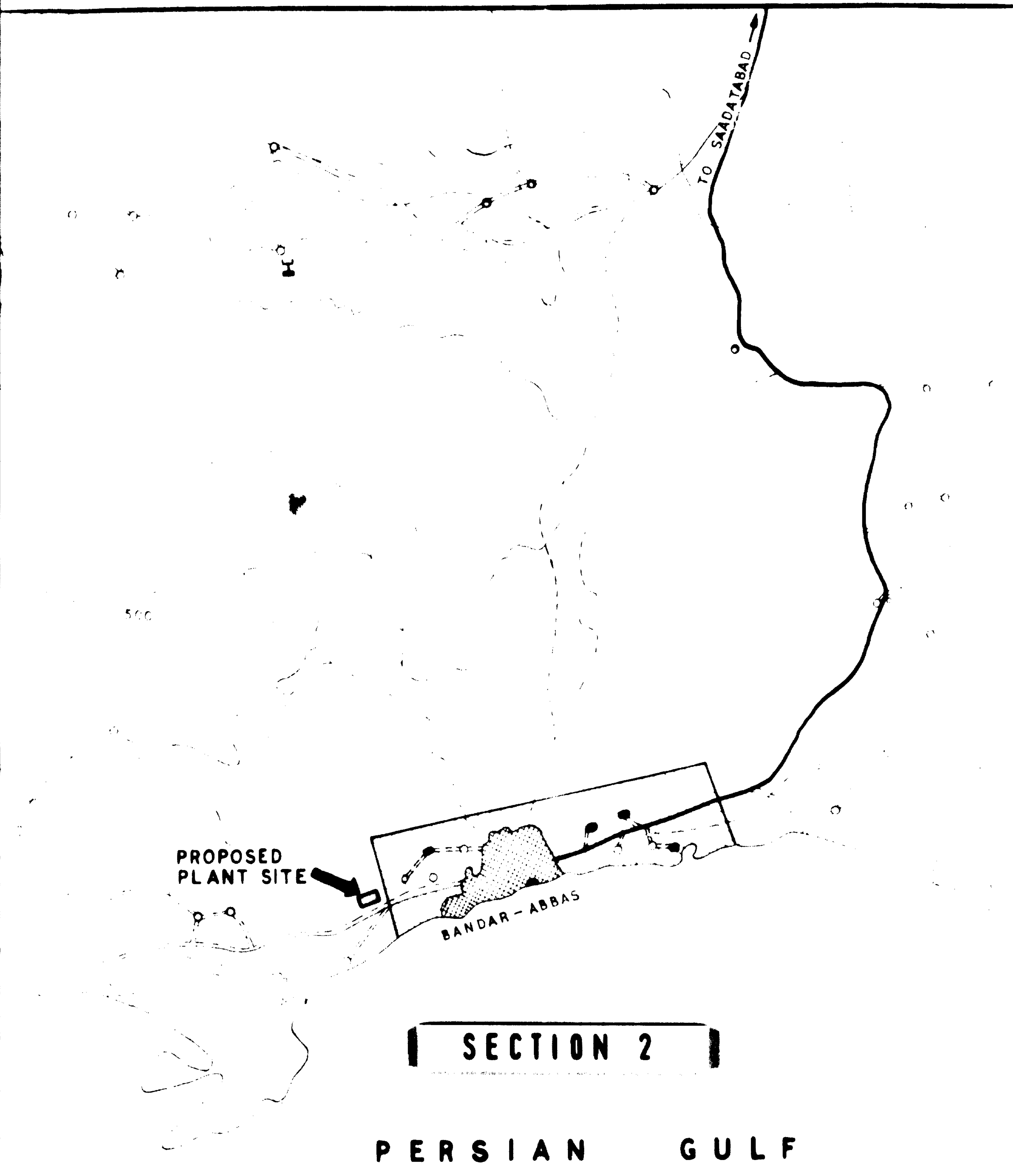
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROCHROME PLANT-LOCATION AT AHWAZ

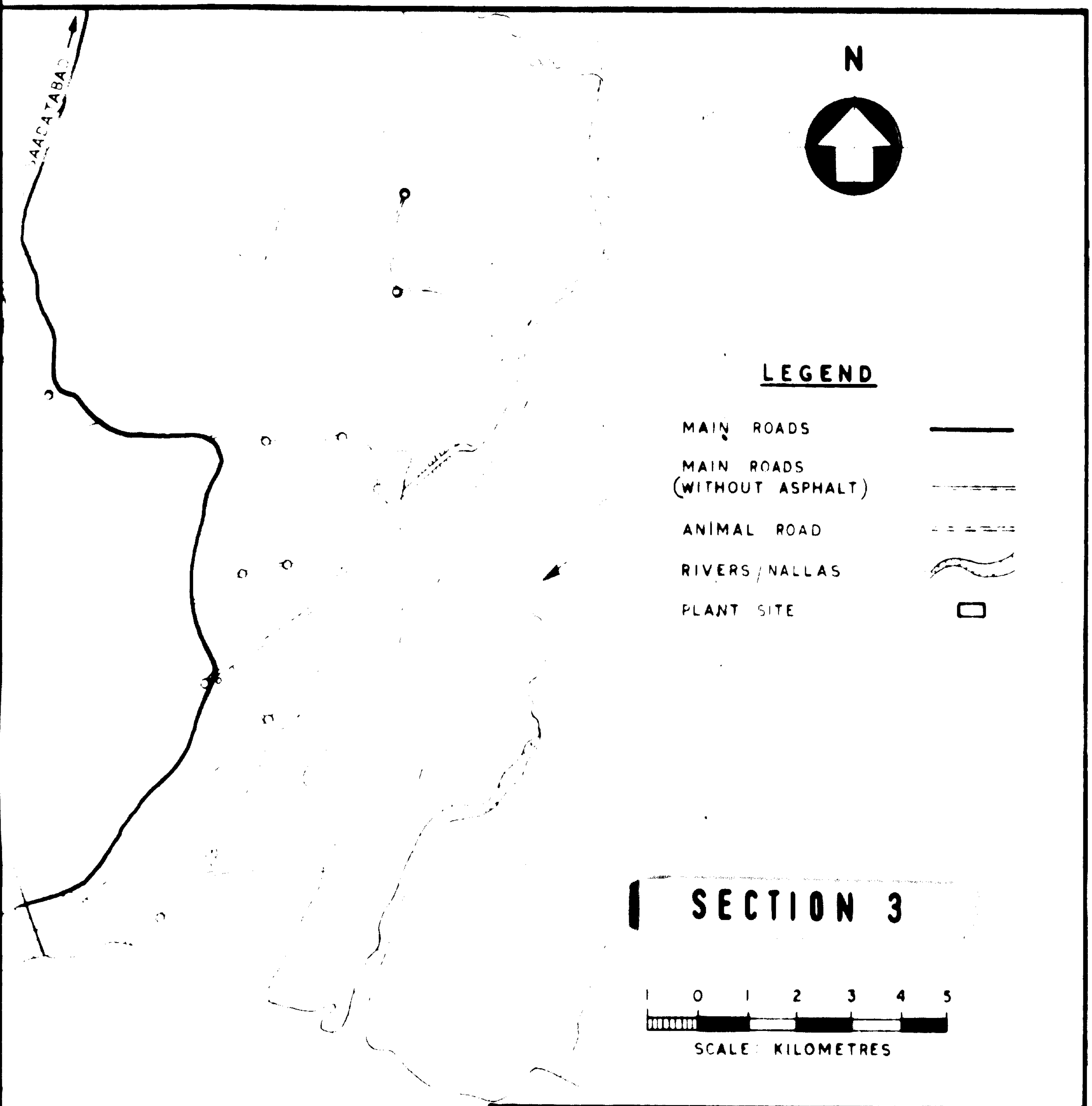
DRAWN	S.c. Bodak	24.11.69	No. 5131-III-2
APPROVED		28.11.69	



SECTION 1


TO SAADATABAD
500
PROPOSED PLANT SITE
BANDAR-ABBAS
PERSIAN GULF

SECTION 2



LEGEND

MAIN ROADS —
MAIN ROADS (WITHOUT ASPHALT) ═
ANIMAL ROAD - - -
RIVERS / NALLAS ≈
PLANT SITE ▭

SECTION 3

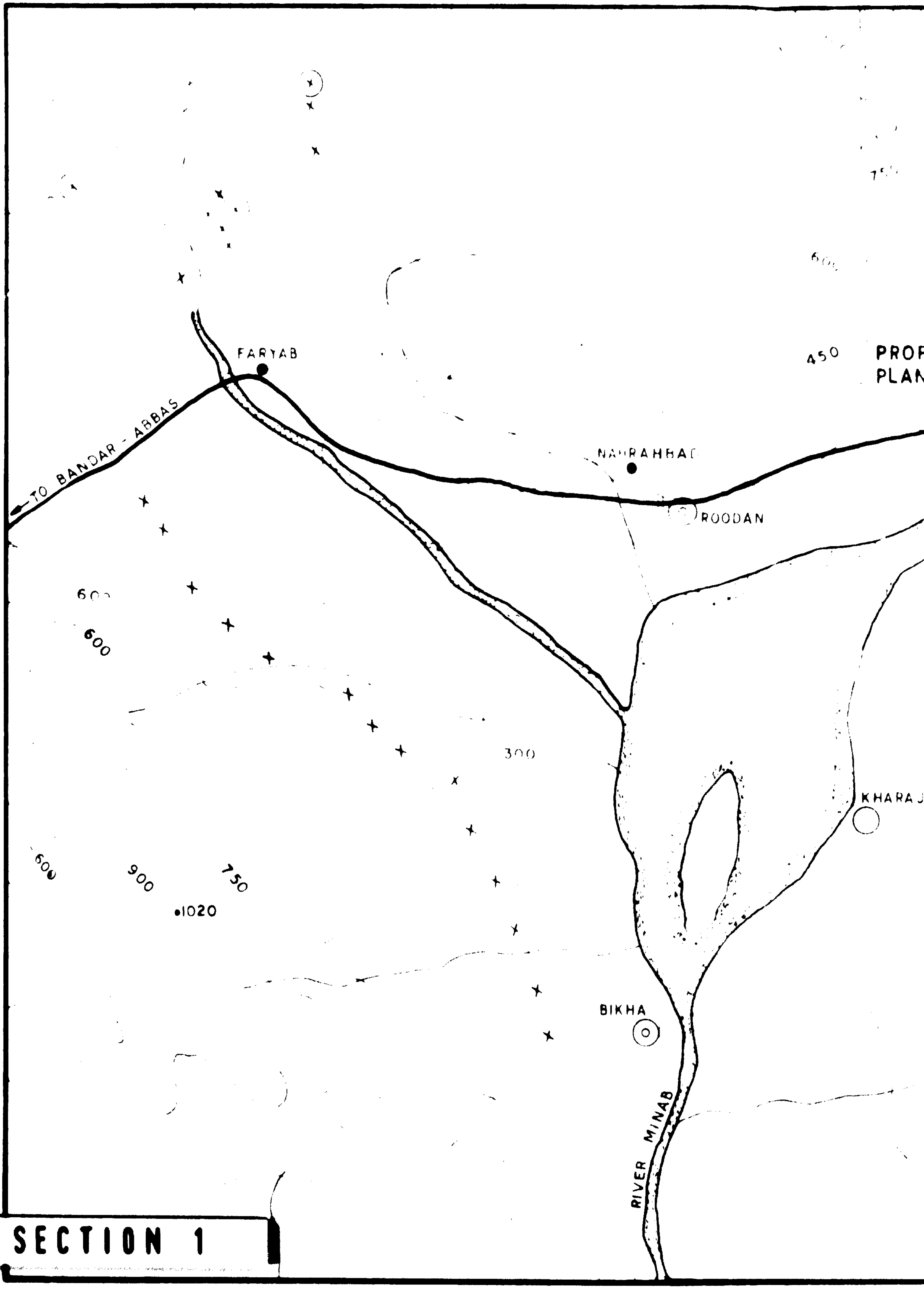
1 0 1 2 3 4 5
SCALE: KILOMETRES

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

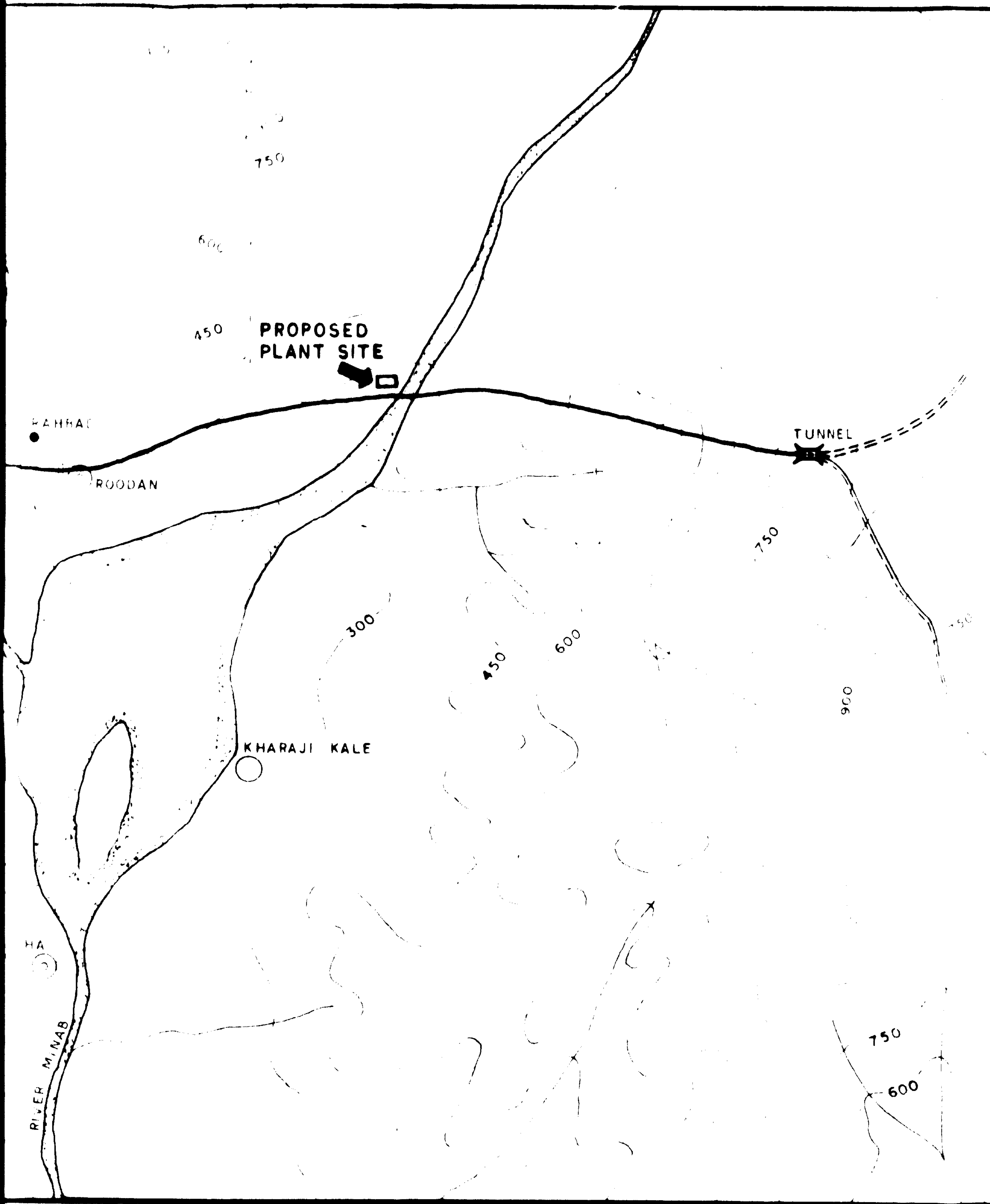
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROCHROME PLANT — LOCATION AT BANDAR-ABBAS

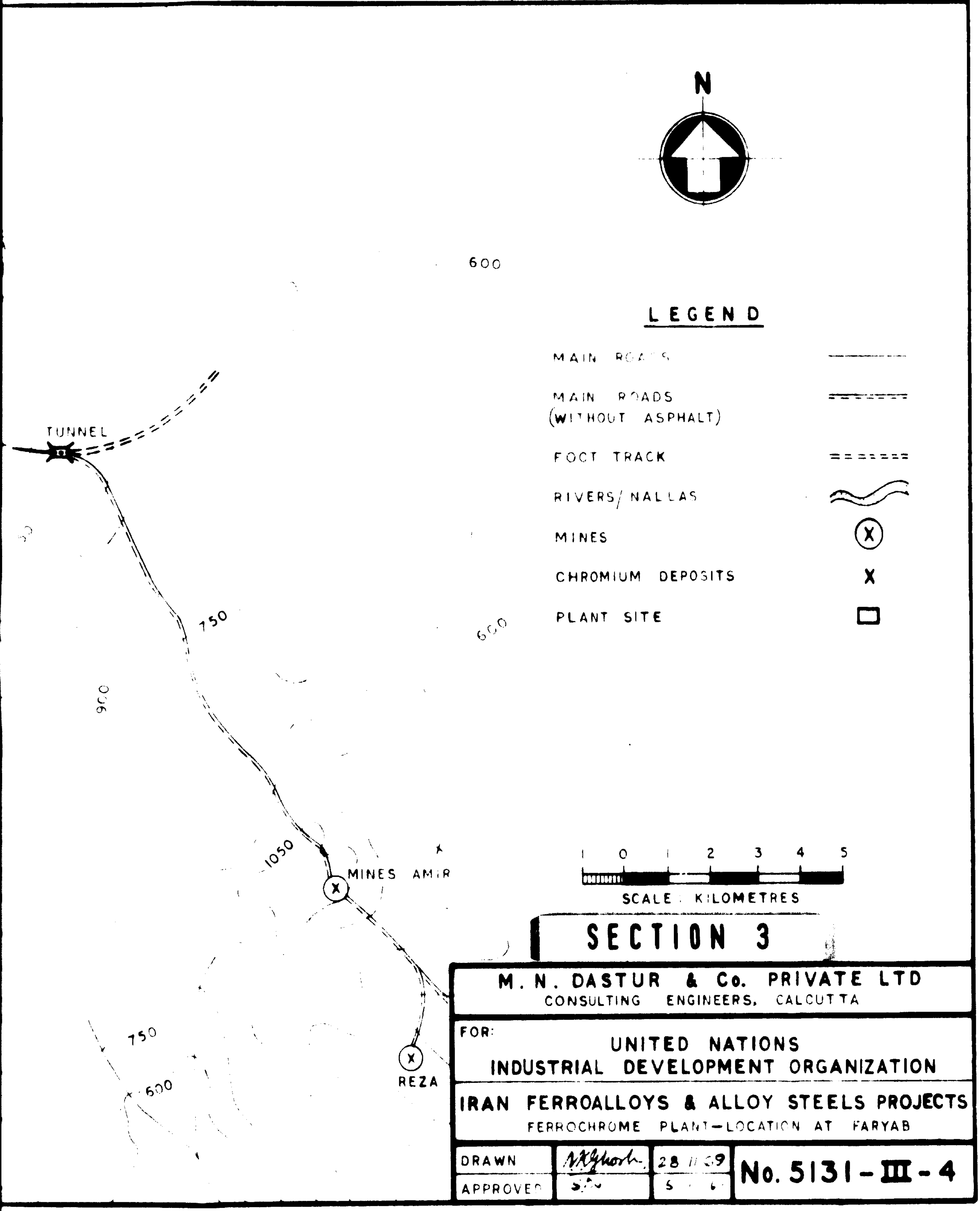
DRAWN	NKGhosh	24.11.69	No. 5131 – III – 3
APPROVED		26.11.69	


FARYAB
TO BANDAR - ABBAS
NAHRAHBAD
ROODAN
450
PROP
PLAN
600
KHARAJ
600
600
600
900
750
•1020
300
BIKHA
RIVER MINAB

SECTION 1


750
600
450
PROPOSED
PLANT SITE
ROODAN
TUNNEL
750
300
450
600
900
KHARAJI KALE
HA
RIVER MINAB
750
600

SECTION 2



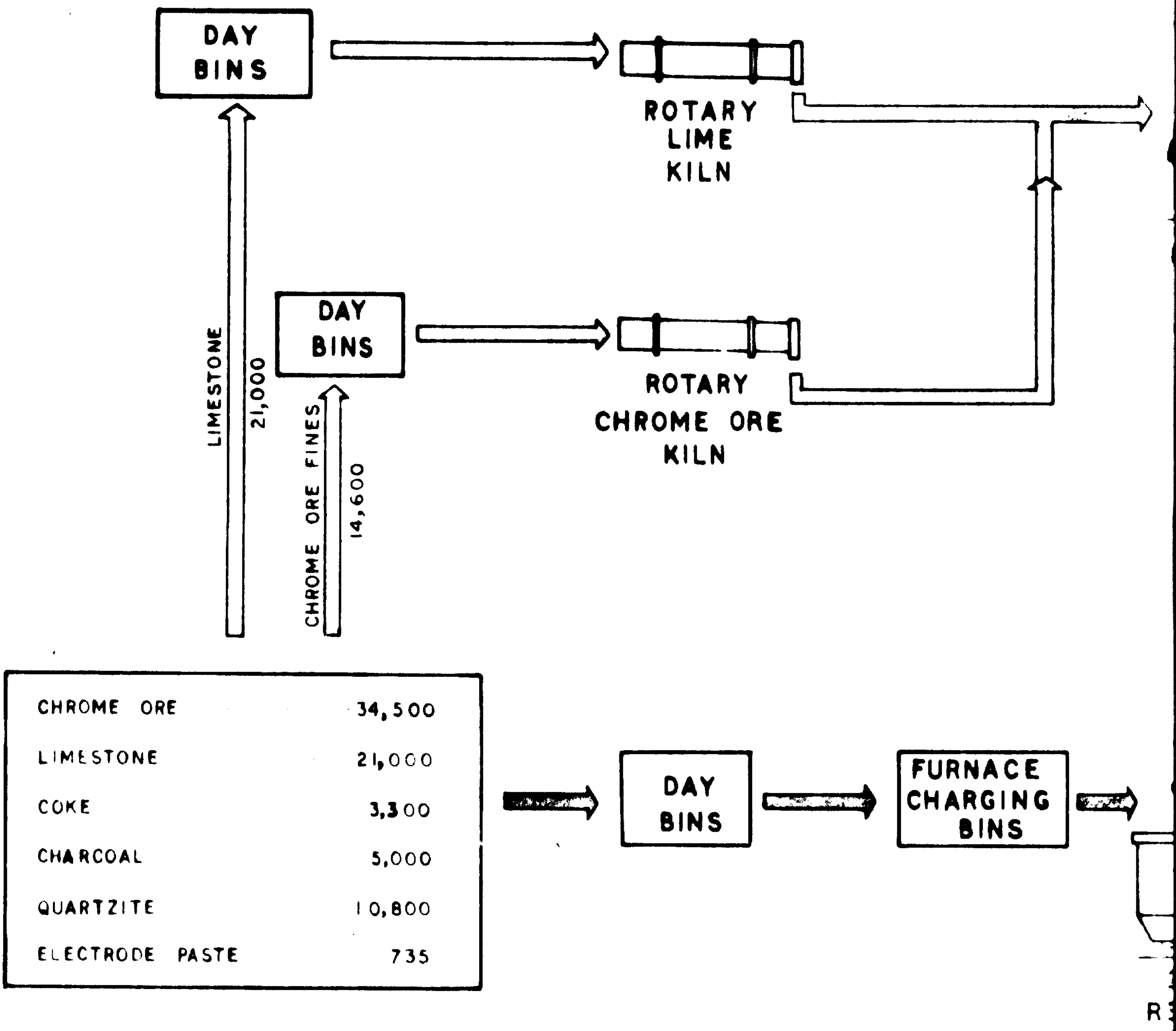
SECTION 3

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

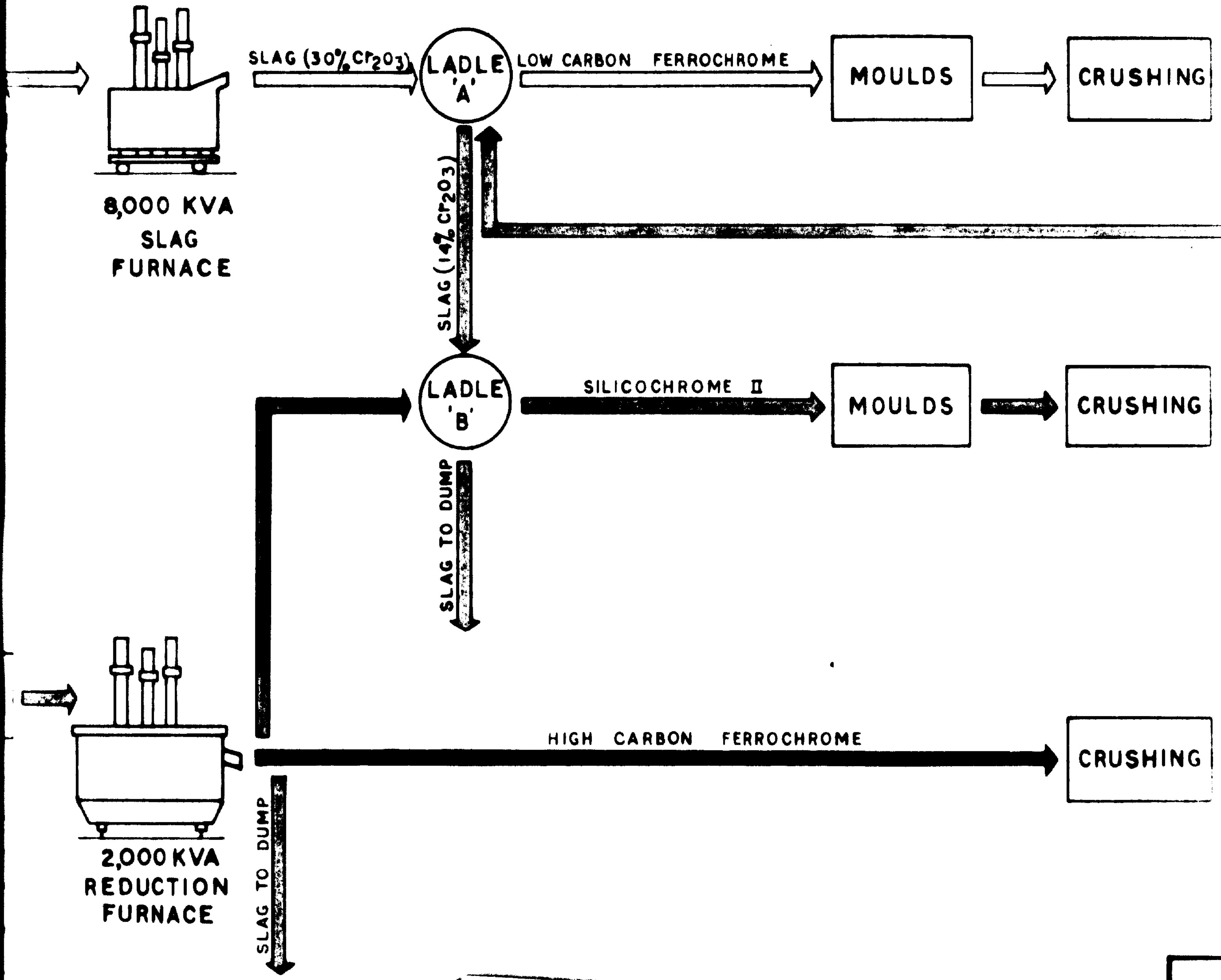
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROCHROME PLANT—LOCATION AT FARYAB

DRAWN	N.K.Ghosh	28 11 69	**No. 5131 - III - 4**
APPROVED			

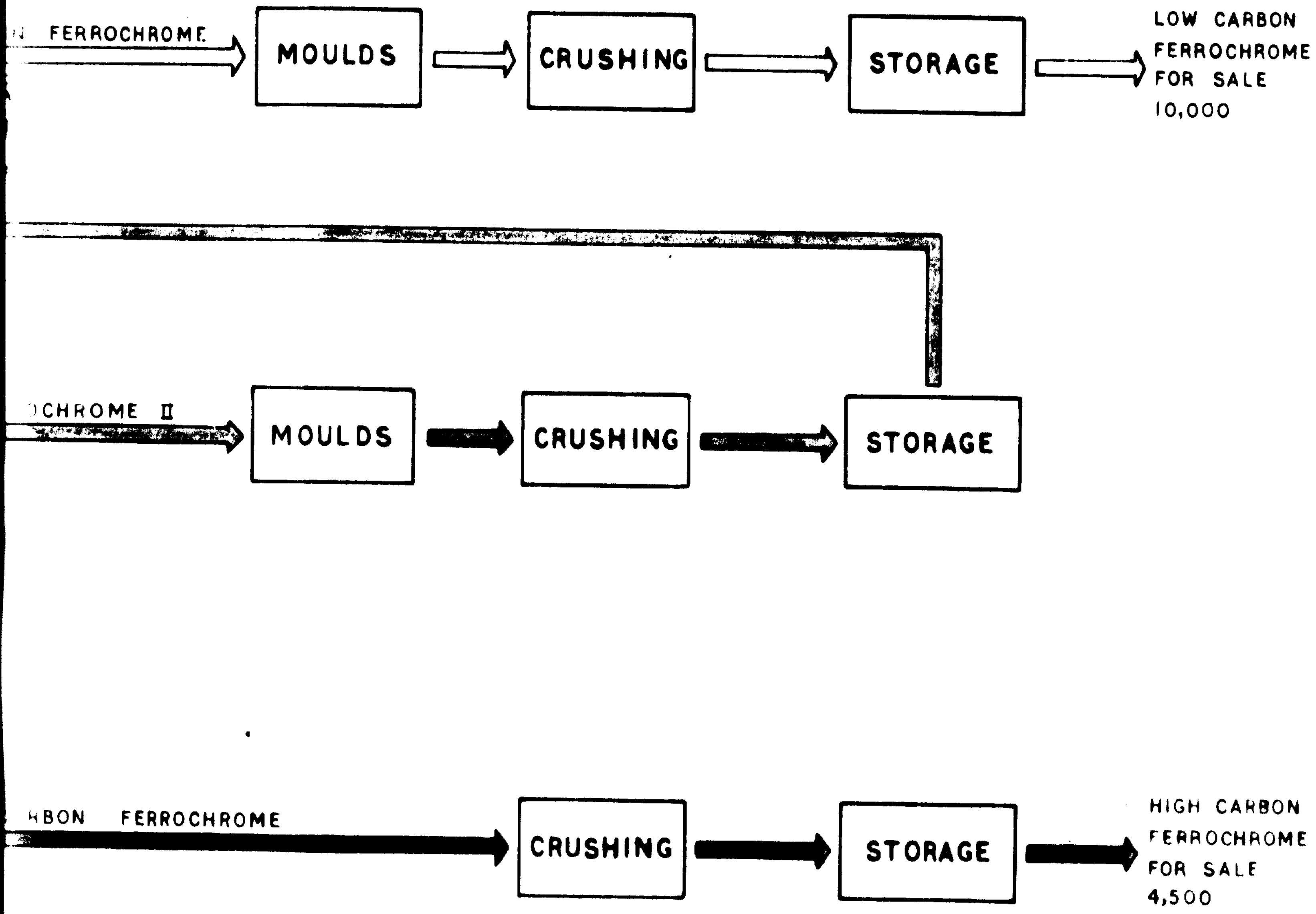

DAY BINS
ROTARY LIME KILN
LIMESTONE
21,000
DAY BINS
ROTARY CHROME ORE KILN
CHROME ORE FINES
14,600
CHROME ORE 34,500
LIMESTONE 21,000
COKE 3,300
CHARCOAL 5,000
QUARTZITE 10,800
ELECTRODE PASTE 735
DAY BINS
FURNACE CHARGING BINS
R

SECTION 1



SECTION 2

NOTE:
QUANTITIES ARE IN TONS/YEAR.



SECTION 3

IN TONS/YEAR.

M. N. DASTUR & Co. PRIVATE LTD CONSULTING ENGINEERS, CALCUTTA			
FOR: UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION			
IRAN FERROALLOYS & ALLOY STEELS PPOJECTS FERROCHROME PLANT — FLOW SHEET			
DRAWN		21.11.69	No. 5131 - III - 5
APPROVED	PHBos.	27.11.69	

Appendix 10-2 (continued)

Power supply (cont'd)

One	(1)	no.	25 MVA 132/11/6 kV three winding power transformer
One	(1)	no.	Three unit 11 kV, 250 MVA switchboard
One	(1)	no.	Three unit 6 kV, 150 MVA switchboard
One	(1)	no.	380 V load centre comprising two 800 kVA, 6/0.4 kV transformers and multi-unit 380 V distribution board
One	(1)	no.	150 kW emergency diesel generating set
One	(1)	no.	50 line private automatic telephone exchange with instruments

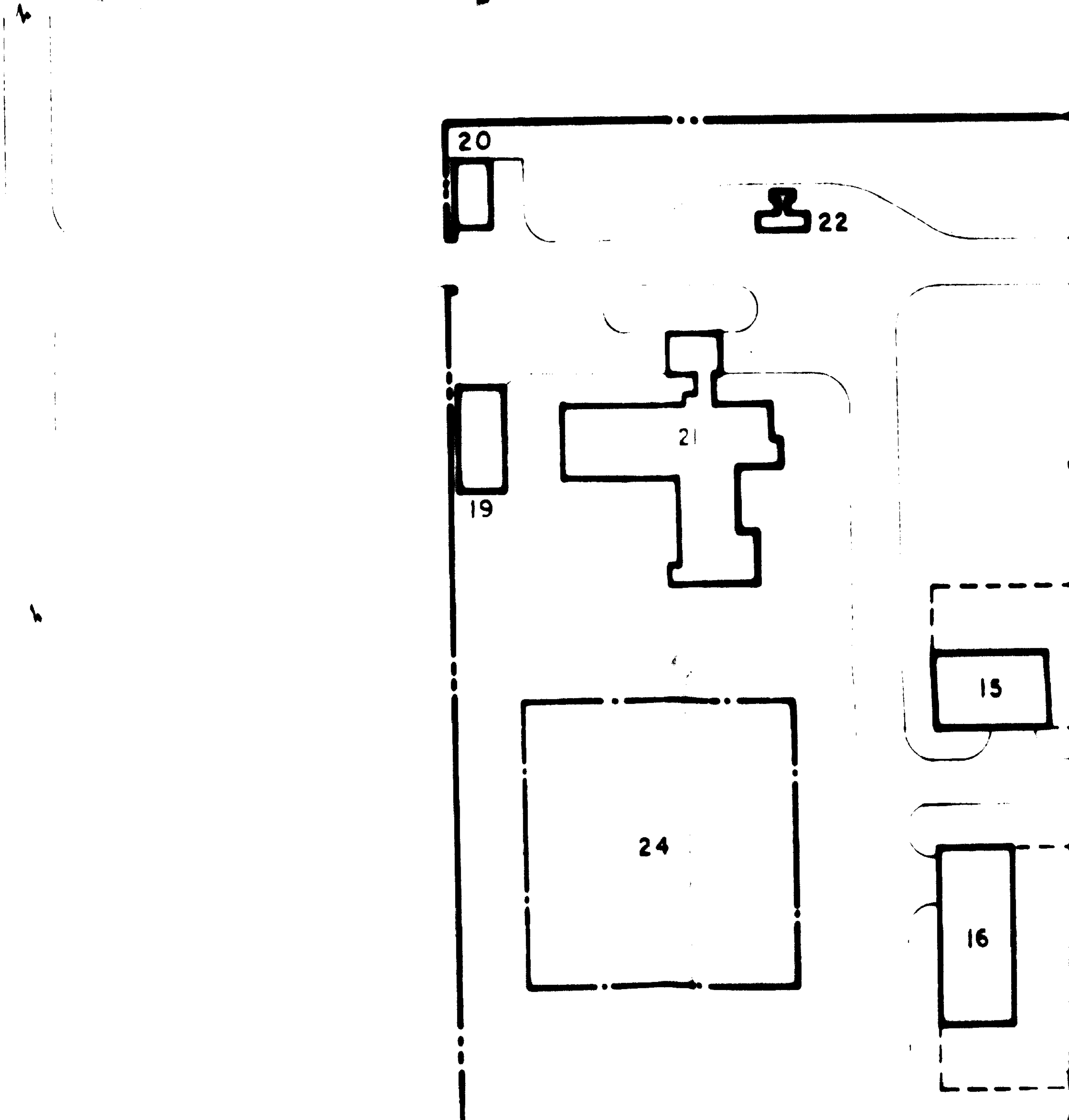
Utilities

Six	(6)	nos.	Air compressors for plant compressed air, 500 m³/hour capacity
One	(1)	no.	Raw water storage tank
One	(1)	no.	Hopper bottom settling tank
One	(1)	no.	Clarified water tank
One	(1)	no.	Pressure filter
One	(1)	no.	Water softener
One	(1)	no.	Chlorinator for drinking water
Two	(2)	nos.	Pumps, 25 m³/hour capacity, 40 m head
One	(1)	no.	Cooling tower, 325 cu m/hour
Two	(2)	nos.	Pumps, 70 m³/hour, 80 m head
Three	(3)	nos.	Pumps 160 m³/hour, 50 m head
Three	(3)	nos.	Overhead tanks, heights 18 m, 30 m and 45 m
One	(1)	no.	Diesel driven emergency water pump, capacity 160 m³/hour, head 80 m
One	(1)	no.	Fuel oil storage tank, 300 cu m capacity
Two	(2)	nos.	Fuel oil unloading pumps, 30 cu m/hour
Two	(2)	nos.	Fuel oil circulating pumps, 20 cu m/hour
One	(1)	no.	Ring main for fuel oil with oil preheater etc

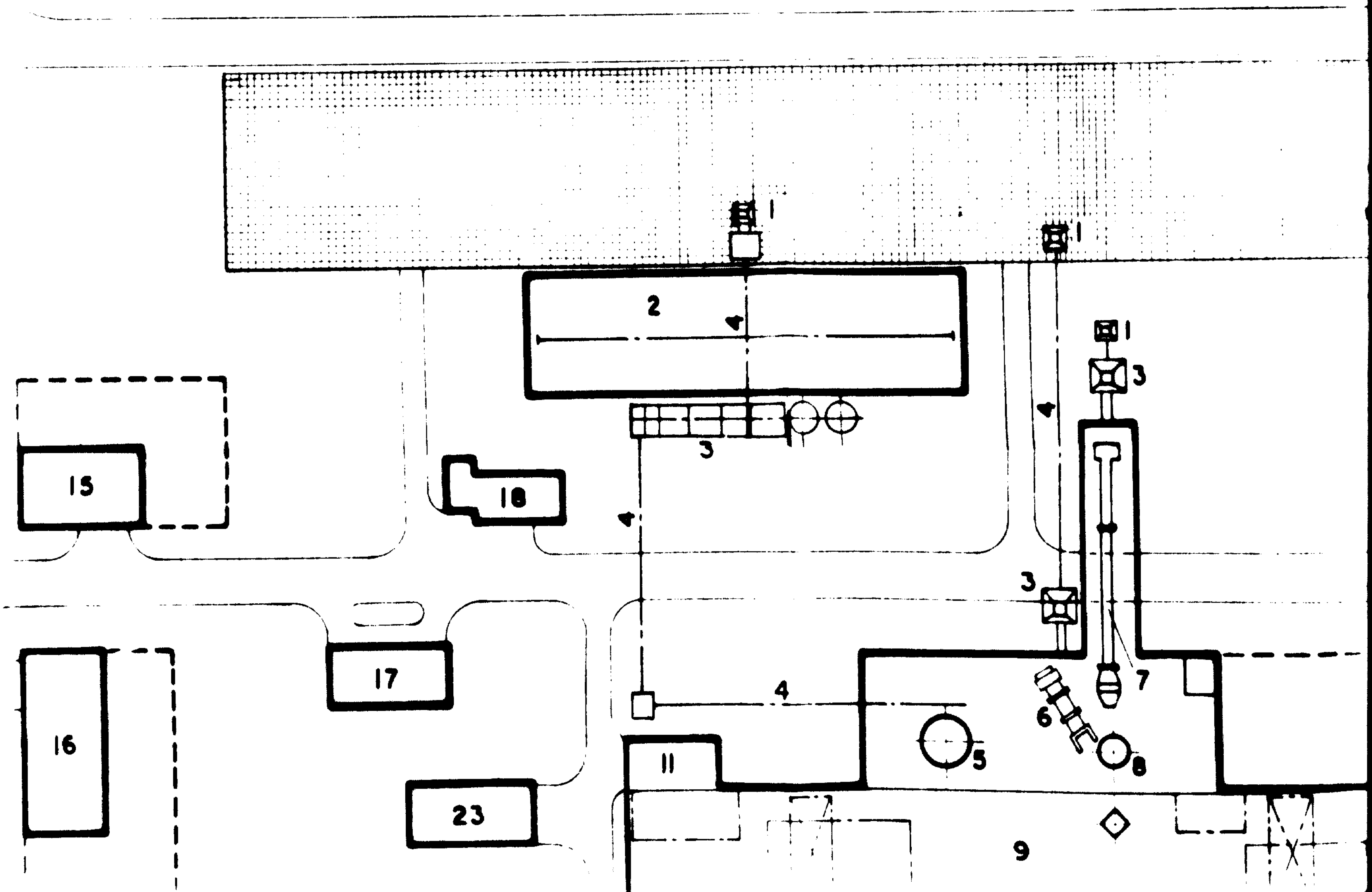
Maintenance shop

One	(1)	no.	Centre lathe, capacity 530 mm swing x 3 000 mm between centres
One	(1)	no.	Double wheel pedestal grinder, capacity 300 mm wheel dia x 30 mm face width
One	(1)	no.	Shaping machine, capacity 600 mm stroke
One	(1)	no.	Radial drilling machine, capacity 900 mm radius x 40 mm hole in steel
One	(1)	no.	Pillar drilling machine, capacity 25 mm drill in steel

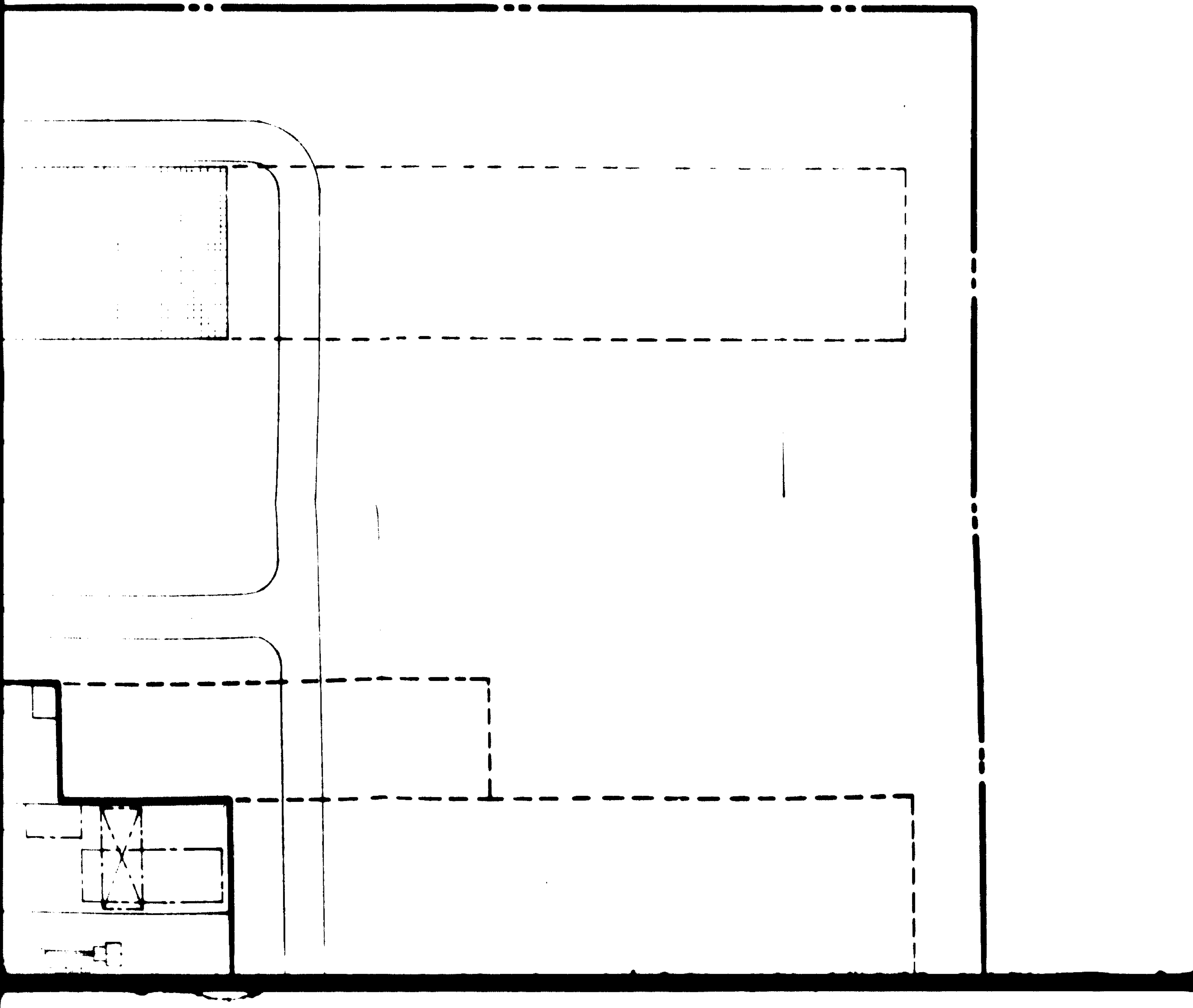
SECTION 1

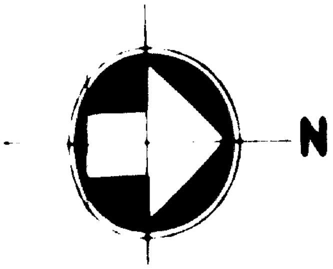


SECTION 2



SECTION 3

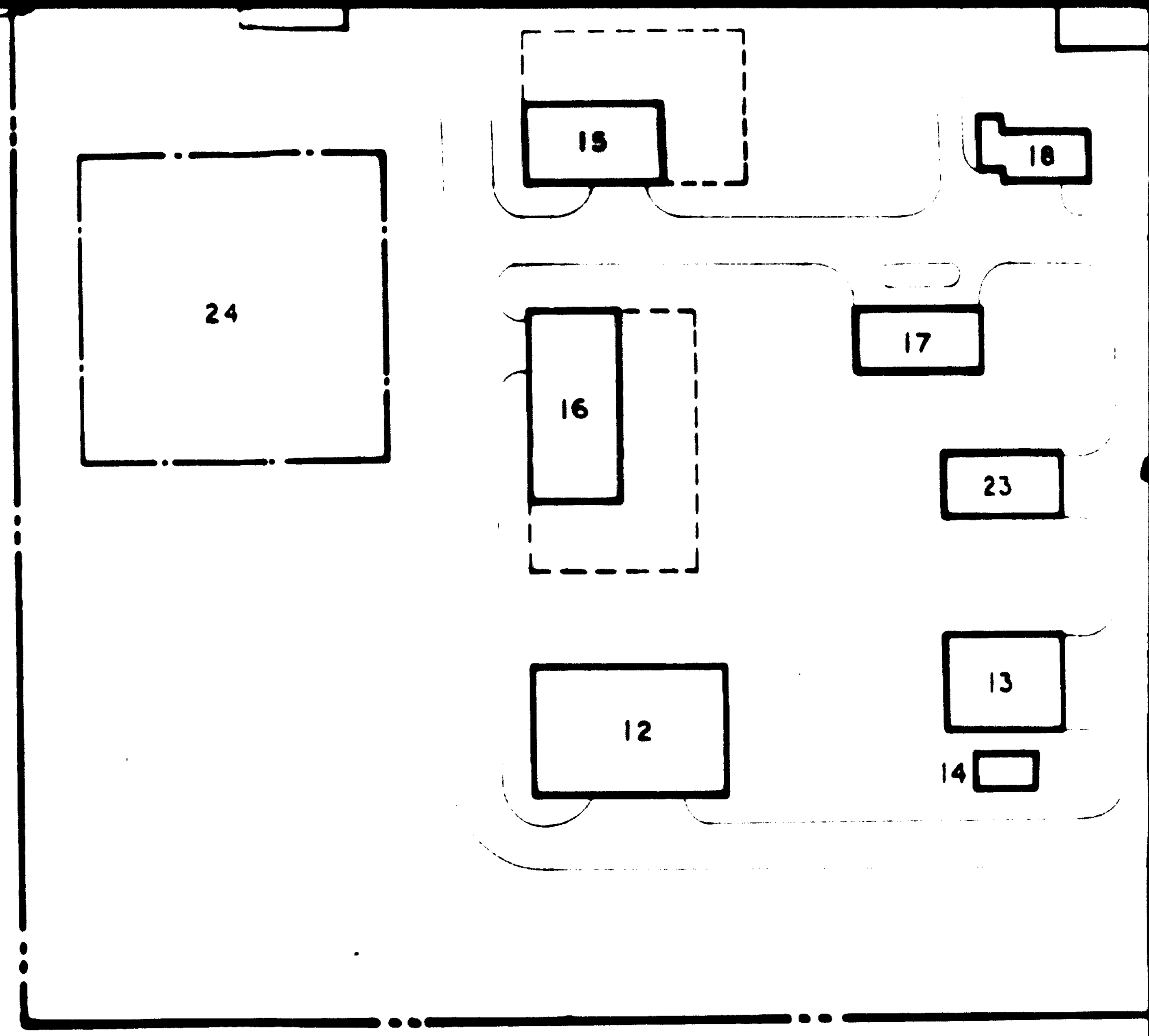




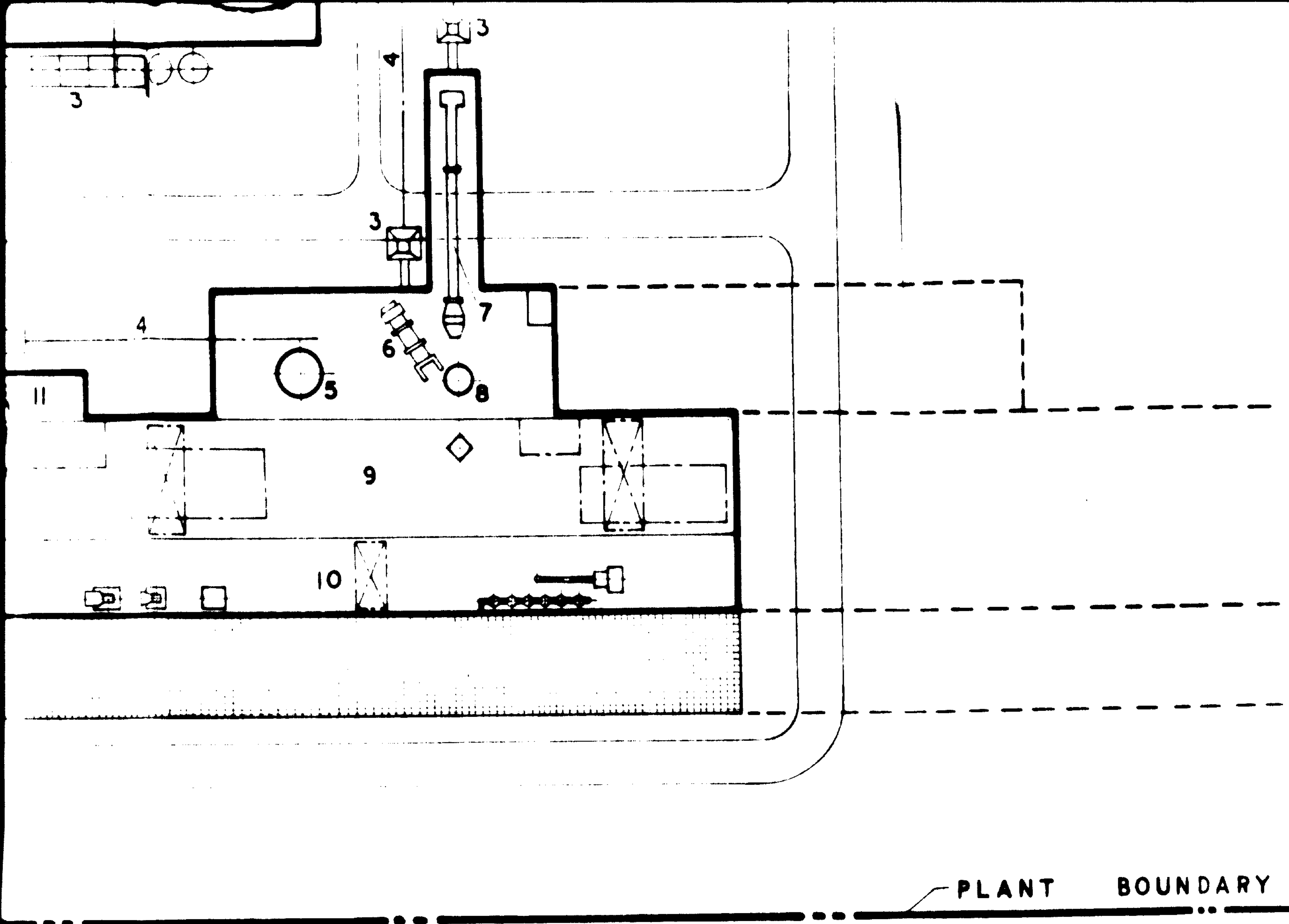
SECTION 4

LEGEND

1 GROUND HOPPERS
2 CLOSED STORAGE FOR RAW MATERIALS
3 DAY BINS
4 CONVEYORS
5 12000 KVA REDUCTION FURNACE
6 CHROME ORE DRYING KILN
7 LIME KILN
8 8000KVA SLAG FURNACE
9 TAPPING BAY
10 FINISHING BAY
11 REFRACTORY STORAGE
12 RAW WATER TREATMENT PLANT
13 PUMP HOUSE
14 WATER COOLING TOWER
15 GENERAL STORES
16 MAINTENANCE & REPAIR SHOP
17 LABORATORY
18 CANTEEN
19 GARAGE
20 GATE HOUSE
21 ADMINISTRATIVE OFFICE

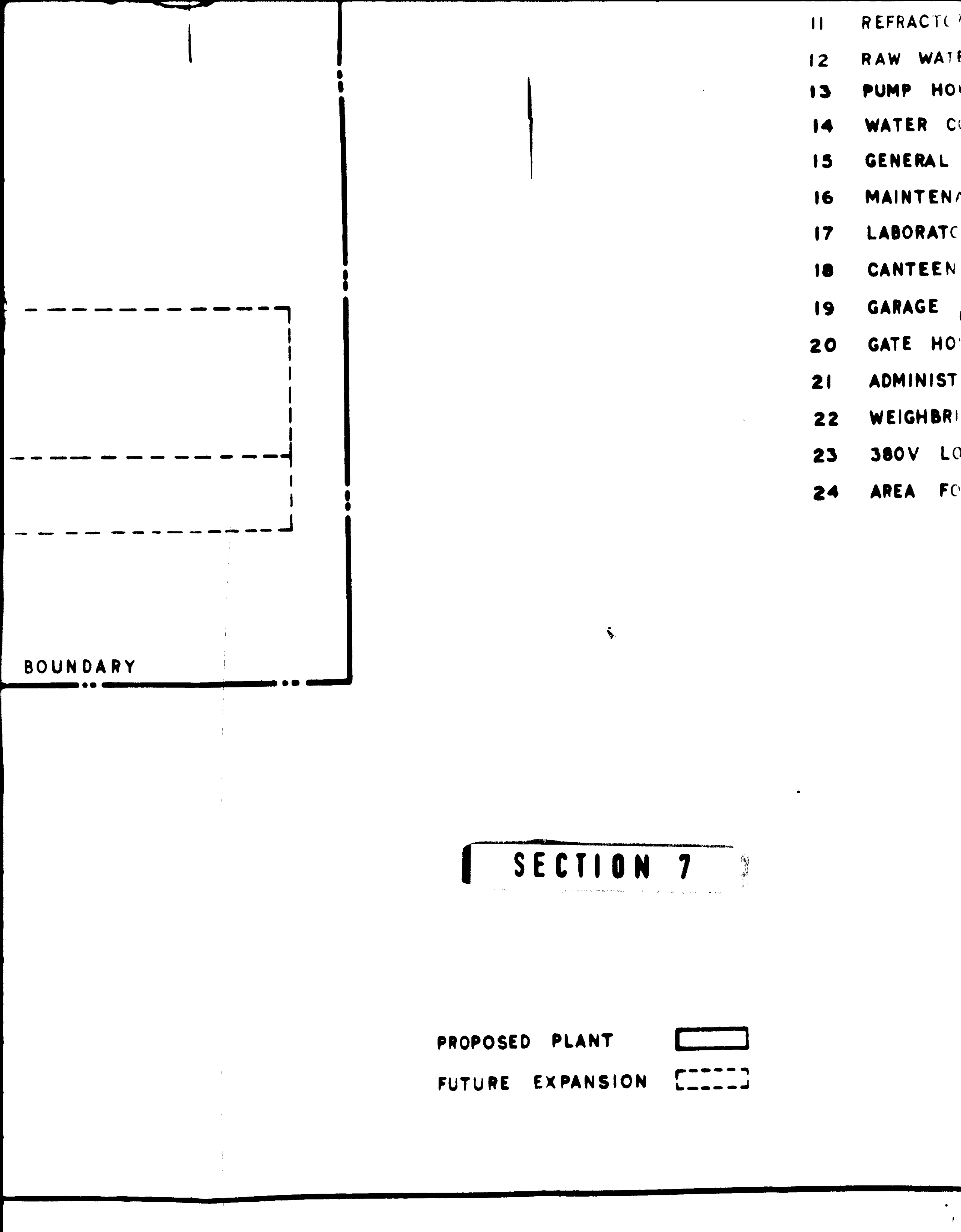


SECTION 5



SECTION 6

SECTION 7


11 REFRACTO
12 RAW WAT
13 PUMP HO
14 WATER C
15 GENERAL
16 MAINTENA
17 LABORATO
18 CANTEEN
19 GARAGE
20 GATE HO
21 ADMINIST
22 WEIGHBRI
23 380V LO
24 AREA FO
BOUNDARY
PROPOSED PLANT
FUTURE EXPANSION

11	REFRACTORY STORAGE
12	RAW WATER TREATMENT PLANT
13	PUMP HOUSE
14	WATER COOLING TOWER
15	GENERAL STORES
16	MAINTENANCE & REPAIR SHOP
17	LABORATORY
18	CANTEEN
19	GARAGE
20	GATE HOUSE
21	ADMINISTRATIVE OFFICE
22	WEIGHBRIDGE
23	380V LOAD CENTRE SUBSTATION
24	AREA FOR 132KV RECEIVING STATION

SCALE : METRES

SECTION 8

▭

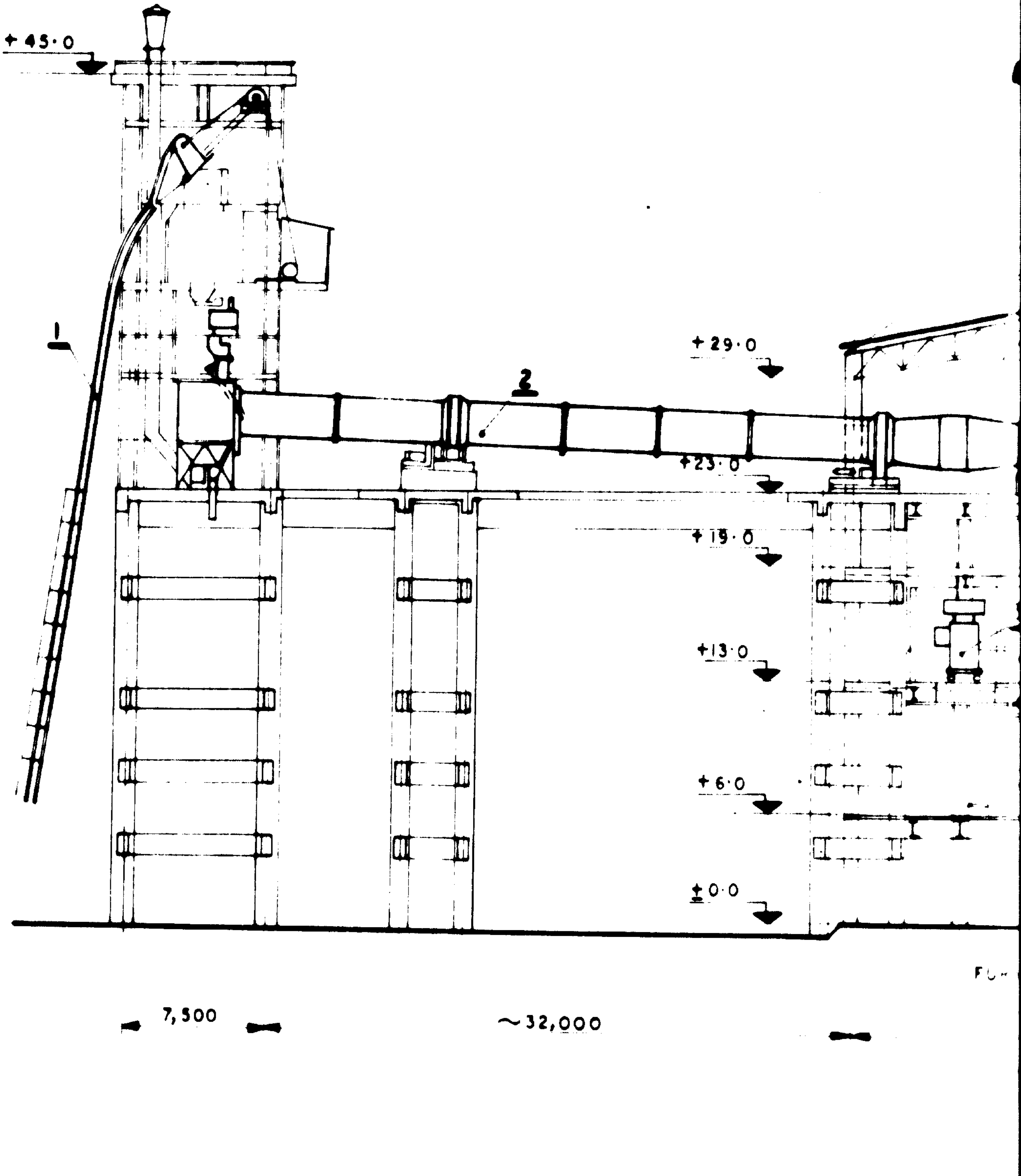
ON ⬚

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

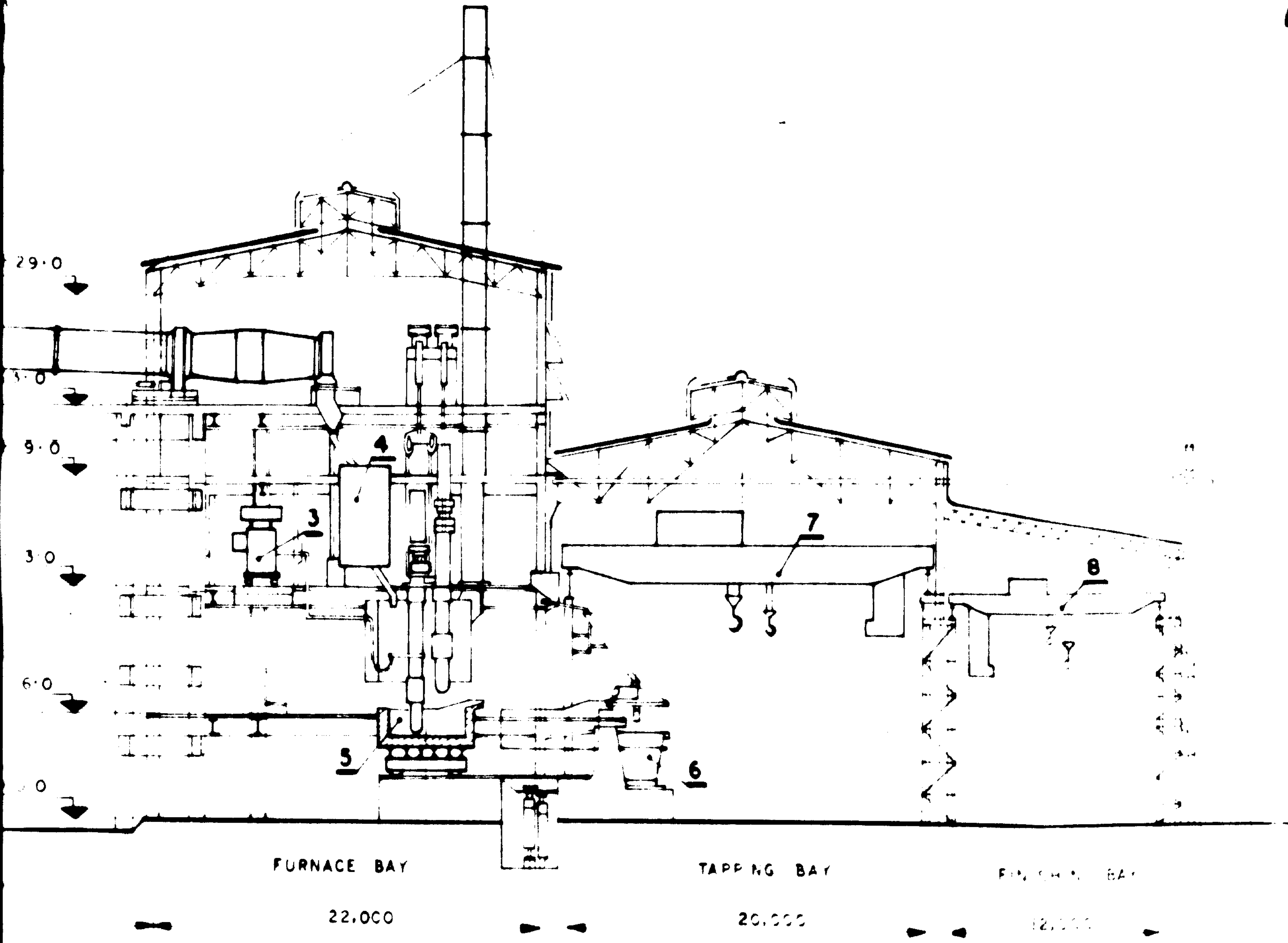
FOR
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROCHROME PLANT—GENERAL LAYOUT

DRAWN	[illegible]	'3 [illegible] 69	No. 5131 - III - 6
APPROVED	[illegible]	[illegible]	



SECTION 1


29·0
3·0
9·0
3·0
6·0
0
3
4
5
6
7
8
FURNACE BAY
TAPPING BAY
FINISHING BAY
22,000
20,000
12,000

SECTION 2

Appendix 10-2 (continued)

Maintenance shop (cont'd)

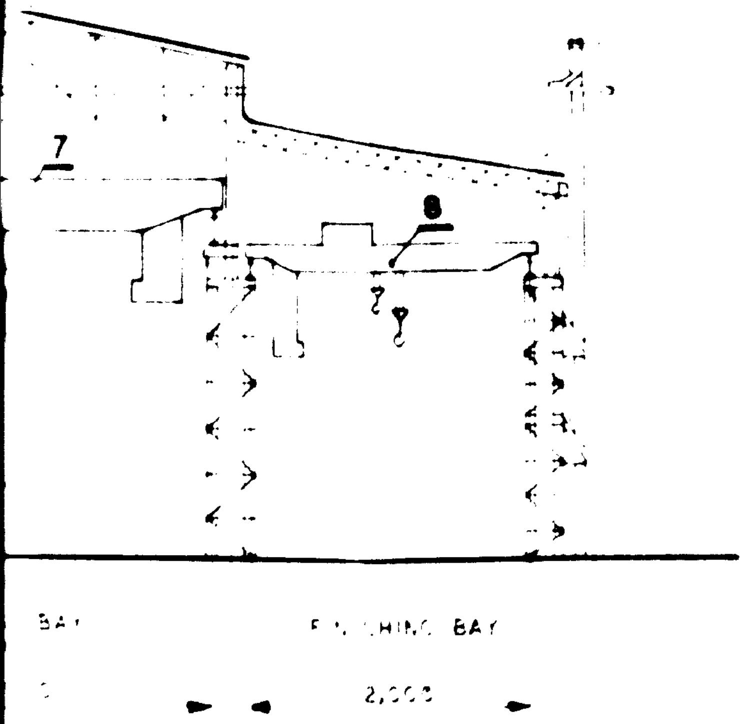
Two	(2) nos.	Fitter's benches 2 500 x 900 mm each
One	(1) no.	Power hacksaw, capacity 300 mm square or round at 90°C
One	(1) no.	Double ended bench grinder, capacity 200 mm wheel dia
Two	(2) nos.	Portable electric drilling machines, capacity 12.5 mm drill
Two	(2) nos.	Flexible shaft grinders, capacity 150 mm wheel dia
Two	(2) nos.	Electric welding machines with accessories, capacity 300 amps
One	(1) no.	Oxy-acetylene gas welding and cutting set complete with cylinder carriers and accessories
One	(1) no.	Pipe bonding machine, capacity 12 to 75 mm bore steel pipe
One	(1) no.	5-ton floor operated electric crane
Three	(3) sets	Pneumatic hammers, rammers and tamping tools and tackles
One	(1) no.	Shearing machine, capacity 1 830 x 6 mm
One	(1) no.	Marking table with jig, capacity 2 000 x 1 800 mm
One	(1) no.	Table for punching
One	(1) no.	Punching press, capacity 25 tons
One	(1) no.	Bending and folding machine
One	(1) no.	Portable electric shear
One	(1) no.	Spot welding machine
One	(1) no.	Welding stand

Laboratory

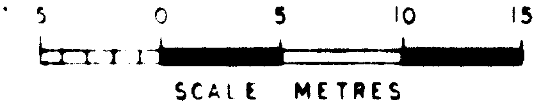
One	(1) no.	Carbon and sulphur determinator
One	(1) no.	Muffle furnace, 1 000°C
One	(1) no.	Drying oven, 150°C
Two	(2) nos.	Hot plates
One	(1) no.	Analytical balance, 200 gm capacity
One	(1) no.	Water still, 10 lit/hour capacity
One	(1) set	Equipment for fuel oil testing such as flash point tester, viscosimeter, bomb calorimeter etc
One	(1) no.	Orsat gas analyser for combustion gases
One	(1) set	Laboratory ware such as burette stands, pipette stands, heating mantles etc
One	(1) set	Laboratory glassware and chemicals
One	(1) set	Furniture
One	(1) no.	Laboratory jaw crusher
One	(1) no.	Bench drilling machine
One	(1) no.	Ore sampling equipment
One	(1) no.	Rockwell hardness tester

LEGEND

1. SKIP HOIST
2. LIME KILN
3. TRANSFORMER
4. HOT MATERIAL BIN
5. SLAG FURNACE
6. LADLE
7. TWO-80/25-TON E.O.T CRANES
8. ONE-10/5-TON E.O.T CRANE



SECTION 3



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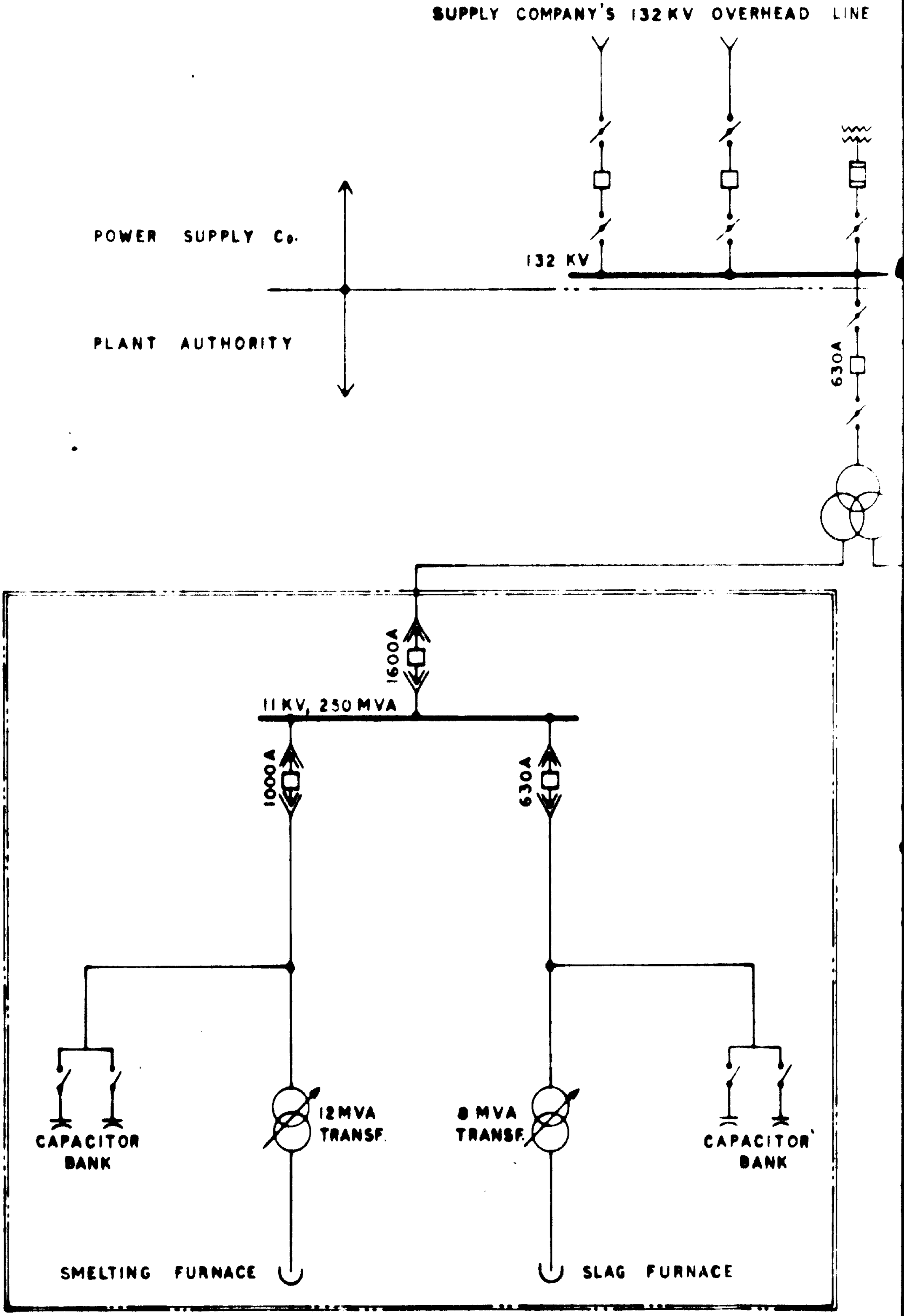
FOR
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

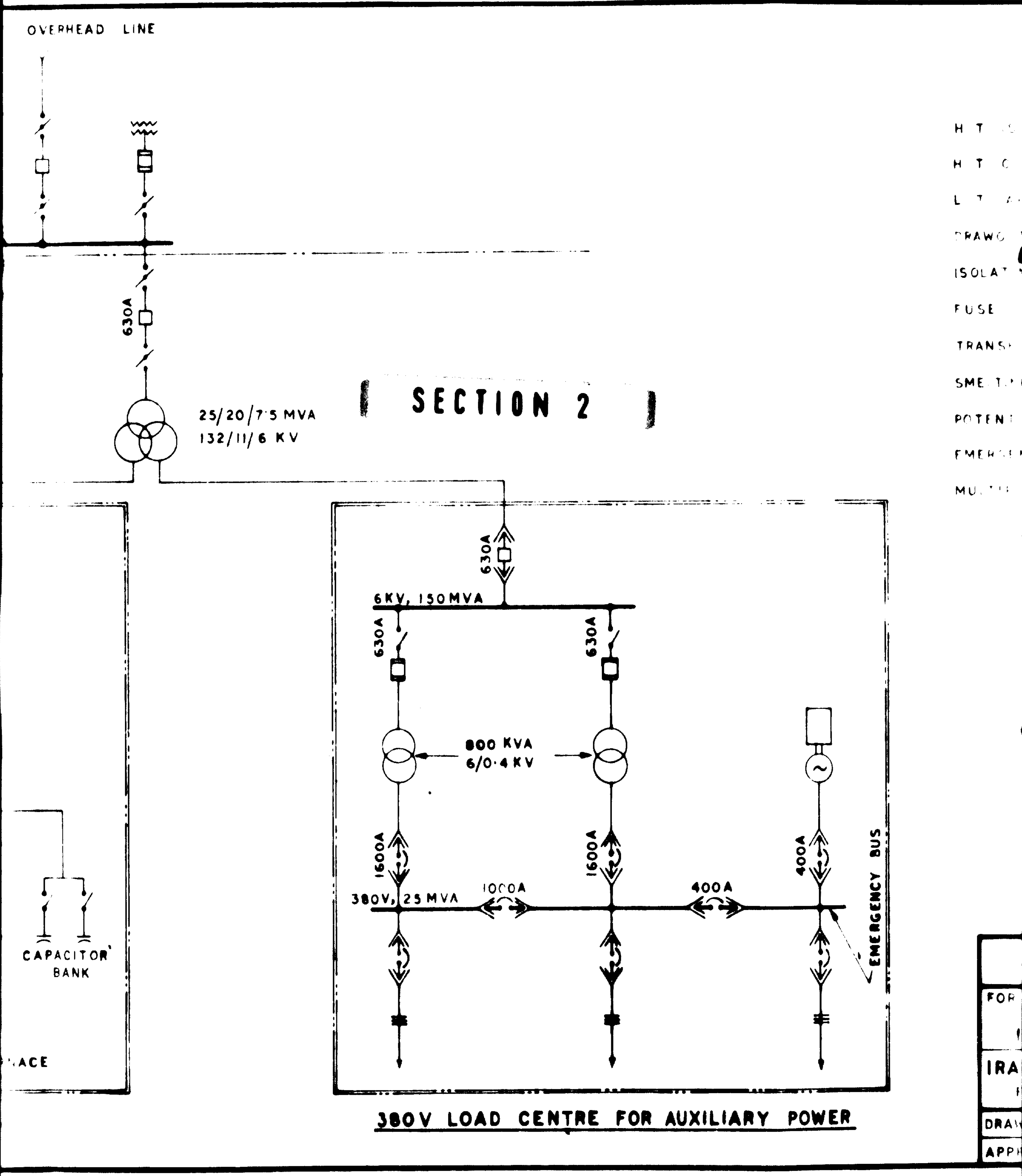
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROCHROME PLANT—FURNACE BUILDING—SECTION
THROUGH SLAG FURNACE

DRAWN	[illegible]	[illegible]	**No. 5131-III-7**
APPROVED	PKBose	28 · 61	



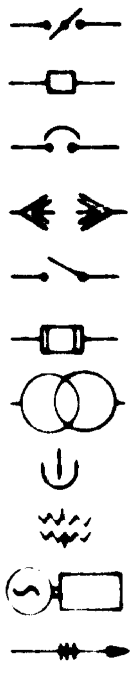
SECTION 1

FERROCHROME FURNACES

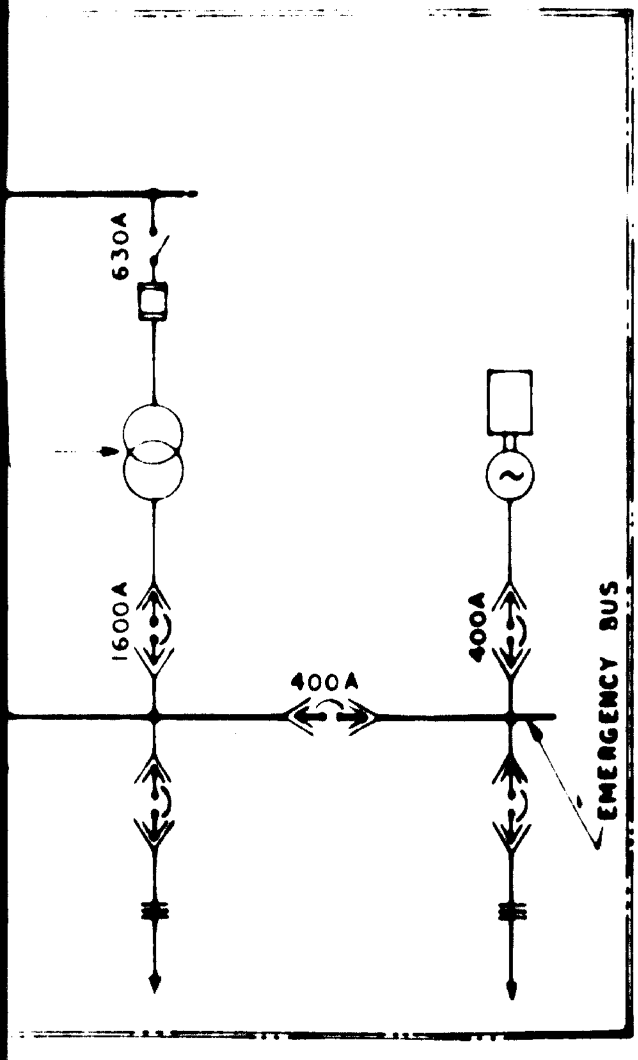

OVERHEAD LINE
630A
25/20/7·5 MVA
132/11/6 KV
SECTION 2
630A
6KV, 150MVA
630A
630A
800 KVA
6/0·4 KV
1600A
1600A
400A
380V, 25 MVA
1000A
400A
EMERGENCY BUS
CAPACITOR BANK
ACE
380V LOAD CENTRE FOR AUXILIARY POWER
H T
H T C
L T
DRAWG
ISOLAT
FUSE
TRANS
SME
POTENT
EMER
MU
FOR
IRA
DRAW
APP

LEGEND

- H.T ISOLATOR
- H.T CIRCUIT BREAKER
- L.T AIR CIRCUIT BREAKER
- DRAWOUT DEVICE
- ISOLATING SWITCH
- FUSE
- TRANSFORMER
- SMELTING FURNACE
- POTENTIAL TRANSFORMER
- EMERGENCY DIESEL GENERATOR
- MULTIPLE FEEDERS



SECTION 3



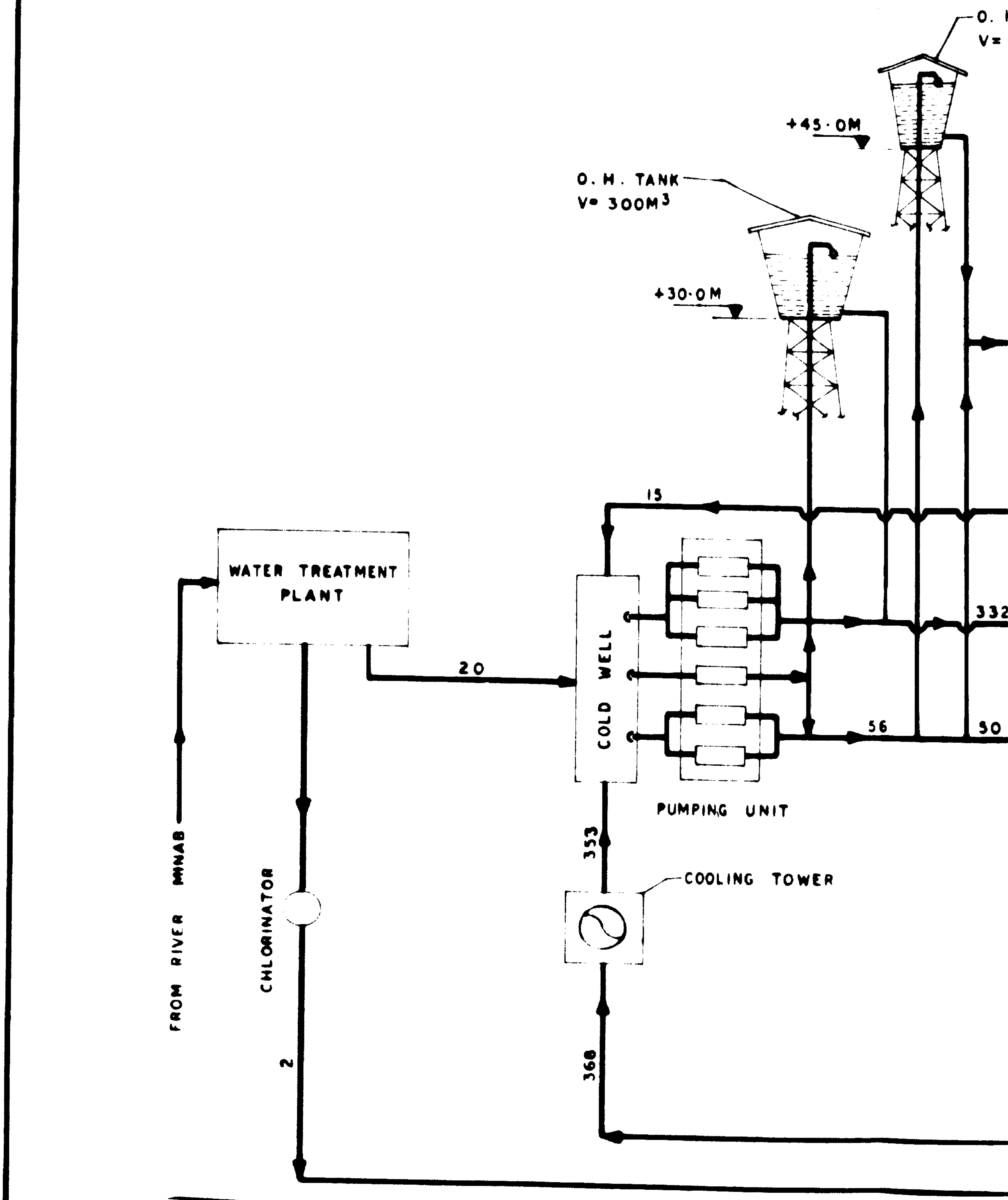
ENTRE FOR AUXILIARY POWER

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

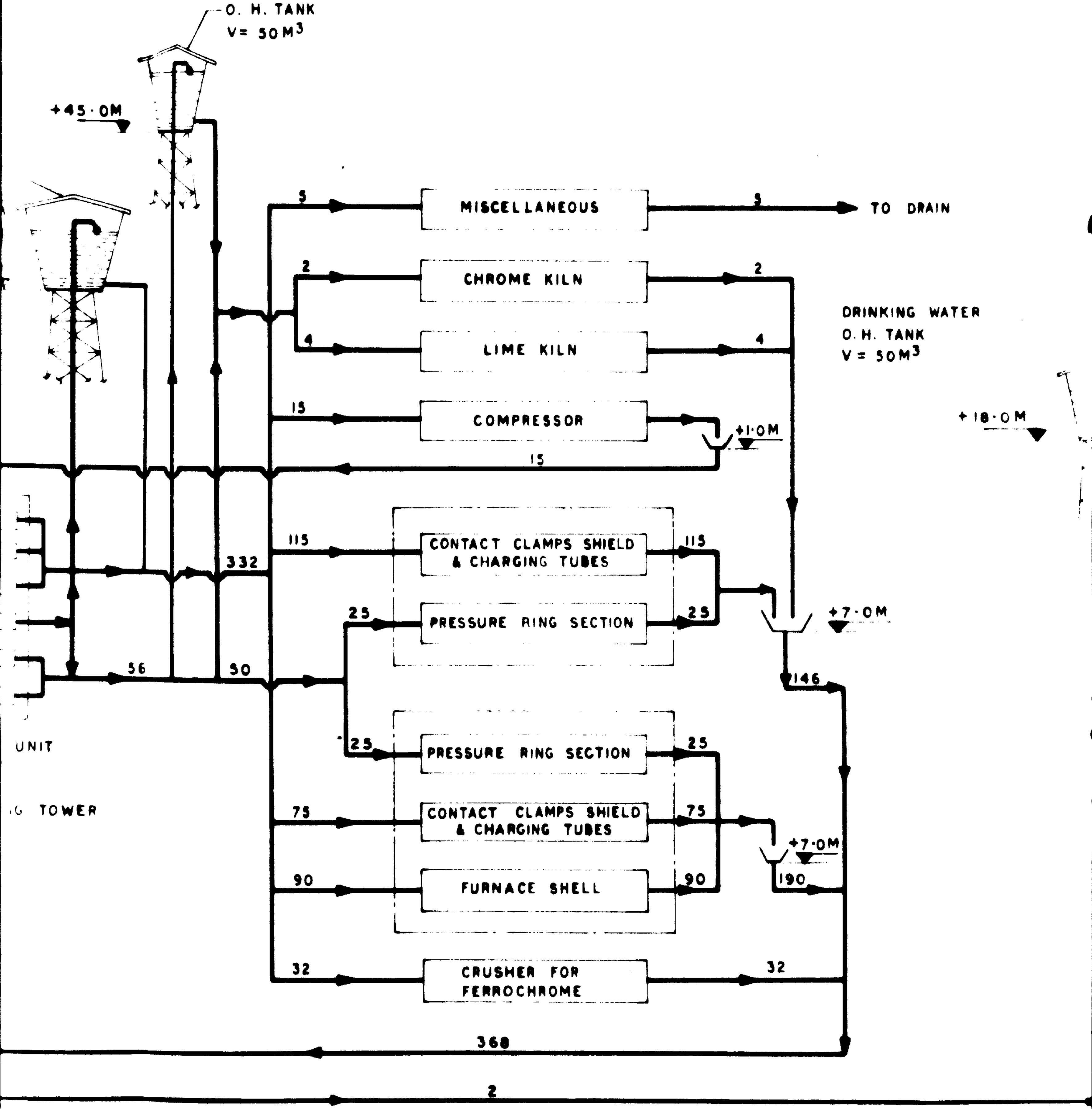
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROCHROME PLANT — POWER DISTRIBUTION SYSTEM

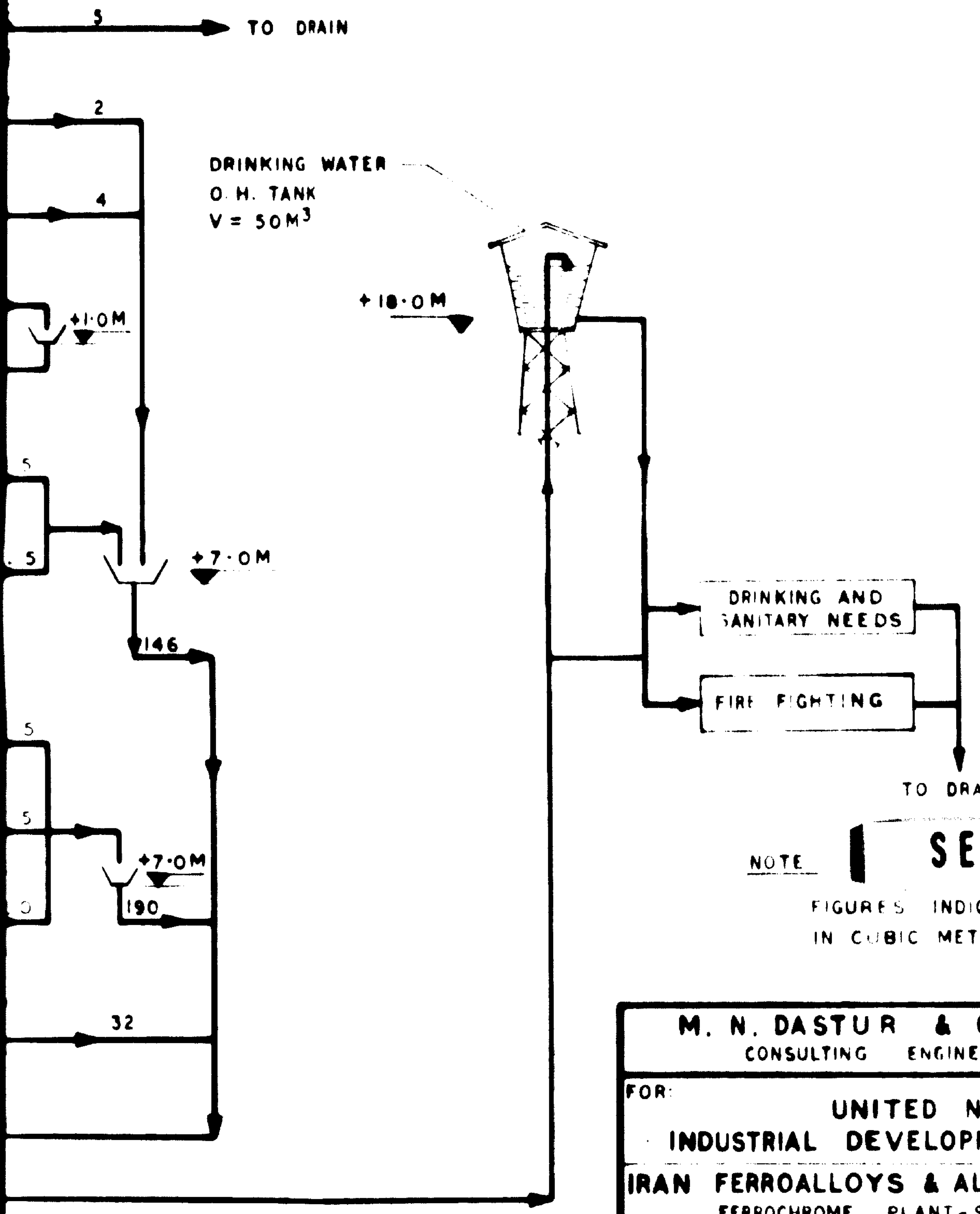
DRAWN	KCasu	10 11 69	No. 5131 - III - 8
APPROVED	E Banji	14 11 69	


O. H. TANK
V= 300M³
+45·0M
+30·0M
15
WATER TREATMENT PLANT
20
COLD WELL
PUMPING UNIT
332
56
50
353
COOLING TOWER
368
FROM RIVER MINAB
CHLORINATOR
2

SECTION 1


O. H. TANK
V= 50M³
+45·0M
5
MISCELLANEOUS
5
TO DRAIN
2
CHROME KILN
2
4
LIME KILN
4
DRINKING WATER
O. H. TANK
V = 50M³
15
COMPRESSOR
+1·0M
+18·0M
15
115
CONTACT CLAMPS SHIELD & CHARGING TUBES
115
332
25
PRESSURE RING SECTION
25
+7·0M
56
50
146
UNIT
25
PRESSURE RING SECTION
25
TOWER
75
CONTACT CLAMPS SHIELD & CHARGING TUBES
75
+7·0M
90
FURNACE SHELL
90
190
32
CRUSHER FOR FERROCHROME
32
368
2

SECTION 2



SECTION 3

NOTE

FIGURES INDICATE FLOW
IN CUBIC METRES PER HOUR

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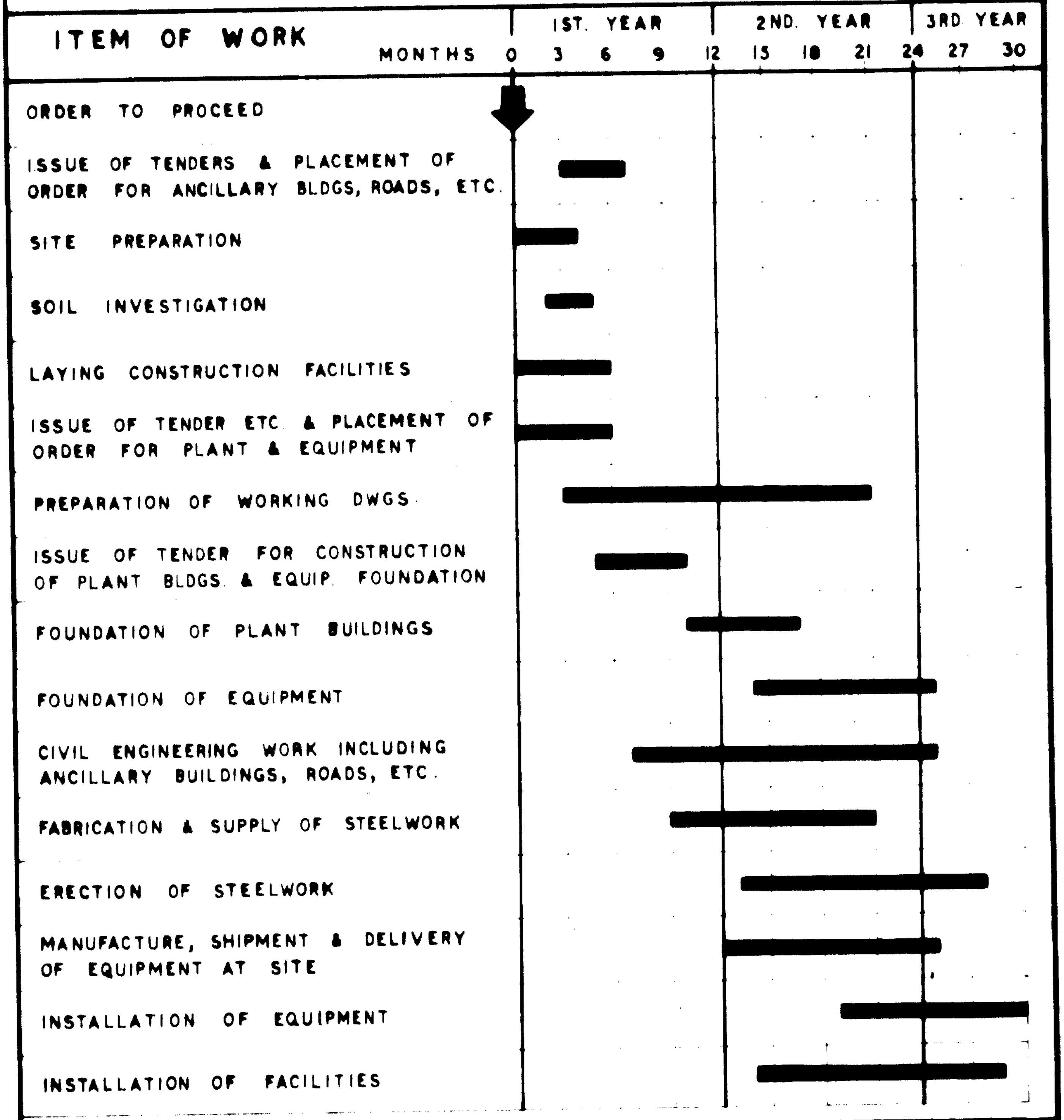
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROCHROME PLANT-SCHEMATIC DIAGRAM
OF WATER SYSTEM

DRAWN 25 .. 69
APPROVED 28 II 69

No. 5131-III-9

CONSTRUCTION SCHEDULE



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FERROCHROME PLANT-CONSTRUCTION SCHEDULE

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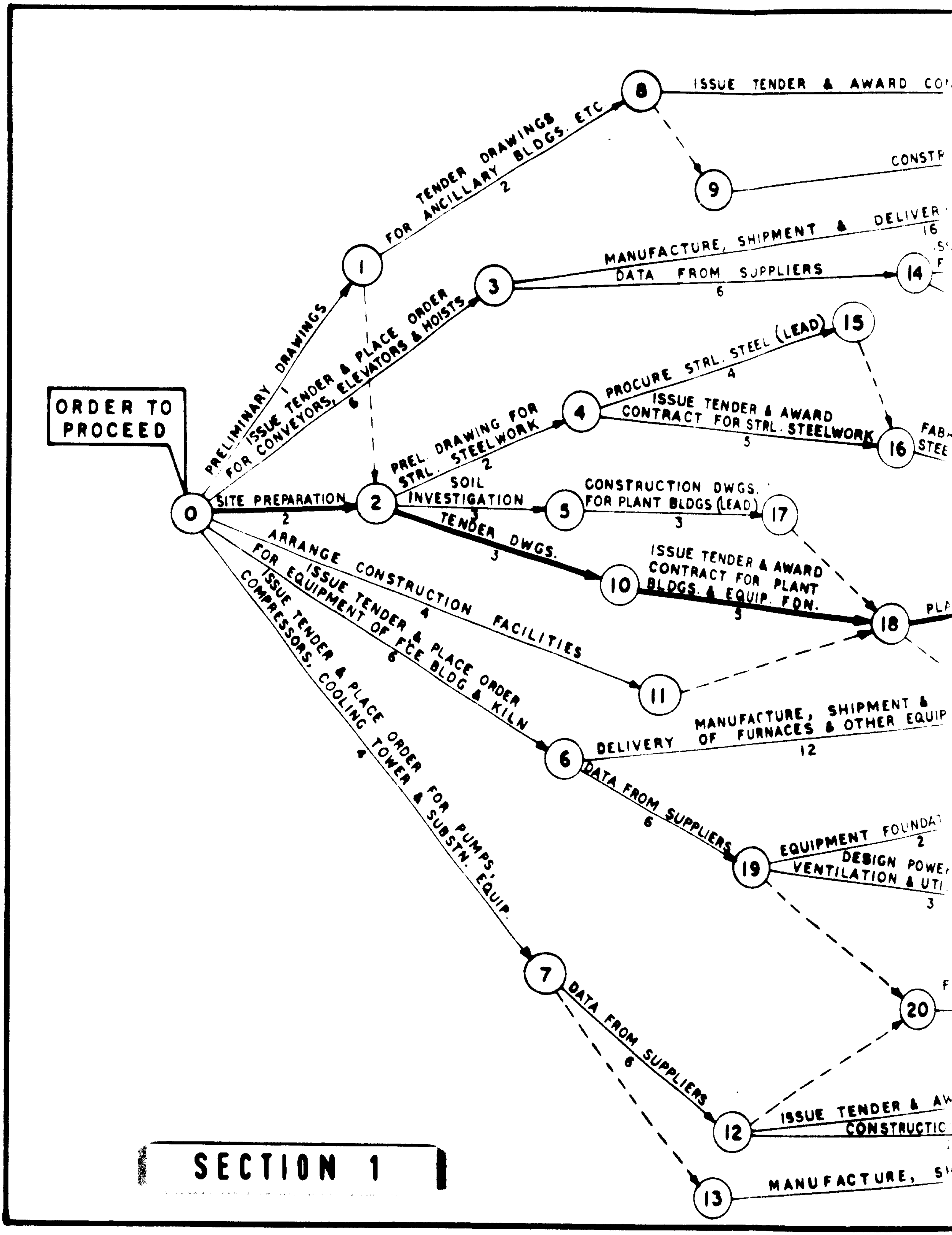
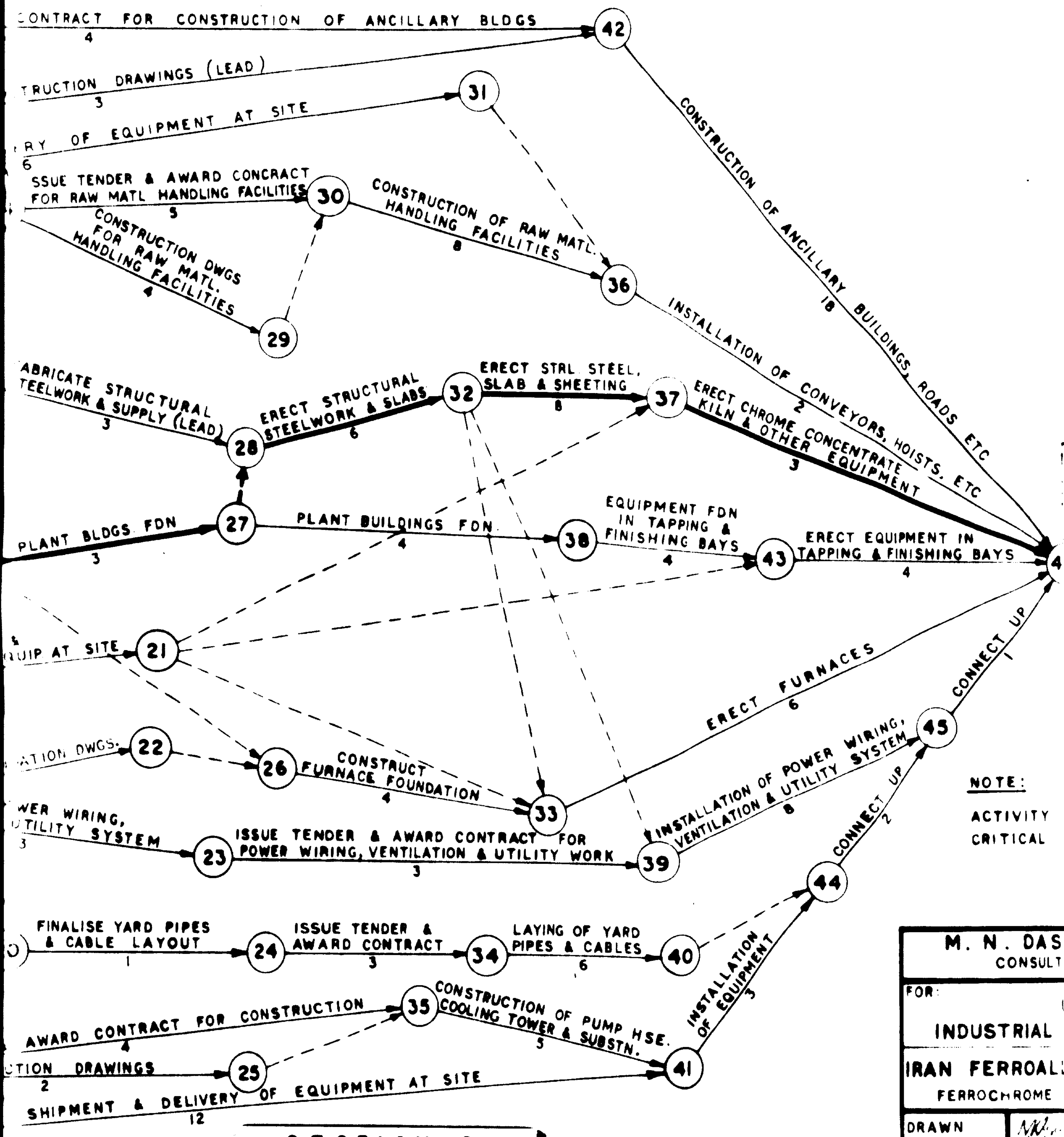
APPROVED		9.12.69	


ORDER TO PROCEED
0
PRELIMINARY DRAWINGS
1
1
TENDER DRAWINGS FOR ANCILLARY BLDGS. ETC.
2
8
ISSUE TENDER & AWARD CO
9
CONSTR
ISSUE TENDER & PLACE ORDER FOR CONVEYORS, ELEVATORS & HOISTS
6
3
MANUFACTURE, SHIPMENT & DELIVER
16
DATA FROM SUPPLIERS
6
14
SITE PREPARATION
2
2
PREL. DRAWING FOR STRL. STEELWORK
2
4
PROCURE STRL. STEEL (LEAD)
4
15
ISSUE TENDER & AWARD CONTRACT FOR STRL. STEELWORK
5
16
FAB
STEE
SOIL INVESTIGATION
3
5
CONSTRUCTION DWGS. FOR PLANT BLDGS (LEAD)
3
17
TENDER DWGS.
3
10
ISSUE TENDER & AWARD CONTRACT FOR PLANT BLDGS. & EQUIP. FDN.
5
18
PLA
ARRANGE CONSTRUCTION FACILITIES
4
11
ISSUE TENDER & PLACE ORDER FOR EQUIPMENT OF FCE BLDG & KILN
6
6
DELIVERY
MANUFACTURE, SHIPMENT & OF FURNACES & OTHER EQUIP
12
DATA FROM SUPPLIERS
6
19
EQUIPMENT FOUNDA
2
DESIGN POWE
VENTILATION & UTI
3
ISSUE TENDER & PLACE ORDER FOR PUMPS, COMPRESSORS, COOLING TOWER & SUBSTN. EQUIP.
4
7
DATA FROM SUPPLIERS
6
20
F
12
ISSUE TENDER & AW
CONSTRUCTIO
13
MANUFACTURE, S
SECTION 1



NOTE:

ACTIVITY

CRITICAL

SECTION 2

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IRAN FERROAL
FERROCHROME

DRAWN	
APPROVED	

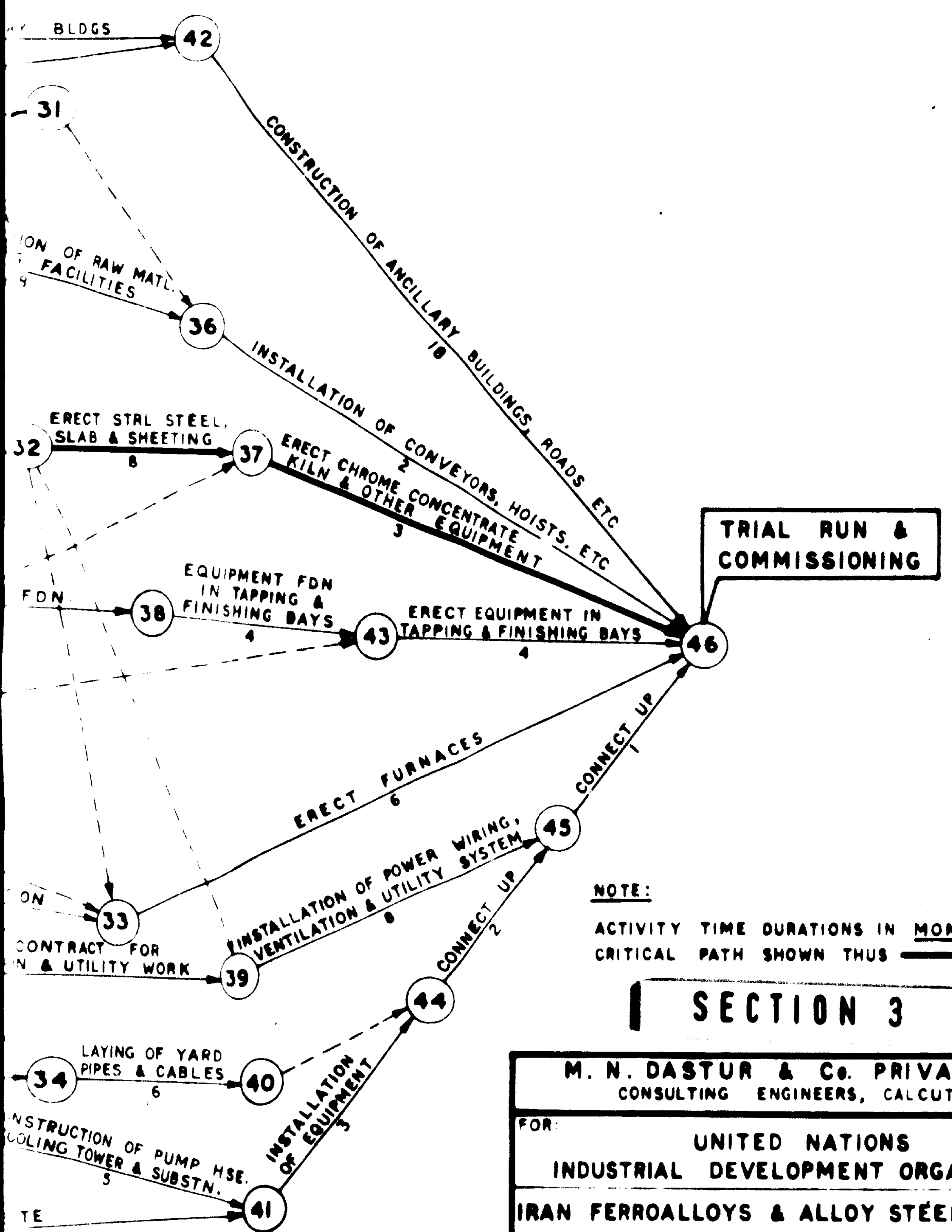
Appendix 12-1

PRELIMINARY CAPITAL COST ESTIMATE

Basis: Equipment - One 12 000 kVA reduction furnace
One 8 000 kVA slag furnace

Production - 10 000 tons of low carbon ferro-chrome
4 500 tons of high carbon ferro-chrome

		Thousand $		
		Foreign currency	Local currency	Total amount
A. Land				
11.5 ha @ $ 1 300 per ha	..	-	15	15
B. Civil and structural steelwork				
1. Civil work Earthwork, masonry and concrete work for buildings, equipment foundations, roads, drainage, sewerage and off site facilities	..	110 a/	1 255 b/	1 365
2. Structural steelwork Structural steelwork for buildings, conveyor supports, galleries and utility systems	..	343 c/	723	1 086
Sub-total (B)	..	453	1 978	2 431
C. Mechanical and electrical equipment				
1. Raw material handling Equipment for raw material unloading, stocking, reclaiming and handling	..	290	-	290
2. Reduction furnace 12 000 kVA reduction furnace including tap changing transformer, refractories, charging equipment and ventilation equipment	..	950	-	950
3. Slag furnace 8 000 kVA slag furnace including tap changing transformer, refractories, rotary kilns with drives, weighing scales and ventilation equipment	..	2 310	-	2 310
4. Tapping bay Tapping bay equipment including ladles, moulds, crushing and handling equipment and overhead cranes	..	425	-	425
5. Utilities and services Equipment for utilities such as water, power, fuel oil, compressed air and auxiliary equipment for laboratory and maintenance shop	..	442	150	592
Sub-total (C)	..	4 417 d/	150	4 567



NOTE:

ACTIVITY TIME DURATIONS IN MONTHS.

CRITICAL PATH SHOWN THUS ━━━━ ━ ━

SECTION 3

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FERROCHROME PLANT-NETWORK FOR CONSTRUCTION

DRAWN		1.12.69	No. 5131 - III - 11
APPROVED		5.12.69	

SL. No.	ACTIVITY CODE	DURATION (MONTHS)	EARLIEST		LATEST		FLOAT		REMARKS
			START	FINISH	START	FINISH	TOTAL	FREE	
1	0 - 1	1	0	1	1	2	1	0	
2	1 - 8	2	1	3	6	8	5	0	
3	8 - 9	0	3	3	9	9	6	0	
4	8 - 42	4	3	7	8	12	5	0	
5	9 - 42	3	3	6	9	12	6	1	
6	42 - 46	18	7	25	12	30	5	5	
7	1 - 2	0	1	1	2	2	1	1	
8	0 - 2	2	0	2	0	2	0	0	CRITICAL
9	2 - 10	3	2	5	2	5	0	0	CRITICAL
10	10 - 18	5	5	10	5	10	0	0	CRITICAL
11	18 - 27	3	10	13	10	13	0	0	CRITICAL
12	27 - 28	0	13	13	13	13	0	0	CRITICAL
13	28 - 32	6	13	19	13	19	0	0	CRITICAL
14	32 - 37	8	19	27	19	27	0	0	CRITICAL
15	37 - 46	3	27	30	27	30	0	0	CRITICAL
16	0 - 3	6	0	6	3	9	3	0	
17	3 - 31	16	6	22	12	28	6	0	
18	31 - 36	0	22	22	28	28	6	3	
19	3 - 14	6	6	12	9	15	3	0	
20	14 - 30	5	12	17	15	20	3	0	
21	14 - 29	4	12	16	16	20	4	0	
22	29 - 30	0	16	16	20	20	4	1	
23	30 - 36	8	17	25	20	28	3	0	
24	36 - 46	2	25	27	28	30	3	3	
25	2 - 4	2	2	4	3	5	1	0	
26	4 - 15	4	4	8	6	10	2	0	
27	4 - 16	5	4	9	5	10	1	0	
28	15 - 16	0	8	8	10	10	2	1	
29	16 - 28	3	9	12	10	13	1	1	
30	2 - 5	3	2	5	4	7	2	0	
31	5 - 17	3	5	8	7	10	2	0	
32	17 - 18	0	8	8	10	10	2	2	
33	0 - 11	4	0	4	6	10	6	0	
34	11 - 12	0	4	4	10	10	6	6	
35	0 - 6	6	0	6	3	9	3	0	
36	6 - 21	12	6	18	12	24	6	0	

SECTION 1

REMARKS
CRITICAL
CRITICAL
CRITICAL
CRITICAL
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CRITICAL
CRITICAL
CRITICAL

SL. No.	ACTIVITY CODE	DURATION (MONTHS)	EARLIEST		LATEST		FLOAT		REMARKS
			START	FINISH	START	FINISH	TOTAL	FREE	
37	21-37	0	18	18	27	27	9	9	
38	21-43	0	18	18	26	26	8	3	
39	21-33	0	18	18	24	24	6	1	
40	27-38	4	13	17	18	22	5	0	
41	38-43	4	17	21	22	26	5	0	
42	43-46	4	21	25	26	30	5	5	
43	6-19	6	6	12	9	15	3	0	
44	19-22	2	12	14	18	20	6	0	
45	22-38	0	14	14	22	22	8	3	
46	22-26	0	14	14	20	20	6	0	
47	18-26	0	10	10	20	20	10	4	
48	26-33	4	14	18	20	24	6	1	
49	32-33	0	19	19	24	24	5	0	
50	33-46	6	19	25	24	30	5	5	
51	19-23	3	12	15	15	18	3	0	
52	23-39	3	15	18	18	21	3	1	
53	32-39	0	19	19	21	21	2	0	
54	39-45	8	19	27	21	29	2	0	
55	19-20	0	12	12	17	17	5	0	
56	20-24	1	12	13	17	18	5	0	
57	24-34	3	13	16	18	21	5	0	
58	34-40	6	16	22	21	27	5	0	
59	40-44	0	22	22	27	27	5	0	
60	0-7	4	0	4	5	9	5	0	
61	7-12	6	4	10	9	15	5	0	
62	12-20	0	10	10	17	17	7	2	
63	12-35	4	10	14	15	19	5	0	
64	12-25	2	10	12	17	19	7	0	
65	25-35	0	12	12	19	19	7	2	
66	35-41	5	14	19	19	24	5	0	
67	7-13	0	4	4	12	12	8	0	
68	13-41	12	4	16	12	24	8	3	
69	41-44	3	19	22	24	27	5	0	
70	44-45	2	22	24	27	29	5	3	
71	45-46	1	27	28	29	30	2	2	

SECTION 2

LATEST		FLOAT		REMARKS
START	FINISH	TOTAL	FREE	
27	27	9	9	
26	26	8	3	
24	24	6	1	
18	22	5	0	
22	26	5	0	
26	30	5	5	
9	15	3	0	
18	20	6	0	
22	22	8	3	
20	20	6	0	
20	20	10	4	
20	24	6	1	
24	24	5	0	
24	30	5	5	
15	18	3	0	
18	21	3	1	
21	21	2	0	
21	29	2	0	
17	17	5	0	
17	18	5	0	
18	21	5	0	
21	27	5	0	
27	27	5	0	
5	9	5	0	
9	15	5	0	
17	17	7	2	
15	19	5	0	
17	19	7	0	
19	19	7	2	
19	24	5	0	
12	12	8	0	
12	24	8	3	
24	27	5	0	
2[illegible]	29	5	3	
29	30	2	2	

NOTE:

THIS TABLE REFERS TO
THE NETWORK No. 5131 - III - 11

SECTION 3

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IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROCHROME PLANT-NETWORK TABLE

DRAWN		31.12.69	No. 5131 - III -12
APPROVED		5.1.70	

01602
(4 of 5)

FEASIBILITY REPORT

TO

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

FERRO-ALLOY PLANTS AND ALLOY STEEL PLANT

FOR

THE MINISTRY OF ECONOMY, IMPERIAL GOVERNMENT OF IRAN

FEASIBILITY REPORT
TO
THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
ON
FERRO-ALLOY PLANTS AND ALLOY STEEL PLANT
FOR
THE MINISTRY OF ECONOMY, IMPERIAL GOVERNMENT OF IRAN

01602
(4 of 5)

VOLUME IV
FERRO-SILICON AND FERRO-MANGANESE PLANT

MAY 1970

M. N. DASTUR & COMPANY PRIVATE LTD. CALCUTTA
DASTUR ENGINEERING INTERNATIONAL GMBH, DUSSELDORF
Consulting Engineers

LIST OF VOLUMES

ABSTRACT
(Vol IV)

A single ferro-alloys plant for the production of both ferro-silicon and ferro-manganese has been proposed. The plant is designed for the production of these ferro-alloys in different grades with a rated capacity of 17,000 tons of ferro-silicon (75 per cent grade) and 38,000 tons of ferro-manganese (standard grade). Alternative locations at Ahwaz and Isfahan have been studied and a plant site adjoining the integrated steel plant at Isfahan is considered preferable. Suitable facilities for production, utilities and services have been selected and a general layout developed. Estimates of capital cost, manpower and production costs have been derived.

It is suggested that the surplus ferro-silicon available after meeting the domestic requirement be exported during the initial years of operation in order to improve the efficiency and economics of operation of the plant. Export of ferro-manganese has not been considered in the financial analysis as the marginal cost is higher than f.o.b. prices. However, in view of the possible foreign exchange earnings and the existence of an exportable surplus in the first eight years of operation, this deserves some consideration.

The export price of ferro-silicon has been computed on the basis of the prevailing international market prices. The domestic prices have been derived on the basis of current prices in Iran and the delivered costs of these ferro-alloys from international markets. The effect of energy charges on production cost has been analysed. The financial analysis has been made based on a power rate of 5 mills (0.375 Rials) per kWh.

From the economic evaluation it is observed that ferro-silicon could be produced locally at prices competitive with the landed cost of imported ferro-silicon from world markets. In the case of ferro-manganese, the cost would be higher than the landed cost of imported ferro-manganese, primarily because the production is based on imported manganese ore. However, the production cost can be lowered to some extent by blending indigenous manganese ore with the imported ore.

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TABLE OF CONTENTS - VOLUME IV
(continued)

transformer, refractories, total, kilns with drives, weighing scales and ventilation equipment	..	2 310	-	2 310
4. **Tapping bay** Tapping bay equipment including ladles, moulds, crushing and handling equipment and overhead cranes	..	425	-	425
5. **Utilities and services** Equipment for utilities such as water, power, fuel oil, compressed air and auxiliary equipment for laboratory and maintenance shop	..	442	150	592
Sub-total (C)	..	**4 417** d/	**150**	**4 567**
D. Other costs				
1. Spares at 5% of C ..	..	220 d/	8	228
2. Ocean freight and insurance on imported equipment and spares at 10% of C+D1 ($ 4.637 mill)	..	464	-	464
3. Port charges and inland transport at 3% of C+D1+D2 ($ 5.259 mill) ..	..	-	158	158
4. Equipment erection ..	..	137 e/	548	685
Sub-total (D)	..	**821**	**714**	**1 535**
E. Engineering, supervision, construction administration etc at 12% of B+C+D ($ 8.533 mill)	..	307 f/	717	1 024
Sub-total (A to E)	..	**5 998**	**3 559**	**9 557**
F. **Contingencies** at 5% of A to E ($ 9.557 mill)	..	300	179	479
Total (A to F)	..	**6 298**	**3 758**	**10 061**

a/ Includes cost of imported equipment and facilities for off site water supply from river Minab, with ocean freight and insurance; and shuttering.

b/ Includes off site facilities comprising approach road rail link and water supply from river Minab. Power supply connection assumed to be on electric supply company account.

c/ Includes ocean freight and insurance on imported structural steel and sheeting.

d/ f.o.b. value of imported plant and equipment.

e/ 20% of the total erection charges assumed as foreign currency expenditure for foreign erectors' services.

f/ 30% of the total expenditure for engineering, supervision and construction administration assumed to be in foreign currency for foreign consultant's services.

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(continued)

TABLES IN VOLUME IV

TABLE OF CONTENTS - VOLUME IV
(continued)

TABLE OF CONTENTS - VOLUME IV
(continued)

Page

FIGURES IN VOLUME IV

DRAWINGS IN VOLUME IV

EXPLANATION OF SYMBOLS

Three dots (...) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A blank space ( ) in a table means that the item is not applicable.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A space is used to distinguish thousands and millions (1 346 849).

A full stop (.) is used to indicate decimals.

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954.

An asterisk (*) is used to indicate figures partially or wholly estimated.

Use of a hyphen (-) between dates representing years, e.g. 1960-1964, normally signifies an annual average for the calendar years involved, including the beginning and end years. 'To' between the years indicates the full period, e.g. 1960 to 1964 means 1960 to 1964, inclusive.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

16 - FERRO-SILICON AND FERRO-MANGANESE: PRODUCTION PROCESS AND PLANT CAPACITY

Electric furnace smelting and blast furnace smelting have both been used in the manufacture of ferro-alloys of silicon and manganese. The selection of process, however, is governed by the grade of alloy and availability of raw materials and power.

Selection of production process

The reducing agent used in the production of ferro-silicon and ferro-manganese is carbon. The thermal requirements are, however, different and this factor has significant effect on the production technology.

Ferro-silicon

Electric smelting

The production of ferro-silicon on a commercial scale was first carried out in the blast furnace. The use of this method, however, is restricted because of the technological restraints which limit the production to 10-18 per cent grades only. Therefore, ferro-silicon (with silicon content over 18 per cent) is, as a rule, produced in submerged electric arc furnaces, as the higher temperatures involved cannot be attained in blast furnaces.

16 - Ferro-silicon and ferro-manganese production process and plant capacity (cont'd)

The smelting process, unlike that of iron for instance, is a 'slag-free' operation, because reduction of silica in fused state proceeds very slowly and the process is practically impossible. It is therefore essential that the temperature of slag formation and quartz/quartzite fusion should be higher than that required for reduction processes. Further, the quality of raw materials should be so selected that there is no possibility of fusible slag and slag forming constituents are restricted.

Ferro-manganese

Blast furnace and electric smelting possible

Ferro-manganese (high carbon) is produced in blast furnaces as well as electric furnaces. The selection of production process is mainly dependent on the availability and cost of metallurgical coke and electric power. Countries with well-developed electric power systems like Italy, Sweden, Norway, Canada, Japan and India have adopted electric smelting.

In Iran, the first metallurgical coke plant is now under construction as a captive unit of the integrated iron and steel plant at Isfahan. The coke ovens are not designed for production of metallurgical coke in excess of the requirements of the steel plant. Bye-product coke in smaller sizes, however, would be available, which could be utilised in the electric smelting ferro-alloy plant. A bold plan for hydro-electric power generation is already under execution and, therefore, adequate power is expected to be available in the near future.

In view of resource availability, product quality and economic considerations, electric smelting is proposed to be adopted for the proposed ferro-manganese plant in Iran.

Two different methods - flux process and flux-less process - are adopted in electric smelting of ferro-manganese. In the 'flux process', the slag is characterised by low manganese content of 8 to 12 per cent. The slag obtained from 'flux-less process' contains more than 25 per cent (up to 40 per cent) manganese and is utilised for silico-manganese production.

The manganese ore of Iran has low Mn content and is not considered suitable without blending with high grade ores for the production of standard grade ferro-manganese by a single stage electric smelting process. The possibility of utilising the local ore will have to be investigated and confirmed by appropriate tests.

16 - Ferro-silicon and ferro-manganese: production process and plant capacity (cont'd)

The production process to be adopted at the proposed plant would largely depend on the quality of ore imported which in turn, would depend upon the source of supply. For the purpose of this study it is assumed that manganese ore blend will analyse about 46 per cent Mn, 7 per cent max. Fe, 8 per cent max. SiO_2 and 0.15 per cent max. P. This grade of ore is suitable for manufacture of ferro-manganese containing 74 to 78 per cent Mn.

It is proposed to adopt the flux process which would ensure the maximum recovery of manganese from imported ore. It may be mentioned, however, that as and when production of silico-manganese is envisaged, the same facilities could be utilised for switching over to the flux-less process.

Selection of plant capacity

The selection of plant capacity and furnace size should be in keeping with modern trends in technology and equipment which would offer optimum economic operation.

Ferro-silicon plant capacity

Trend in furnace size

With developments in electric furnace technology and the increasing demand for ferro-silicon as a result of the rising world steel production, the trend is towards installation of larger size furnaces. This is clearly indicated by the bigger furnace sizes constructed in different countries of the world, as shown in Fig. IV-1. As compared to the 10,000 kVA furnaces - which were among the largest units in the forties - today furnaces of 39,000 kVA and 48,000 kVA capacities are already in operation. The economies of scale in installing optimum capacity units are well-known and therefore this is to be kept in view in the selection of unit sizes for the plant.

Assuming a gestation period of three to four years, the ferro-silicon plant can be expected to materialise by about 1973/74, and the plant should be designed keeping 1980-horizon in view. The total demand in 1982 has been estimated at about 20,000 tons (13,000 tons local demand and 7,000 tons of possible export), and a plant capacity of between 15,000 tons to 20,000 tons could be selected. Based on raw material and other considerations, an optimum sized furnace unit would produce about 17,000 tons of 75 per cent grade ferro-silicon per year, and is considered for this study.

Two furnace or single furnace unit?

The production of 17,000 tons could be achieved by installation of two furnaces of 12,000 kVA each or by a single furnace of 24,000 kVA. The comparative production cost estimate per ton of ferro-silicon produced in a single furnace plant and a two-furnace plant are given in Table 16-1.

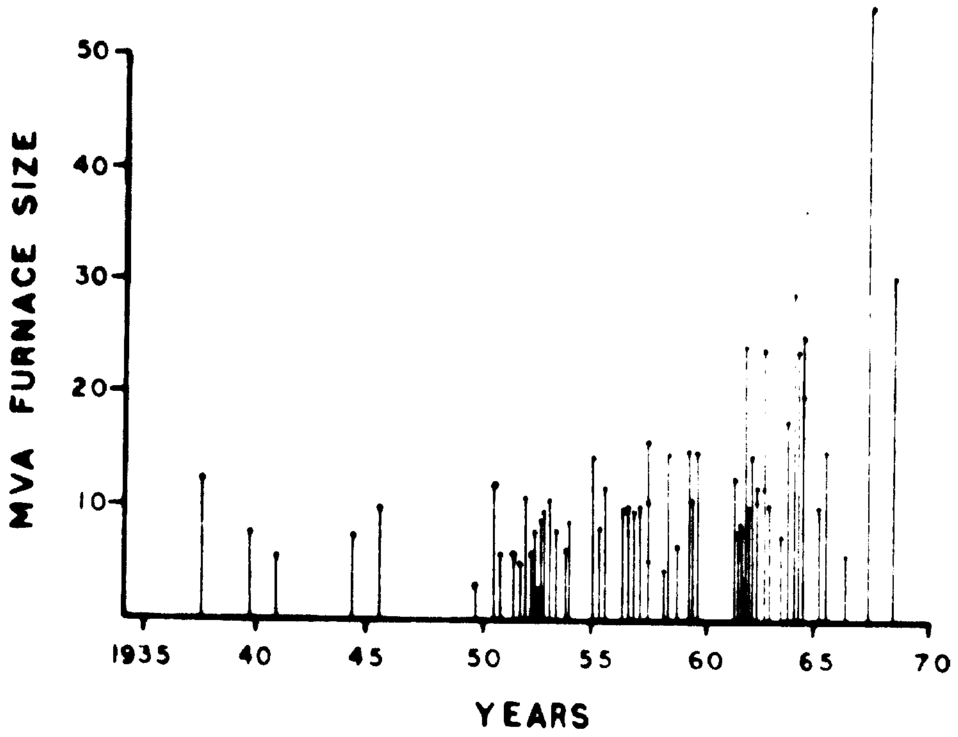


FIG. IV - 1. TREND OF FERROSILICON FURNACE SIZE

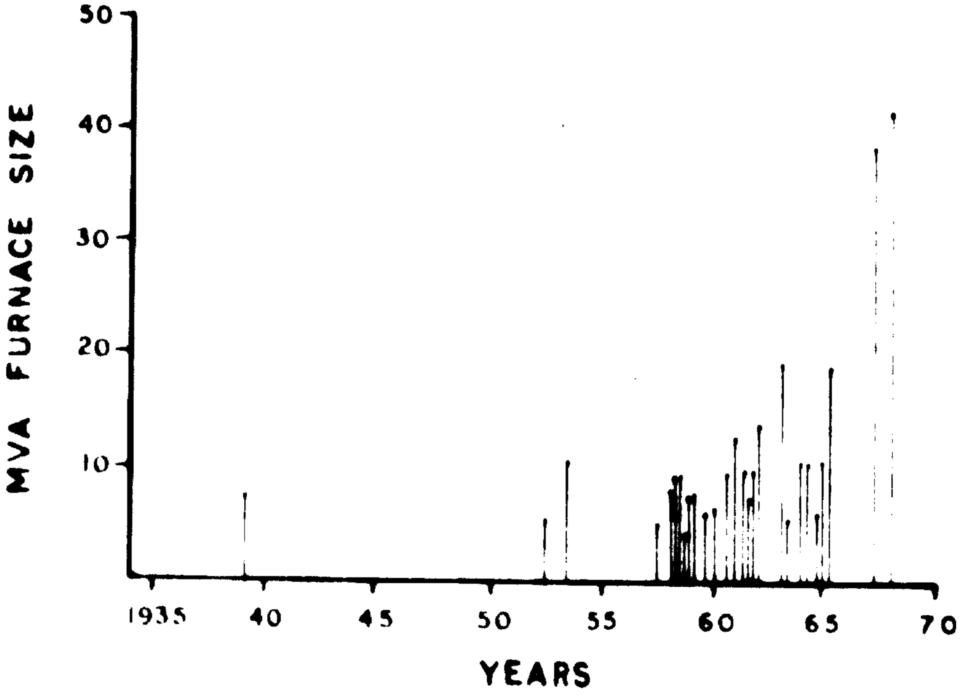


FIG. IV - 2. TREND OF FERROMANGANESE FURNACE SIZE

Appendix 13-1

PRELIMINARY ESTIMATE OF MANPOWER

<u>Basis</u>: Major equipment - One 12 000 kVA electric smelting furnace
One 8 000 kVA slag furnace for ferro-manganese

Production - 10 000 tons per annum low carbon ferro-chrome. and
4 500 tons per annum high carbon ferro-chrome

	Salary classi-fication	Shifts G	I	II	III	Total per weekday	Total payroll
A. Executive staff							
Works manager ..	E-1	1	-	-	-	1	1
Plant superintendent ..	E-2	1	-	-	-	1	1
Administrative officer	E-3	1	-	-	-	1	1
Chief accounts officer	E-3	1	-	-	-	1	1
Materials manager ..	E-3	1	-	-	-	1	1
Sales manager ..	E-3	1	-	-	-	1	1
Sub-total ..		6				6	6
B. Supervisory staff							
General foreman ..	S-1	1	-	-	-	1	1
Chief metallurgist ..	S-1	1	-	-	-	1	1
Metallurgist ..	S-2	1	-	-	-	1	1
Maintenance engineers	S-2	3	-	-	-	3	3
Shift foremen ..	S-2	1	1	1	1	4	4
Technical assistant ..	S-2	1	-	-	-	1	1
Desk operators ..	S-3	-	2	2	2	6	7
Maintenance foremen ..	S-3	1	1	1	-	3	3
Chemists ..	S-3	2	1	1	2	6	6
Sub-total ..		11	5	5	5	26	27
C. Operation staff							
Pay loader operator ..	W-1	-	2	2	-	4	5
Raw material attendant	W-2	-	1	1	-	2	2
Stock house attendant	W-2	-	3	3	3	9	10
Stoking car operator ..	W-1	-	1	1	1	3	4
Tappers ..	W-1	-	2	2	2	6	7
Assistant tappers ..	W-2	-	4	4	4	12	14
Crane/truck drivers ..	W-1	-	5	5	5	15	16
Shift fitter ..	W-2	-	2	2	2	6	7
Paste filler ..	W-3	-	2	2	2	6	7
Karigar-e-mamuli ..	W-3	-	12	12	10	34	40
Sub-total ..			34	34	29	97	112

16 - Ferro-silicon and ferro-manganeset production process and plant capacity (cont'd)

Table 16-1

COST COMPARISON OF FERRO-SILICON WITH ONE 24 000 kVA AND TWO 12 000 kVA FURNACES a/

	Two 12 000 kVA furnace plant $/ton	One 24 000 kVA furnace plant $/ton
Cost of materials		
Quartz, coke, charcoal and scrap	64.0	64.0
Electrode paste	11.0	9.0
Smelting power b/	47.0	43.0
Sub-total	122.0	116.0
Cost above materials		
Labour and supervision	13.0	11.0
Utilities, repairs and maintenance	13.0	10.0
General plant expenses	12.0	12.0
Sub-total	38.0	33.0
Works cost of 75% grade ferro-silicon	160.0	149.0
Fixed charges (interest and depreciation at 16%)	71.0	52.0
Total cost	230.0	201.0

a/ Figures are not absolute and are meant for comparison only.

b/ Assumed at 5 mills (0.375 Rials) per kWh.

It is noted that the total production cost per ton is $ 30 lower for a single furnace plant. Based on the economic comparison and keeping in view technological trends, the installation of one 24,000 kVA furnace is recommended.

Ferro-manganese plant capacity

Like other electric smelting processes, the unit size of ferro-manganese furnaces has also been increasing progressively, as indicated by the trend of some selected furnaces in Fig. IV-2. The selection of the plant size for ferro-manganese would also be governed by the same factors which have been discussed for the ferro-silicon plant capacity.

The local demand in 1982 is estimated as 38,000 tons. As initially the plant will operate with imported manganese ore, the export possibility may be limited. The plant is, therefore, designed on the basis of local demand, and installation of a single furnace of 20,000 kVA with a production capacity of 38,000 tons per annum is suggested. It is considered better to install an optimum-sized furnace of above capacity, although in the initial years the output may have to be somewhat lower than rated capacity, in order to match the local demand and limited export possibilities. This has been taken into account in the financial analyses.

17 - SITE SELECTION

The principal consumer of ferro-silicon and ferro-manganese will be the growing iron and steel industry of Iran. Major raw materials, except manganese ore, required for production of these alloys are locally available.

Though during initial years the plant may have to operate with imported ores, the possibility of blending local ore with imported ore has to be kept in view in selecting the plant site. The proportion in which local ore may be blended with the imported ore would depend on the quality of the latter which will have to be ascertained by tests.

Possible locations

The possible locations for the ferro-alloy plant could be based either on market considerations or on the proximity to major raw material sources.

Market based locations

Ferro-silicon and ferro-manganese will be consumed in iron and steel plants and foundries. Based on the plants under construction and those presently planned or envisaged, the expected pattern of distribution of ferro-alloys has been estimated and given in Table 17-1.

It will be observed that Isfahan would be the major consumer of these ferro-alloys, with Ahwaz coming next in importance. Both these locations have, therefore, been considered for locating the ferro-alloy plant.

Table 17-1

EXPECTED PATTERN OF DISTRIBUTION OF FERRO-SILICON AND FERRO-MANGANESE IN 1982

Consuming area		Ferro-silicon %	Ferro-manganese %
Ahwaz	..	10.6	11.6
Arak	..	0.7	0.5
Isfahan	..	64.7	85.8
Tabriz	..	2.2	1.3
Teheran	..	1.3	0.8
Export	..	20.5	-
Total		**100.0**	**100.0**

Raw material based locations

Ghazvin not suitable

For ferro-silicon production the major raw material required is quartzite. Known deposits of quartzite occur at Ghazvin and Lachoulle. The Ghazvin deposits are being presently worked mainly for meeting the requirements of the glass industry. The type of quartzite presently mined in this area is <u>not</u> suitable for ferro-silicon production. Though there are some indications of stray occurrence of lumpy quartzite suitable for ferro-silicon smelting, no systematic exploration work has so far been conducted. Owing to the uncertainties, this deposit is not considered suitable for basing a ferro-silicon plant.

Lachoulle not considered

The quartzite deposit at Lachoulle located at about 70 km from Isfahan and connected to the transport network of the country through Isfahan, is proposed to be developed for meeting the quartzite requirements of the integrated steel plant at Isfahan. This deposit could also sustain the operations of a ferro-silicon plant, but as a possible site Lachoulle has drawbacks. First, as the reductant and the scrap required for ferro-silicon smelting would have to be transported from Isfahan, the transport cost on assembly of raw materials and distribution of finished products would be higher at Lachoulle than at Isfahan. Further, substantial investment will have to be made on infrastructure development required for the ferro-silicon plant at Lachoulle.

<u>Ghom not considered</u>

Limited mining of manganese ore now done in Iran is confined to Shahrokh mines near Ghom. As the proportion of local ore which may be used for ferro-manganese production is limited, this location has not been considered.

As mentioned earlier, imported manganese ore is proposed to be received at Khorramshahr. Therefore, this area also needs to be considered as a possible location for a ferro-manganese plant. Khorramshahr region has been reviewed in Chapter 9, and based on considerations mentioned therein a suitable location in this area would be near Ahwas.

Review of locations

The available information on the Isfahan and Ahwas locations are given in Appendix 17-1. As the production of ferro-silicon and ferro-manganese is a power intensive electro-metallurgical operation, availability of adequate electric power would be a major consideration in selecting a suitable location.

Power development plan

Considering the electrical loading conditions, the ferro-alloy plant should have a firm feeder capacity of 45,000 kVA. The present plans for the development of power generating capacity in the Isfahan and KWPA regions are given in Table 17-2. The proposed national power grid of Iran is indicated in Drawing No. 5131-III-1 (Volume III).

Table 17-2

PLANNED POWER GENERATING CAPACITY IN ISFAHAN AND KWPA REGIONS

Region	Name of generating station	Total generating capacity, MW								
		1972			1977			1982		
		Steam	Hydro	Gas	Steam	Hydro	Gas	Steam	Hydro	Gas
Isfahan	Isfahan Shah Abbas	175	-	70	195	-	105	315	-	105
	Kabeer Dam	-	53	-	-	53	-	-	53	-
	Steel mill	-	-	15	-	-	15	-	-	15
KWPA	Ahwaz	150	-	-	350	-	-	400	-	-
	Pahlvi Dam	-	500	-	-	500	-	-	500	-
	Reza Shah Dam	-	-	-	-	1 000	-	-	1 000	-
	Karun Dam	-	-	-	-	420	-	-	870	-
	Rivers Power	-	-	-	-	-	-	-	-	1 200

Source: Ministry of Water and Power, Imperial Government of Iran

Isfahan

Land and subsoil

Adequate land for the installation of a ferro-alloy plant is available at Isfahan, adjacent to the northern boundary of the steel plant now under construction as shown in Drawing No. 5131-IV-1. Detailed investigations have been carried out for determining the subsoil characteristics of the steel plant area, which may be assumed to reflect the conditions of the soil at the proposed plant site. Bore holes have been driven up to 20 m depth in the steel plant area and 20 per cent of the core samples have been tested. It is reported that the soil 1 m below the ground level is very strong with negligible settling. The load bearing capacity is reported as 3 to 8 kg/sq. cm. It has been observed that at some places the subsoil contains sulphate and may, therefore, require special precautions for making the concrete corrosion-resistant. While selecting the exact plant location it may be possible to avoid such areas. The country rocks of the area are shales, limestone and sandstone occurring 300 to 400 m below ground level.

The proposed plant location could take advantage of the transport links already developed for the installation of the steel plant. The ferro-alloy plant could be connected by a short spur from the rail line which links the steel plant to the railway network of the country. Similarly, a short road would have to be constructed to connect the plant to the metalled road linking the steel plant to Isfahan town.

17 - Site selection (cont'd)

Water

The water requirement of the plant could be met from Zayande Rud river which is also the supply source for the steel plant. It is understood that the Imperial Government has assured a supply of 10 cu m/sec from the river for meeting the steel plant's requirement. For industrial use the river water has to be settled and chemically treated. In order to meet the increased requirements of water after the expansion of the steel plant, it would be also necessary to expand the water treatment and supply facilities. Considering the limited water requirement of the ferro-alloy plant (as compared to the steel plant), necessary arrangement may be made to obtain industrial quality water from the steel plant itself.

Power

From discussions held with the Ministry of Water and Power, the Imperial Government of Iran, it is understood that the present availability of power at Isfahan is about 100 MW of which about 45 MW will be required for the integrated iron and steel plant. The power supply to Isfahan in future will be enhanced after the construction of a 400 kV transmission line network. The Ministry of Water and Power has assured that adequate power for the ferro-alloys plant would be available at Isfahan by 1973/74.

17 - Site selection (cont'd)

Township

The nearest town is Isfahan which is located at a distance of 42 km towards north-east. However, the new steel plant township, now under construction and located at about 12 km from the proposed location, could also provide all the necessary amenities required for the personnel for the proposed ferro-alloy plant.

Ahwaz

Transport

Another possible location for the ferro-alloy plant in Ahwaz area is at a distance of about 10/12 km from the town centre and close to the existing steel rolling mill plant of Iranian Rolling Mills Company, as shown in Drawing No. 5131-IV-2. Ahwaz is well connected by road and rail. The proposed plant site could be connected to the main rail line with a short spur. The plant location is adjacent to the metalled highway connecting Ahwaz to Khorramshahr.

Water

The water requirement of the plant would have to be met from Karun river. It would be necessary to develop a suitable water supply system including the necessary settling and treatment facilities for meeting the water requirement of the ferro-alloy plant.

Appendix 13-1 (continued)

	Salary classi-fication	Shifts G	Shifts I	Shifts II	Shifts III	Total per weekday	Total payroll
D. Maintenance staff							
Mechanical							
Pump-comp.attendants	W-2	-	1	2	2	6	7
Machine operators ..	W-1	-	3	3	-	6	7
Welders ..	W-1	-	2	1	1	4	5
Fitters ..	W-1	2	3	3	1	9	10
Mason ..	W-2	1	-	-	-	1	1
Blacksmith ..	W-2	1	-	-	-	1	1
Karigar-e-mamuli ..	W-3	-	3	3	3	9	10
Sub-total ..		4	13	12	7	36	41
Electrical							
Fitters ..	W-1	1	-	-	-	1	1
Electrician and wireman	W-1	-	2	2	2	6	7
Karigar-e-mamuli ..	W-3	-	2	2	2	6	7
Sub-total ..		1	4	4	4	13	15
E. Administration and commercial staff							
Personnel officer ..	A-1	1	-	-	-	1	1
Labour officers ..	A-1	2	-	-	-	2	2
Office superintendent	A-1	1	-	-	-	1	1
Administration assistant	A-2	1	-	-	-	1	1
Security officer ..	A-1	1	-	-	-	1	1
Security staff ..	A-3	-	4	4	6	14	17
Stores officer ..	A-1	1	-	-	-	1	1
Purchase officer ..	A-1	1	-	-	-	1	1
Stores assistants ..	A-2	2	-	-	-	2	2
Purchase assistants ..	A-2	2	-	-	-	2	2
Market research officer	A-1	1	-	-	-	1	1
Marketing officer ..	A-1	1	-	-	-	1	1
Marketing assistants ..	A-2	3	-	-	-	3	3
Fire fighting men ..	A-2	1	3	3	3	10	12
Accounts officer ..	A-1	3	-	-	-	3	3
Accounts assistants ..	A-2	3	-	-	-	3	3
Time keeper ..	A-3	1	1	1	1	4	4
Medical officer ..	A-1	1	-	-	-	1	1
Medical assistants ..	A-2	4	-	-	-	4	4
Secretarial staff ..	A-2	13	-	-	-	13	13
Nomeresan ..	A-4	3	-	-	-	3	3
Raftegar ..	A-4	3	-	-	-	3	3
Sub-total ..		49	8	8	10	75	80
Total on payroll ..		..			..		281
Reserve for leave and absenteeism (on C & D groups) @ 18.5%							31
Total Manpower ..		..			..		312

Power

The Ministry of Water and Power, the Imperial Government of Iran has assured that adequate supply of power for the ferro-alloys plant would be available at Ahwaz by about 1973.

Township

It may not be necessary to develop a separate township for the plant personnel. Suitable accommodation can be found for them in the nearby Ahwaz town, and only transport facilities need to be provided.

Evaluation of locations

Technically both locations suitable

From the viewpoint of resource availability and other technical considerations both Isfahan and Ahwaz are suitable for locating the ferro-alloy plant. The Ministry of Water and Power, Imperial Government of Iran has assured that adequate power would be available at both locations by 1973/74. The choice between the two locations would be determined by economic considerations. The locational factors which would govern the project economics could be broadly grouped into two, namely:

i) those affecting the investment cost, and
ii) those affecting the operating cost.

A comparison of economic factors is given in Appendix 17-2.

Investment costs

The investment cost items dependent on plant location could be sub-divided into (i) those affecting the capital cost of the plant for equipment and facilities within the plant boundary, and (ii) those affecting the cost of infrastructure and off site facilities.

Equipment and facility

As most of the equipment required for the construction of the ferro-alloy plant would have to be imported, the difference in cost of equipment and materials as delivered to the site would mainly be accounted for by the difference in the freight payable from the port of entry to the possible location. As Ahwaz is located close to the Persian Gulf ports, the inland transport cost of equipment and facilities would be lower than that for Isfahan.

For the same reason, the cost of imported structural steel as delivered to site would be higher at Isfahan. But it is estimated that the cost of civil work at Isfahan would be substantially lower than that at Ahwaz, based on the prevailing rates of construction materials.

Climatological factors and cost

Other items of cost which would affect the capital investment are due to the climatological factors. At Ahwaz, due to the prevalence of dust-storms it is customary to have the plant buildings covered on all sides. This results in increased cost of steelwork in terms of sheeting. The administrative and welfare buildings require to be air-conditioned to provide relief from the severe summer heat. On the other hand, at Isfahan, the plant buildings as well as the administrative buildings need to be designed to withstand snowload and suitable heating facilities need to be provided. These would involve some additional investment. It may be expected that the extra expenditure arising from climatological factors may be more or less similar at both locations.

A plant located at Isfahan could take full advantage of the infrastructure facilities already developed for the integrated iron and steel plant.

Operating economics

The factors affecting the operating economics are the transport cost of raw materials assembly and product distribution. A comparison of relative costs for both locations is presented in Appendix 17-2 and summarised in Table 17-3.

17 - Site selection (cont'd)

Table 17-3

RELATIVE TRANSPORT COSTS AT ISFAHAN AND AHWAZ LOCATIONS

		Isfahan ($/ton)	Ahwas ($/ton)
Ferro-silicon			
Freight cost			
Raw materials assembly	..	6.1	33.6
Product distribution	..	8.5	16.5
Total	..	14.6	50.1
Ferro-manganese			
Freight cost			
Raw materials assembly (20% local ore + 80% import through Khorramshahr)	..	24.6	12.4
Product distribution	..	3.2	20.5
Total	..	27.8	32.9

Selection of location

Isfahan preferable

The relative economic evaluation indicates that costs of the ferro-silicon plant at Isfahan would be significantly better than that at Ahwas. For the ferro-manganese plant also, Isfahan is preferable in the case of three alternative sources of manganese ore, namely, use of local ore, import from USSR, and import through Bandar-Abbas.

In view of the above considerations, a plant for production of ferro-silicon as well as ferro-manganese could be advantageously located at Isfahan. The installation of facilities for both products at Isfahan would also lower the total investment and operation costs compared to separate facilities at two places.

18 - PLANT GENERAL LAYOUT AND MAJOR FACILITIES

The plant is designed for production of ferro-silicon and ferro-manganese of the following grades:

Ferro-silicon

Si %	C (max) %	S (max) %	P (max) %	Al(max) %
75	0.15	0.05	0.05	1.0
45	0.15	0.05	0.05	1.0

Ferro-manganese

Mn %	C %	S (max) %	P (max) %	Si(max) %
74-78	6-8	0.05	0.35	1.5

Product mix

The quantities of different grades of ferro-silicon to be produced will depend on the market demand. The facilities are designed for a total production of either 17,000 tons of 75 per cent grade or 28,000 tons of 45 per cent grade, or an equivalent of various grades. The ferro-manganese facilities are designed for an annual output of 38,000 tons of standard grade.

Raw materials

The raw material sources for the ferro-alloys plant are discussed in Chapter 3. Based on the analyses in

Appendix 18-1, the estimated consumption of raw materials per ton of product is given in Table 18-1.

Table 18-1

RAW MATERIAL CONSUMPTION PER TON OF FERRO-ALLOYS

Materials	Consumption - kg/ton		
	Ferro-silicon		Ferro-manganese
	45% grade	75% grade	75% grade
Quartzite ..	1 100	1 940	
Manganese ore ..			2 250
Scrap ..	630	200	
Limestone ..			510
Charcoal (dry) ..		480	
Coke (dry) ..	545	545	610
Electrode paste ..	40	70	22

In view of the high ash content of the local coke, it is essential to use charcoal for the production of high grade ferro-silicon in order to ensure smooth furnace operation. The annual material flow sheet is shown in Drawing No. 5131-IV-3.

Plant general layout

Transport link

The general layout of the proposed plant is shown in Drawing No. 5131-IV-4. The ferro-alloy plant is proposed to be located north of the Isfahan steel plant. The transport links enter the ferro-alloy plant from the eastern boundary. It is proposed that the ferro-alloy plant be connected by a short spur from the rail link connecting the Isfahan steel plant to the railway network of the country. The single track entry to the ferro-alloy plant is then bifurcated within the plant to serve the raw materials yard and finished storage yard by separate and short rail links. The main road to the plant is also connected to the road linking the steel plant and Isfahan.

Raw material stockyard

The raw materials receiving and handling facilities are located along the northern boundary of the plant which permit the raw material traffic to be kept at one end. Separate storage yards are being provided for all the major raw materials.

The stock house facilities are located to the south, parallel to the raw materials storage yard. Crushing and screening facilities are separated in between the raw materials stockyard and stock house.

Furnace building

The furnace building is parallel to the stock house with longitudinal axis running east-west. Both the furnaces are located within the same building and at the same level to facilitate operation and supervision. The furnace building comprises four parallel bays, namely the transformer bay, furnace bay, tapping bay and the finishing and despatching bay. A typical section of the furnace building is shown in Drawing No. 5131-IV-5.

The ferro-silicon furnace is located to the east, while the ferro-manganese furnace is to the west. This would facilitate the movement of slag which will be transported by trucks and dumped outside the western boundary of the plant.

Power and water

The electric supply company's outdoor receiving substation is located towards south-east as it is expected that the incoming power line would be entering the plant from the eastern side. Pump house and cooling towers of the water system are located close to the southern boundary as the water main may be conveniently connected to the steel plant from that end.

Roads and tracks

A suitable transport network has been provided to facilitate movement of men and material. The length of roads within the plant boundary is 2.0 km and that of rail tracks 1.8 km.

Future expansion

Space provision has been made in the plant layout for future expansion. Ferro-manganese facilities will be expanded westwards and ferro-silicon facilities eastwards.

Major equipment

The list of major equipment proposed is given in Appendix 18-2.

Raw materials stockyard

Quartzite is expected to be received in road trucks. As the source of supply is only 70 km distant from the plant, a stock of three weeks' requirements in the storage yard would be adequate.

Imported manganese ore will be received in railway wagons, manually unloaded and conveyed to the storage yard by a system of conveyors. Storage of three months' requirements of imported manganese ore is proposed. The manganese ore storage facilities comprises five parallel stockpiles, each served by a 8 m high tripper conveyor.

Supplies of suitably sized limestone will come from the same sources which supply the requirement of the steel plant's blast furnaces and is expected to be received by trucks. A separate stockpile for limestone is proposed.

The coke and charcoal stockyards are located adjacent to the quartzite stockyard and are adequate for storing two to three weeks' requirements. Pay loaders have been provided for handling the raw materials.

Raw materials preparation

Separate crushing and screening facilities have been provided for sizing the quartzite and manganese ore. The coke is expected to be received suitably sized from the Isfahan steel plant. A single roll crusher has been provided for crushing the plus 75 mm fraction of charcoal. The charcoal will be screened for separating out minus 3 mm fines.

The sizes of raw materials required for ferro-alloy smelting are given in Table 18-2.

Table 18-2

RAW MATERIAL SIZES REQUIRED FOR FERRO-ALLOY SMELTING

Quartzite	..	10 to 100 mm
Manganese ore	..	5 to 50 mm
Limestone	..	5 to 50 mm
Coke	..	3 to 20 mm
Charcoal	..	3 to 75 mm

Sized raw materials will be moved to stock house bins by conveyors. There is a common conveyor system for reductants for both furnaces. A separate conveyor system has been provided for other raw materials for each furnace.

Stock house

The stock house comprises two separate systems of bins - one for each furnace. Separate bins have been provided for storage of different raw materials. Each furnace has a separate charging system comprising weighing and conveying facilities. Raw materials in weighed

Appendix 13-2

PERSONNEL TO BE TRAINED ABROAD

	No.	Training duration months
General foreman ..	1	3
Chief metallurgist ..	1	3
Maintenance engineers..	2	3
Shift foremen ..	4	6
Desk operators ..	7	6
Maintenance foremen ..	2	6
Tappers ..	4	6

quantities are withdrawn from the bins by a system of vibratory feeders and belt weighers. The raw materials are then conveyed by belt conveyor systems from the stock house to the furnace building and distributed into the feeding chutes of each furnace by separate systems of conveyors.

Scrap is stored in a separate shed adjacent to the ferro-silicon building and is transported to the plant by wheel barrows. Weighed quantities of scrap is hoisted to the charging floor by an elevator.

Smelting furnaces

Ferro-silicon

For ferro-silicon a 24,000 kVA 'low hood type' smelting furnace has been provided with suitable cooling arrangement. The furnace is proposed to be chute charged, and the distribution of raw materials at the top is done by a system of conveyors. The furnace is provided with a charging/stoking machine.

The tapping of the furnace will be done in ladles. The ladle with melt will be handled by a 12/3-ton EOT crane located in the tapping and finishing bay. From the ladle, the melt will be poured into refractory lined tapping pans. The pans will be handled by the overhead crane. Necessary facilities such as crushers, screens etc are provided for sizing and handling the product.

Ferro-manganese

A covered rotating furnace with 20,000 kVA transformer capacity has been provided for smelting ferro-manganese. The three-phase transformer is equipped with an on load tap changer for remote control. The furnace gas is cleaned in wet scrubbers. The cleaned gas could be utilised for general heating purposes during winter.

For casting the ferro-alloy, a furnace runner with skimmer is provided and the adoption of cascade system is proposed. Refractory lined pans will be used for casting the ferro-alloy into blocks. The pans will be handled by a 12/3-ton EOT crane. The ferro-manganese will be suitably sized, for which the necessary crushing and screening facilities have been provided.

Solidified slag will be collected at the west end of the tapping bay by utilising the overhead crane and later transported by dump trucks to the dumping ground outside the plant boundary.

Water supply system

Recirculation system for water supply is proposed to be utilised to minimise the make-up water requirement of the plant. The water requirement of the plant is proposed to be obtained from the adjacent integrated iron and steel plant. The total make-up water requirement of the plant is estimated at about 45 cu m per hour. In addition, drinking water requirement of 2 cu m per hour is to be provided to meet the drinking and sanitary needs of plant personnel as well as for fire fighting.

Two separate recirculating systems are proposed as shown in Drawing No. 5131-IV-6. A clean water recirculation system has been provided for meeting the water requirement of the furnace, transformer, compressor etc. This is designed for 600 cu m per hour water in circulation with a make-up water requirement of 30 cu m per hour. The system comprises of pumps and necessary cooling towers.

A contaminated water recirculation system has been provided for supplying the water requirement of the ferro-manganese gas cleaning facilities. The system is designed for 100 cu m per hour in circulation. The make-up water requirement is estimated at 15 cu m per hour. Necessary settling facilities have been provided for treatment of return water. The sludge collected is proposed to be dumped outside the plant boundary.

For emergency water supply one overhead tank is proposed with a staging height of 30 m. During power failure, water will flow by gravity to the furnace.

Electric power system

The electrical loading conditions of the plant are estimated as given in Table 18-3.

Table 18-3

ESTIMATED ELECTRICAL LOADING CONDITION

Annual energy consumption	..	279.5 million kWH
Plant average load based on calendar year	..	31 750 kW
15-min max. demand	..	39 237 kW
Plant average corrected power factor	..	0.9
Firm feeder capacity	..	45 000 kVA

Selection of power system voltages

The electric supply company will have to make suitable arrangements for providing firm feeder capacity of about 45 MVA.

According to the present plans, power to the Isfahan steel plant will be fed from nearby substation over 63 kV overhead lines. It is therefore assumed that power to the proposed plant will also be made available from this 63 kV substation. The electric supply company will have to bring power at 63 kV and step down to 20 kV at the south-eastern corner of the plant site so that power can be fed to the plant at 20 kV over duplicate 20 kV feeders from the supply company's 63/20 kV substation.

It is proposed that the plant main distribution voltage will be at 20 kV on the basis of following considerations:

i) 20 kV is one of the preferred voltages in this area.

ii) 20 000 kVA and 24 000 kVA smelting furnaces can be economically designed to operate directly from 20 kV.

iii) At 20 kV power carrying capacity of cables is higher than at 11 kV thereby reducing the number of parallel cables required for feeding these two high powered furnaces.

iv) Indoor metal-clad switchgear is available for 20 kV, use of which will permit installation of 20 kV indoor substation thereby reducing maintenance problems.

Apart from the two furnaces all the other plant electrical loads will be fed from 380/220 volts medium voltage distribution system, as this is the prevalent Iranian standard distribution voltage.

Plant power distribution system

The proposed plant power distribution system is shown in Drawing No. 5131-IV-7, and the main features of the design are briefly enumerated below.

i) power will be purchased at 20 kV over two full capacity underground feeders.

ii) the supply company's feeders will be connected to the indoor metal-clad 20 kV switchboard of the plant main reciving station, which will be located on the south-east side of the furnace building.

iii) The two smelting furnaces will be fed directly from 20 kV bus over independent remote operated circuit-breakers and underground 20 kV cables. These breakers will also act as furnace switching devices thus eliminating provision of duplicate breakers.

iv) The plant auxiliary loads will be fed from two 1000 kVA, 20/0.4 kV step down transformers connected to the two different sections of the 20 kV bus.

v) In case of total power failure vital services and plant emergency lighting will be fed from automatic mains failure diesel generating sets.

Plant power supply equipment

It is recommended that all switchgear should be of indoor, enclosed, sheet steel design with air or minimum oil circuit-breakers of adequate interrupting rating. The current ratings of the circuit-breakers shall be standardised at 400, 630, 1250, 1600 and 2000 amps as per load requirements.

For 380/220 volts system two 1000 kVA, 20/0.4 kV transformers with 380 volts switchgear combined in form of a load centre is proposed and will be located in the main receiving station. Each section of the plant will have its own sub-distribution boards in form of motor control centres which will be fed from the 380 V load centre.

Communication system

To provide two-way communication within the plant, it is proposed to provide a private telephone exchange having a capacity of 50 lines. This system will have direct dialling facility for private communication between extensions. In addition, conference calling facilities can also be incorporated in the system.

A controlled electric clock system is also proposed to indicate synchronised time throughout the plant and to provide impulses to the time recorders from a master clock.

Maintenance and service facilities

The maintenance and service facilities comprise of mechanical workshop, laboratory and transport equipment. The maintenance facilities include the necessary bending machines for the electrode casing and a limited number of other facilities for day-to-day maintenance of the plant. The laboratory is provided with necessary facilities for sample preparation and chemical analysis. A wagon shunter has been provided for placement and handling of wagons within the plant boundary. Two trucks have been provided for general material movement within the plant. Transport of slag is proposed to be done through contract arrangement.

Auxiliary buildings

The plant will have a main office building which also houses the laboratory and first-aid station. In addition, provision has been made for necessary gate house, canteen, ablution blocks, stores, road weighbridge etc. The auxiliary buildings and plant buildings are provided with necessary central heating facilities.

19 - PLANT CONSTRUCTION

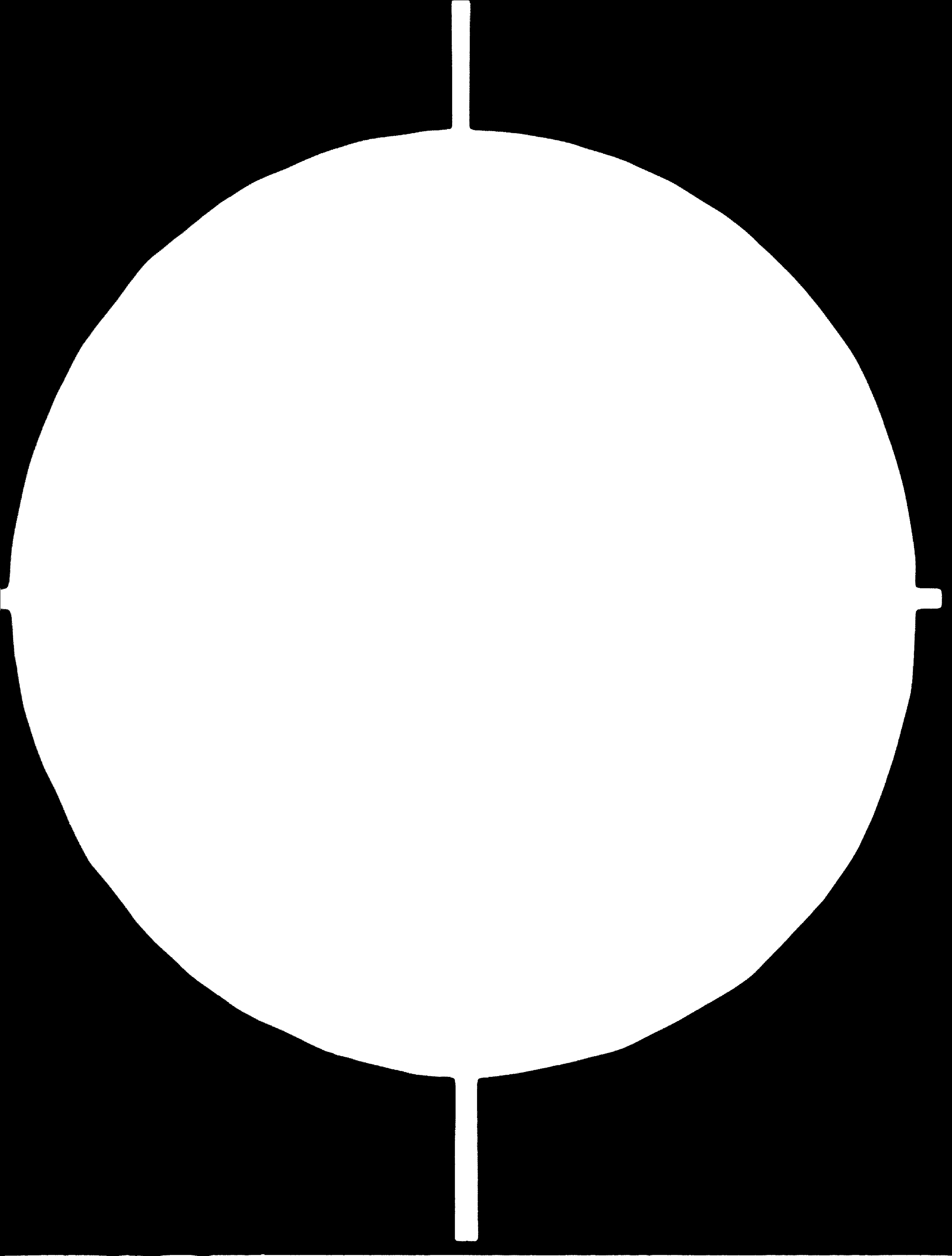
Salient features of the construction of a ferro-alloy plant have been discussed in chapter 11 (Volume III).

Preparatory phase

Raw materials

An important task in the preparatory phase will be investigations regarding raw materials. Planning for the development of quartzite deposit to ensure continuous supply of the required quantity and quality of raw material will have to be taken up on priority basis. Necessary investigations would also have to be undertaken to ensure availability of adequate supply of charcoal from the neighbouring region. The prospects of maximising the use of local manganese ore would have to be properly examined.

Maximum utilisation of the infrastructure developed for the integrated steel plant is proposed. The possibility of receiving adequate water supply for the plant, as well as for the construction of the necessary transport links - roads and railway - from the existing facilities of the Isfahan steel plant would have to be negotiated and finalised.



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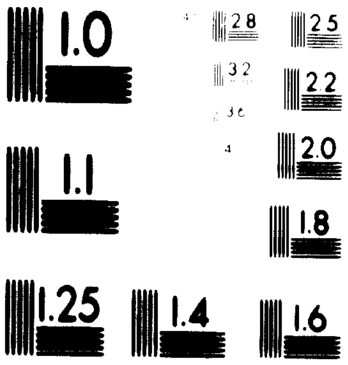

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

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utilities, material handling and other miscellaneous facilities. The electric smelting furnace and associated equipment cost are based on international prices indicated by equipment manufacturers.

Bulk of the equipment will be imported, involving a f.o.b. price of $ 4.3 million. Local supplies may be limited to a part of utility and service facilities. However, at the engineering stage it may be possible to include a larger component of local supply depending on availability, thereby reducing the import component correspondingly.

Other costs

Essential capital and commissioning spares will be purchased along with the main plant. The cost of spares has been estimated at 5 per cent of the cost of equipment.

Freight and insurance

Ocean freight and insurance has been estimated at an average of 10 per cent of the f.o.b. cost of equipment and spares, all in foreign exchange. Provision for inland freight and port handling has been made at 3 per cent of c.i.f. cost of imported equipment and ex-works cost of local equipment.

Equipment erection

The erection costs for equipment have been assumed at about 16 per cent of the f.o.b. cost of equipment. This includes the provision for necessary tools, tackles and erection rigs required which would be supplied by the erection contractor. In view of complicated work involved in the erection of equipment such as furnaces and related facilities, it is envisaged that foreign assistance for erection will be required. A provision of 20 per cent of the total erection expenses has been made in foreign exchange.

No provision has been made for customs duty as it is expected that in keeping with the Government policy, the equipment and supplies imported for this project will be exempted from customs duty, as the plant is being set up for the processing of minerals.

Engineering, supervision and construction administration

Provision has been made for expenses for engineering the project, administration and supervision of construction at 12 per cent of the plant cost. Of the total amount of $ 1.0 million, 30 per cent is allowed in foreign currency to cover the foreign exchange component of the consultant's services.

Contingencies

A 5 per cent provision has also been made to cover contingencies.

21 - PLANT ORGANISATION, MANPOWER AND KNOW-HOW REQUIREMENTS

A typical plant organisation structure has been described in Chapter 13 (Vol. III). The same considerations would apply also to this ferro-silicon/ferro-manganese plant.

Manning list

In estimating the manpower requirements for the proposed plant, provision of 16.6 per cent has been made for weekly offs. The leave reserve has been provided on the basis of following annual leave entitlements:

Legal holidays	10 days
Earned leave	12 days
Estimated incidence of medical leave and absenteeism	14 days

Earned leave or paid vacation varies in different parts of Iran. In some parts it is 12 days per year and in others, where bad climate is not unusual, it is 24 days per year. Considering the proposed location of the ferro-alloy plant, the earned leave entitlement has been assumed as 12 days annually.

Reserve for leave and absenteeism has been provided only for workers. Based on the leave entitlement mentioned earlier, it is estimated at 14 per cent of the total payroll of workers.

The proposed manning list for the ferro-alloy plant including executives, supervisors, operation and maintenance personnel and administrative and commercial staff is given in Appendix 21-1 and summarised in Table 21-1.

Table 21-1

SUMMARY OF MANNING LIST

Executives	-	5
Supervisors	-	27
Operation and maintenance personnel	-	179
Administrative and commercial staff	-	81
Sub-total	-	292
Reserve for leave and absenteeism	-	25
Total	-	317

Salaries and wages

The basic salary of different categories of personnel in the managerial, technical and skilled cadres varies widely in Iran, depending partly on the location and type of industry. In the absence of any established wage levels for the ferro-alloy industry under consideration, it has been necessary to assume the salary scale of different categories of personnel in order to derive the labour and supervision component of production cost.

The classification in terms of the proposed salary scales is indicated by the (E-) series for executives, (S-) series for supervisory grades, (W-) series for workers, and (A-) series for administration and commercial staff and are indicated in Appendix 21-1 against each job title. The average salaries considered for each category are given in Table 21-2. The salaries for executives, supervisors and office staff are normally fixed on monthly basis. Wage payment for workers in Iran is on hourly or daily basis for skilled, semi-skilled and unskilled workers, whereas mechanics and chemists are paid at monthly rates. The average monthly salaries for workers indicated below have been derived on the basis of the prevailing daily rate and 30-day month.

Table 21-2

BASIC SALARIES AND WAGES FOR DIFFERENT SALARY CLASSIFICATIONS

Salary classification	Average salary per month $
E-1	900
E-2	750
E-3	600
S-1	550
S-2	400
S-3	240
S-4	120
W-1	100
W-2	60
W-3	40
A-1	200
A-2	150
A-3	80
A-4	40

It is emphasised that the salary and wage structure should be determined during project finalisation. The remuneration system should have a bearing, among other things, on the job content, experience and qualifications, and a reasonable growth potential.

Cost of labour and supervision

The cost of labour and supervision comprises the basic salaries and wages, and other fringe benefits.

The labour laws of Iran provide for health insurance schemes for workers to cover medical treatment to the insured and his immediate members of family, payment of wages during inability/illness, matrimonial allowance, maternity benefit, child allowance, retirement allowance to aged, burial costs to heirs and payment of stipend to heirs. The health insurance premium amounts to 18 per cent of the basic wage of workers, of which 5 per cent is deducted from the salary and 13 per cent is contributed by the employer. It is understood that it is customary to pay a bonus equivalent to one month's average earnings to workers during 'Navruj'.

Payment of shift premium and night premium for night shifts is in vogue and has been taken into account. It is also expected that suitable incentive schemes may be introduced.

It is estimated that the various legal and extra-legal fringe benefits would increase the total wage bill by an average of about 50 per cent.

Know-how requirement

Imported know-how and assistance will be required for certain specialist services during the construction of the project and initial operation of the plant for a few years.

The know-how required could be broadly grouped as follows:

i) design, engineering and technical assistance during construction, and

ii) production know-how.

Design, engineering and construction services

The design services are for project planning, selection of appropriate equipment and facilities, engineering and construction supervision, suited to local requirements and conditions. Any error at this stage is permanent in nature and has far-reaching effects on the economics of the project. Proper management and supervision of construction are essential for ensuring expeditious and correct execution of construction activities.

Process know-how

Unlike production of ferro-chrome, smelting of ferro-silicon and ferro-manganese do not call for extensive know-how. It is suggested that the key personnel of the plant should be adequately trained abroad and during the initial period of operation some technical assistance may be obtained from suitable foreign agencies for starting up the plant and stabilising the operations. Such technical assistance is also provided by the equipment suppliers.

21 - Plant organisation, manpower and know-how requirements(cont'd)

Training

It is envisaged that 25 supervisors and operators may have to be trained for three to six months' duration as given in Appendix 21-2. The training expenses will include the home salary, travel to and from the training centre and allowance for staying abroad. The average expenses of training for shift foremen and above categories is estimated at $ 1,200 per month and that for others at $ 850 per month. On the basis of the training duration suggested in Appendix 21-2, the total expense for training is estimated at about $ 120,000.

The technical assistance needed for the initial operation of the plant is to be imported from abroad. A provision for $ 80,000 has been made to cover the expenses for experts in this connection.

22 - PRODUCTION COST ESTIMATE

The production cost includes all costs associated with raw materials and processing them through various sections of the plant. The production cost of the finished products comprises **cost of materials and cost** above materials.

Cost of materials

The quantity of raw materials required for production of one ton of salable products multiplied by their individual unit costs gives the total material cost.

The estimated cost of raw materials delivered at site is given in Appendix 22-1 and summarised in Table 22-1.

Table 22-1

COST OF MAJOR RAW MATERIALS

Materials		Cost delivered at site $/ton
Manganese ore	..	41.0
Quartzite	..	7.0
Limestone	..	2.0
Coke	..	25.0
Charcoal	..	61.0
Scrap	..	50.0
Electrode paste	..	158.0

Similarly, to ensure adequate supplies of power, appropriate action would have to be taken for installing the outdoor substation of the power supply company.

Land
acquisition

After the final decision on the plant site and obtaining necessary concurrence of the National Iranian Steel Company, prompt measures would have to be taken for acquisition of the land for the project. Soil investigations and survey work at site have also to be taken up early so that site preparation studies, foundation designs and civil work estimates are prepared in time.

Authorisation
to proceed

It is also essential that the project authorities take an early decision on the appointment of consulting engineers. This would expedite the finalisation of the general concept of the project and the preliminary work as well as facilitate an early start of the engineering on the project.

Construction facilities

Extensive construction facilities have already been established at Isfahan for the integrated steel plant. In order to minimise the time and investment costs for the ferro-alloy plant, it is suggested that the possibilities of utilising the same construction facilities for the ferro-alloys plant may be considered. Arrangements for

Cost above materials

The cost above materials covers all other items of expenses incurred in the production of finished products such as labour, supervision, water, fuel, power, maintenance, refractories etc.

Labour and supervision

Based on the manning list and average salaries indicated in Chapter 21, the annual cost for supervision and operation and maintenance staff including leave reserves works out to $ 383,000. This estimate includes the provision made (50 per cent on basic salaries) for fringe benefits. In order to estimate the production cost of ferro-alloys separately it is estimated that 50 per cent of the total salaries would be charged for ferro-silicon and the other 50 per cent for ferro-manganese.

Water

The cost of water has been taken at the rate of $ 12 per thousand cu m on the basis of the price estimated in the detailed project report of the Isfahan steel plant. The total make-up water requirement of the plant is 45 cu m per hour of which 30 cu m per hour is for ferro-manganese production. The drinking water requirement of 10 cu m per hour is equally apportioned to ferro-silicon and ferro-manganese.

Maintenance and supplies

The other items of cost above materials include cost for periodical repairs and maintenance, supplies, consumables, stores, refractories, lubricants etc. To take care of these expenses a provision of $ 8.7 has been made per ton of ferro-silicon and $ 8.0 per ton for ferro-manganese. An additional sum of $ 0.55 per ton of production of each ferro-alloy has been allocated to cover the relining expenses. These estimates are based on ferro-alloy practice prevailing in India.

General plant expenses

The general plant expenses cover the salaries and fringe benefits for the executives, administrative and commercial staff and other expenses for stationery, postage, telephone and insurance for fixed assets and inventories. The total annual expense on this account is estimated at $ 597,000 which has been equally apportioned for ferro-silicon and ferro-manganese for calculating the production cost of ferro-alloys. The general administration and overhead expenses per ton of ferro-silicon (75 per cent grade) is estimated at $ 11.7 and that for ferro-manganese at $ 5.2.

Cost of electric power

The manufacturing expenses of ferro-silicon and ferro-manganese excluding electric power, have been estimated in Appendices 22-2 to 22-4. As discussed earlier, electric power constitutes a significant portion of the production cost of ferro-alloys. The incidence of varying energy costs on the works production cost of the ferro-alloys involved, other factors remaining the same, is indicated in Figures IV-3 and IV-4.

The financial analysis has been made on the basis of an average power rate of 5 mills (0.375 rials) per kWh. As mentioned earlier, this is approximately double the power rate charged for the Arak aluminium plant. The rate of 5 mills per kWh is considered reasonable for an electro-metallurgical plant like the proposed ferro-alloy plant with a large power consumption.

Production cost

The works production costs of ferro-silicon and ferro-manganese on the basis of the suggested power rate of 5 mills per kWh are given in Table 22-2.

Table 22-2

PRODUCTION COST ESTIMATE OF FERRO-SILICON AND FERRO-MANGANESE

	Ferro-silicon		Ferro-manganese
	75% grade	45% grade	
	$/ton	$/ton	$/ton
Cost of materials	75.53	44.66	110.34
Cost of electric power a/	43.10	23.50	17.50
Other costs	32.35	23.51	18.77
Total	148.98	91.67	146.61

a/ Average power cost 5 mills/kWh

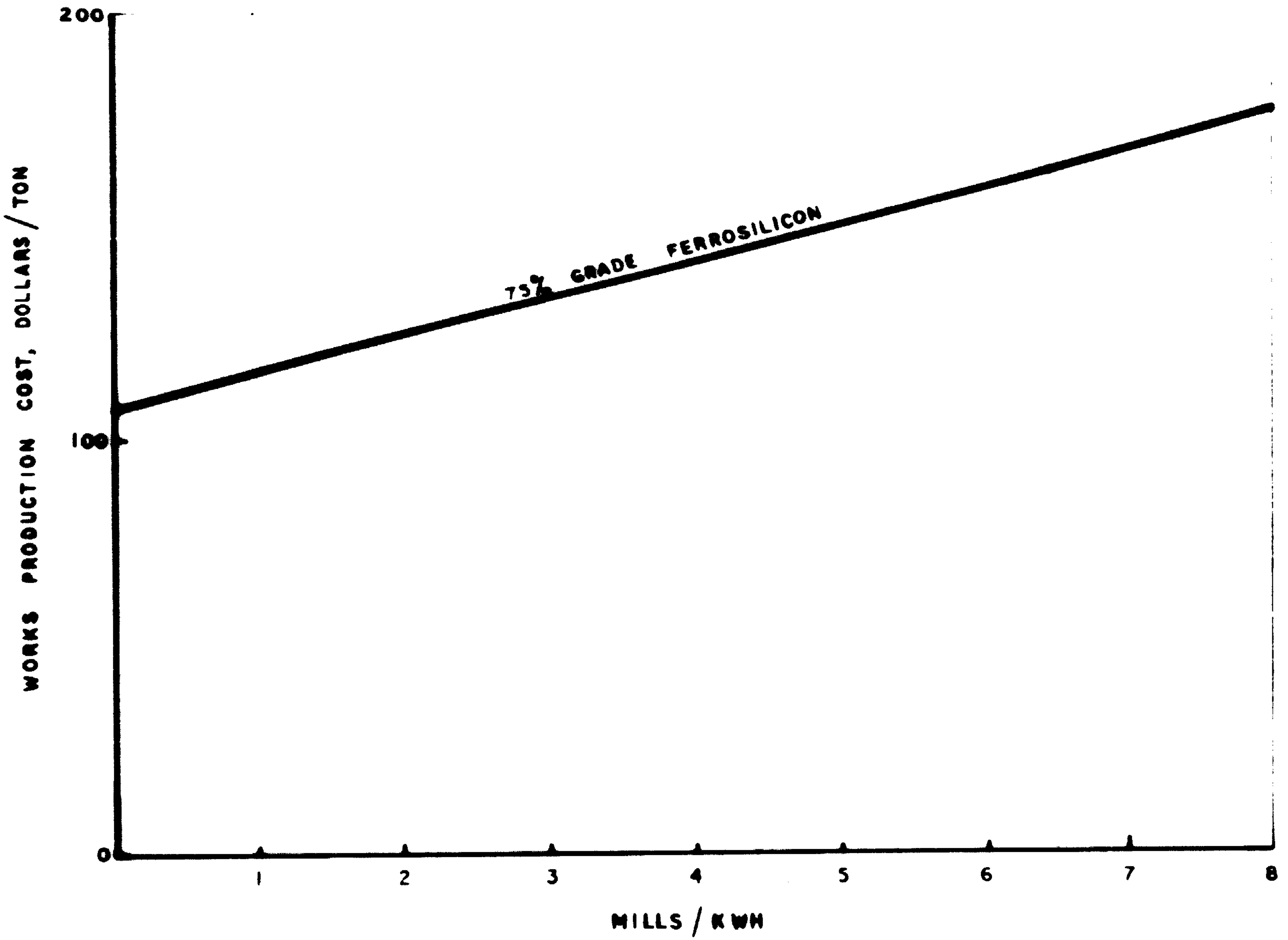

FIG. IV – 3. VARIATION OF PRODUCTION COST WITH ENERGY CHARGES

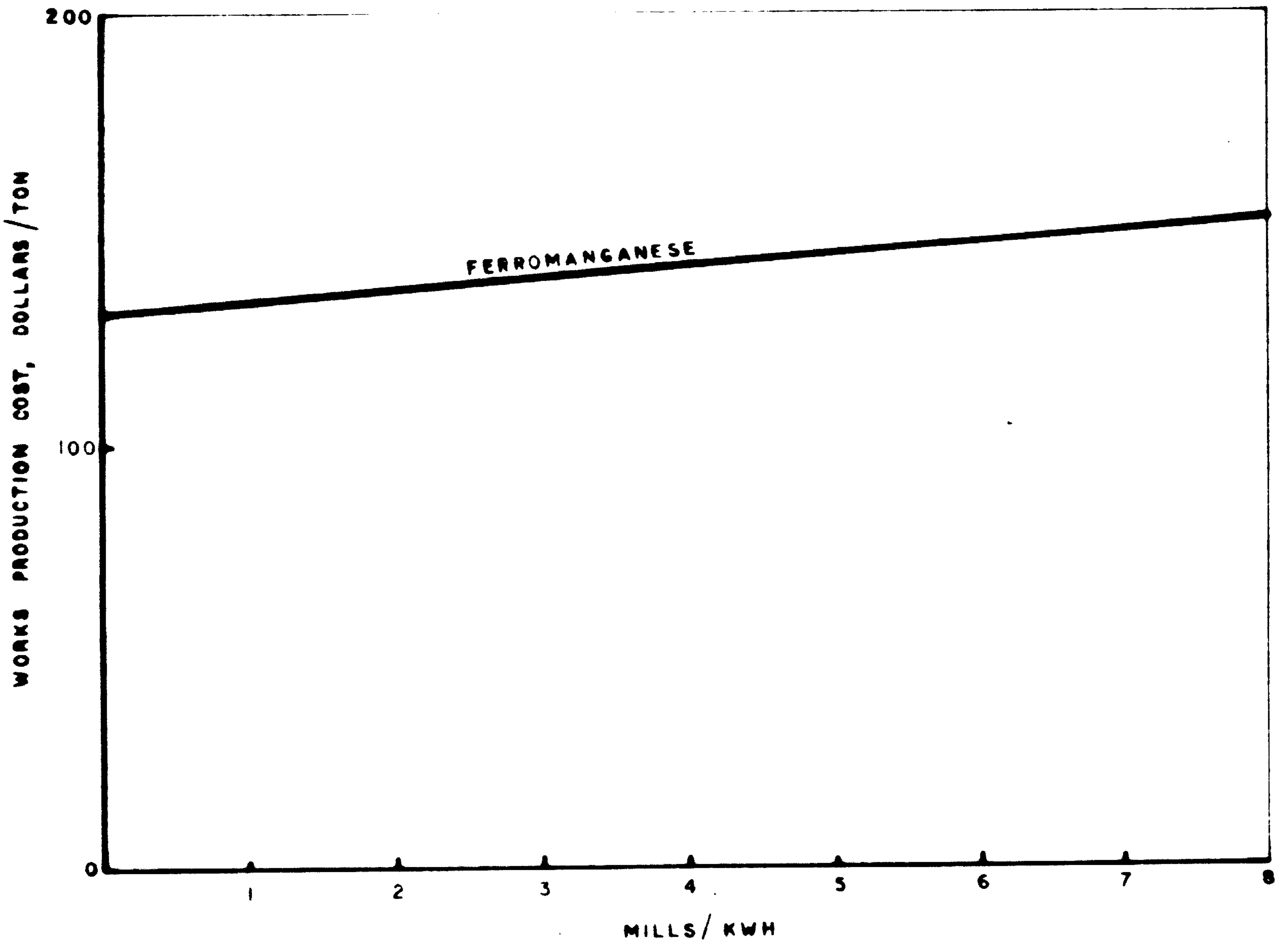

FIG. IX – 4. VARIATION OF PRODUCTION COST WITH ENERGY CHARGES

23 - FINANCIAL ANALYSIS

In this chapter the financial implications of the project for first fifteen years of operation have been discussed.

Estimated project cost

The total project cost comprises capital cost of the plant, promotional expenses, start up expenses, training expenses and expenditure incurred in obtaining technical assistance. The estimated total project cost is given in Table 23-1.

Table 23-1

ESTIMATED TOTAL PROJECT COST
(Thousand dollars)

		Foreign currency	Local currency	Total
1.	Plant cost ..	6 139	3 719	9 858
2.	Promotional expenses ..	-	50	50
3.	Start up expenses ..	-	32	32
4.	Training expenses ..	42	78	120
5.	Technical assistance ..	-	80	80
6.	Interest on loan during construction ..	400	-	400
	Total ..	6 581	3 959	10 540
		Say $ 10.5 million		

23 - Financial analysis (cont'd)

The total project cost is estimated at about $ 10.5 million of which the capital cost of the plant is $ 9.9 million as discussed in chapter 22.

Promotional expenses

The promotional expenses include expenses for issue of shares, company flotation, printing of memorandum and articles of association etc. The entire expenditure of $ 50,000 is expected to be in local currency.

Start up expenses

Start up expenses include the cost of materials, utilities, consumables and labour involved in trial runs to start the plant. The entire expenses estimated at $ 32,000 are assumed to be incurred in local currency.

Training expenses

The estimates for expenses in training key personnel have been discussed in chapter 21. The expenditure incurred in this connection is partly in local currency and partly in foreign currency. The local currency expenditure of $ 78,000 covers the salaries and wages of the key personnel during the training period and travel expenses from Iran to and from the training centres abroad. All living expenses at the place of training estimated at $ 42,000 have to be incurred in foreign currency.

Technical assistance

A provision of $ 80,000 in local currency has been made to cover the expenses to be incurred on foreign experts to provide technical assistance during initial period of operation.

Interest during construction

The interest on loan capital during the construction period is part of the total project cost. It is assumed that no payments against the interest accumulations will be made till the plant goes into production. Based on phasing of borrowings, the interest on loan capital computed at 8 per cent per annum during construction period works out to $ 400,000.

Financing pattern of capital

The capital structure as envisaged provides for raising $ 5 million by equity capital and the remaining $ 5.5 million as loan. The financing pattern has been evolved on the basis of the proposed construction schedule, and is given in Table 23-2.

Table 23-2

FINANCING PATTERN OF CAPITAL

(Thousand dollars)

		1st year	2nd year	Total
Equity capital	..	2 500	2 500	5 000
Loan amount	..	-	5 100	5 100
Interest on loan during construction at 8%	..	-	400	400
Total capital	..	2 500	8 000	10 500

Profit and loss statement

The profit and loss statement has been prepared on the basis of the following assumptions:

i) **Production**: The plant can operate at the rated capacity within three years from the date of starting up. However, the actual production of ferro-manganese is assumed at a lower level than the rated capacity till the 8th year to match the anticipated domestic market demand. From the 9th year, the plant is expected to produce at the full rated capacity.

ii) **Pattern of sales**: It is assumed that ferro-silicon will be sold in the domestic market to meet the local demand and the surplus will be exported. In the case of ferro-manganese, the works cost of production amounts to $ 146.6 per ton. Since the export price per ton is about $ 105 (based on U.K. market prices for the last quarter of 1969), it is assumed that ferro-manganese will be produced to meet the local demand only and there will be no exports. However, the implications of exports are also discussed later in this chapter.

23 - Financial analysis (cont'd)

The pattern of sales has been assumed as given in the following table:

Table 23-3

PATTERN OF SALES OF FERRO-ALLOYS

Year of operation	Ferro-silicon (75%)		Ferro-manganese domestic
	Domestic tons	Export tons	tons
I	4 500	4 500	13 000
II	6 000	9 000	17 500
III	7 500	9 500	22 000
IV	9 000	8 000	26 500
V	10 000	7 000	29 000
VI	11 000	6 000	31 500
VII	12 000	5 000	34 000
VIII	13 000	4 000	36 500
IX	14 000	3 000	38 000
X	15 000	2 000	38 000
XI	16 000	1 000	38 000
XII to XV	17 000	-	38 000

Government protection and subsidy

iii) Sales price: The sales price of ferro-alloys has been estimated taking into consideration the local prices prevailing in September 1969, and U.K. prices of 1969 and the policy regarding protection and subsidy of the Imperial Government of Iran. The Ministry of Economy, Imperial Government of Iran, has indicated that if necessary a protection of 30 per cent maximum on c.i.f. value could be extended to local producers for sale of ferro-alloys in the local market, and a subsidy of 20 per cent maximum on f.o.b. price could be granted for exports.

the supply of water and power requirements for construction may be made from the National Iranian Steel Company.

Surveys

An initial survey will have to be conducted to fix a grid pattern at the selected site and to locate the main reference towers for a precision survey to be carried out at a later date.

A central construction campus consisting of open storage areas, covered sheds etc will have to be constructed to receive and store construction material, consumables and incoming equipment. Special provision will have to be made for storage of cement in covered sheds.

Construction phase

The major activities of plant construction with their durations are indicated in the construction schedule given in Drawing No. 5131-IV-8. The major operations in their proper sequence are outlined in the critical path network given in Drawing No. 5131-IV-9 and the activities that will need special care for the completion of the project in time are emphasised. It is expected that the completion time of the project excluding the preparatory phase would be about 24 months.

23 - Financial analysis (cont'd)

Prevailing prices

Recent prices of 75 per cent grade ferro-silicon and ferro-manganese are given in Table 23-4.

Table 23-4

RECENT PRICES OF FERRO-SILICON AND FERRO-MANGANESE

		Ferro-silicon (75% grade) $/ton	Ferro-manganese $/ton
A. Local market			
f.o.b. West European port	Sep 1969	220	...
f.o.b. India	Jun 1969	...	118
c.i.f. Khorramshahr	Sep 1969	250	140
f.o.r. Isfahan	Sep 1969	290 a/	180 a/
f.o.r. Isfahan	-	...	288 b/
f.o.r. Arak	-	...	266 c/
B. U.K. market			
1969 - 3rd quarter		170 d/	120
- 4th quarter		180 d/	123
1970 - 1st quarter		196 d/	133

a/ Derived by adding customs duty and internal freight to c.i.f. Khorramshahr price

b/ As per detailed project report of Isfahan steel plant

c/ As per Memorandum of instructions for designing of machine building plant at Arak

d/ Maximum of bulk delivery

Sales price

The selling prices assumed for this study are as follows:

Market	Basis	Ferro-silicon (75% grade) $/ton	Ferro-manganese $/ton
Domestic	f.o.r. Isfahan	280	200
Export	f.o.r. Isfahan	135	85
Export	f.o.b. Persian gulf port	160	105

iv) Sales receipts: The total sales receipts are computed on the basis of the proposed pattern of sales (Table 23-3) and the sales prices as assumed above.

v) Manufacturing expenses: The manufacturing expenses include cost of raw materials, electric power, labour, supervision, general plant expenses and other costs. The other costs comprise expenses incurred for utilities, consumables, repair and maintenance and relining reserve. The different items of costs involved in the manufacturing expenses have been discussed in chapter 22 for ferro-silicon and ferro-manganese separately. The total manufacturing expenses are computed on the basis of the total annual production and the costs involved for each item per ton of production as discussed in chapter 22.

vi) Depreciation: Depreciation has been calculated on straight line basis at 8 per cent per annum on the plant cost excluding land.

vii) Working capital: Working capital requirement is estimated as oqual to 3 months' manufacturing expenses.

23 - Financial analysis (cont'd)

Interest on working capital has been taken at 12 per cent per annum.

viii) Repayment of loan capital and interest: The loan capital is assumed to be repaid in 10 equal annual instalments starting from the third year of operation. Interest on loan capital at 8 per cent has been assumed to be paid annually on the balance amount outstanding at the beginning of the year.

ix) Deferred charges: The expenses incurred in starting up the plant, in obtaining technical assistance and the interest on loan capital during construction period have been amortized in full in the first 10 years of operation in equal instalments. The total deferred charges work to $ 682,000 as follows:

			(Thousand dollars)
1.	Promotional expenses	..	50
2.	Start up expenses	..	32
3.	Training expenses	..	120
4.	Technical assistance	..	80
5.	Interest on loan during construction	..	400
	Total	..	682

This amount has been rounded off to $ 700,000 and amortization charge per annum is $ 70,000.

x) <u>Taxation</u>: According to the Inland Revenue Act 1967, corporations are taxed on their gross profits, less exemptions. Exemptions which could be availed of are:

i) <u>5 to 100 per cent of the gross profit for 5</u> years depending on the importance, nature and geographical location of the proposed industry;

ii) <u>20 to 100 per cent of the gross profit for 10</u> years for enterprises located outside the principal cities, near the geographic boundaries of the country; and

iii) export incentive in the form of full exemption on profits earned from exports.

Considering the importance of the ferro-alloys industry and the proposed location of the project (about 43 km outside the city of Isfahan) it is assumed: (a) the project will be exempted from payment of income-tax for the initial period of five years, and (b) thereafter (from 6th year onwards) profits earned from exports will be exempted from tax; and (c) 50 per cent of the profits earned from domestic sale after the initial period of 5 years will be exempted from the tax.

It will be observed that tax will be payable only from the 6th year of operation. For the purpose of this exercise an adhoc taxation rate of 33 per cent of the total income from the project from the 6th year onwards has been assumed.

Profit and loss statement

The statement of estimated profit and loss after tax resulting from the operation of the plant over a period of 15 years is given in Table 23-5. The results of the first two years reveal a total loss of about $ 766,000; all the subsequent years reveal profits. The profits improve over the years as the long-term loans are being repaid and interest charges are progressively reduced. Also, as the deferred charges are amortized in the first ten years of operation, there is a marked improvement in profitability from the eleventh year.

The cumulative net profits after tax over the fifteen year period are of the order of about $ 21 million yielding an annual average net profit after tax of $ 1.4 million. This corresponds to a return of about 13.3 per cent per annum on the initial investment of $ 10.5 million.

Table 23-5

PROFIT AND LOSS STATEMENT

(Thousand dollars)

		YEAR OF OPERATION											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
A. Income													
Sales receipt - Ferro-silicon													
- domestic @ $ 280	..	1 260	1 680	2 100	2 520	2 800	3 080	3 360	3 640	3 920	4 200	4 480	4
- export @ $ 135	..	608	1 215	1 283	1 080	945	810	675	540	405	270	135	
Ferro-manganese													
- domestic @ $ 200	..	2 600	3 500	4 400	5 300	5 800	6 300	6 800	7 300	7 600	7 600	7 600	7
Total (A)	..	4 468	6 395	7 783	8 900	9 545	190	10 835	11 480	11 925	12 070	12 215	12
B. Manufacturing expenses													
Raw materials	..	2 096	3 036	3 678	4 173	4 448	4 668	4 998	5 218	5 438	5 438	5 438	5
Electric power	..	616	953	1 118	1 197	1 241	1 276	1 328	1 363	1 398	1 398	1 398	1
Labour & supervision	..	383	383	383	383	383	383	383	383	383	383	383	
General plant expense	..	397	397	397	397	397	397	397	397	397	397	397	
Other costs	..	203	301	380	401	423	441	468	486	504	504	504	
Total (B)	..	3 695	5 070	5 936	6 551	6 892	7 165	7 574	7 [illegible]	8 120	8 120	8 120	8
C. Gross profit/loss (A-B)	..	773	1 325	1 847	2 349	2 653	3 025	3 261	3 [illegible]	3 805	3 950	4 095	4
D. Other expenses													
Depreciation	..	784	784	784	784	784	784	784	784	784	784	784	
Interest on working capital	..	120	156	180	192	204	216	228	240	240	240	240	
Interest on loan capital	..	440	440	440	396	352	308	264	220	176	132	88	
Deferred charges	..	70	70	70	70	70	70	70	70	70	70	-	
Total (D)	..	1 414	1 450	1 474	1 442	1 410	1 378	1 346	1 314	1 270	1 226	1 112	1
E. Net profit/loss (C-D) - current	..	- 641	- 125	373	907	1 243	1 547	1 915	2 [illegible]	2 535	2 724	2 983	3
F. Tax	..	-	-	-	-	-	544	632	765	837	899	984	1
G. Profit/loss - current	..	- 641	- 125	373	907	1 243	1 103	1 283	1 [illegible]	1 698	1 825	1 999	2
(after tax) - cumulative	..	- 641	- 766	- 393	514	1 757	2 860	4 143	5 [illegible]	7 395	9 [illegible]	11 219	13

Table 23-5

PROFIT AND LOSS STATEMENT

(Thousand dollars)

YEAR OF OPERATION													
II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
1 680	2 100	2 520	2 800	3 080	3 360	3 640	3 920	4 200	4 480	4 760	4 760	4 760	4 760
1 215	1 283	1 080	945	810	675	540	405	270	135	-	-	-	-
3 500	4 400	5 300	5 800	6 300	6 800	7 300	7 600	7 600	7 600	7 600	7 600	7 600	7 600
6 395	7 783	8 900	9 545	190	10 835	11 480	11 925	12 070	12 215	12 360	12 360	12 360	12 360
3 036	3 678	4 173	4 448	4 668	4 998	5 218	5 438	5 438	5 438	5 438	5 438	5 438	5 438
953	1 118	1 197	1 241	1 276	1 328	1 363	1 398	1 398	1 398	1 398	1 398	1 398	1 398
383	383	383	383	383	383	383	383	383	383	383	383	383	383
397	397	397	397	397	397	397	397	397	397	397	397	397	397
301	360	401	423	441	468	486	504	504	504	504	504	504	504
5 070	5 936	6 551	6 892	7 165	7 574	7 847	8 120	8 120	8 120	8 120	8 120	8 120	8 120
1 325	1 847	2 349	2 653	3 025	3 261	3 633	3 805	3 950	4 095	4 240	4 240	4 240	4 240
784	784	784	784	784	784	784	784	784	784	784	399	-	-
156	180	192	204	216	228	240	240	240	240	240	240	240	240
440	440	396	352	308	264	220	176	132	88	44	-	-	-
70	70	70	70	70	70	70	70	70	-	-	-	-	-
1 450	1 474	1 442	1 410	1 376	1 346	1 314	1 270	1 226	1 112	1 068	639	240	240
- 125	373	907	1 243	1 547	1 915	2 319	2 535	2 724	2 983	3 172	3 601	4 000	4 000
-	-	-	-	544	632	765	837	899	984	1 047	1 188	1 320	1 320
- 125	373	907	1 243	1 103	1 283	1 554	1 698	1 825	1 999	2 125	2 413	2 680	2 680
- 766	- 393	514	1 757	2 860	4 143	5 697	7 395	9 220	11 219	13 344	15 757	18 437	21 117

Cash flow

Estimated figures of cash flows generated by the project operations over a period of 15 years are presented in Table 23-6. It will be seen from this table that sufficient funds are available from the third year of operation for repayment of long-term loans at a fairly steady rate. The full amount of long-term loans is repaid by the twelfth year. After repayment of long-term loans, there is a cumulative net surplus of about $ 26 million at the end of the fifteenth year against the shareholders' investment of about $ 5 million.

Contributory margin

The difference between the annual sales receipts and sum of annual costs of raw materials, power and other direct manufacturing costs represents the 'contributory margin'. This amounts to $ 4.59 million on the ninth year, which is the first year of production at rated capacity. This corresponds to a contributory margin : sales receipt ratio of 0.39. It increases to $ 5.02 million from the twelfth year onwards when the entire production is sold to the domestic market, giving a contributory margin : sales receipt ratio of 0.41.

Table

CASH FLOW

(Thousand

		I	II	III	IV	V	VI
Cash inflow							
Profit/loss after tax	..	-641	-125	373	907	1 243	1 1
Add: depreciation	..	784	784	784	784	784	7
deferred charges	..	70	70	70	70	70	
Operating surplus/	..	213	729	1 227	1 761	2 097	1 9
Cash outflow							
Loan repayment	..	-	-	550	550	550	55
Net surplus/deficiency - current	..	213	729	677	1 211	1 547	1 4
- cumulative	..	213	942	1 619	2 830	4 377	5 7

SECTION 1

Table 23-6

CASH FLOW STATEMENT

(Thousand dollars)

Table 23-6

Year of operation												
III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
373	907	1 243	1 103	1 283	1 554	1 698	1 825	1 999	2 125	2 413	2 680	2 680
784	784	784	784	784	784	784	784	784	784	399	-	-
70	70	70	70	70	70	70	70	-	-	-	-	-
1 227	1 761	2 097	1 957	2 137	2 408	2 552	2 679	2 783	2 909	2 812	2 680	2 680
550	550	550	550	550	550	550	550	550	550	-	-	-
677	1 211	1 547	1 407	1 587	1 858	2 002	2 129	2 233	2 359	2 812	2 680	2 680
1 619	2 830	4 377	5 784	7 371	9 229	11 231	13 360	15 593	17 952	20 764	23 444	26 124

SECTION 2

Procurement and installation of equipment

After the capacities and type of major equipment are decided upon, the specifications and tender documents will have to be prepared by consulting engineers for inviting tenders from selected parties on a global basis. The issue of tenders and the placing of orders will be phased out in the order of priority so that the equipment is delivered in time and units planned for early completion as well as those with long delivery period are expedited.

The feasibility of having the equipment manufactured locally will have to be investigated. Maximum utilisation of local supplies will be kept in view at all stages of designing and engineering.

The erection of major equipment will be entrusted to firms having sufficient experience, finance, tools, tackles and skilled labour, and the work will be carried out under the guidance of the oquipment supplier.

Structural steelwork

Structural steel requirements which cannot be met from the local producers are proposed to be imported directly by the project authorities. Fabrication of structural steel (totalling about 2,600 tons) will be

23 - Financial analysis (cont'd)

Break-even chart

The break-even chart (Fig. IV-5) indicates the variable cost, total cost and sales receipt at various levels of output. For the purpose of this exercise fixed costs are deemed to include the following:

i) labour and supervision,
ii) general plant expenses,
iii) depreciation,
iv) deferred charges, and
v) interests on working and loan capital.

The fixed costs work out to $ 2.05 million in the ninth year (the first year of operation at the rated capacity).

The variable cost comprises costs of following items:

i) raw materials,
ii) electric power
iii) other manufacturing expenses

The cost of these variable items amounts to $ 7.34 million per annum at the rated capacity of the plant thus bringing the total costs to about $ 9.4 million per annum.

The sales realisation in the ninth year is about $ 11.9 million or say $ 12 million and the break-even chart (Fig. IV-5) is prepared on the basis of sales realisation and expenses in the ninth year of operation. It will be seen from the chart that the break-even point is reached when the plant operates at about 44 per cent of the rated capacity.

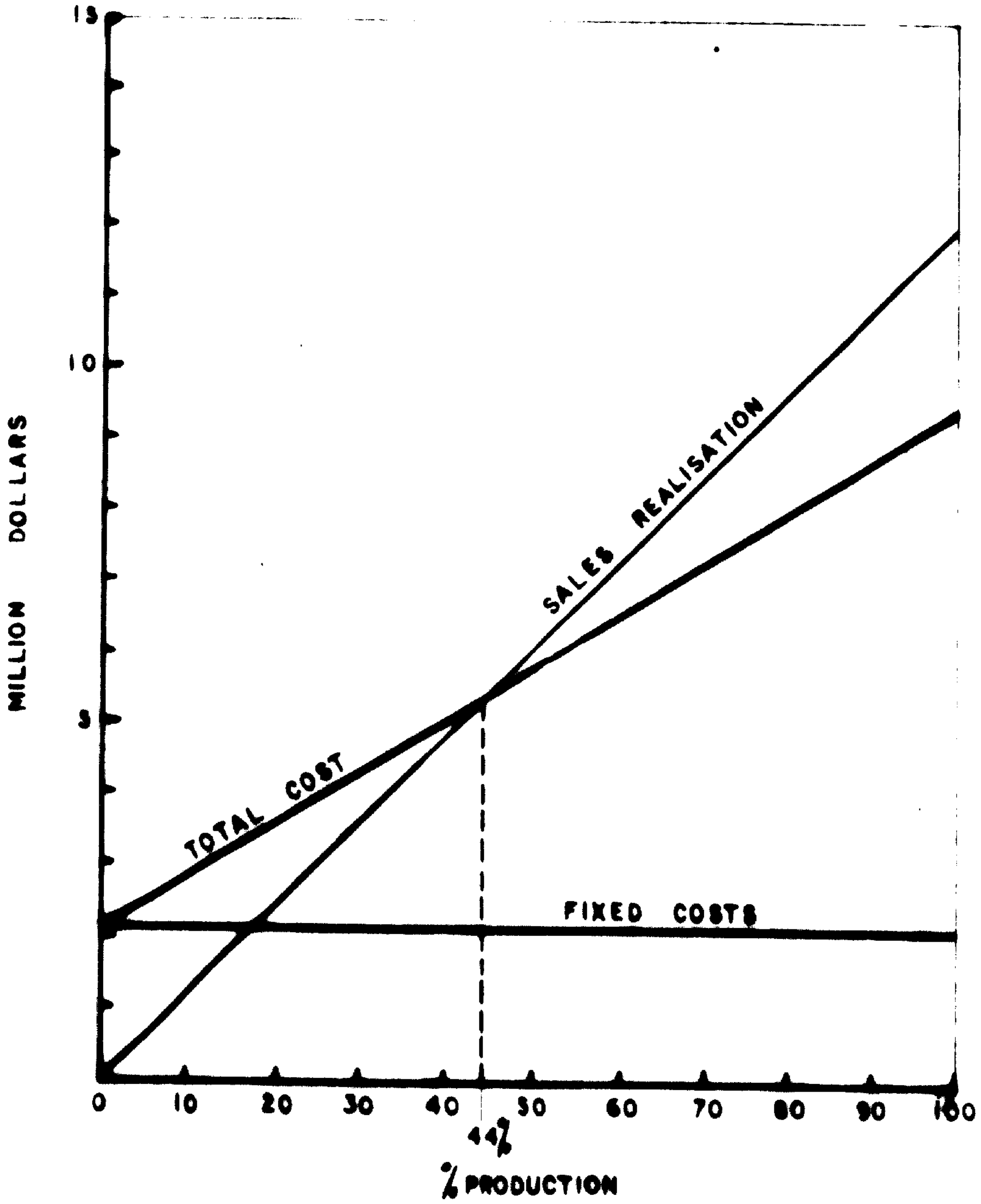

FIG. II-5. BREAK-EVEN CHART

23 - Financial analysis (cont'd)

Internal rate of return

Adjusted cash flow

The cash flow figures adjusted to find out the real cash surplus generated by the plant operation for working out the internal rate of return and the excess present value are given in Table 23-7.

Table 23-7

ADJUSTED CASH FLOW

(Thousand dollars)

Year of operation	Operating surplus[a]	Add interest		Residual value of equipment	Salvaged working capital	Adjusted inflow
		Working capital	Loan capital			
I	213	120	440			773
II	729	156	440			1 325
III	1 227	180	440			1 847
IV	1 761	192	396			2 349
V	2 097	204	352			2 653
VI	1 957	216	308			2 481
VII	2 137	228	264			2 629
VIII	2 408	240	220			2 828
IX	2 552	240	176			2 968
X	2 679	240	132			3 051
XI	2 783	240	88			3 111
XII	2 909	240	44			3 193
XIII	2 812	240	-			3 052
XIV	2 680	240	-			2 920
XV	2 680	240	-	980	2 000	5 900

a/ From Table 23-6.

For this adjustment, apart from adding back depreciation charges (which do not involve actual cash outflows during the operation period), interest on long-term loans and interest on working capital have also been added back to net surplus from operation. In the fifteenth year of operation, the residual value of the plant estimated at about $ 980,000 (10 per cent of the original plant cost) is added back. The working capital requirement of about $ 2 million is also shown as fully salvaged at the end of fifteen years and for the purpose of this exercise, shown as an inflow in the fifteenth year.

Internal rate of return

The beginning of the first year of operation is taken as the zero point for the purpose of working out present values and, therefore, all fixed investment outflows during the two year construction period have been compounded. Outflows by way of working capital during the first eight years of operation are discounted and all cash inflows representing net operational surplus as derived from Table 23-7 have been discounted. All outflows are assumed to be occurring at the beginning of each year and inflows to accrue at the end of each year. In Table 23-8 the present values of the outflows and inflows have been arrived at by adopting two trial rates - 14 per cent and 15 per cent. This analysis reveals that the internal rate of return after tax on this project is about 14.8 per cent.

23 - Financial analysis (cont'd)

Table 23-8

INTERNAL RATE OF RETURN

(Thousand dollars)

		Cash outflow			Cash inflow		
		Estimate for the period	Discounted at		Estimate for the period	Discounted at	
			14%	15%		14%	15%
Construction period							
0-12 months		2 500	3 249	3 306			
13-24 months		7 600	8 664	8 740			
Year of operation							
I	..	1 000	1 000	1 000	773	678	673
II	..	300	263	261	1 325	1 019	1 002
III	..	200	154	151	1 847	1 247	1 215
IV	..	100	68	66	2 349	1 391	1 344
V	..	100	59	57	2 653	1 377	1 319
VI	..	100	52	50	2 481	1 131	1 072
VII	..	100	46	43	2 629	1 052	989
VIII	..	100	40	38	2 868	1 007	939
IX	..	-	-	-	2 968	914	843
X	..	-	-	-	3 051	824	754
XI	..	-	-	-	3 111	737	669
XII	..	-	-	-	3 193	664	597
XIII	..	-	-	-	3 052	555	497
XIV	..	-	-	-	2 920	467	412
XV	..	-	-	-	5 900	826	726
Total	..	12 100	13 595	13 712	41 120	13 889	13 051

Average rate of return

Excess at lower trial rate (14%) = 13 889-13 595 = 294

Deficit at higher trial rate (15%) = 13 712-13 051 = 661

$$\therefore \text{Average rate of return} = 14 + \left(\frac{294}{(294 + 661)}\right) = 14.31\% \quad \underline{\text{Say } 14.3\%}$$

23 - Financial analysis (cont'd)

Excess present value analysis

The adjusted net cash flows (given in Table 23-7) have been discounted at a rate of 8 per cent to work out the estimated present value of the net inflows over the fifteen year period and is given in Table 23-9.

It is noted that the total present value of net inflows at 8 per cent amounts to $ 21 million as against a total outflow of about $ 13 million including working capital. The excess present value on this basis amounts to $ 8 million ($ 21 million - 13 million).

The present value index which is worked out as the ratio of the total present value ($ 21 million) divided by total outflow ($ 13 million) is 1.62.

Pay-back period

The pay-back period is worked out on the traditional basis of actual net inflows and also on the basis of discounted net inflows. For this analysis, only fixed investment ($ 10.5 million) is taken into consideration; investment in working capital is ignored. Therefore, only interest on long-term loans is added back. The working is shown in Table 23-10.

On the traditional basis, the pay-back period is worked out at 7.2 years and on discounted basis at 8 per cent per annum it works out to 8.5 years.

23 - Financial analysis (cont'd)

Table 23-9

EXCESS PRESENT VALUE

(Thousand dollars)

Cost of capital - 8%

		Cash outflows		Cash inflows	
		Estimate for the period	Present value	Estimate for the period	Present value
Construction period					
0-12 months	..	2 500	2 916		
13-24 months	..	7 600	8 208		
Year of operation					
I	..	1 000	1 000	773	716
II	..	300	278	1 325	1 136
III	..	200	171	1 847	1 467
IV	..	100	79	2 349	1 727
V	..	100	74	2 653	1 807
VI	..	100	68	2 481	1 563
VII	..	100	63	2 629	1 533
VIII	..	100	58	2 [illegible]	1 540
IX	..	-		2 968	1 484
X	..	-		3 051	1 413
XI	..	-		3 111	1 335
XII	..	-		3 193	1 268
XIII	..	-		3 052	1 123
XIV	..	-		2 920	993
XV	..	-		5 900	1 859
Total	..	12 100	12 915	41 [illegible]	21 973

23 - Financial analysis (cont'd)

Table 23-10

PAY BACK PERIOD
(Thousand dollars)

A. CASH INFLOW

Year of operation (1)	Current (2)	Cumulative (3)	Adjusted cash flow Add interest of loan (4)	Adjusted cash flow Adjusted inflow (5)=(2)+(4)	Present value of (5) at 8% discount Current (6)	Present value of (5) at 8% discount Cumulative (7)
I	213	213	440	653	605	605
II	729	942	440	1 169	1 002	1 607
III	1 227	2 169	440	1 667	1 324	2 931
IV	1 761	3 930	396	2 157	1 585	4 516
V	2 097	6 027	352	2 449	1 668	6 184
VI	1 957	7 984	308	2 265	1 427	7 611
VII	2 137	10 121	264	2 401	1 400	9 011
VIII	2 408	12 529	220	2 628	1 419	10 430
IX	2 552	15 081	176	2 728	1 364	11 794
X	2 679		132	2 811	1 301	13 095
XI	2 783		88	2 871		
XII	2 909		44	2 953		
XIII	2 812		-	2 812		
XIV	2 680		-	2 680		
XV	2 680		-	2 680		

B. CASH OUTFLOW (Investment)

Construction period		Estimate for the period	Present value compounded at 8%
0-12 months	..	2 500	2 916
13-24 months	..	7 600	8 208
Interest during construction		400	-
		10 500	11 124

C. PAY-BACK PERIOD

(a) Conventional method = $7 + \frac{10\ 500 - 10\ 121}{2\ 408}$ = 7.16 years

(b) Present value basis = $8 + \frac{11\ 124 - 10\ 430}{1\ 364}$ = 8.51 years

Savings in foreign exchange

For the establishment of the proposed plant the foreign exchange requirement will be about $ 6.6 million. As against this, Iran will not only be self sufficient in respect of its ferro-silicon and ferro-manganese requirement, but there will be a recurring saving in foreign exchange.

However, initially Iran will have to import manganese ore, electrode paste, refractories etc. The net annual savings in foreign exchange for the first fifteen years of operation are estimated in Table 23-11.

Table 23-11

SAVINGS IN FOREIGN EXCHANGE
(Thousand dollars)

Year of operation	Foreign exchange earnings from export a/ (1)	Cost of imported ferro-alloys b/ (2)	Expenses on Import of materials c/ (3)	Expenses on Capital charges d/ (4)	Net savings (1+2)-(3+4)
I	720	3 075	1 029	540	2 226
II	1 440	4 125	1 416	540	3 609
III	1 520	5 175	1 760	540	4 395
IV	1 280	6 225	2 082	540	4 883
V	1 120	6 850	2 261	540	5 169
VI	960	7 475	2 439	540	5 456
VII	800	8 100	2 618	540	5 742
VIII	640	8 725	2 797	540	6 028
IX	480	9 200	2 904	540	6 236
X	320	9 450	2 904	540	6 326
XI	160	9 700	2 904	494	6 462
XII	-	9 950	2 904	494	6 552
XIII	-	9 950	2 904	251	6 795
XIV	-	9 950	2 904	-	7 046
XV	-	9 950	2 904	-	7 046
					[illegible] 971

a/ Based on exports indicated in Tables 23-5 and f.o.b. price given in page 23.6

b/ Based on Sept 1969 c.i.f. Khorramshahr prices of ferro-alloys (Table 23-4) and domestic sales indicated in Table 23-5, excluding customs duty and internal freight.

c/ Based on production indicated in Table 23-5.

d/ 63% of depreciation plus 65% of deferred charges given in Table 23-5.

The estimated saving in foreign exchange in the first year of operation is $ 2.2 million and increases progressively to about $ 7 million per annum by the 15th year. The total net savings in foreign exchange in the first 15 years of operation amount to about $ 84 million.

Rate of return of foreign exchange

For working out the rate of return, the foreign exchange, cash flow figures have been adjusted. The foreign exchange cash outflows during the two years of construction period have been considered as 63 per cent of the total outflows indicated in Table 23-9. (This corresponds to the same proportion as the foreign exchange component of capital investment). The annual foreign exchange flows have been derived by adding back the expenses on capital charges to the net savings (Table 23-11).

All outflows are assumed to be occurring at the beginning of the year and inflows to accrue at the end of the year. The start of operation has been considered as the zero point. The present values of outflows and inflows have been calculated at different rates and are given in Table 23-12. The analysis indicates that the rate of return of foreign exchange is 43.7 per cent.

carried out at site. The selection of contractors may preferably be done on the basis of rate contract (rate per ton) for different categories of steelwork.

Civil work

Construction of ancillary buildings such as administration office, canteen etc and construction of roads have to be taken up well ahead of the plant buildings. During the construction period, these buildings may be utilised as site offices.

Tenders have to be invited for the construction of foundations for plant buildings and foundations for machinery and equipment. Contractors with sufficient experience of this kind of work have to be engaged to ensure speedy and efficient execution of the work. Tenders will be called on item rate basis and quantities for all the major items of work will be indicated in the tender. Total quantity of r.c. work is estimated at about 9,200 cu m.

Roads

It will be advisable to take up the construction of the main internal roads and early as possible to avoid unnecessary construction of a number of temporary roads independent of the permanent roads. The roads should be

23 - Financial analysis (cont'd)

Table 23-12

RATE OF RETURN OF FOREIGN EXCHANGE

(Thousand dollars)

	Foreign exchange outflow			Foreign exchange inflow		
	Estimate for the period	Compounded at		Estimate for the period	Discounted at	
		40%	45%		40%	45%
Construction period						
0-12 months ..	1 600	3 136	3 364			
13-24 months ..	4 800	6 720	6 960			
Commencement of operation						
I ..				2 766	1 975	1 909
II ..				4 149	2 116	1 975
III ..				4 935	1 796	1 618
IV ..				5 423	1 410	1 226
V ..				5 709	1 062	891
VI ..				5 996	797	648
VII ..				6 282	597	465
VIII ..				6 568	447	335
IX ..				6 776	325	237
X ..				6 866	240	165
XI ..				6 956	174	118
XII to XV ..				28 184	324	211
Total ..	6 400	9 856	10 324	90 610	11 263	9 798

Average rate of return:

Excess at lower trial rate (40%) = 11 263 - 9 856 = 1 407

Deficit at higher trial rate(45%) = 10 324 - 9 798 = 526

$$\text{Average rate of return} = 40 + 5 \left(\frac{1\,407}{(1\,407 + 526)}\right)$$

$$= \underline{43.65\%}$$

Effect of ferro-manganese export

The financial analysis presented so far has not considered export of ferro-manganese, as the cost of production is below the export price obtainable as discussed earlier. However, in the first eight years of operation the plant does have excess capacity for production of ferro-manganese and since there is no demand for it in the home market, the implications of export may be considered. Although the export price may not cover the full cost of production, the possibility of export should be explored with a view to:

a) earn foreign exchange towards compensating for the exchange incurred in initial imports of manganese ore, and

b) improve the commercial viability of the project by spreading the incidence of fixed charges over a larger quantity of production.

The second objective will be achieved provided the export price is adequate to cover atleast the works cost of production. However, as discussed earlier, the works cost of production is about $ 146 per ton as against the export price of only $ 105 and hence by producing the extra quantity the plant's economics will deteriorate and involve losses in local currency at the rate of about $ 41 ($ 146-$ 105) per ton of production.

The only consideration then for manufacturing ferro-manganese would be to earn foreign exchange and the implications of doing so are now examined. After meeting domestic demand, the exportable surplus available is as follows:

Year of operation		Exportable surplus Tons
I	..	9 000
II	..	10 000
III	..	11 000
IV	..	11 000
V	..	9 000
VI	..	6 500
VII	..	4 000
VIII	..	1 500
IX onwards	..	-

The works cost of production of ferro-manganese has been estimated at $ 146 per ton. The foreign exchange component of the works cost with different proportions of imported manganese ore and f.o.b. earnings are compared as follows:

Proportion of imported manganese ore %	Foreign exchange in work cost of ferro-manganese production $/ton	Export price of ferro-manganese f.o.b. $/ton
100	71.5	105
80	58.0	105

With 100% imported ore, foreign exchange earned through export of ferro-manganese is estimated at $ 33.5 ($ 105 - $ 71.5) per ton.

23 - Financial analysis (cont'd)

At the rate of $ 33.5 per ton of production, the additional foreign exchange inflow arising out of ferro-manganese export for the first eight years of operation would be about $ 2 million as worked out below:

Year of operation		Foreign exchange earning from export ('000 $)
I	..	301
II	..	335
III	..	368
IV	..	368
V	..	301
VI	..	218
VII	..	134
VIII	..	51
Total	..	2 076

The effect of ferro-manganese export on return on foreign exchange has been evaluated in Table 23-13. The analysis indicates that the rate of return of foreign exchange would correspond to 45.4 per cent if the surplus ferro-manganese is exported.

Table 23-13

RATE OF RETURN OF FOREIGN EXCHANGE CONSIDERING EXPORT OF FERRO-MANGANESE

(Thousand dollars)

	Foreign exchange outflows			Foreign exchange inflows				
	Estimate for the period[a]	Compounded at		Estimate for the period			Discounted at	
		45%	50%	Fe-Mn export	Others[a]	Total	45%	50%
Construction period								
0-12 months ..	1 600	3 360	3 600					
13-24 months ..	4 800	6 960	7 200					
Year of operation								
I ..				301	2 766	3 067	2 116	2 046
II ..				335	4 149	4 484	2 134	1 991
III ..				368	4 935	5 303	1 739	1 570
IV ..				368	5 423	5 791	1 309	1 147
V ..				301	5 709	6 010	938	793
VI ..				218	5 996	6 214	671	547
VII ..				134	6 282	6 416	475	379
VIII ..				51	6 568	6 619	338	258
IX to XV ..				-	48 782	48 782	731	502
Total ..	6 400	10 320	10 800	2 076	90 610	92 686	10 451	9 233

Average rate of return

Excess at lower trial rate (45%) = 10 451 - 10 320 = 131
Deficit at higher trial rate (50%) = 10 800 - 9 233 = 1 567

Average rate of return $= 45 + 5 \left(\frac{131}{(131 + 1\,567)}\right)$

$= \underline{45.4\%}$

[a] Table 23-12.

APPENDICES - VOLUME IV

SECTION 1

Appendix 17.1

COMPARISON OF GENERAL FACTORS AT DIFFERENT SITES

	Isfahan	Ahwaz
1. Area		
a) Location	51°40'E. 32°37' N, Ht, above sea level 1 590 m. Isfahan site 43 km south-west of Isfahan, at Rizlanjan, north of steel plant boundary.	48°41' E. 31°20' N. Ht. above sea level 20 m. Site 12 km south-west of Ahwaz, near Iranian Rolling Mill Co area.
b) Availability of land	Adequate	Adequate
c) Acquisition problem	No difficulties envisaged except confirmation from the Isfahan steel plant authorities.	No difficulties envisaged
d) Soil conditions	Soil investigations conducted in steel plant area. Soil 1 m below ground level is very strong, negligible settling, praluvium with little gravel. Bearing capacity 3 to 8 kg/sq cm. Sub-soil water level 25 to 30 m below ground level in area near site. At some places soil contains sulphate.	Soil investigations conducted in Rolling Mill area. Bearing capacity 0.7 to 1.8 kg/sq cm. Sub-soil water 4.2 to 6.7 m below ground level. At some places, soil contains sulphate.
2. Raw material sources		
a) Quartzite	Lachoulle - 70 km by road	Lachoulle - 1 253 km by rail
b) Manganese ore - Imported	Through Khorramshahr - 1 390 km by rail	Through Khorramshahr - 137 km by rail
- Local	Ghom - 250 km by road	Ghom - 773 km by rail
c) Scrap	Isfahan steel plant - by road	Local - by road
d) Limestone	Pyrbakhon - 22 km by road	Source to be located, assumed within 100 km
e) Coke	Isfahan steel plant - by road	Isfahan steel plant - 1 253 km by rail
f) Charcoal	Isfahan area - 20 km radius, by road	Isfahan area - 1 253 km by rail
g) Electrode paste	Imported through Khorramshahr - 1 390 km by rail	Imported through Khorramshahr - 137 km by rail
3. Power supply	National Grid, 63 kV supply	National Grid, thro' K.W.P.A.
4. Water supply	From Zayanderud river, supplied by the Isfahan steel plant.	From river Karun, separate intake, treatment plant and 2 km pipeline
5. Transport link		
[illegible]	Isfahan town located on Teheran -	Ahwaz town connected to Teheran.

c) Scrap	Isfahan steel plant - by road	Local - by road
d) Limestone	ryrbakhon - 22 km by road	Source to be located, assumed within 100 km
e) Coke	Isfahan steel plant - by road	Isfahan steel plant - 1 253 km by rail
f) Charcoal	Isfahan area - 20 km radius, by road	Isfahan area - 1 253 km by rail
g) Electrode paste	Imported through Khorramshahr - 1 390 km by rail	Imported through Khorramshahr - 137 km by rail
3. Power supply	National Grid, 63 kV supply	National Grid, thro' K.W.P.A.
4. Water supply	From Zayanderud river, supplied by the Isfahan steel plant.	From river Karun, separate intake, treatment plant and 2 km pipeline
5. Transport link		
a) Road	Isfahan town located on Teheran - Shiraz metalled highway. Proposed area connected to Isfahan by a metalled road.	Ahwaz town connected to Teheran, Khorramshahr and Bandar Shahpur. Site adjacent to Ahwaz Bandar Shahpur.
b) Rail	Rail road to connect to country's network is under consideration	Nearest railway station - 15 km. Ahwaz-Khorramshahr rail passes close to the boundary.
c) Waterway	-	River Karun navigable between Ahwaz and Khorramshahr
d) Port	Khorramshahr - 1 390 km by rail	Khorramshahr - 137 km by rail or 125 km by road
6. Climatology	Temperature range from 40°C in summer and -7°C in winter. Annual rainfall varied from 60 to 300 mm in last ten years	Hot and desert dry, maximum temperature rising to 50°C.

	1964	1963	1962	1961	1960	1964	1963	1962	1961	1960
a) Temperature										
Average max °C	22.8	23.6	23.2	23.0	23.9	32.3	32.5	33.7	32.3	33.6
Average min °C	8.4	9.4	8.5	8.4	8.8	15.6	17.4	17.6	16.7	17.6
Highest max °C	40.2	40.0	38.4	40.4	41.5	48.0	48.4	49.0	49.0	49.8
Lowest min °C	-16.0	-13.5	-6.5	-10.5	-7.5	-7.0	0.6	3.0	1.2	2.0
b) Annual precipitation mm	62.6	50.9	85.6	115.5	39.7	75.3	157.6	171.3	215.6	116.1
c) Relative humidity										
Average max %	45	45	45	50	48	56	66	67	65	64
Average min %	26	23	24	29	24	26	35	35	37	37

SECTION 2

	Isfahan	Ahwas
7. Seismicity		
Modified mercally earthquake intensity scale	10	5
8. Socio economic factors		
a) Nearest town - Name	Existing - Isfahan. Population 255,000 Under construction - Aryameher township of Steel Co.	Ahwas - Population 120 000
Distance	43 km from Isfahan town	
b) Housing facilities	Separate housing facilities may not be necessary, arrangements may be made with Steel Company	Ahwas town facilities. No housing facilities need be built.
c) Educational facilities	Schooling facilities at Isfahan	University, including an agricultural university 40 km from Ahwas
d) Hospital	May be shared with Steel Company	Ahwas facilities could be used.
e) Industrial development		
i) Existing	Textile Mills at Isfahan. An integrated steel plant under construction	Pipe plant . Steel Rolling Mill
ii) Proposed	-	Arc furnace-cum-continuous casting plant for billets. Cold Rolling Mill.
f) Availability of labour	Unskilled and skilled labour available	Unskilled and skilled labour available
g) Availability of contractors	Industrial contractors from Teheran	Industrial contractors from Teheran
h) Nearest airport	Isfahan	Ahwas
i) Tele-communication	Connected to the country network	Connected to the country network.

		plant for billets. Cold Rolling Mill.
f) Availability of labour	Unskilled and skilled labour available	Unskilled and skilled labour available
g) Availability of contractors	Industrial contractors from Teheran	Industrial contractors from Teheran
h) Nearest airport	Isfahan	Ahwas
i) Tele-communication	Connected to the country network	Connected to the country network.

SECTION 2

built in two stages. In the first phase of work, only water bound macadam roads need be constructed and opened for traffic during plant construction. In the final phase these roads may be repaired as required and wearing surface provided.

Management and supervision of construction

The organisation required for the supervision and management of construction will be determined in relation to the detailed construction schedule. Modern methods of project control such as CPM and PERT will be utilised to anticipate bottlenecks and take advance action. Control on the construction programme will be daywise, weekwise and monthwise and the actual performance will be compared continuously with the schedule, as records of progress unrelated to a schedule are deceptive. A central coordinating organization will be necessary to ensure the efficient execution of the various facets of the construction programme.

Appendix 17-2

COMPARISON OF CAPITAL AND OPERATING COST FACTORS

A. Capital cost factors

	Ahwaz	Isfahan
1. Site preparation	There may not be any significant difference in the cost of site preparation at different locations	
2. Cost of construction material		
Cement $/ton	26	18.7
Sand $/cu m	4	1.6 to 2.3
Gravel $/cu m	4	1.6
Bricks $/1 000	11.3 to 13.3	8.0
3. Cost of construction labour, $/day		
Unskilled	1.33	1.07
Welder	4.67	2.67
Plastering mason	3.73	4.00
Mason	5.33	4.00
Blacksmith) Plumber) Bar bender)	4.00	2.67
4. Infrastructure development		
Water	Separate intake, treatment plant and 2 km pipeline	None
Transport	2 km rail link	Short spur to connect to steel plant link
Power	None	None
5. Transport of imported equipment and supplies to site	c.i.f. cost + freight cost to transport about 125 km by road or 137 km by rail	c.i.f. cost + freight cost to transport about 1 390 km by rail
6. Special considerations in design	Buildings to have complete side sheeting for protecting against dust storm. Some precautions against soil corrosion	Snow load 50 kg/sq m. Depth of ground freezing 0.65 m. At some places precautions against soil corrosion may be necessary

Appendix 17-2 (continued)

	Ahwaz	Isfahan
B. Operating cost factors, $/ton product		
1. Ferro-silicon (75% grade)		
Freight cost of		
a) Raw materials assembly	33.6	6.1
b) Product distribution	16.5	8.5
2. Ferro-manganese		
Freight cost of		
a) Raw materials assembly		
i) 100% imported ore through Khorramshahr	10.7	26.0
ii) 80% imported through Khorramshahr + 20% local ore	12.4	24.6
b) Product distribution	20.5	3.2
3. Tax holiday	20% to 100% for 10 years	Needs to be negotiated as within 50 km of Isfahan

Appendix 18-1

ANALYSIS OF MAJOR RAW MATERIALS

	Mn %	Fe %	SiO_2 %	Al_2O_3 %	CaO %	MgO %	F.C. %	V.M. %	Ash %	S %	P %
Manganese ore	46.0	7.0	8 max	5 max	-	-	-	-	-	-	0.15
Quartzite	-	-	97	1.0	0.5	-	-	-	-	-	-
Limestone	-	-	1.3/5.2	0.02/0.8	51/55.5	0.3/0.6	-	-	-	Trace	-
Coke	-	-	-	-	-	-	85.0	1.0	14.0	1.5	-
Coke ash	-	14.0	36.0	28.5	6.5	2.3	-	-	-	-	0.056
Charcoal	-	-	1.0	-	-	1.0	75.1	10.0	-	0.01	-

Appendix 18-2

LIST OF MAJOR EQUIPMENT FOR THE FERRO-ALLOY PLANT

A. Raw material handling and preparation system

1. Belt conveyors and tripper conveyors for transport and storage of raw materials from wagon unloading yard to stockpiles
2. Three payloaders of 1.5 cu m capacity
3. One quartz crusher and feeder
4. One charcoal crusher and feeder
5. One manganese ore crusher
6. Belt conveyors from crushers to screens over day bins
7. Screens for coke, charcoal, quartz and manganese ore
8. Feeders for daybins
9. Two belt conveyor systems for collection and despatch of charge to furnace
10. Control panels and accessories for automatic charge collection and despatch
11. Platform scale and hoist for scrap iron

B. Open rotating ferro-silicon furnace

1. Charging bins and chutes
2. One stoking cum charging machine
3. Furnace proper including furnace shell, refractories and rotation machinery
4. Hydraulic electrode hoists complete with hydraulic system and electrode holders complete with slipping devices and auxiliary equipment
5. Three single phase furnace transformers of 8 000 kVA capacity each with onload tap changers and transformer oil
6. High tension equipment inside furnace building
7. Secondary current supply equipment including bus bars, flexible cables, pressure plates etc
8. Control panel, desk and instruments for control of furnace equipment
9. Tap hole opening device

C. Closed rotating ferro-manganese furnace

1. Charging bins and chutes
2. Furnace proper including furnace cover, furnace shell, refractories and rotating machinery
3. Hydraulic electrode hoists complete with hydraulic system and submerged electrode holders complete with slipping devices and auxiliary equipment

Appendix 18-2 (continued)

C. Closed rotating ferro-manganese furnace (cont'd)

4. Three single phase furnace transformers of 6 600 kVA capacity each with onload tap changers and transformer oil
5. High tension equipment inside furnace building
6. Secondary current supply equipment including bus bars, flexible cables, pressure plates etc
7. Control panel, desk and instruments for control of furnace equipment
8. Tap hole opening device
9. Gas cleaning equipment including gas mains, stack valves, gas scrubber and control equipment

D. Tapping bay

1. Two overhead travelling cranes
2. Tapping ladles with refractories
3. Wagons for tapping ladles
4. Tapping pans with refractories
5. Equipment for crushing, screening and packing ferro-alloys including crushers, feeder, screens, scales, rollways etc.

Appendix 20-1

PRELIMINARY CAPITAL COST ESTIMATE

Basis: Equipment - One 24 000 kVA ferro-silicon furnace
One 20 000 kVA ferro-manganese furnace

Production - 17 000 tons per annum 75% grade ferro-silicon
38 000 tons per annum standard grade ferro-manganese

	Thousand $		
	Foreign currency	Local currency	Total amount
A. Land			
10.8 hectare @ $ 5 000 ..	-	54	54
B. Civil and structural steelwork			
1) Civil work			
Earthwork, masonry and concrete work for plant buildings, equipment foundations, auxiliary buildings and utilities. Roads and rail tracks, sewerage, drainage and off site facilities	30 a/	1 260 b/	1 290
2) Structural steel work			
Structural steelwork for plant and auxiliary buildings, conveyor supports and galleries and utility systems ..	400 a/	770	1 170
Sub-total (B) ..	430	2 030	2 460
C. Plant and equipment			
1) Raw material handling			
Equipment for raw material unloading, stocking, reclaiming, sizing and handling ..	633	-	633
2) Ferro-silicon furnace			
One 24 000 kVA open rotating type furnace for ferro-silicon, including charging equipment, stoking car, high tension electric equipment, furnace transformer, secondary current supply, tapping equipment, refractories, smokehood, furnace body and rotating machinery ..	1 273	-	1 273

SECTION 2

C. Plant and equipment

1) **Raw material handling**			
Equipment for raw material unloading, stocking, reclaiming, sizing and handling ..	633	-	633
2) **Ferro-silicon furnace**			
One 24 000 kVA open rotating type furnace for ferro-silicon, including charging equipment, stoking car, high tension electric equipment, furnace transformer, secondary current supply, tapping equipment, refractories, smokehood, furnace body and rotating machinery ..	1 275	-	1 275
3) **Ferro-manganese furnace**			
One 20 000 kVA closed furnace for ferro-manganese, rotating type, including charging equipment, electrode equipment, furnace cover, body and rotation machinery, high tension electric equipment, furnace transformer, secondary current supply, refractories, and gas clearing plant ..	1 406	-	1 406
4) **Tapping bay**			
Tapping bay equipment, including EOT cranes, tapping ladles and crushing facilities	418	-	418
5) **Utilities and services**			
Equipment for utilities such as water and power, and auxiliary service facilities such as laboratory, maintenance shop and transport ..	570	56	626
Sub-total (C) ..	4 300 a/	56	4 356

D. Other costs

1) Spares at 5% of C ..	215 a/	3	218
2) Ocean freight and insurance on imported equipment and spares at 10% of C + D1 ($ 4.515 mill)	452	-	452
3) Port charges and inland transport at 3% of C + D1 + D2 ($ 5.057 mill) ..	-	151	151
4) Equipment erection ..	139 a/	558	697
Sub-total (D) ..	806	712	1 518

		Thousand $		
		Foreign currency	Local currency	Total amount
E. Engineering, supervision, construction, administration etc				
At 12% of B + C + D ($ 8.335 mill)	..	300 f/	700	1 000
Sub-total (A to E)	..	5 836	3 552	9 388
F. Contingencies				
At 5% of A to E ($ 9.335 mill)	..	292	177	469
TOTAL (A to F)	..	6 128	3 729	9 857

a/ Includes timber for shuttering.

b/ Includes off site facilities comprising approach road and rail link. Water supply connection assumed to be provided by Isfahan Steel Plant. Power supply connection assumed to be on electric supply company account.

c/ Includes ocean freight and insurance on imported structural steel and sheeting.

d/ f.o.b. value of imported plant and equipment.

e/ 20% of the total erection charges assumed as foreign currency expenditure for foreign erectors' services.

f/ 30% of the total expenditure for engineering, supervision and construction administration assumed to be in foreign currency for foreign consultant's services.

SECTION 2

Appendix 21-1

PRELIMINARY ESTIMATE OF MANPOWER

Basis: Major equipment - One 24 000 kVA electric smelting furnace for ferro-silicon
One 20 000 kVA electric smelting furnace for ferro-manganese

Production - 17 000 tons per annum ferro-silicon, and
40 000 tons per annum ferro-manganese

	Salary classi- fication	Shifts G	I	II	III	Total per weekday	Total payroll
A. Executive staff							
Works manager ..	E-1	1	-	-	-	1	1
Plant superintendent ..	E-2	1	-	-	-	1	1
Administrative officer	E-3	1	-	-	-	1	1
Chief accounts officer	E-3	1	-	-	-	1	1
Materials manager ..	E-3	1	-	-	-	1	1
Sub-total ..		5				5	5
B. Supervisory staff							
General foreman ..	S-1	1	-	-	-	1	1
Chief metallurgist ..	S-1	1	-	-	-	1	1
Metallurgist ..	S-2	1	-	-	-	1	1
Maintenance engineers	S-2	3	-	-	-	3	3
Shift foreman ..	S-2	1	1	1	1	4	4
Technical assistant ..	S-2	1	-	-	-	1	1
Desk operators ..	S-3	-	2	2	2	6	7
Maintenance foreman ..	S-3	1	1	1	-	3	3
Chemists ..	S-4	2	1	1	2	6	6
Sub-total ..		11	5	5	5	26	27
C. Operation staff							
Pay loader operator ..	W-1	-	2	2	-	4	5
Raw material attendant	W-2	-	1	1	-	2	2
Stock house attendant	W-2	-	3	3	3	9	10
Stoking car operator ..	W-1	-	1	1	1	3	4
Tappers ..	W-1	-	2	2	2	6	7
Assistant tappers ..	W-2	-	4	4	4	12	14
Crane/truck drivers ..	W-1	-	5	5	5	15	16
Shift fitter ..	W-2	-	2	2	2	6	7
Paste filler ..	W-3	-	2	2	2	6	7
Scrap weigher ..	W-2	-	1	1	1	3	4
Karigar-e-mamuli ..	W-3	-	14	14	12	40	47
Sub-total ..			37	37	32	106	123

20 - CAPITAL COST ESTIMATE

The preliminary capital cost estimate of the ferro-silicon/ferro-manganese plant is given in Appendix 20-1 and summarised in Table 20-1.

Table 20-1

PRELIMINARY CAPITAL COST ESTIMATE
(Thousand dollars)

		Foreign currency	Local currency	Total
A.	Land ..	-	54	54
B.	Civil and structural work	430	2 030	2 460
C.	Plant and equipment ..	4 300	56	4 356
D.	Other costs			
	Spares ..	215	3	218
	Ocean freight and insurance ..	452	-	452
	Port handling and inland freight ..	-	151	151
	Equipment erection ..	139	558	697
E.	Engineering, supervision and construction administration ..	300	700	1 000
F.	Contingencies ..	292	177	469
	Total ..	6 128	3 729	9 857

Appendix 21-1 (continued)

	Salary classification	Shifts				Total per weekday	Total payroll
		G	I	II	III		
D. Maintenance staff							
Mechanical							
Pump-comp.attendants	W-2	-	2	2	2	6	7
Machine operators	W-1	-	3	3	-	6	7
Welders	W-1	-	2	1	1	4	5
Fitters	W-1	2	3	3	1	9	10
Mason	W-2	1	-	-	-	1	1
Blacksmith	W-2	1	-	-	-	1	1
Karigar-e-mamuli	W-3	-	3	3	3	9	10
Sub-total		4	13	12	7	36	41
Electrical							
Fitters	W-1	1	-	-	-	1	1
Electrician and wireman	W-1	-	2	2	2	6	7
Karigar-e-mamuli	W-3	-	2	2	2	6	7
Sub-total		1	4	4	4	13	15
E. Administration and commercial staff							
Personnel officer	A-1	1	-	-	-	1	1
Labour officers	A-1	2	-	-	-	2	2
Office superintendent	A-1	1	-	-	-	1	1
Administration assistant	A-2	1	-	-	-	1	1
Security officer	A-1	1	-	-	-	1	1
Security staff	A-3	-	5	5	8	18	21
Stores officer	A-1	1	-	-	-	1	1
Purchase officer	A-1	1	-	-	-	1	1
Stores assistants	A-2	2	-	-	-	2	2
Purchase assistants	A-2	2	-	-	-	2	2
Marketing officer	A-1	1	-	-	-	1	1
Marketing assistants	A-2	2	-	-	-	2	2
Fire fighting men	A-2	1	3	3	3	10	12
Accounts officers	A-1	3	-	-	-	3	3
Accounts assistants	A-2	3	-	-	-	3	3
Time keeper	A-3	1	1	1	1	4	4
Medical officer	A-1	1	-	-	-	1	1
Medical assistants	A-2	4	-	-	-	4	4
Secretarial and clerical staff	A-2	12	-	-	-	12	12
Nameresan	A-4	3	-	-	-	3	3
Roftegar	A-4	3	-	-	-	3	3
Sub-total		46	9	9	12	76	81
Total on payroll			..			..	292
Reserve for leave and absenteeism (for C & D) @ 15.8%						..	25
Total Manpower			..			..	317

Appendix 21-2

PERSONNEL TO BE TRAINED ABROAD

		No.	Duration months
General foreman	..	1	3
Chief metallurgist	..	1	3
Maintenance engineers	..	2	3
Shift foreman	..	4	6
Desk operators	..	7	6
Maintenance foreman	..	2	6
Tappers	..	6	6

Appendix 22-1

ASSEMBLY COST OF RAW MATERIALS

		Cost/ton at source $	Transport					Cost/ton at plant site $
			Distance km	Mode	Freight rate c/ Rials/ton km	Total freight Rials	$	
Manganese ore	..	29.8 a/	1 390	Rail	0.6	840	11.2	41
Quartzite	..	3.4	70	Road	2.4	168	3.2	7
Limestone	..	0.9	20	Road	5.0	100	1.3	2
Scrap	..	-	-	-	-	-	-	30
Coke	..	22.6 b/	-	-	-	-	0.4	23
Charcoal	..	59.5	20	Road	5.0	100	1.3	61
Electrode Paste	..	-	-	-	-	-	-	138

a/ CIF price Persian Gulf port assumed at 54 cents/unit Mn/ton based on recent CIF prices of European market and including a provision of 20% for port, handling and other charges.

b/ Salable small sized coke price indicated by National Iranian Steel Company.

c/ Railway freight rates based on Iranain railway tariff. Road freight rates computed on the basis of 'telescopic rates' - lower rates for higher haulage distance.

Appendix 22-2

PRELIMINARY PRODUCTION COST ESTIMATE a/ OF FERRO-SILICON (75% GRADE)

Basis: Equipment - One 24 000 kVA electric smelting furnace
Production - Annual production of 17 000 tons of 75% grade ferro-silicon

	Price/ton material $	Quantity/ton Kg	Cost/ton $
Cost of materials			
Quartsite	7	1 940	13.58
Scrap	30	200	6.00
Coke	23	480	11.04
Charcoal	61	545	33.25
Electrode paste	138	70	9.66
Total cost of materials		..	73.53
Cost above materials a/			
Labour and supervision	-	-	11.29
Water	0.012/cu m	10 cu m	0.12
Maintenance, supplies, consumables and services	-	-	8.70
Relining reserve	-	-	0.53
General plant expenses	-	-	11.71
Total cost above materials		..	32.35
Works cost a/		..	105.88

a/ Excluding electric power.

Appendix 22-3

PRELIMINARY PRODUCTION COST ESTIMATE a/ OF FERRO-SILICON (45% GRADE)

Basis: Equipment - One 24 000 kVA electric smelting furnace
Production - Annual production of 28 000 tons of 45% grade ferro-silicon

	Price/ton material $	Quantity/ton Kg	Cost/ton $
Cost of materials			
Quartzite	7	1 100	7.70
Scrap	30	630	18.90
Coke	23	545	12.54
Charcoal	61	-	-
Electrode paste ..	138	40	5.52
Total cost of materials ..		..	44.66
Cost above materials a/			
Labour and supervision ..	-	-	6.85
Water	0.012/cu m	6.0 cu m	0.72
Maintenance, supplies, consumables and services ..	-	-	5.50
Relining reserve ..	-	-	0.33
Packing	-	-	3.00
General plant expenses ..	-	-	7.11
Total cost above materials		..	23.51
Works cost a/ ..		..	68.17

a/ Excluding electric power.

Appendix 22-4

PRELIMINARY PRODUCTION COST ESTIMATE [a] OF FERRO-MANGANESE

Basis: Equipment - One 20 000 kVA electric smelting furnace
Production - Annual production of 38 000 tons of ferro-manganese

		Price/ton material $	Quantity/ton Kg	Cost/ton $
Cost of materials				
Manganese ore ..	..	41	2 250	92.25
Coke ..	..	23	610	14.03
Limestone ..	..	2	510	1.02
Electrode paste	..	138	22	3.04
Total cost of materials	..		..	110.34
Cost above materials [a]				
Labour and supervision	..	-	-	5.03
Water ..	..	0.012/cu m	0.9 cu m	-
Maintenance and supplies, consumables, services and slag handling	..	-	-	8.00
Relining reserve	..	-	-	0.53
General plant expenses	..	-	-	5.21
Total cost above materials			..	18.77
Works cost [a]	..		..	129.11

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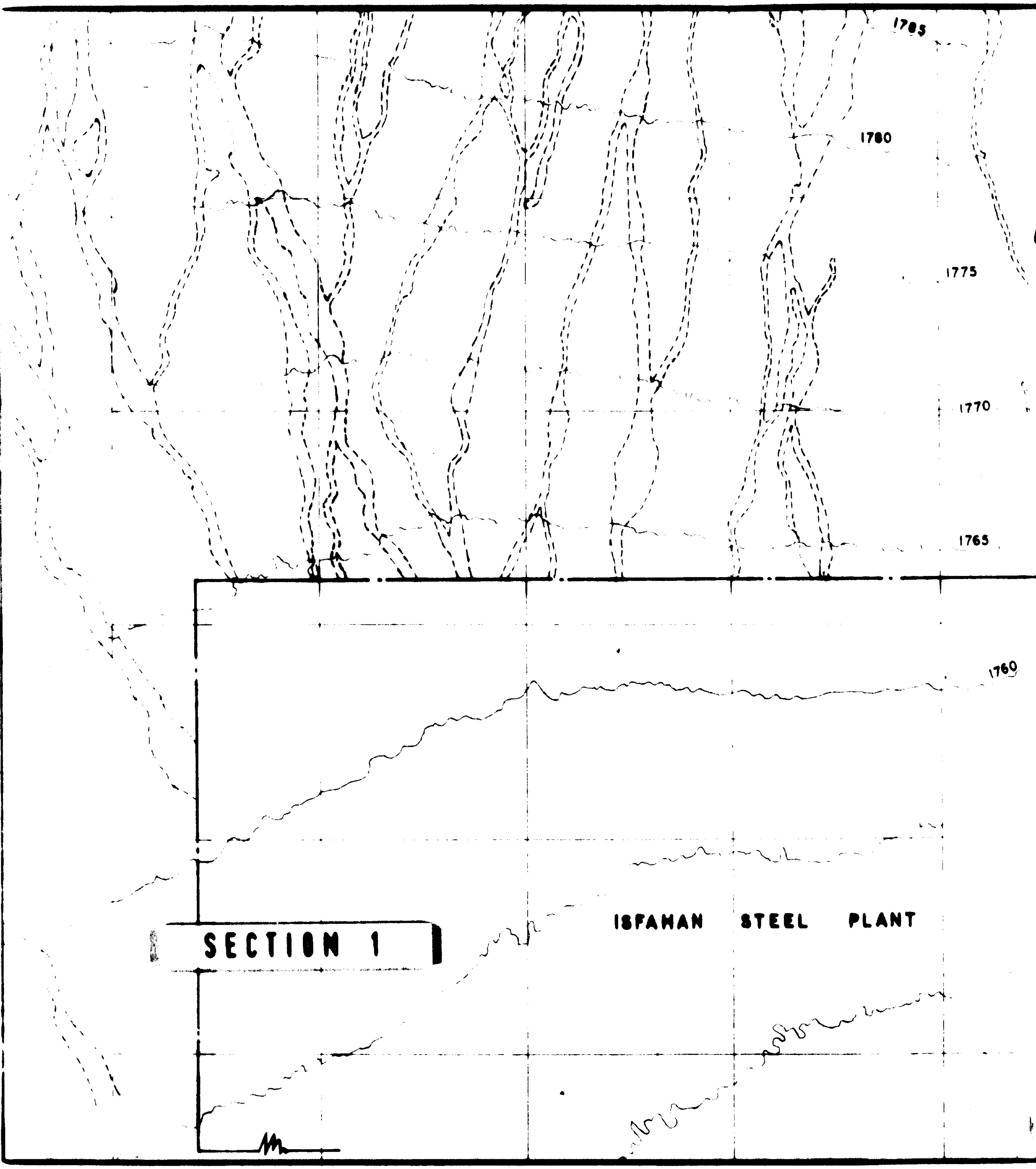
[a] Excluding electric power

M. N. DASTUR & CO PRIVATE LTD

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

FEASIBILITY REPORT ON
FERRO-ALLOYS PLANTS AND ALLOY STEELS PLANT IN IRAN

DRAWINGS - VOLUME IV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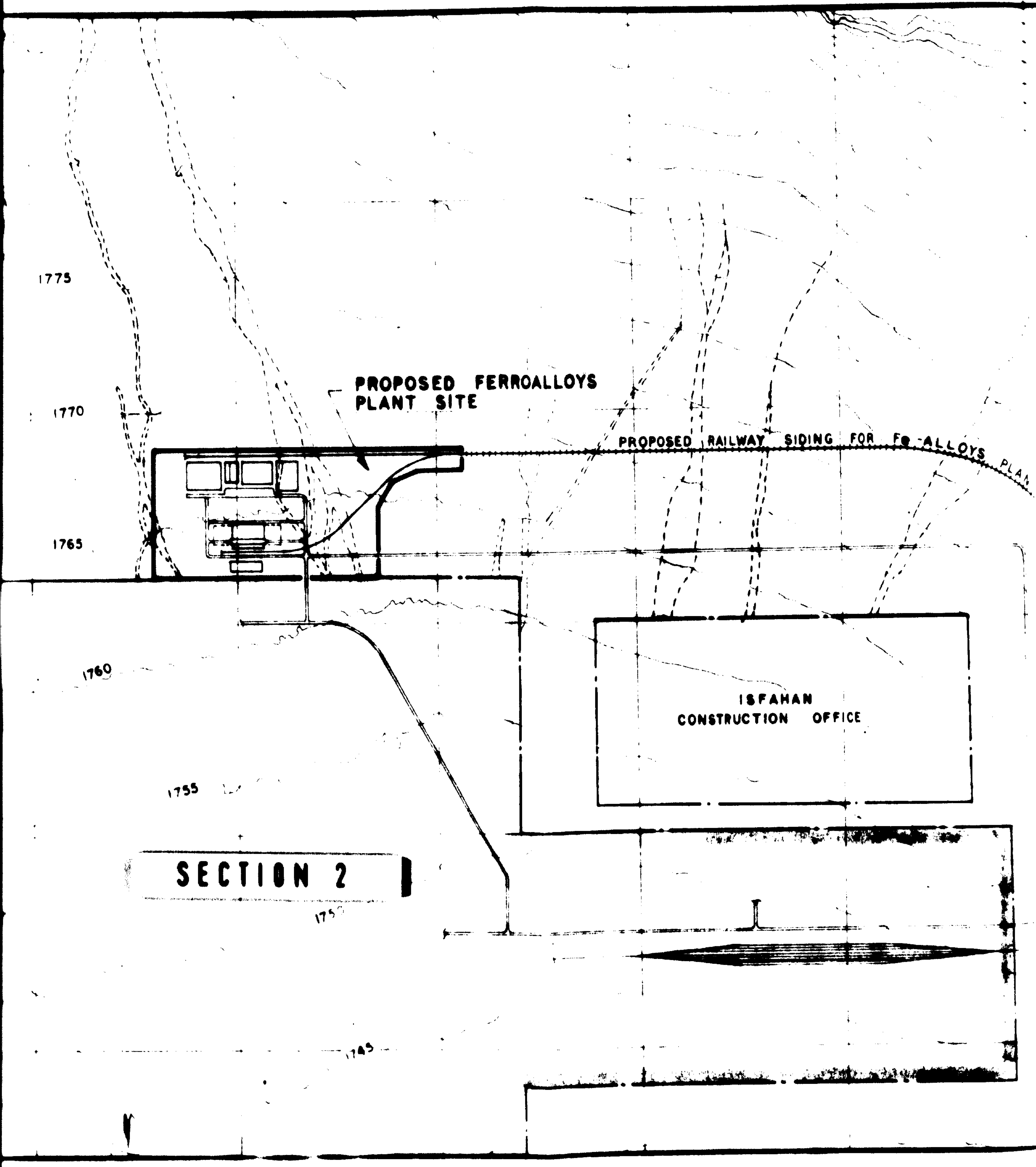
ISFAHAN STEEL PLANT
SECTION 1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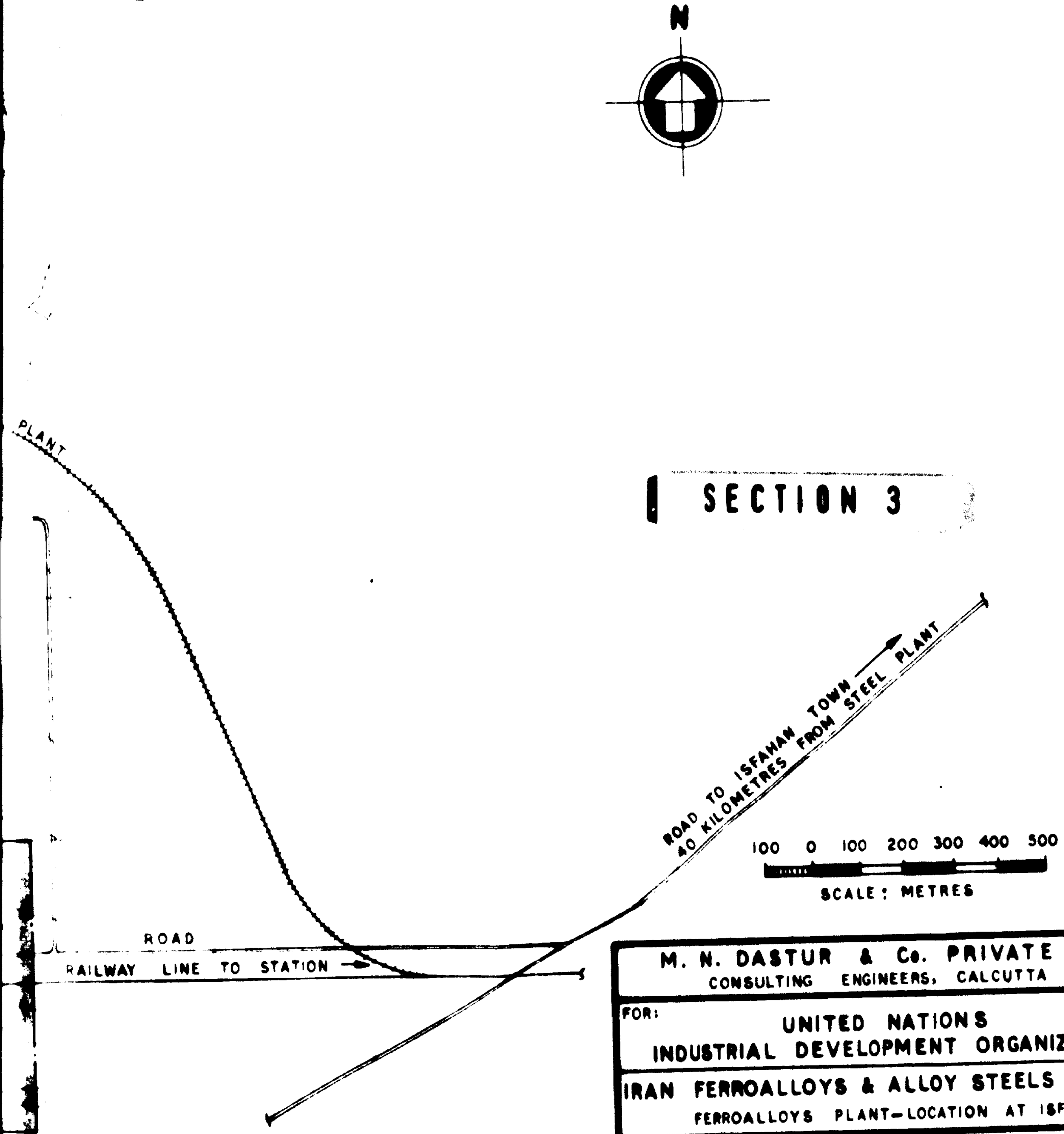
PROPOSED FERROALLOYS PLANT SITE
PROPOSED RAILWAY SIDING FOR Fe-ALLOYS PLAN
ISFAHAN CONSTRUCTION OFFICE
SECTION 2

SECTION 3



M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROALLOYS PLANT—LOCATION AT ISFAHAN

DRAWN	S c Bodak	28.11.69
APPROVED	[illegible]	5.12.69

No. S131-IV-1

The foreign exchange requirement is estimated at $ 6.13 million which is about 62 per cent of the estimated total capital cost of $ 9.9 million.

Civil and structural work

Civil work

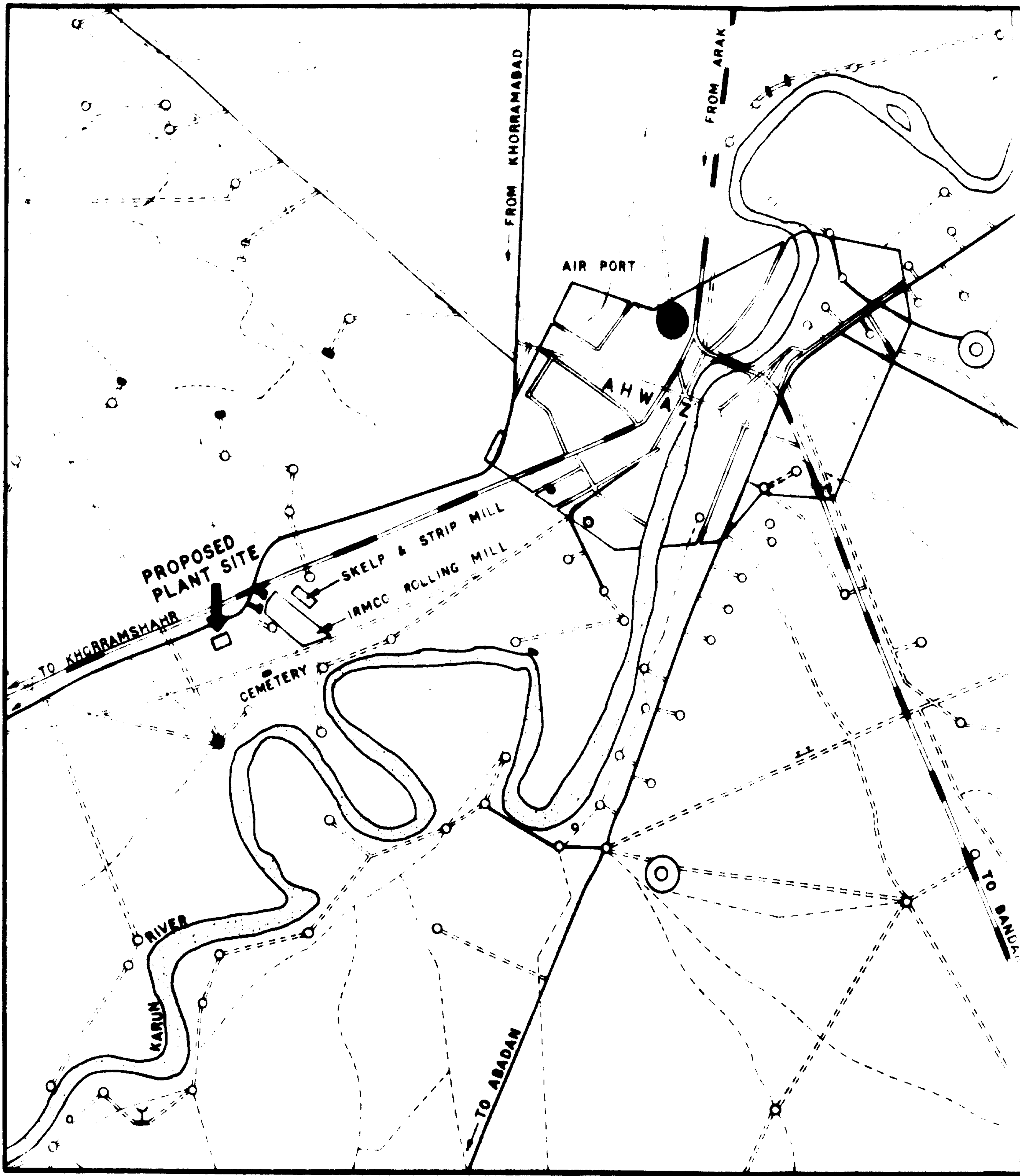
The civil work estimate includes costs of all civil items like earthwork; foundations for building columns, plant and equipment, masonry and reinforced concrete for buildings, roads, tracks and boundary wall. It also covers offsite facilities comprising approach road and rail link. Water connection is to be provided from the Isfahan steel plant and electric power connections by the supply company at their cost. The estimates are based on the prevailing prices of cement, sand and gravel in Isfahan area as given in Table 20-2.

Table 20-2

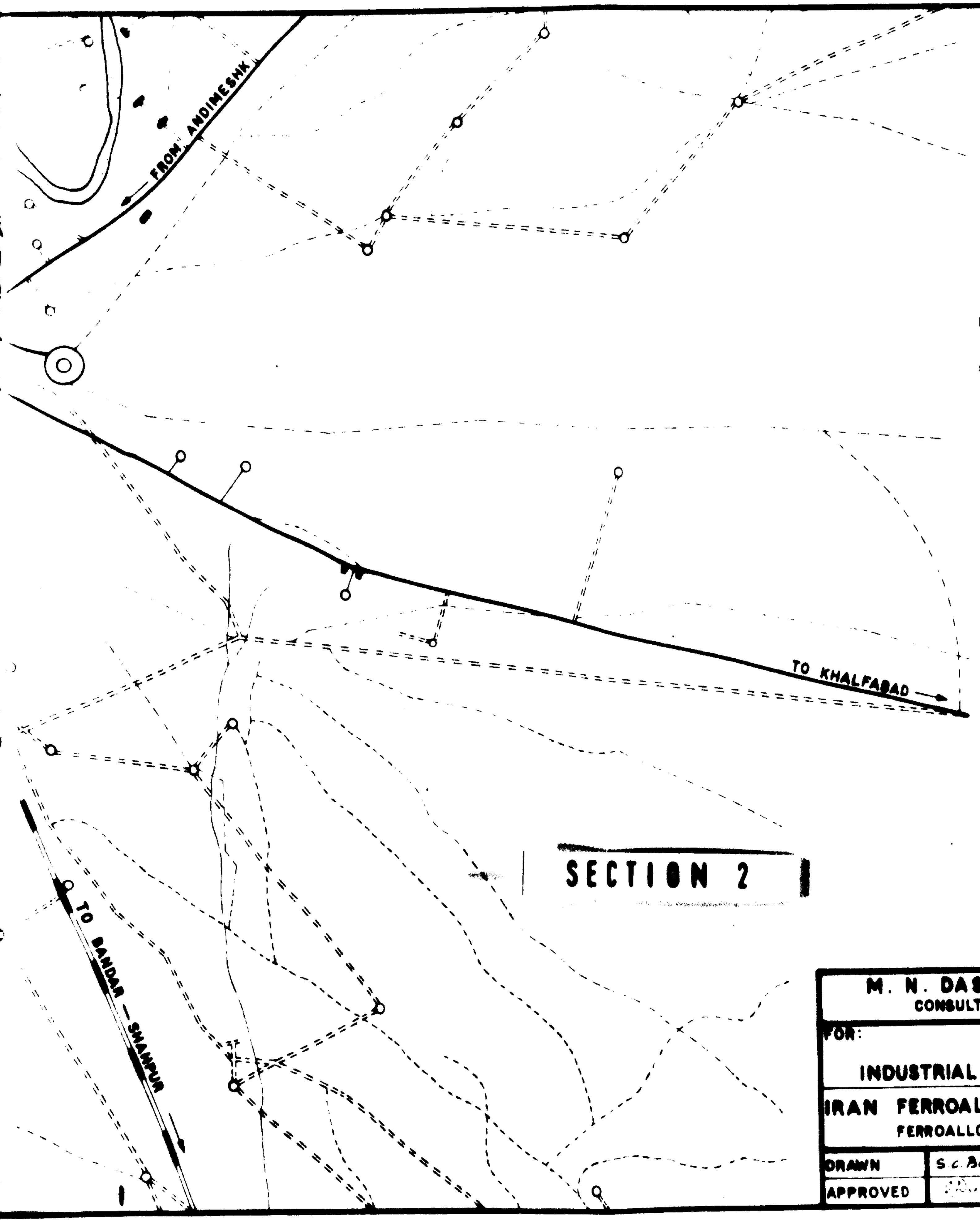
PRICES OF CONSTRUCTION MATERIALS AT ISFAHAN

Material		Unit	Cost $
Cement	..	ton	18.7
Sand	..	cu m	1.6 to 2.3
Gravel	..	cu m	1.6
Bricks	..	1 000	11 to 13

Except timber required for shuttering, it is expected that all supplies required for civil work will be obtained from local sources.


FROM KHORRAMABAD
FROM ARAK
AIR PORT
AHWAZ
PROPOSED PLANT SITE
SKELP & STRIP MILL
IRMCC ROLLING MILL
TO KHORRAMSHAHR
CEMETERY
KARUN RIVER
9
TO ABADAN
TO BANDA

SECTION 1



LE

MAIN ROADS

MAIN ROADS
(WITHOUT A

ANIMAL ROA

RAILWAY TRA

RIVERS/NAL

PLANT SITE

1 0 1

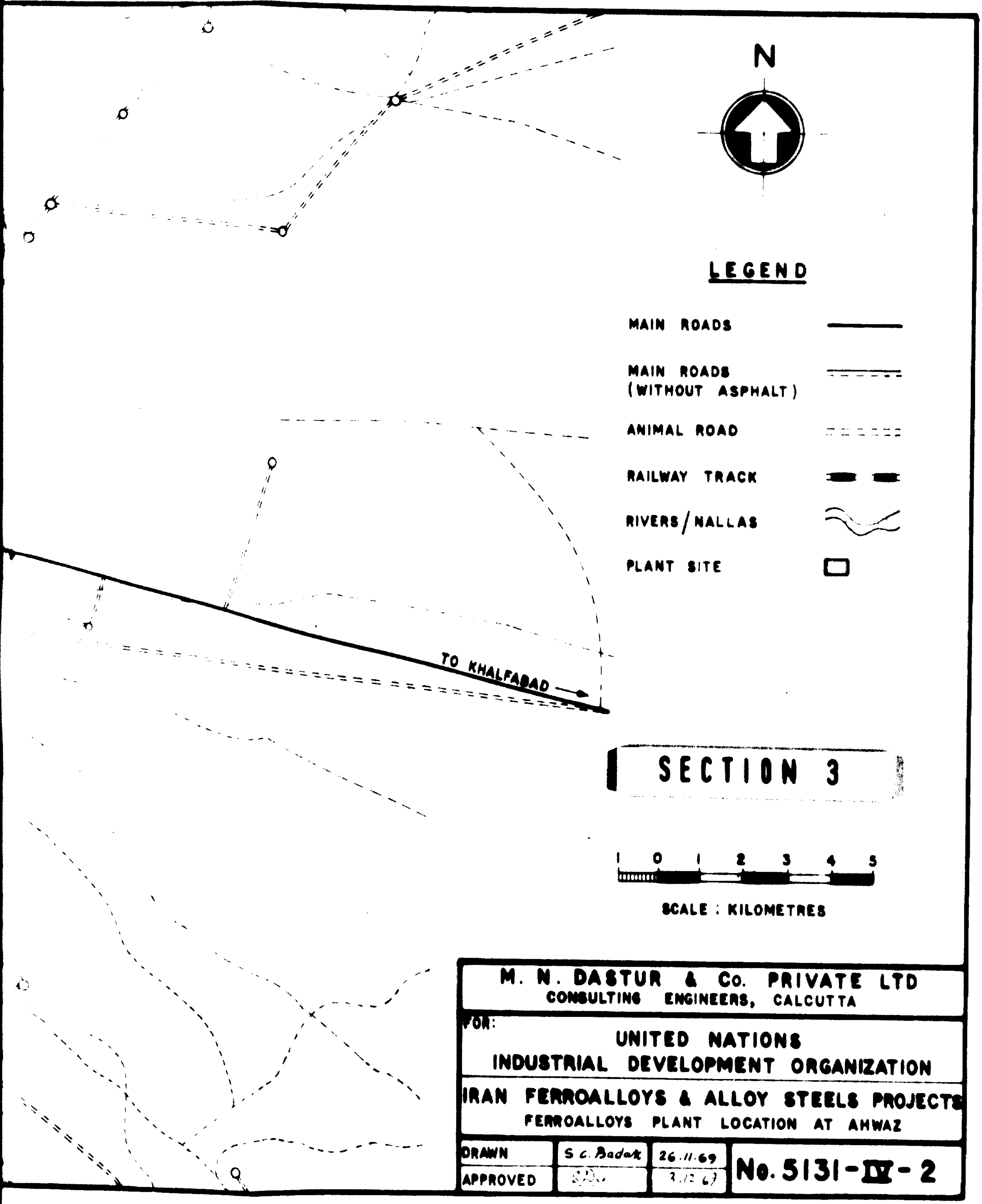
SCALE

M. N. DASTUR &
CONSULTING ENGINE

FOR:
UNITED N
INDUSTRIAL DEVELOP

IRAN FERROALLOYS & A
FERROALLOYS PLANT

DRAWN	S. c. Badak	26.11.6
APPROVED	[illegible]	3.12.

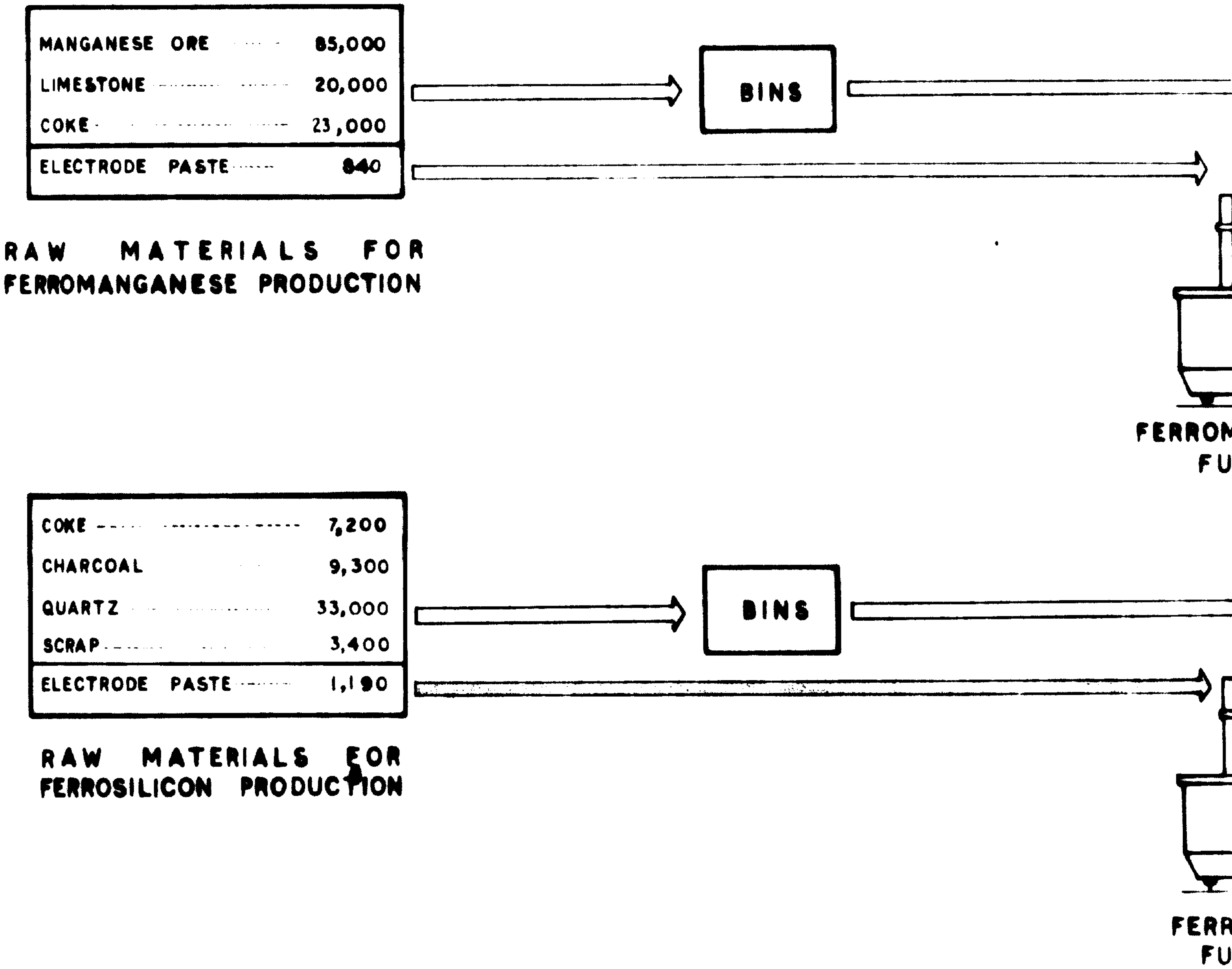


M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

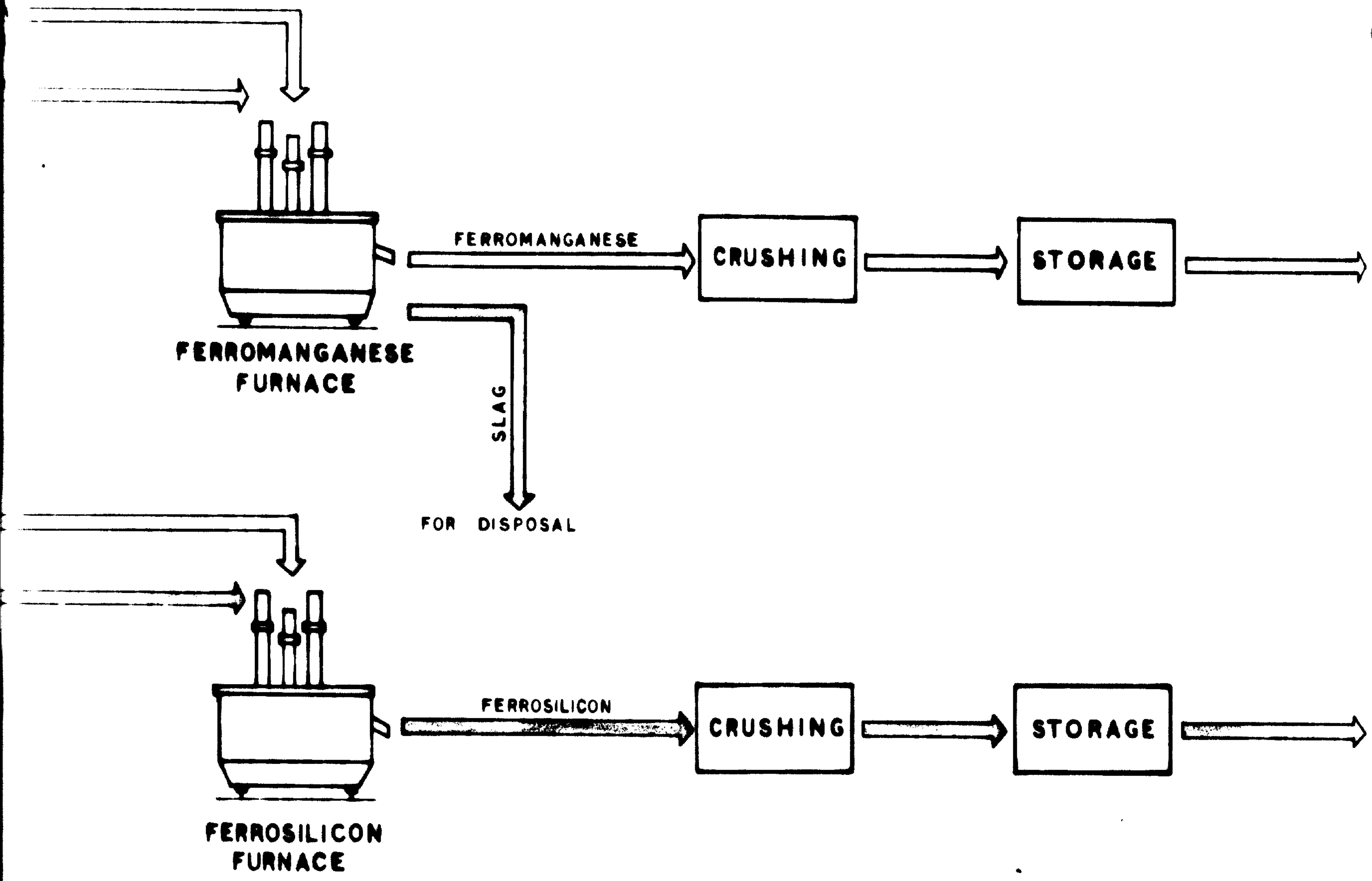
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROALLOYS PLANT LOCATION AT AHWAZ

DRAWN	S. c. Badak	26.11.69	No. 5131 - IV - 2
APPROVED		3.12.69	


MANGANESE ORE 85,000
LIMESTONE 20,000
COKE 23,000
ELECTRODE PASTE 840
BINS
RAW MATERIALS FOR FERROMANGANESE PRODUCTION
FERROM
FU
COKE 7,200
CHARCOAL 9,300
QUARTZ 33,000
SCRAP 3,400
ELECTRODE PASTE 1,190
BINS
RAW MATERIALS FOR FERROSILICON PRODUCTION
FERR
FU

SECTION 1

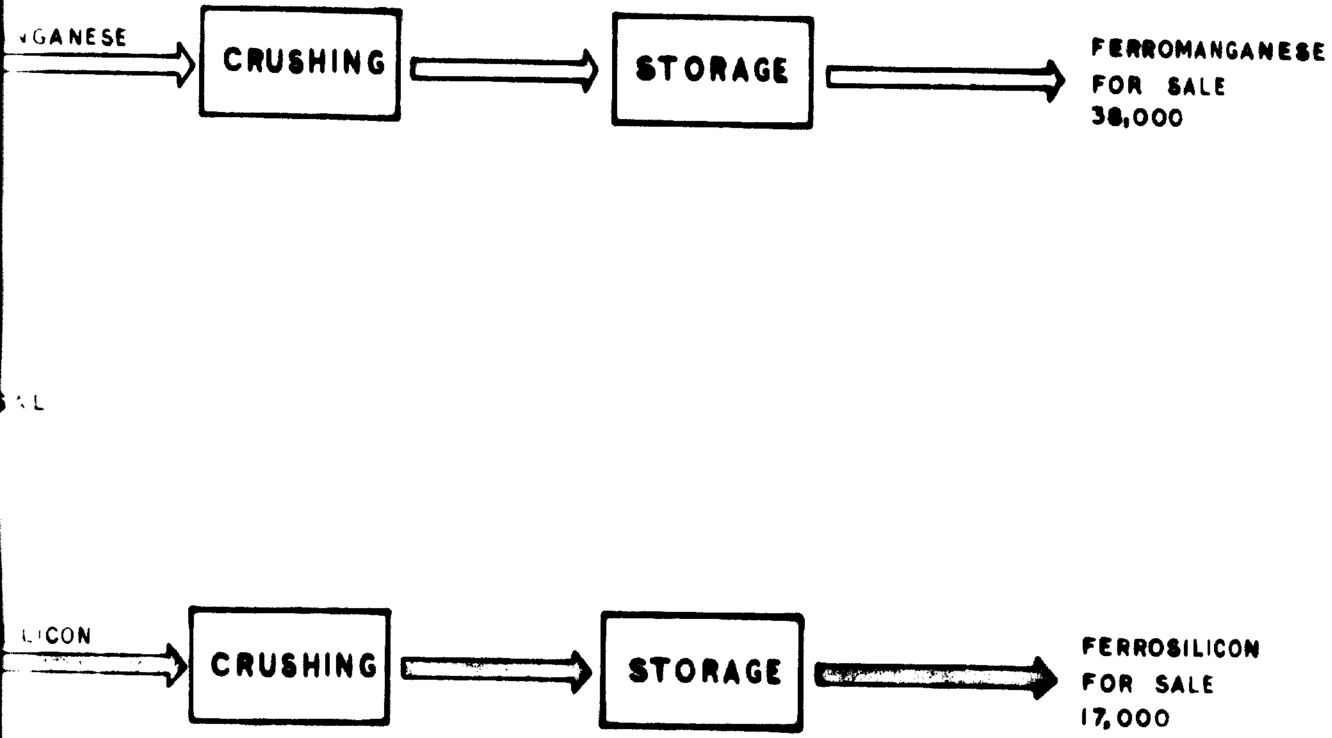


SECTION 2

NOTE:
QUANTITIES ARE IN TONS/YEAR

M. N. DAST
CONSULTI
FOR:
UN
INDUSTRIAL D
IRAN FERROALL
FERROA

DRAWN	
APPROVED	



SECTION 3

RE IN TONS/YEAR

M. N. DASTUR & Co. PRIVATE LTD.
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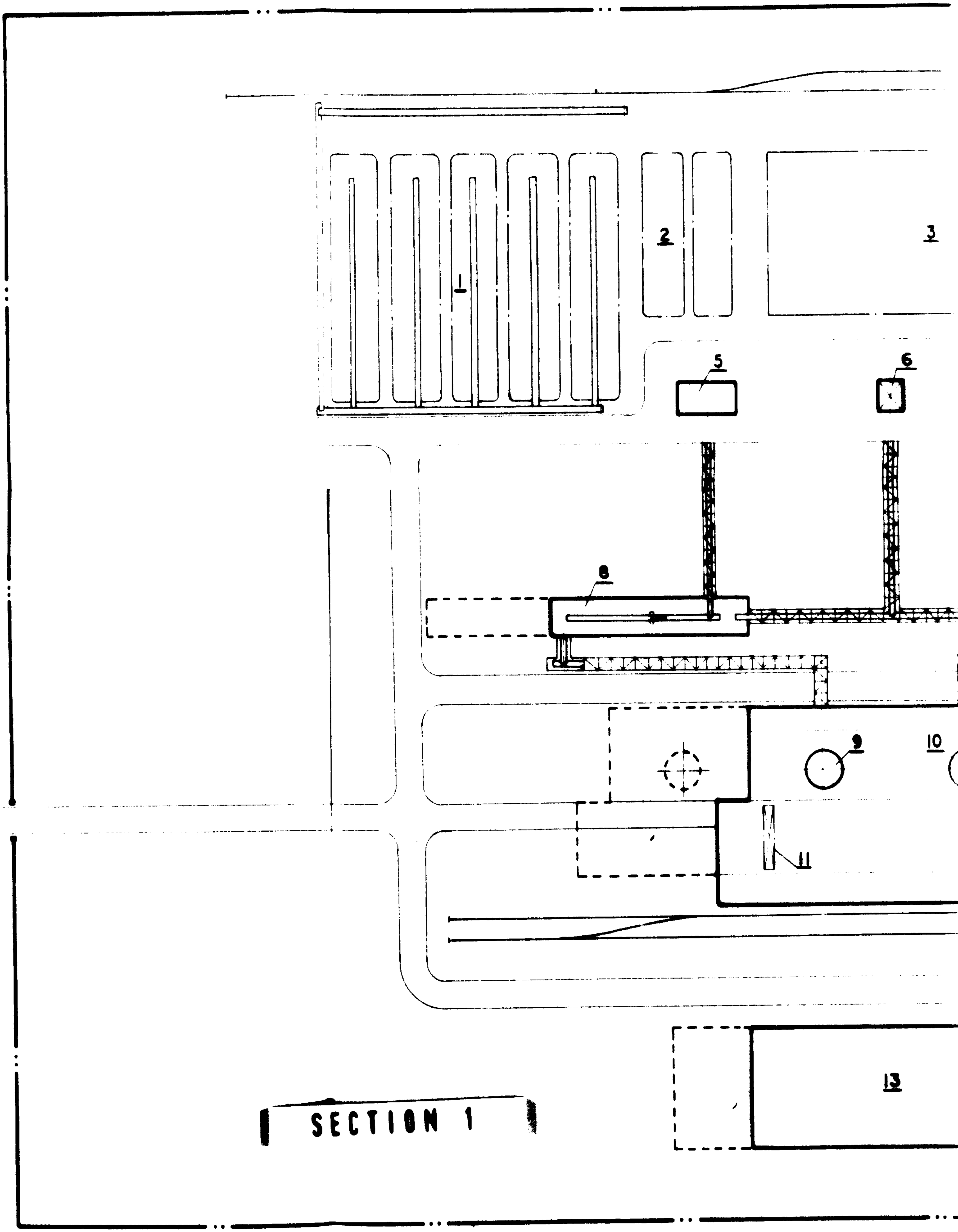
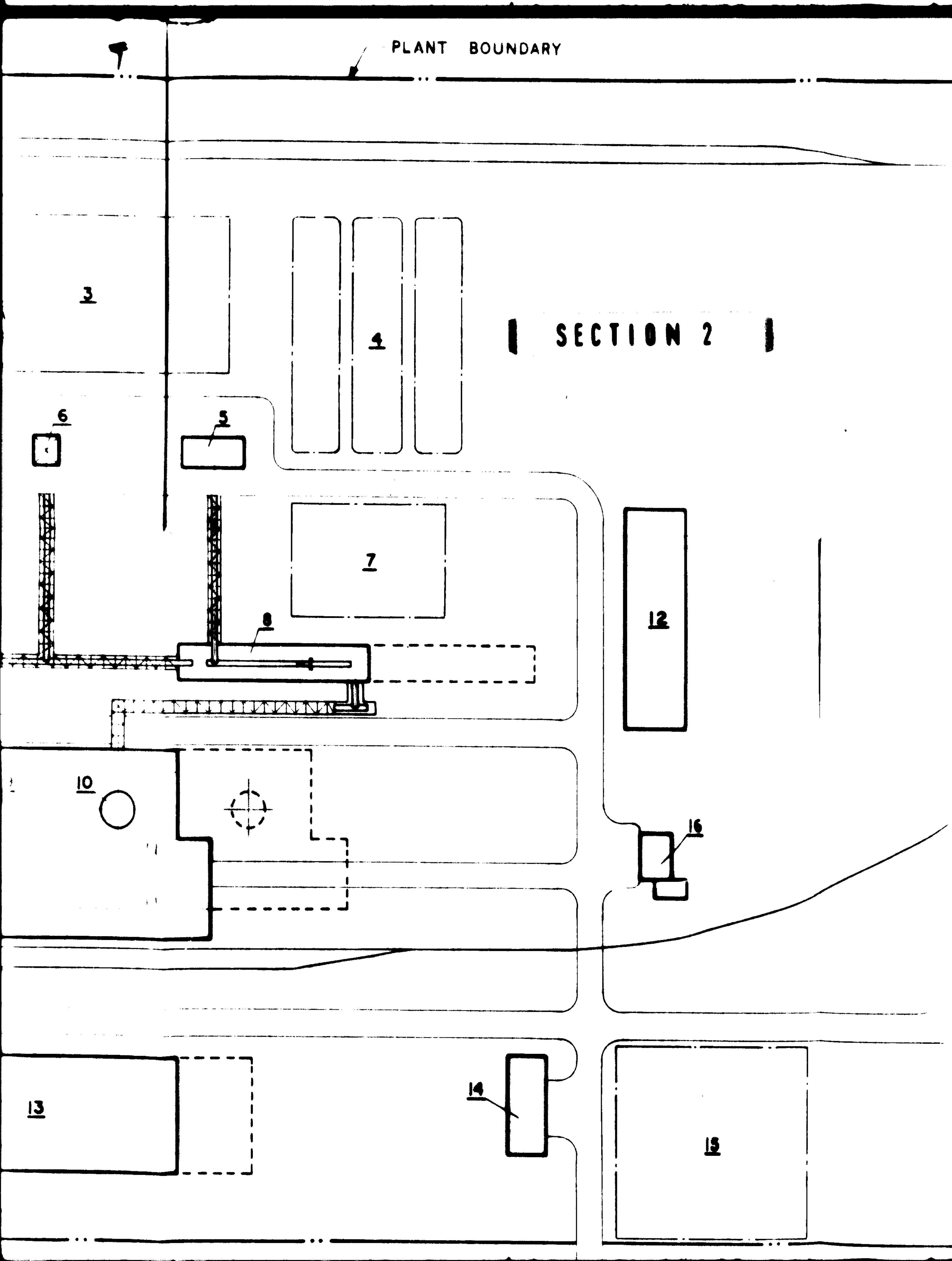
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

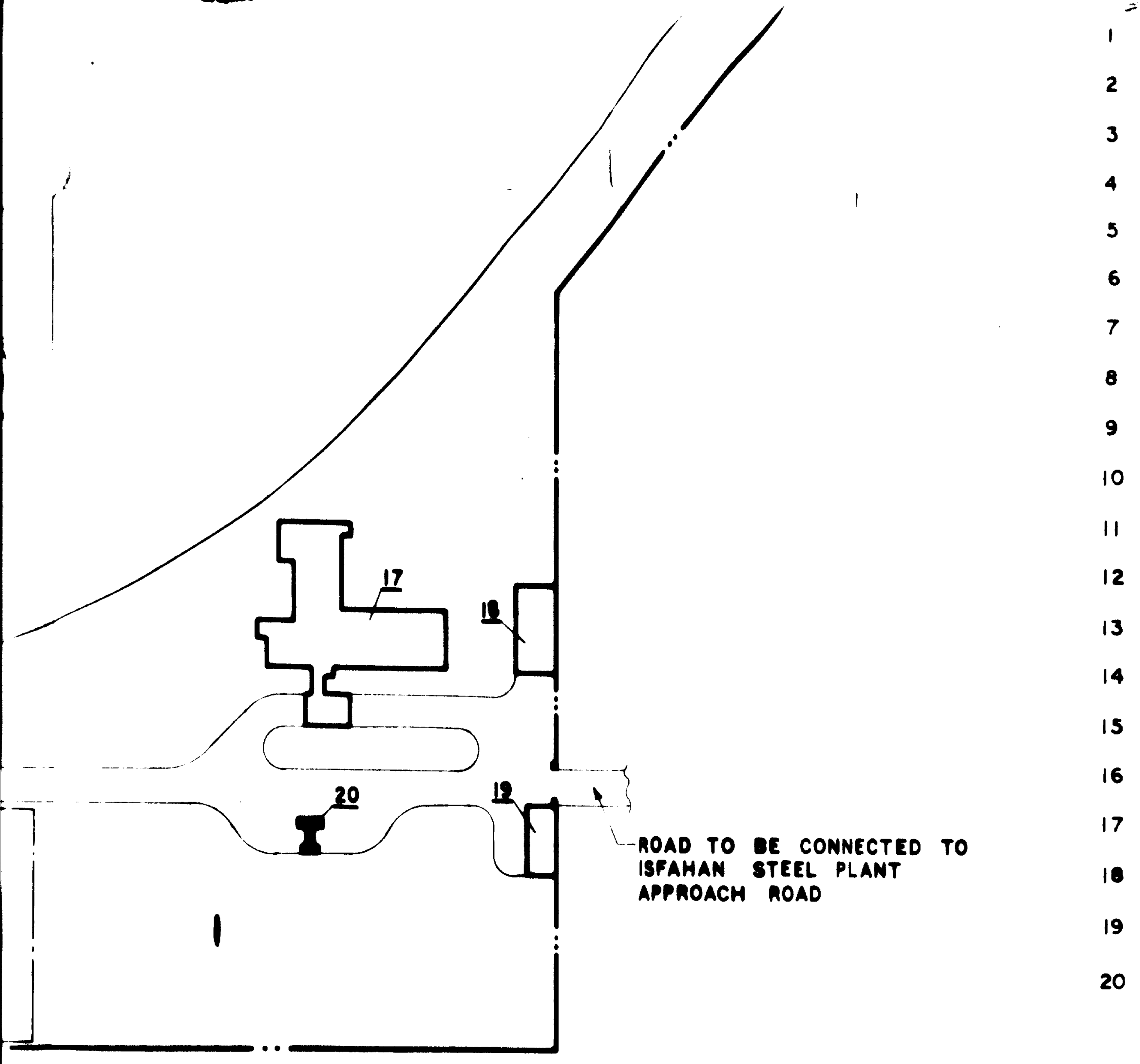
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROALLOYS PLANT — FLOW SHEET

DRAWN		28 11 69	No. 5131 - IV - 3
APPROVED	PKBose	4.12.70	



SECTION 1


PLANT BOUNDARY
3
4
SECTION 2
6
5
7
8
12
10
16
13
14
15

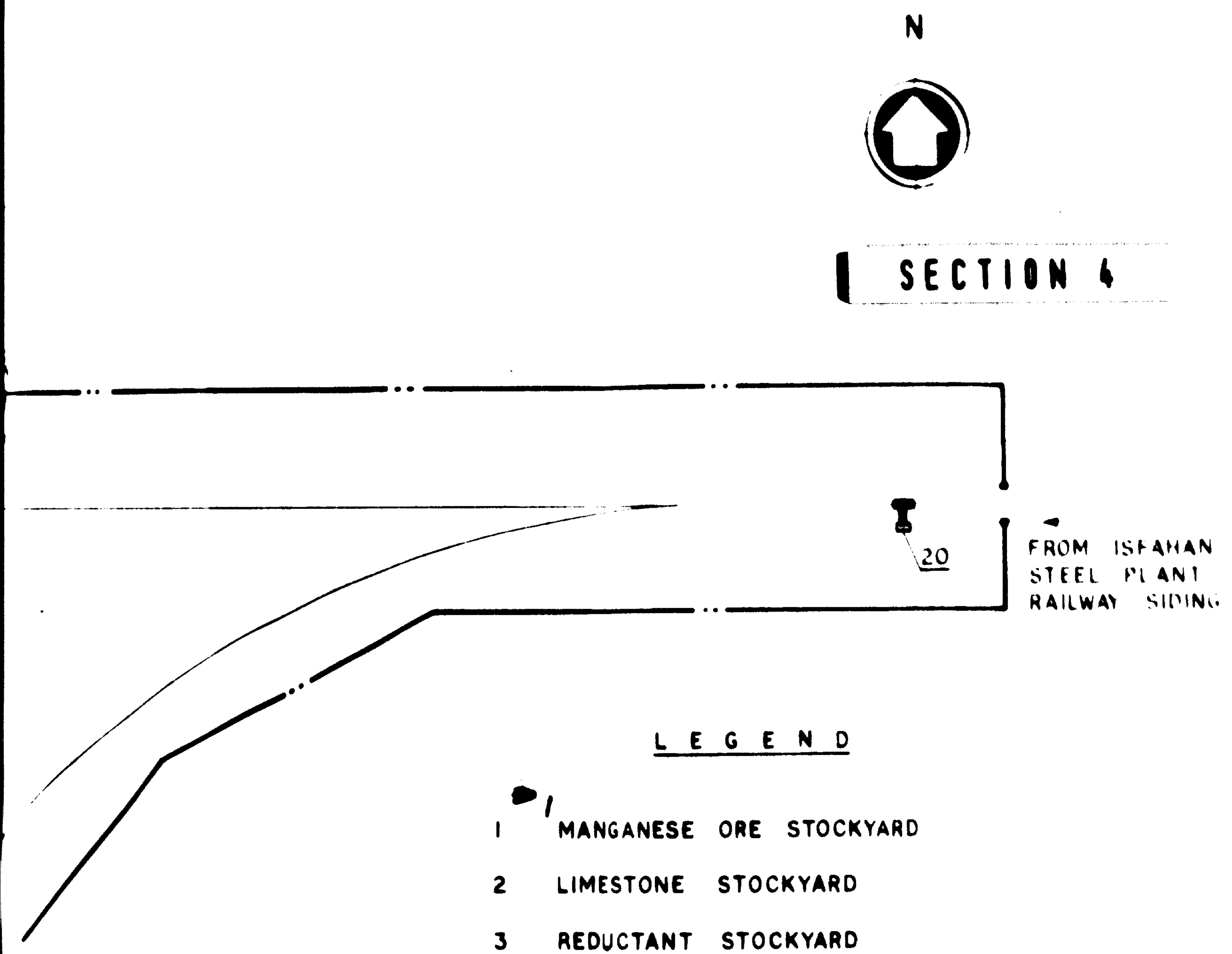


ROAD TO BE CONNECTED TO ISFAHAN STEEL PLANT APPROACH ROAD

SECTION 3

PROPOSED PLANT ☐

FUTURE EXPANSION ▨



LEGEND

1	MANGANESE ORE STOCKYARD
2	LIMESTONE STOCKYARD
3	REDUCTANT STOCKYARD
4	QUARTZ STOCKYARD
5	CRUSHING STATION
6	GROUND HOPPER
7	SCRAP STORAGE
8	STOCK BINS
9	20,000 KVA FERROMANGANESE FURNACE
10	24,000 KVA FERROSILICON FURNACE
11	12/3-TON EOT CRANE
12	MAINTENANCE SHOP & STORES
13	WATER TREATMENT PLANT
14	SWITCHGEAR ROOM
15	SUPPLY COMPANY'S OUT-DOOR RECEIVING STATION

Structural work

The cost estimates of structural steel work includes structural work involved in the plant building complete as erected. Technological structurals are included in the cost of equipment. The structural part comprises steel work for plant building including roof sheeting, cladding etc.

The average cost of structural steel delivered to plant site is estimated at $ 277 per ton on the basis of f.o.b. price of $ 140 and adding ocean freight, insurance and port handling charges, inland freight, customs duty, and commercial benefit tax.

In keeping with the present trend of fabricating building structurals at site it has been assumed that similar fabrication will be undertaken for the ferro-alloys plant. The fabrication and erection of steel structures will be done locally. The conversion and erection cost of steel has been assumed as $ 123 per ton based on prevailing rates.

The foreign exchange required for importing structural steel and sheeting is estimated at about $ 400,000.

Plant and equipment

The equipment cost covers production and auxiliary equipment including electricals, EOT cranes, refractories,

1	MANGANESE ORE STOCKYARD
2	LIMESTONE STOCKYARD
3	REDUCTANT STOCKYARD
4	QUARTZ STOCKYARD
5	CRUSHING STATION
6	GROUND HOPPER
7	SCRAP STORAGE
8	STOCK BINS
9	20,000 KVA FERROMANGANESE FURNACE
10	24,000 KVA FERROSILICON FURNACE
11	12/3-TON EOT CRANE
12	MAINTENANCE SHOP & STORES
13	WATER TREATMENT PLANT
14	SWITCHGEAR ROOM
15	SUPPLY COMPANY'S OUT-DOOR RECEIVING STATION
16	CANTEEN
17	ADMINISTRATIVE BUILDING
18	GARAGE
19	GATE HOUSE
20	WEIGHBRIDGE

TO BE CONNECTED TO
N STEEL PLANT
ACH ROAD

SECTION 5

SCALE : METRES

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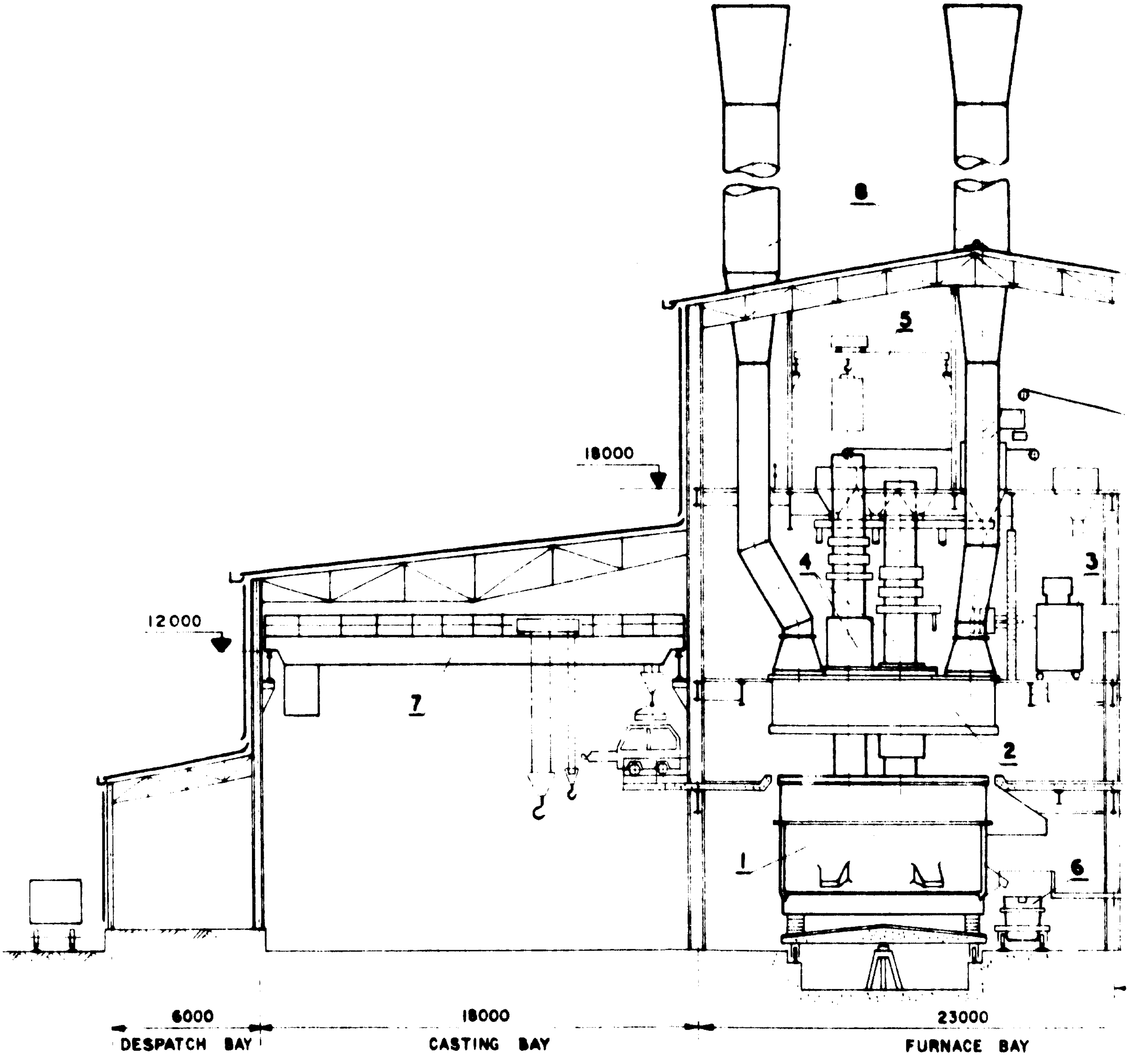
CONSULTING ENGINEERS, CALCUTTA

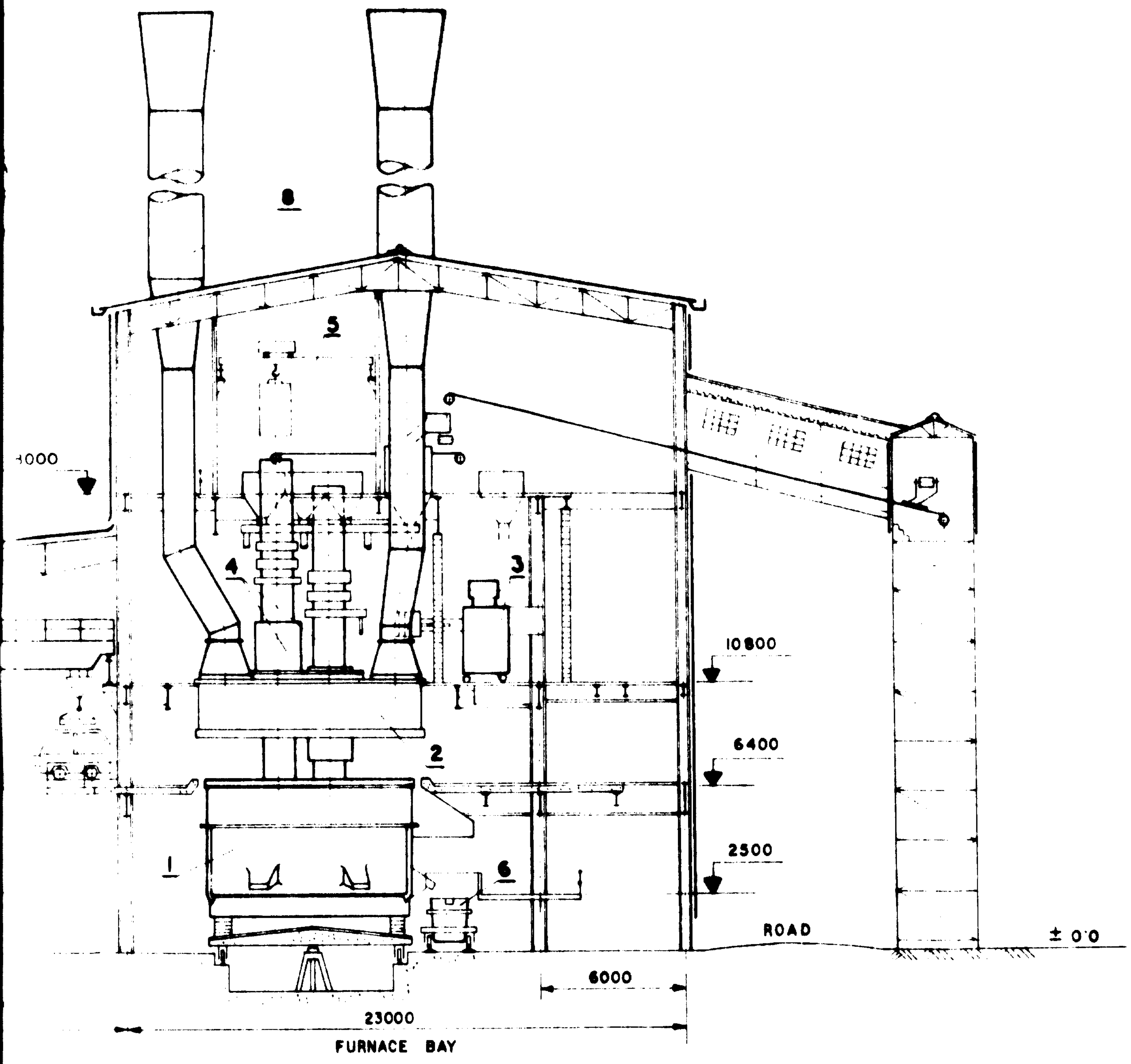
FOR
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROALLOYS PLANT — GENERAL LAYOUT

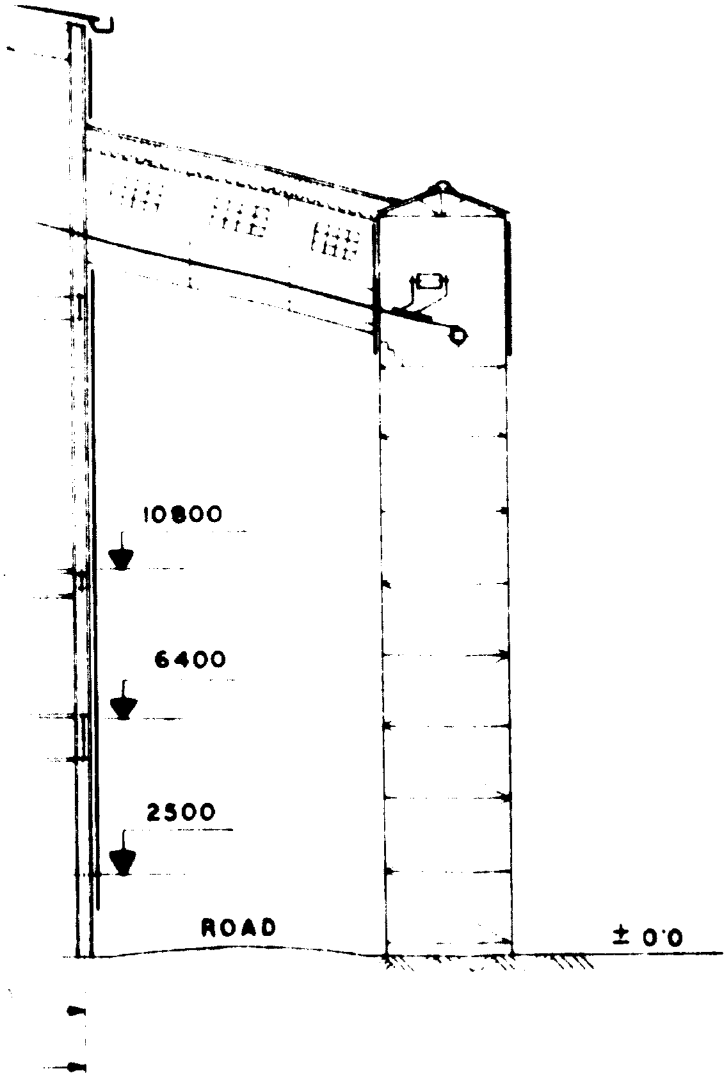
DRAWN	[illegible]	[illegible]	No. 5131-IV-4
APPROVED	[illegible]	[illegible]	


8
5
18000
4
3
12000
7
2
1
6
6000
DESPATCH BAY
18000
CASTING BAY
23000
FURNACE BAY

SECTION 1



SECTION 2



LEGEND

1 ROTATING FURNACE
2 SMOKE HOOD
3 TRANSFORMER
4 ELECTRODES
5 10-TON ELECTRODE HOISTING CRANE
6 LADLE
7 12/5-TON CASTING BAY CRANE
8 SMOKE CHIMNEY

SECTION 3

SCALE : METRES

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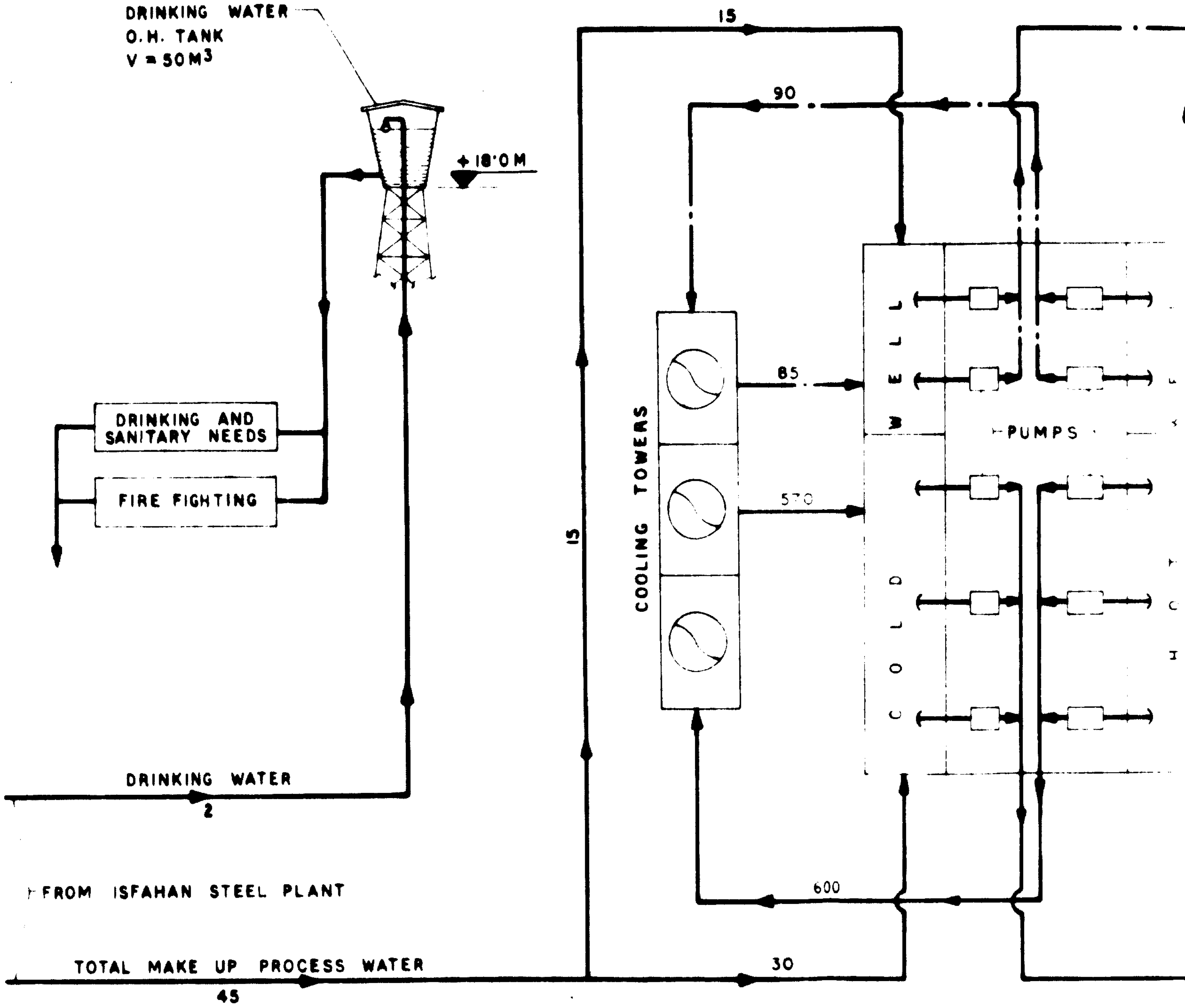
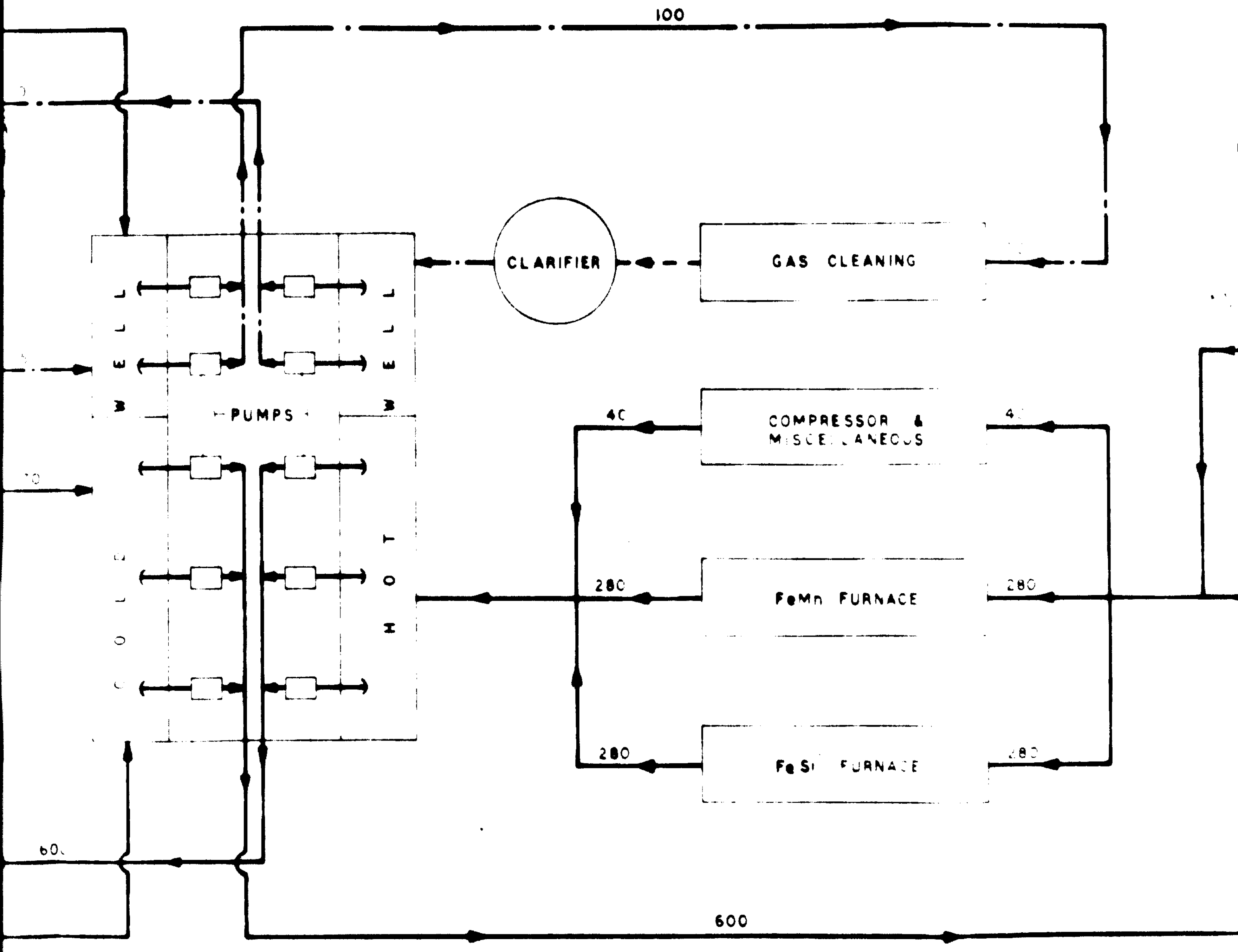
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROALLOYS PLANT—FURNACE BUILDING CROSS - SECTION

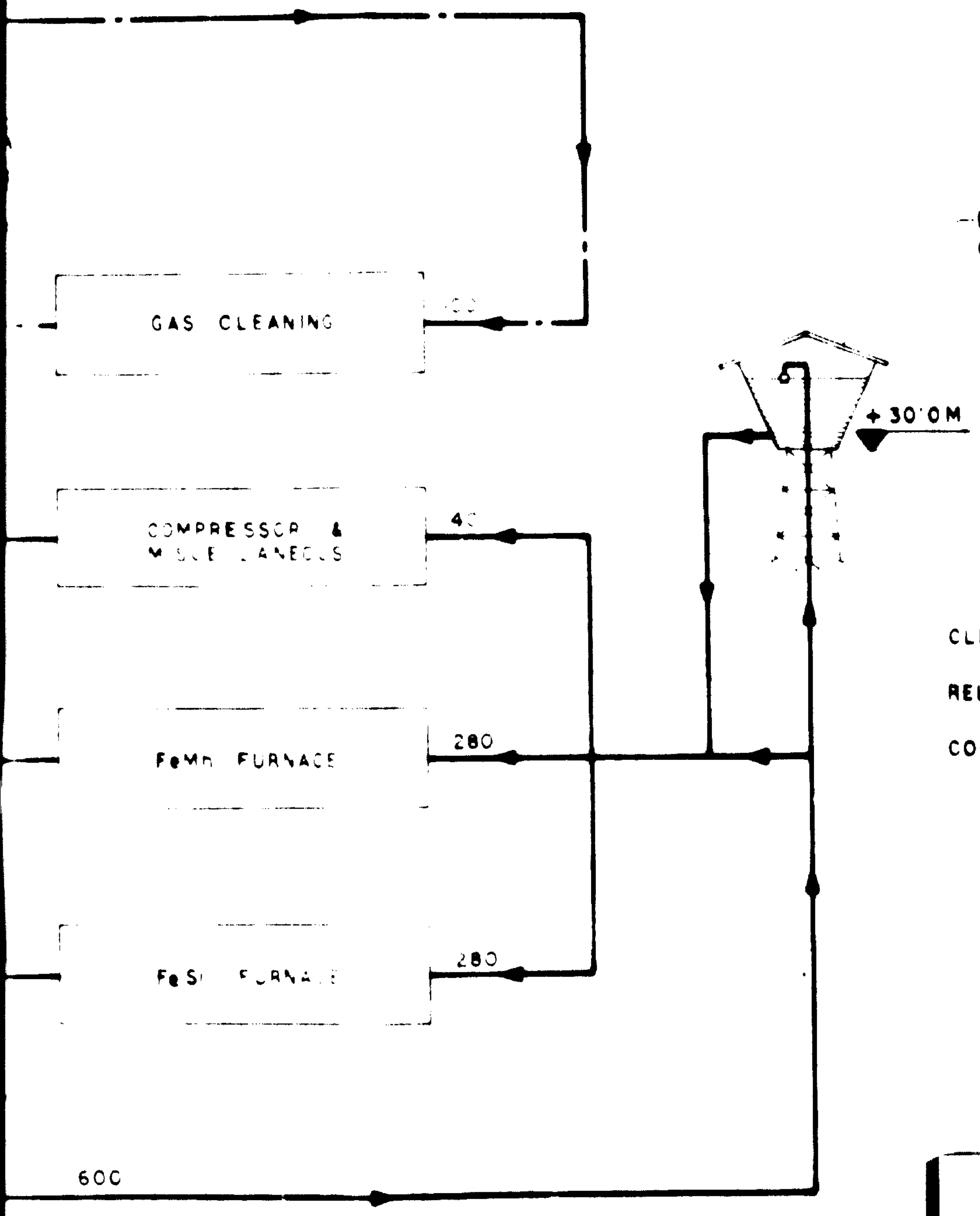
DRAWN		24.11.69	No. 5131 - IV - 5
APPROVED		28.11.69	


DRINKING WATER
O.H. TANK
V = 50M3
+18'0 M
DRINKING AND SANITARY NEEDS
FIRE FIGHTING
DRINKING WATER
2
FROM ISFAHAN STEEL PLANT
TOTAL MAKE UP PROCESS WATER
45
15
90
15
COOLING TOWERS
85
570
600
30
COLD WELL
PUMPS

SECTION 1


100
CLARIFIER
GAS CLEANING
WELL
WELL
PUMPS
COMPRESSOR &
MISCELLANEOUS
40
40
COLD
HOT
280
FeMn FURNACE
280
280
FeSi FURNACE
280
600

SECTION 2



LEGEND

CLEAN WATER	──▶──
RELATIVELY CLEAN WATER	─▶─·─
CONTAMINATED WATER	--◀--

NOTE:

FIGURES INDICATE FLOW IN CUBIC METRES PER HOUR.

SECTION 3

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FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
FERROALLOYS PLANT—SCHEMATIC DIAGRAM OF WATER SYSTEM

DRAWN		26.11.69	No. 5131-IV-6
APPROVED		2.12.69	

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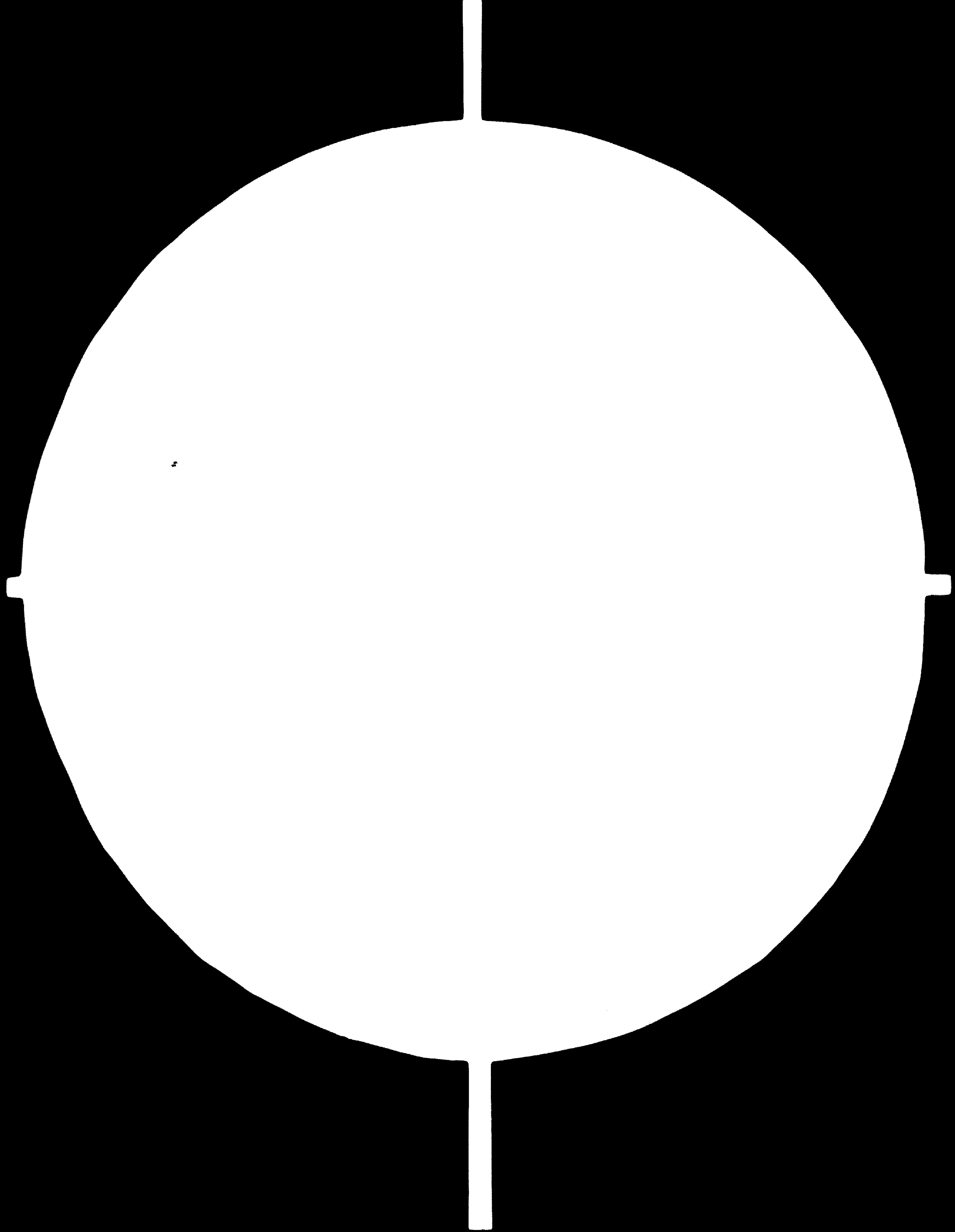
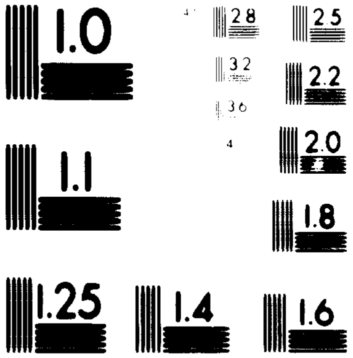


7 OF 10



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
ANSI and ISO TEST CHART No. 2

24x
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TABLE OF CONTENTS - VOLUME V
(continued)

Page

TABLES (Cont'd)

TABLE OF CONTENTS - VOLUME V
(continued)

Page

APPENDICES IN VOLUME V

TABLE OF CONTENTS - VOLUME V
(continued)

FIGURES IN VOLUME V

DRAWINGS IN VOLUME V

TABLE OF CONTENTS - VOLUME V
(continued)

DRAWINGS (Cont'd)

EXPLANATION OF SYMBOLS

Three dots (...) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A blank space ( ) in a table means that the item is not applicable.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A space is used to distinguish thousands and millions (1 346 849).

A full stop (.) is used to indicate decimals.

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954.

An asterisk (*) is used to indicate figures partially or wholly estimated.

Use of a hyphen (-) between dates representing years, e.g. 1960-1964, normally signifies an annual average for the calendar years involved, including the beginning and end years. 'To' between the years indicates the full period, e.g. 1960 to 1964 means 1960 to 1964, inclusive.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

24 - PLANT CAPACITY AND PRODUCT-MIX

The past consumption and possible future demand of alloy and special steels in Iran have been discussed in Chapter 7, Volume II. The consumption of alloy steels in 1968/69 including indirect imports in the form of finished metal products, machinery and parts was about 31 000 tons. As mentioned in Chapter 7 the installation of the alloy steel plant is being considered against the possible demand of 1977/78, estimated at about 76,000 tons per year, which would correspond to about 3 per cent of the total steel requirement.

Plant capacity and product-mix

Keeping in view the estimated future shortfall and the optimum scale of operations for an alloy steel plant, it is proposed to install a plant with a capacity of about 50,000 tons of finished alloy steels per year (that is, about 75,000 tons of ingot steel). At an intermediate stage during construction, the plant would have a capacity of 45,000 tons finished products (stage I), which would build up to 50,000 tons (stage II).

24 - Plant capacity and product-mix (cont'd)

Proposed plant to meet 60% of demand

It is neither feasible nor desirable to meet the entire requirements from one plant due to the diverse nature of the demand in terms of steel types and categories. For example, about 70 per cent of the deamnd for stainless steels and 10 per cent of the demand for other steels would be in flat products such as plates, sheets and strip. But stainless steel constitutes only a small fraction of the total and there is no economic rolling mill unit to handle such a small tonnage of flat products. Considering these factors, it is proposed to start with a plant which would meet about 60 per cent of the demand and handle a general range of products and excluding special requirements of small tonnages in a variety of types and categories. However, provision has been made for rapid expansion and diversification of the plant to cope with increased demand in future with minimum additional capital outlay.

Product-mix

The initial output of 45,000 tons of finished steel will include 25,000 tons of carbon and alloy constructional steels and 20,000 tons of spring steels.

Production of 5,000 tons of tool and die steels to supply tool blanks, die blocks, forged gear blanks as well as hot rolled tool steel bars to meet the requirement of tool and forging industry is envisaged for stage II. Construction of this stage would continue after the initial plant is commissioned.

24 - Plant capacity and product-mix (cont'd)

A break-down of the proposed product-mix for stages I and II giving the types of steels, product categories and sizes is set out in Tables 24-1 and 24-2.

Table 24-1

PROPOSED PRODUCT-MIX BY STEEL TYPES (STAGE I AND STAGE II)
(Finished steel in tons/year)

Stage I			
Constructional steels			
Carbon constructional steel ..	8 000		
Low alloy medium tensile steel ..	8 000		
Medium alloy high tensile steel ..	2 000		
Case hardening steel ..	5 000		
Free cutting steel ..	2 000		
Sub-total ..		25 000	
Spring steels			
Carbon spring steel ..	5 000		
Silico-manganese spring steel ..	12 000		
Chrome-vanadium spring steel ..	3 000		
Sub-total ..		20 000	
Total (stage I) ..			45 000
Stage II			
Alloy tool and die steels			
High speed steel ..	200		
Hot work die steel ..	300		
Cold work die steel ..	1 000		
Low alloy tool steel ..	1 000		
Die block ..	500		
Carbon tool steel ..	2 000		
Total (stage II) ..			5 000
Total (stage I and stage II)			50 000

24 - Plant capacity and product-mix (cont'd)

Table 24-2

PROPOSED PRODUCT-MIX BY PRODUCT CATEGORIES AND SIZES (STAGE I AND STAGE II)

(Finished steel in tons/year)

Product category	Size	Constructional steels	Spring steels	Total
Stage I				
Rounds mm dia	12-25	2 000	6 500	8 500
	26-75	8 500	-	8 500
	80-125	2 000	-	2 000
Total rounds		12 500	6 500	19 000
Squares, mm^2	12-25	1 500	500	2 000
	26-75	3 500	-	3 500
	80-125	3 500	-	3 500
Total squares		8 500	500	9 000
Flats, mm thick	4-10	-	10 000	10 000
	10-15	-	3 000	3 000
	6-12	2 000	-	2 000
	13-18	500	-	500
	19-25	300	-	300
	26-75	1 200	-	1 200
Total flats		4 000	13 000	17 000
Total (all products)		25 000	20 000	45 000

Stage II

		Forged products a/	Rolled products a/	Total
High speed steel	..	50	150	200
Hot work die steel	..	100	200	300
Cold work die steel	..	600	400	1 000
Low alloy tool steel	..	100	900	1 000
Die block	..	500	-	500
Carbon tool steel	..	200	1 800	2 000
Total	..	1 550	3 450	5 000
Total (stage I & stage II)	..		..	50.000

a/ Forged products sizes will be up to 150 mm sections, die blocks up to 500 mm dia/sq and rolled sections from 8 mm to 50 mm

24 - Plant capacity and product-mix (cont'd)

The product-mix is primarily based on the requirements of the automobile sector. However, production facilities would permit of considerable flexibility in the mix as regards grades of steel and the mill shapes and sizes to be produced. All products would be of non-flat categories. Flat products have not been included in the initial product-mix due to the small demand.

<u>Typical grades to be produced</u>

Based on the anticipated consumption pattern the typical grades of steels selected for initial production are given in Appendix 24-1. The corresponding British, German, U.S., Japanese and Indian Standard specifications are indicated alongside. Some plain carbon and low alloy tool steels, which do not call for small ingots or forging of ingots in the first breaking down stage, could also be produced with the facilities provided for the stage I.

<u>Future expansion</u>

The plant layout and utility systems have been so planned that the initial complex of facilities could expand to about 150,000 ingot tons per year (which is the capacity of the proposed primary rolling mill) to give 100,000 tons of finished products.

FEASIBILITY REPORT

TO

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

FERRO-ALLOY PLANTS AND ALLOY STEEL PLANT

FOR

THE MINISTRY OF ECONOMY, IMPERIAL GOVERNMENT OF IRAN

01602
(5 of 5)

VOLUME V
ALLOY STEEL PLANT

MAY 1970

M. N. DASTUR & COMPANY PRIVATE LTD, CALCUTTA
DASTUR ENGINEERING INTERNATIONAL GMBH, DUSSELDORF
Consulting Engineers

24 - Plant capacity and product-mix (cont'd)

Later, if required, a second steelmaking and rolling mill complex could be started to further expand the plant, for which space provision has been made.

Also, the plant's activities could be diversified, as indicated in Chapter 27.

25 - SELECTION OF PRODUCTION PROCESSES AND EQUIPMENT

The capacity of the alloy steel plant after stages I and II are completed will be 50,000 tons of hot rolled and forged products. It is necessary to select production processes and equipment which are proven and up-to-date as well as of optimum size, in order that the plant can produce alloy steels of high quality at competitive operating costs.

Quality considerations

The production of high carbon and alloy steels involves special techniques and greater care at the various stages of production as compared to plain carbon tonnage steels. The steels have to be of the 'killed', that is fully deoxidised, type. Ingots are cast wide-end-up with hot top in order to ensure solid sound steel in the body of the ingot. Hydrogen content of the steel has to be kept below certain limits and freedom from non-metallic inclusions is a very important consideration. Freedom from surface defects has to be ensured by surface dressing at the ingot stage and/or some intermediate stage before rolling into finished products.

Further, care has to be exercised in reheating for rolling. Rolling temperature ranges are more restricted, and reduction per pass less than in the case of mild steels.

Slow cooling is necessary for some of these steels to avoid 'flaking' (internal fissures). Extensive testing and inspection at various stages are necessary to ensure product quality.

Process flow

The general process and material flow envisaged for alloy and special steel production in stage I are shown in Appendix 25-1 and Drawing No. 5131-V-1 respectively.

Alloy steelmaking process

There are several processes available for steelmaking such as open-hearth, bessemer converter, oxygen converter, electric arc furnace and coreless induction furnace. Open-hearth and converter processes are suitable for tonnage production of plain carbon mild steels. Electric arc furnace and induction furnace are more suited for alloy and special steelmaking.

Induction melting

It is possible to make high-grade steels in small tonnages by high frequency induction melting, but it is too costly a process for constructional alloy steels. Induction furnace steelmaking is essentially a remelting process without any attempt at refining. The charge must consist of clean high grade steel scrap of known analysis plus the necessary ferro-alloys to give the desired final analysis. Induction melting is therefore not feasible with purchased scrap of commercial quality.

Keeping in view the proposed capacity and the process requirements, the facilities proposed for stage I and stage II are discussed below.

Electric arc furnace process

Electric arc furnace recommended

Selection of the proper steelmaking process and the right type of melting unit is important, as quality of the finished product can be ensured only by starting with good quality steel at the ingot stage. Taking into account the types of steels to be produced, the total production envisaged, availability of material supplies, electric arc furnaces are considered to be the only suitable melting units for successful production of these steels. Clean commercial scrap (as well as some proportions of sponge iron) can be used in the electric arc furnace to make any type of high grade steel.

Average yield

For the product-mix envisaged for stage I the yield (from ingot to finished product) will vary from 65 per cent to 70 per cent depending on grade of steel, the overall average yield being 67.5 per cent. With this average yield, the total ingot steel production required to give an annual production of 45,000 tons of finished material amounts to about 67,000 tons.

Arc furnace capacity

Four to six alloy steel heats per day can be tapped from a medium size arc furnace, depending on transformer rating, type of scrap etc. Oxygen lancing during the melt down and refining periods may be advantageously used to cut down the heat time, but at present oxygen in bulk quantity will not be available at the recommended site. Iron ore additions will have to be depended on for all oxidising reactions. Five heats per day is therefore assumed for estimating the furnace capacity required. The furnace will work three 8-hour shifts a day and about 330 days per year. Furnace availability is estimated at 95 per cent. On this basis, two 20/25-ton electric arc furnaces producing 22.5 tons of liquid steel each per heat on an average can give the production required.

Scrap <u>pre-heating</u>

Scrap will be preheated to 350°C-400°C by natural gas fired burners. This will result in about 10 per cent saving on power consumption and five to six per cent increase in production. As natural gas in Iran is cheap while power is not, 10 per cent saving of power will effect substantial economies in melting cost.

Generally conventional double-slag process will be adopted. Melt-down and initial refining is under a basic oxidising slag. After phosphorus has been reduced below the required limits the bath is deslagged, a fresh reducing carbide slag is prepared and maintained throughout the further refining period of 40 to 60 minutes. During this period the bath is deoxidised, necessary alloy additions are made, analysis adjusted to specification, and the metal brought up to temperature and tapped.

Continuous casting process

Continuous casting would appear to be an attractive proposition, since it eliminates altogether one stage of operation from ingot to billet, and the yield from liquid steel to billet is of the order of 95 per cent (as against about 80 per cent when the steel is cast into ingots and rolled into billets). In spite of these advantages (such as better yield, elimination of the primary mill, less segregation etc) continuous casting is not proposed for the following reasons:

i) Considering the maximum size of continuous cast billets to be about 150 mm sq and the reduction ratio of 8:1 necessary in rolling for alloy steels, the maximum size of finished bars would be 55 mm sq or 75 mm rounds. Hence the bigger sizes of bars required by the product-mix cannot be produced.

With strand reduction (for example, with the Böhler Block method) cast billet sizes could be much larger, but this is still under experimentation.

ii) Considering the variety of steels to be produced and the problems still being faced in continuous casting with respect to finding and maintaining suitable casting temperature, withdrawal speed and cooling rate as well as elimination of central porosity, corner cracks, pin holes and other internal and external defects, continuous casting would not be suitable at this stage of the project. It could however be adopted for certain steels during future expansion.

Ingot sizes

All steels are of the fully deoxidised type. Ingots proposed will be square (sizes up to 500 mm sq x 1,800 mm ht, weight 3 tons) and duodecagonal fluted (522 mm Ø, weight 1.9 tons).

The ingots will be hot topped wide-end-up and cast by top pouring method. Ingot moulds will be of bottom closed type with a central hole at the bottom which will be closed by a cast iron or refractory plug before teeming the liquid steel into the mould.

The most extensively used ingot size will be 375 mm square at the widest part just below the hot top and 1, 200 mm height, weighing about 1.3 ton. This ingot size would give the required reduction in cross-sectional area of 80 per cent minimum from ingot to bar even on the heavier sections rolled.

For some nickel-bearing steels like En 25 and En 36, which on reheating form a tightly adherent scale, a duodecagonal fluted mould may be adopted to facilitate scale removal in the early stages of cogging. Such a shape also reduces ingot elongation in the early stages of cogging and thus helps consolidate the weak ingot structure without risk of transverse cracking.

Teeming method

For teeming small ingots bottom pouring is generally preferred, since a cluster of 8 to 12 ingots can be teemed at a time, and due to less turbulence and splashing of the metal stream during teeming the ingot surface is smoother and free from defects than in top-teemed ingots. Bottom teeming practice is however more expensive than top-pouring.

Top-teeming proposed

Bottom teeming method is not recommended for this project, because in the first place this will require bottom teeming facilities, refractories and labour, which will add to ingot cost. Special refractory shapes of the required finish and quality are not available in Iran and they would have to be imported. Without such special refractories bottom teeming would give trouble due to frequent breakouts and also adversely affect the steel quality due to refractory erosion and spalling, thereby increasing non-metallic inclusions in steel. Further, from the view-point of proper directional solidification of the steel to give solid ingots, bottom teeming is a metallurgically unsound practice, since the colder metal entering the mould first rises to the top and requires a larger amount of metal in the hot top than top teemed metal to produce sound ingots. In view of these problems, and in particular due to non-availability of suitable refractories in Iran, top teeming method will be adopted.

Soaking pits

The ingots are stripped from the moulds after complete solidification by special stripping mechanism. As far as practicable ingots will be hot charged into the soaking pits soon after stripping, as against the practice of cooling the ingots, conditioning them, and again re-heating for rolling.

When hot charging is not possible ingots will be cooled in air or in slow cooling pits, depending on the type of steel. The cold ingots will be slowly heated in a bogie hearth pre-heating furnace to about 800°C before being transferred to the hot soaking pits.

Three batteries of three holes each, each hole capable of accommodating 25 tons of ingots (that is one full heat of steel) are provided. Space has been provided for the installation of more batteries in the expansion phase.

Blooming mill

The cast ingots have to be cogged down to bloom or billet size before further rolling into bars. The ingots can be cogged in a cogging mill or in a forging press of suitable capacity. Forge cogging is not recommended as it will not be economical for the production envisaged and the types of steels handled.

Reversing mill speed

Ingots can be roll cogged either in a 2-high reversing or a 3-high mill. A 700 mm reversing mill is considered to be the most suitable unit for the ingot sizes handled. The reversing mill will be about twice as expensive as a 3-high mill of the same size. However, in the reversing mill it would be possible to roll billets down to 80 to 100 mm sq, thus eliminating a separate billet mill at the initial stage. With the 3-high mill on the other hand, the minimum size of billets that can be rolled will be 125 to 150 mm sq and a separate mill will be necessary for further rolling billets of 100 mm sq. Therefore, a 700 mm 2-high reversing mill is suggested. Mill speed will be 0-60-120 rpm. The mill will be driven by 1,800 MW DC motor.

Two-shift operation

The mill will roll 375 mm sq ingots of 1.3 ton weight into 100 mm sq billets at the rate of 15 ingots per hour (that is, about 20 tons per hour). Operating six days a week, with mill efficiency assumed at 70 per cent, the mill will be able to roll about 67,000 tons of ingots in two shifts of 8 hours each. This will be adequate to meet the initial requirements.

LIST OF VOLUMES

If the minimum size rolled is restricted to 150 mm sq, the mill can roll 22 ingots, (that is, 28 tons per hour). Assuming the same mill efficiency of 70 per cent, the throughput would be about 150,000 tons of ingots in three shift operation, that is the mill capacity could be doubled if required by rolling three shifts and restricting bloom size to 150 mm sq minimum.

In-line hot scarfing

To minimise initial investment, an in-line hot scarfing machine, an expensive item has not been provided; only space has been left for its future installation by extending the roller table ahead of the shear. Apart from high cost the in-line hot scarfer requires ample quantity of oxygen which will not be available at present at the selected site at Ahwaz. If the in-line hot scarfer is to be installed, an oxygen plant will also be required. Further, in hot scarfing, metal is removed from the surface of the bloom to a depth of 1.5 to 3.0 mm, resulting in loss of yield unless the bloom is of fairly large size (at least 150 mm square compared to 100 mm square, which will be predominantly used in the initial plant).

Without the in-line hot scarfer, bloom and billet inspection and conditioning will have to be rather more thorough and extensive than with the scarfer. Installation of an in-line hot scarfer would be justified in the expansion phase when cogging mill production could be doubled.

Billet conditioning

In the production of alloy and special steels, ingots or billets need to be conditioned to remove surface defects much more thoroughly than in the case of ordinary steels. The amount of conditioning would depend on the type and grade of each steel. It is proposed to do this conditioning after the break-down of ingots in the primary mill.

European practice

Surface conditioning procedures adopted in European and American practices differ rather widely. Generally, European practice is to bottom teem all alloy, tool and special steels. The ingots are round or square, wide-end-up and hot topped. The ingots are allowed to cool down, annealed and surface machined. Round ingots are machined on lathes. Square ingots may be machined on specially designed contour turning lathes or plano-milling machines. Ingot surface is peeled to a depth of 1.5 to 5.0 mm by this machining operation, depending on the grade of steel, ingot size and surface condition to eliminate surface defects. Deeper defects are eliminated by spot grinding on swing grinders. With less critical grades sometimes only swing grinding is adopted. Blooms and billets rolled from these ingots are inspected and further dressed to remove surface defects if necessary.

American practice

In American practice the ingots are charged hot into the soaking pits or reheating furnaces. Surface dressing practice at the ingot stage is rarely adopted. Shallow surface defects are often eliminated with the thick scale formed on reheating, this scale falling off during break-down rolling.

For the Iran plant, the practice of top teeming and conditioning in the bloom or billet stage will be adopted.

Extensive billet conditioning required

As the in-line hot scarfer is not provided initially, the billets will be extensively conditioned prior to further rolling by hand scarfing, chipping and grinding. For this, the conditioning facilities provided include pneumatic hand chipping, swing frame and automatic billet grinding equipment and hand scarfing torches.

Billets susceptible to 'flaking' will be cooled slowly in slow cooling covers. Billets to be scarfed will be pre-heated in special heating covers. Critical grades will be sub-critical annealed for chipping and grinding.

Some of the billets will be pickled to facilitate inspection. Magnetic flaw detector would be used to locate surface defects. All billets would be carefully inspected both before and after conditioning. Conditioned billets would be heated in reheating furnaces to rolling temperature and rolled into bars.

Bar rolling

Two bar mills proposed

Of the total of 45,000 tons comprising the initial product-mix, 17,700 tons will be heavy sections consisting of rounds and squares above 35 mm size up to and including 125 mm size, and flats above 100 mm width up to and including 150 mm width. The balance 27,300 tons will consist of medium and light sections including rounds and squares 12 mm to 35 mm size and flats 4 to 25 mm thick and 12 to 100 mm width. For this wide range of section sizes it is considered desirable to install two bar mills (one for heavy sections and the other for medium and light sections).

Heavy bar mill

With an expected yield of 92.5 per cent from rolled to finished bar in the case of heavy sections, 19,000 tons of bars will have to be rolled to give a finished tonnage of 17,700 tons. Heavy sections will be rolled in a 550 mm 3-high, 3-stand mill driven by 1,500 kW AC motor through reduction gearing and 3-high pinion stand. Daily two shift operation of the mill for 300 days a year would be adequate to give the required production.

Light bar mill

Medium and light sections will be rolled in another bar mill consisting of a roughing mill train of two 450 mm, 3-high stands driven by 1,200 kW AC motor and finishing mill train consisting of two 380 mm, 3-high stands driven by one 750 kW DC motor, two 300 mm 3-high stands driven by another 750 kW DC motor and one 280 mm 2-high stand driven by a 300 kW DC motor. With an expected yield of about 90 per cent from rolled to finished bars, about 29,000 tons of bars will have to be rolled in this mill to give a finished tonnage of 27,300 tons of medium and light sections. The mill will have to operate 3 shifts daily, 300 days a year, to give this output.

Billet reheating

Billets have to be heated slowly and steadily to rolling temperature. This necessarily means that they must be heated in some type of continuous furnace which is comparatively cold at the charging end and of sufficient holding capacity to allow slow and steady heating to rolling temperature by the time the material reaches the discharge end.

Walking beam furnace preferred

Of the different types of continuous furnaces the pusher type has the advantage of cheapness and simplicity. But with this type of furnace the heating rate is controlled by the mill rolling rate and cannot be varied as required by the material being heated. Further, the furnace has to be full always, and cannot be emptied completely when required. To take care of these reheating problems walking beam furnaces, although comparatively expensive, are recommended. One walking-beam billet reheating furnace of 15 ton per hour capacity for the heavy bar mill and two walking-beam billet reheating furnaces each of 10 ton per hour capacity for the light bar mill are proposed.

Heat-treatment and finishing

Shipment of rolled bars

About 80 per cent of the total output will be dispatched to consumers in the 'as rolled' condition for forging, machining and fabrication by other processes into finished parts. The rolled bars will be straightened, ends squared and subjected to careful inspection and testing. Minor surface defects will be removed by hand grinding. Bars will be checked for internal and external defects by magnetic and supersonic flaw detectors. Macro-etch, hardness and end quench tests will be carried out to check quality and hardenability.

Heat-treatment

About twenty per cent of the finished steel output, that is about 9,000 tons only will be supplied in the heat treated condition. Of this, about 6,000 tons would be normalised and full/or sub-critical annealed. About 3,000 tons, which may be utilised for machining into high strength components without further treatment, are quenched and tempered.

Two bogie hearth gas fired furnaces operating at temperatures up to 950°C are provided for normalising, full annealing and quenching treatments. Tempering and sub-critical annealing will be carried out in one bogie hearth recirculated air convection heating type furnace.

Finishing facilities

Bar straightening will be carried out on multi-roll rotary straighteners for rounds, roller type shape straightener for squares,flats and other shapes, horizontal mechanical press straightener for further touching up light bars and horizontal oil hydraulic press straightener for heavy bars. Power hack saws and band saws are provided for end squaring and test piece cutting. Other facilities provided at the finishing end include inspection benches, magnetic and supersonic flaw detectors, hardness tester, macro-etch facilities, oil coating, bundling, stamping, tagging, handling and storage facilities.

Stage II facilities

The general flow sheet for stage II production is given in Drawing No. 5151-V-2.

Steelmaking

In stage II, for an output of 5,000 tons of finished tool and die steels and die blocks about 8,000 tons of ingots will be required. High carbon and high alloy tool and die steels have to be cast into comparatively small size ingots to minimise segregation and improve workability. A 6-ton electric arc furnace will be installed for the production of tool and die steels.

Forging

High carbon and high alloy tool and die steels have to be forge-cogged in the initial stage to consolidate the fragile ingot structure before further rolling into finished products. Heavy bars required in comparatively small tonnages can be finished entirely by forging. A 1,000-ton hydraulic forging press for forging ingots and large die blocks, and a 2-ton pneumatic forging hammer for forging billets, heavy bars and forged blanks, together with necessary pre-heating and heating furnaces will be installed.

Large forgings

Plain carbon tool steels with less than one per cent carbon and medium carbon low alloy tool steels like shock resisting tool steels do not need to be forged in the ingot stage and can be rolled straight in the blooming mill. Any surplus press capacity available due to this can be advantageously utilised for the production of large forgings and die blocks from heavy ingots of alloy constructional and die block steels made in the 20/25-ton arc furnace.

Rolling

Tool steel bars of comparatively low carbon and low alloy contents could be rolled in the same bar mills as the constructional steels. But high alloy tool steels like high speed steels and high chromium die steels would need to be rolled with light reductions in slow hand operated mills. Moreover, as tool steels will generally be required in small tonnages which cannot conveniently be fitted into the production programme of the high production guide mills, a four stand, 3-high, 250 mm mill with batch type preheating and

Conditioning

Two additional swing grinders and one additional automatic billet grinder will be installed to take care of billet conditioning.

Finishing

All tool steels have to be supplied in the annealed condition. Two natural gas fired, radiant tube heated lift-off hood type atmosphere controlled annealing furnaces of 10 tons capacity each, with two bases for each hood, will be provided in the finishing end for annealing tool steels.

26 - SELECTION OF PLANT SITE

Factors influencing site selection

Availability of adequate quantity and quality of steel scrap, bulk electric power at reasonable tariff, requisite supply of water and availability of adequate land with suitable soil characteristics, are considered the major factors for selection of site for this plant. These as well as other factors such as raw materials assembly and product distribution costs, factors affecting capital investment, availability of transport and ancillary facilities, and labour environment, are analysed to locate a suitable site for the plant.

Materials and utilities consumption

The initial plant production and requirements of major raw materials, consumable items, power, water and fuel relevant to this discussion are summarised in Table 26-1.

ABSTRACT
(Vol V)

To meet part of the 1977/78 shortfall of 76,000 tons in alloy and special steels, a plant is proposed with an initial capacity of 45,000 tons per year of finished constructional and spring steels in stage I, to be raised to 50,000 tons in stage II by the addition of 5,000 tons of tool and die steels. The plant design has provision for future expansion to 150,000 tons per year.

A comparison of the economics of four alternative locations indicates that Ahwaz and Arak are suitable sites. The rationale for selection of processes and equipment is discussed. Modern, proven technology is proposed for the production of high quality products at competitive costs.

The project cost is estimated at $ 46 million (including $ 26.5 million in foreign currency) for stage I, and $ 6 million (including $ 2.8 million in foreign currency) for stage II. These figures do not include working capital.

The technical know-how and training arrangements considered necessary are indicated. Detailed production cost estimates for typical alloy steels have been developed.

The selling prices assumed are lower than present prices in Iran but higher than international prices. At present there is some disparity in the custom duties on steel, with lower duties levied on alloy steels than on mild steel. These need to be rationalised and the duties on alloy steels revised by about 20 to 30 per cent to enable the plant to sell its product for the initial period in the Iranian market.

The financial analysis indicates that over a period of 15 years, the average net profit after tax comes to about $ 3.4 million representing about 6.5 per cent return on the total capital investment of $ 52 million or about 15 per cent return on the equity capital of about $ 23 million. From the cash flow analysis, it is observed that the plant will have adequate funds to repay the long-term loan from the third year of operation and that at the end of fifteenth year, there will be a net surplus after tax of about $ 74.7 million. By discounted cash flow method, the internal rate of return works out to about 10 per cent and the present excess value at 8 per cent rate works out to about $ 12.5 million.

26 - Selection of plant site (cont'd)

Table 26.1

REQUIREMENT OF MATERIALS AND SUPPLIES

		Tons/year
Plant production		
Constructional steel	..	25 000
Spring steel	..	20 000
Alloy tool and die steel	..	5 000
Production requirements		
Steel scrap ..	..	62 100
Ferro-alloy and additions	..	2 830
Iron ore ..	..	3 020
Limestone ..	..	11 500
Fluorspar ..	..	770
Petroleum coke ..	..	1 200
Electrodes ..	..	545
Moulds, stools and hot tops	..	2 500
Refractories (for operation)	..	6 000
Electric power (peak demand)	..	30 000 kVA
Water (make up) ..	..	300 cu m/hr
Fuel - natural gas (at 8 000 Kcal/cu m)		6.25 cu m/hr x 10^3

Further, availability of additional quantities of raw materials, power, water etc must be assured at the selected site for the expansion of the plant in future.

Sites for consideration

Industrial development

At present, more than 80 per cent of the industries in Iran are located around Teheran and the principal market for alloy steels is also Teheran. Other areas where new industries are now coming up are Tabriz, Arak, Isfahan, Ahwaz, Quasvin etc. For example, tractor plant, machine

26 - Selection of plant site (cont'd)

tool plant and diesel engine plant have been located at Tabriz; machine building plant and aluminium plant at Arak; the first integrated steel plant in Iran at Isfahan; and rolling mills and pipe plant at Ahwaz. In view of these and other new plants likely to come up in these areas (such as the proposed wagon building plant, cold rolling mill plant, seamless tube plant, sponge iron plant etc), the market for alloy steels is bound to develop in these areas also. However, as the rapidly developing automobile industry (at present the major consumer of alloy steels) is located in Teheran, this area will continue to be the major consumer of alloy steels for quite some time.

Apart from the market for alloy steels, good quality melting scrap which is the main raw material for alloy steelmaking, would be available mostly from the steel producing and consuming industries.

Sites <u>considered</u>

In view of these, the sites which appear to be promising for the proposed plant are Tabriz, Arak, Isfahan and Ahwaz as shown in Drawing No.5131-V-3. These areas have therefore been studied and relevant data for comparison tabulated in Appendix 26-1.

Scrap in Iran

Scrap position in Iran

The current availability of steel scrap in Iran is about 30 000 to 35 000 tons per year. Of this, about 50 per cent is generated by processing industries around Teheran and the rest is mainly from Ahwas.

Scrap availability at Ahwas

Iranian Rolling Mills Co and the NIOC pipe plant at Ahwas currently generate some steel scrap at their rolling and pipe mills as estimated below.

	Present production tons/yr	Scrap generation tons/yr
Iranian Rolling Mills Co	100 000	7 000
NIOC - Ahwas pipe plant	150 000	10 000
Total		17 000

The Iranian Rolling Mills Company's capacity is being expanded to about 300,000 tons per year. Taking into consideration also scrap generation by the skelp and pipe plant (capacity: 140,000 tons per year) under construction at Ahwaz, the probable availability of steel scrap from plants at Ahwas, as indicated by Industrial Mining and Development Bank of Iran (IMDBI) and IRMCO, would be as follows:

26 - Selection of plant site (cont'd)

	Future scrap availability - Ahwaz Tons/yr
Iranian Rolling Mills Co (capacity 300 000 tons/yr)	20 000
NIOC-Ahwaz pipe plant (capacity 360 000 tons/yr)	20 000
IMDBI-Skelp and Pipe plant (capacity 140,000 tons/yr)	15 000
Total	**55 000**

As the country's steel consumption increases additional scrap can be expected to be generated at the main processing centres such as Teheran, Arak and Tabris.

Scrap consumption

Due to substantial difference in price between imported pig iron ($ 80 to 85 per ton) and local scrap ($ 15 to 25 per ton), the existing iron foundries use a large proportion of scrap in cupola melting and some of them are even trying to switch over to mains frequency induction melting (to circumvent the difficulties of procurement and high cost of imported pig iron and coke for cupola melting).

The Isfahan steel plant will consume all its internal scrap and also purchase from outside about 6,000 tons of scrap every year for use in LD convertors for the initial production of 550,000 tons of steel. The iron and steel foundry of Arak machine building plant would need some scrap.

Further, a centralised foundry and forge project is being contemplated at Tabriz to meet the requirements of castings and forgings for automobile and other industries in Iran. In addition, the Iranian Rolling Mill Company is installing an arc furnace/continuous casting plant at Ahwas which will also require scrap.

In view of the above, steel scrap is expected to be in short supply in Iran as a whole. In this context, the overall picture of national scrap balance (i.e. possible scrap availability and demand) given in Volume II, Chapter 4 Raw materials for alloy steels,also indicates that there may be a scrap deficit of the order of 245 000 tons per year by 1977/78 and about 350,000 tons per year by 1982/83.

Sponge iron <u>production</u>

Further, the plant being planned to produce sponge iron by direct reduction process needs to be expedited. When this scheme materialises it should be possible to use sponge as part of metallic charge at the proposed alloy steel plant.

Imported <u>materials</u>

Besides scrap, other raw materials and consumable items like ferro-alloys, refractories, electrodes, petroleum coke, fluerspar, magnesite, etc will be required, and all these will have to be imported. In view of this, a plant located as near a port as possible with good hinterland communications will be favoured.

Limestone as flux and dolomite as refractory material for furnace repair are required, but these will be available locally.

Suitability of sites

Suitability of the four sites, that is Tabriz, Arak, Isfahan and Ahwas (which are shown in Drawings No.5131-V-4, 5, 6 and 7 respectively) is discussed below.

Plant location at Tabriz

At Tabriz, adequate land close to railway and road is available. Water will have to be drawn from wells, and for a plant of this magnitude, adequate and constant supply of water from wells will be difficult. By 1974/75 power is expected to be available from the national grid with major generating stations at Tabriz, Aras dam, Kerros dam and Shahpur dam and transmission line voltage of 230-132-20 kV. However, the unit power rate is expected to be higher and power supply not as stable compared to locations at Arak and Ahwas.

Plant location at Arak

Sufficient land is available near the Iranian Aluminium Company (IRALCO) and adjoining the main road connecting Arak to Qom, Isfahan and Ahwas. The Arak Machine Building Plant is also in the same area and near IRALCO. The plant site is near the railway line.

The main source of water is wells. IRALCO and the Machine Building Plant have dug 11 wells, each about 100 m deep to meet their water requirements. The draw of water from each well is reported to be about 230 to 350 cu m per hour (850 to 1,300 gpm). Stability of water supply mainly depends upon rainfall. The extent to which assured year round supply of water would be available from wells could not be ascertained.

Presently power is being supplied from a diesel generating station, but by July 1971, additional bulk power will be available from the grid. A 220/60 kV substation will be built at Arak to meet bulk of the power requirements of about 125 MW for the plants under construction.

The Arak Machine Building Plant would need about 2,500 tons of alloy steels, mainly comprised of sections, sheets and plates. This area is likely to develop rapidly with other ancillary industries springing up. Arak is also near Teheran, the main consuming centre for alloy steels.

With the commissioning of the main gas line from south to north right up to Zolfa on the USSR border, natural gas will be available at Ahwaz, Isfahan, Teheran, Tabris etc; but because of insufficient demand for fuel at Arak, it is not presently included in the scheme for natural gas supply. Besides being a more convenient fuel, natural gas on the basis of its calorific value is expected to be about 30 per cent cheaper than fuel oil in Iran.

Location of the plant at Arak will be faced with difficulties due to uncertainty of water supply.

Plant location at Isfahan

Fairly flat and spacious land with good soil bearing capacity of 3 to 8 kg/sq cm is available near Isfahan steel plant itself, as shown in Drawing No.5131-V-6. Adequate supply of water could be arranged througn Isfahan steel plant from Zayandeh river about 3.5 km from the site. As Isfahan will be connected by the national power grid with major generating stations at Isfahan, Shahabbas Kabir dam and the steel plant, with transmission line voltage of 230-63-20 kV, adequate and stable power supply will be available.

An alloy steel plant at Isfahan could share facilities with tne Isfahan steel plant for such requirements as oxygen, limestone, dolomite and repair shop facilities.

Plant location at Ahwas

As shown in Drawing No.5131-V-7, suitable land for the plant is available near the existing Iranian Rolling Mill Company. The site is close to highway and railway connecting Ahwas to Khorramshahr. There is a proposal to build a railway station near the existing rolling mill plant. Hence, a siding at the plant connected to the nearby station will be possible.

Adequate water is assured from Karun river, about 2 km from the plant site, as shown in Drawings No.5131-V-7 and 8. At present power is supplied to the existing plant at 33 kV. There is a proposal to build a 230 kV substation at Ahwas to meet the increasing requirements of power in the area. This will ensure adequate supply of stable power necessary for the plant.

Comments on sites under consideration

Of the four sites, Ahwaz is extremely hot with maximum temperature going up to 48°C and Tabriz extremely cold with temperature going down to minus 25°C. Arak and Isfahan also experience severe cold accompanied by snowfall.

Factors affecting investment cost

Considering the various factors affecting initial investment as given in Appendix 26-2, the Ahwaz location is preferable from the view-points of lower cost for off-site facilities, transport of imported equipment and township.

In respect of assured supply of water and adequate supply of stable power, Ahwas and Isfahan are better placed compared to Tabris and Arak.

At Ahwaz, located in Khusestan, natural gas will be available at concessional rate not obtainable at present at the other three locations outside Khuzestan.

The total freight charges on account of raw materials assembly and finished product distribution is given in Appendix 26-3 and summarised below:

Table 26-2

TOTAL FREIGHT FOR RAW MATERIALS ASSEMBLY AND PRODUCT DISTRIBUTION

	Tabris	Isfahan	Arak	Ahwas
Raw materials assembly ..	1 209 150	856 220	476 040	188 930
Finished product distribution	540 150	589 150	318 050	690 050
Total	1 749 300	1 445 370	794 090	878 980

It will be seen that for finished product distribution the freight cost is the lowest for Arak, because about 77 per cent of alloy steels will be consumed in Teheran and about 12 per cent in Tabris. On the other hand, the freight for raw materials assembly is lowest for Ahwas. Tabriz and Isfahan are not favourably placed both in respect of raw materials assembly and production distribution costs. The total freight cost for Arak works out to be somewhat lower than for Ahwas.

The plant is expected to break-even when operating at about 68 per cent of the rated capacity. However, because of the in-built capacity in the blooming mill and utility systems, the break-even point will be lower when the plant is expanded beyond the capacity.

Against the initial expenditure of $ 29.3 million on capital investment and about $ 6.5 million for the first four years of operation, the plant is expected to effect foreign exchange savings per annum of about $ 0.35 million in the fifth year and increasing to about $ 4.5 million from the fifteenth year onwards. Foreign exchange savings will further increase.

Besides the commercial gains, the project is destined to play an important role in the national economy by providing vital alloy steels to the defence and heavy engineering and metal process industries and thus in return accelerating the pace of industrial development.

26 - Selection of plant site (cont'd)

Both Ahwas and Arak are considered to be suitable sites for the proposed alloy steel plant, with Ahwas having the advantages of better water supply, natural gas availability and proximity to imported and local scrap. The subsequent discussion is based on the Ahwas site.

27 - PLANT GENERAL LAYOUT

Based on the site for the proposed plant near Ahwaz town, this chapter deals with the general layout, which has an important bearing on the operating economics, capital cost and future expansion of the proposed plant.

Description of site

Area required

The land suggested for the proposed plant covers a total area of 120 hectares as shown in Drawing No. 5131-V-8. Of this area, 110 hectares are within the plant boundary.

Location of site

The site is situated at latitude 31°20'N and longitude 48°40'E, at a distance of about 10 km from Ahwaz. The Ahwaz-Khorramshahr highway and the railway line from Ahwaz and to Khorramshahr pass along the northern boundary of the plant site. Though the railway line is passing very close to the site, the nearest station is Ahwaz. There is a proposal for constructing a new railway station near the existing Iranian Rolling Mills Company which is immediately on the eastern side of the plant boundary. The water supply for the proposed plant would be from river Karun, about 2 km away south of the plant. The Khusestan Water and Power Authority (KWPA) will be setting up a 230/33 kV major step-down substation in the vicinity of the Iranian Rolling Mills Company to feed all major industries in this area. Power at 33 kV will be available to the plant from the proposed substation.

Climate

Rainfall is scanty in this area, the average being around 200 mm per year. The normal rainy season is in winter. The predominant wind direction is south-west to north-east.

The climate is hot and desert-dry. The average temperature varies from maximum 45°C in July to minimum 0.3°C in January. The highest temperature reached is 48°C in August and the lowest is minus 7°C in January.

Topography

The topography of the site is a major factor in deciding the plant general layout and the levels for the various facilities. Topo sheets of the proposed plant site area indicate that the land is fairly flat.

Subsoil conditions

The bearing capacity of the soil varies from 0.7 to 1.8 kg per sq cm. It is envisaged that no piling would be required for building columns and heavy equipment foundations. The water table at the site varies between 4.2 and 6.7 m from ground level. To ascertain subsoil conditions and load bearing capacity soil investigation and tests will be necessary at the engineering stage.

Plant general layout

The planning of the general layout for the proposed alloy steel plant is basically a study to evolve a rational arrangement of the main plant production units, the utility and energy networks, and the repair and maintenance facilities within the limitations imposed by the selected site. The plant general layout as shown in Drawing No. 5131-V-9 has been prepared based on the following major considerations:

i) Uninterrupted receipt of incoming materials and despatch of empty wagons and finished products, with minimum contra-flow of materials.

ii) A rational arrangement of production and auxiliary units so that, together with the utilities, the capital and operating costs are minimised in the initial stage and in the subsequent future expansion.

iii) Flexibility to adopt likely technological advances in the future expansion with minimum interference with plant operations.

27 - Plant general layout (cont'd)

The direction of materials flow for the proposed alloy steel plant would be from east to west. This is mainly because both the rail and the road entries would be from the east end of the plant. All the production units and the major auxiliary departments are on the east-west line.

Materials handling

A large area at the east-end of the plant has been allocated for the incoming scrap and other raw materials in bulk. The slag and debris generated in the plant would be dumped at the area near the river bank. Suitable road connections from the slag and debris originating points within the plant to the slag dump are provided for the movement of dumpers and trucks.

Steelmelt shop

The steelmelt shop has a covered scrap aisle for scrap storage, a two-level furnace aisle for installing arc furnaces and a teeming aisle for ingot casting operation as well as for ingot stripping. At the permanent (west) end of the shop, provision exists for a future continuous casting plant while at the extension (east) end of the shop the structure is designed for expanding the building to accommodate additional arc furnaces of similar or higher capacity. The future vacuum degassing plant can be located at the northern side of the steelmelt shop, near the east end.

Ingot stripping/mould preparation

Considering the scale of operations involved and in order to keep the initial capital cost low, it is proposed to carry out the stripping operation in the last two bays at the west end of the teeming aisle. Mould preparation would be done in a separate building which is adjacent to the teeming aisle on the north side. Ingots will be loosened from the moulds in the teeming aisle. Empty moulds on mould cars from the soaking pits will be brought to the mould preparation building from the west end. After cooling, cleaning and requisite preparation, moulds on cars will be taken to the teeming aisle through the east end.

Soaking pit building

In line with the steelmelt shop and blooming mill is the soaking pit building where pits fired with natural gas will be installed. Loosened ingots, together with their moulds on the mould cars, will be brought to the soaking pits from the east end of the building.

Blooming mill

The blooming mill is parallel to the steelmelt shop, with the mill motor room adjacent to the south side of the mill bay. Hot ingots from the soaking pits will be rolled in the blooming mill and the products will be discharged on the cooling bed in the billet conditioning at the west end.

27 - Plant general layout (cont'd)

Billet conditioning

The billet conditioning building consisting of three aisles is located at right angles to the blooming mill building. The hot billets from the blooming mill bay will be received on the cooling bed in the aisle adjoining the mill building. The necessary conditioning facilities are provided in the middle aisle. In the extreme aisle at the west, conditioned billets will be stored, cut and charged to the bar mills.

Bar mills

The bar mills are located in line with the blooming mill and at right angles to the billet conditioned building. Rolled products from the bar mills are delivered to the heat treating and finishing department.

Heat-treatment and finishing department

The heat-treatment and finishing department is at right angles to the bar mills. The incoming materials from the bar mills are received in the east side aisle. After treatment, straightening and inspection, finished products are despatched to the warehouse. This warehouse provides space for stocking the finished products and also for the shearing, bundling and loading of products for despatch.

27 - Plant general layout (cont'd)

Stage II facilities

For production of 5,000 tons of tool and die steels in stage II, separate steelmelt/forge shop bay and mill bay for a hand operated rolling mill have been provided as shown in Drawing No. 5151-V-9. There is also provision for future expansion of those facilities.

Plant facilities

Electric power will be brought into plant over duplicate 33 kV feeders from the south-east side. The feeders will be terminated at the plant main receiving station located near the plant boundary on the south side of the steelmelt shop.

Water supply mains from the intake pumphouse at the Karun river enters the plant from the south and connects the main ground reservoir and treatment plant located south-east of the rolling mills. The pipeline carrying natural gas enters the plant from the north. The required quantities of oxygen and acetylene will be supplied through cylinders.

Transport facilities

Transport facilities play an important role in an alloy steel plant. An economical and reliable transport system is essential for the movement of incoming, outgoing and in-process materials. The estimated quantities of incoming, in-process and outgoing materials are given in Table 27-1.

27 - Plant general layout (cont'd)

Table 27-1

VOLUME OF GOODS TURNOVER

	Tons/year
Incoming material	
Scrap	62 100
Ferro-alloys	2 850
Fluxes and additions	16 490
Electrodes and nipples	545
Ingot moulds and hot-tops	2 500
Refractories	6 000
Rolls, spares and misc	7 750
In-process materials	
Ingots - steelmelt shops to cogging	75 000
Billets - conditioning to mills	59 500
Rolled bars - mills to heat-treatment and finishing	55 300
Finished products - exit to warehouse	50 000
Plant return scrap - generating points to scrap storage	16 750
Outgoing materials	
Finished products	50 000

Rail track system

The layout of the rail track system is shown on plant general layout Drawing No. 5131-V-9. A rail track system having a standard gauge 1,450 mm as of Iranian State Railways has been provided for a total length of approximately 5 km.

Incoming track

As the proposed new railway station would be on the eastern side of the plant site, it would be convenient to have the entry of the incoming track to the plant from the north-east corner of the plant boundary. A separate exchange yard is not considered necessary for the small traffic of the plant. The loco of the plant would take and deposit the loads at the nearest marshalling yards of the Iranian State Railways.

Curves and switches

Normally curves having a radius of 150 metres are provided for smooth running of locomotives. Curves with 135 metres radius are only in a very few places and would not present operating difficulty. A total of about 25 points and crossings is provided.

Weighbridge

One railway weighbridge is provided within the plant boundary near the entry of the incoming track. This weighbridge with a capacity of 50-tons would be used for weighing finished products and the incoming scrap.

Road system

The road network is shown on general layout Drawing No. 5151-V-9. Except for the heavy ingot traffic between steelmelt shop and soaking pit, other movements

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can be done rapidly and economically by road-bound vehicles. Accordingly, a complete road network is provided suitable for truck transport to each production and auxiliary department.

The total length of the road network is about 4 km, of which about 80 per cent will be concrete-paved initially. All roads will be two-lane traffic roads, excepting the main entry road which will have four lanes.

Provision for expansion and diversification

Provision for expansion

In view of the rising demand for alloy steels, the new plant will inevitably be required to expand soon after starting operations. It is, therefore, essential that the initial planning of the facilities and arrangement of major production shops should be such that expansion can be accomplished with relative ease and without major disruption to operating departments. Provision for expansion in the initial plant costs very little in comparison to the total initial investment, but is more than compensated in later years as the plant grows.

Space has been provided for extending the steelmelt shop building towards the east and also for putting up an additional open scrap yard on the south side of the steelmelt shop. Provison has been made in the layout of the steelmelt shop for future addition of facilities for continuous charging of sponge iron.

Space has been provided in the blooming mill building for installing hot scarfing machine in future. If the bloom size is limited to 150 mm sq and above, the mill can roll about 150,000 tons of ingots per year on three shift basis. For handling the increased tonnage of billets, the billet conditioning building can be extended on both the north and the south sides as required.

In future, one additional finishing stand can be installed in the heavy section bar mill for raising the output to 30,000 tons per year working three shifts. Provision has been kept in the light section bar mill for adding 4 to 6 continuous stands and coilers for the production of wire rods up to 5.5 mm size. Similarly, the heat-treatment and the finishing department can be extended on the south side while keeping the proposed warehouse undisturbed and at the same time serving the expansion facilities as well.

The road network and rail track system are designed with ample scope for extension to serve the expansion facilities. An area has been earmarked on the south side of the water treatment plant for installation of an oxygen plant in future.

Provision for new techniques

In addition to the above, provision has been made in the initial design for adoption of new technological developments. A future continuous casting plant can be put up at the west end of the steelmelt shop whereas a vacuum degassing plant can be installed adjacent to the teeming aisle at the east end. An area has also been earmarked near the eastern boundary of the plant for installing facilities for the production of sponge iron in future, if required, at the site itself.

A large area on the south side has been provided so that another steelmaking/rolling mill complex for flat products can be laid within the plant boundary in future.

Provision for diversification

At alloy steel plants all over the world a number of ancillary operations gradually develop to process the steel produced. The reasons for this are threefold:

i) The scrap generated during processing of alloy steels to finished components has a high value, and the chances of reclaiming it without contamination are much better if the processing plant is located in the main alloy steelworks.

27 - Plant general layout (cont'd)

ii) Quality control of alloy steels starts from the selection of raw materials, through steel-making, rolling, intermediate heat-treatment and conditioning, to the subsequent mechanical forming and final heat-treatment. To facilitate the enforcement of quality, all consecutive operations should be under the same control, so that the history of each job lot is constantly under review.

iii) Defects discovered during machining or heat-treatment of the alloy steels can be more easily rectified if the processing is under the control of the alloy steel plant.

For these reasons space has been provided in the layout for a vertical integration of processes, that is, for the conversion of the alloy steels produced into a variety of finished components.

In future forged blanks like pinion blanks, gear rings, die blocks, forged shafts, and other miscellaneous heavy forgings up to about 5 tons in weight may be handled in the forge shop. This can be supplied to other industries after necessary heat-treatment and rough machining work. For this purpose, the heat-treatment shop and machine shop can be installed in future.

28 - PRODUCTION FACILITIES

The major production facilities proposed for the stage I output of 45,000 tons of finished products (67,000 tons ingots) in constructional and spring steel grades are the steelmelt shop, soaking pits and blooming mill, billet conditioning, bar mills, and heat-treatment and finishing.

Steelmaking department

Initial capacity

The major types of steel and categorywise quantity of ingots required are given in Table 28-1.

Table 28-1

CATEGORYWISE INGOT STEEL PRODUCTION

		Ingot tons/year
Constructional steels		
Carbon constructional (En-8)	..	11 910
Low alloy constructional (En-19)	..	11 910
Medium alloy constructional (En-25)	..	2 980
Case hardening alloy steel (En-36)	..	7 440
Free cutting steel (En-1A)	..	2 980
Spring steels		
High carbon spring steel (En-44)	..	7 440
Silico-manganese spring steel (En-45)	..	17 875
Chrome vanadium spring steel (En-47)	..	4 445
Total	..	67 000

28 - Production facilities (cont'd)

Proposed ingot sizes

Based on the analysis of the steel and the sizes of the finished products, the shape and weight of the ingot will vary. All the steels are of the 'killed', that is, fully deoxidised type. The ingots are hot topped wide-end up and cast by top pouring method. Ingot moulds are of bottom closed type with a central hole at the bottom which is closed by a cast iron or refractory plug before teeming the liquid steel into the mould. An indication of the range of ingot sizes is given below:

	Size mm	Approx ingot wt tons
Square ingots		
Maximum	500 sq x 1 800 ht	3.0
Minimum	330 sq x 1 200 ht	1.0
Medium	375 sq x 1 200 ht	1.3
Fluted ingots		
Duodecagonal fluted	520 dia x 1 580 ht	1.9

Equipment provided for steelmaking is listed in Appendix 28-1.

Open scrap yard

The open scrap yard, 72 m long and 24 m wide between crane rails, is located in continuation of the covered scrap aisle in the main steelmelt shop building. The area occupied by the open scrap yard is 1,900 sq m. The top of the crane rails is 12 m above the floor level. One 10/5-ton EOT magnet crane serves this aisle for handling the scrap. Entry of the railway track to the open scrap yard would be from the east end. One standard gauge track runs through this aisle as well as through the covered scrap aisle.

Of the total requirement of scrap, about 50 per cent would need preparation at site. The scrap preparation equipment provided are one hydraulic baling press, one alligator type bar shear and six oxy-acetylene cutting torches.

Generally, the plant return scrap would be despatched direct to the covered scrap aisle of the steelmelt shop. The open scrap yard has a capacity to stock about one month's supply of scrap.

Steelmelt shop

The steelmelt shop (Drawing No. 5131-V-10) consists of three aisles - a covered scrap aisle, a furnace aisle and a teeming aisle. The columns are spaced at 12 m intervals except at the arc furnace locations and extreme bays where 15 m column spacings have been adopted. The covered area of the steelmelt shop is 8,700 sq m.

Covered scrap aisle

The covered scrap aisle, 108 m long and 24 m wide between crane rails, is served by one 10/5-ton EOT magnet crane. One standard gauge track runs through this aisle and scrap bins are arranged on one side of the track. At the east end of the aisle, an approach road for trucks bringing in scrap and other materials has been provided.

The unloading of the incoming scrap from wagons and loading scrap into the furnace charging buckets is carried out by the magnet crane. The scrap can be stored in bins, the bottom of the bins being 1 m below floor level, and the storage capacity of the covered scrap aisle will also be adequate to meet about one additional month's requirement. While loading the furnace scrap charging buckets the buckets are kept on the transfer cars. Two sets of 30-ton scrap transfer cars and transfer tracks with 50-ton weighbridges on each track are provided for transferring the scrap charging buckets to the furnace aisle. A jaw crusher for reducing ferro-alloys and other additions to small sizes, if required, is provided at one end of this aisle.

The charging platform in the furnace aisle extends into the scrap aisle. Ferro-alloys and additions are loaded manually from the respective storages in portable bins and brought to the scrap aisle. The portable bins are then transferred by the scrap aisle EOT crane to the charging platform. Space is provided for keeping 11 portable bins. Material stored in these bins will be handled by a 1-ton mobile charger in the furnace aisle.

Furnace aisle

The furnace aisle is 108 m long and 21 m wide between crane rails. The top of the crane rails is 18.5 m above the floor level. One 50/10-ton EOT crane will serve this aisle for charging scrap into the furnace with clam-shell type bucket and for handling other bulk materials. This crane will also be used for maintenance work.

Two-level shop

Two 20/25-ton swing roof top-charged electric arc furnaces are located in the furnace aisle, the distance between the centres of the furnaces being 27 m. The charging floor is raised above the floor level so that all work in the teeming aisle can be done at one level without the necessity of pits. The two-level shop allows space very close to the furnaces for storage of ferro-alloys and operating supplies. This enables the charging floor to be kept clean.

The charging platform is at a height of 6 m above floor level to enable filling of the ladle in the pit side and to provide space in the kitchen floor for operation of the mobile handling equipment. The charging platform extends to the full span of the aisle excepting the extreme bays for receiving scrap bucket on transfer car from the scrap aisle.

The scrap preheating station is located at the west end of the aisle whereas the roof relining area is provided at the east end. One ferro-alloy drying oven and one 1-ton mobile charger for charging the ferro-alloys and additions into the arc furnaces are provided on the charging platform. For weighing ferro-alloys and other additions, two portable weighing scales, one 2-ton and the other ½-ton, are also provided on the furnace charging platform.

Main features of arc furnaces

The furnaces are direct arc, tilting type provided with three automatically adjustable vertical electrodes, removable swing roof and multi-voltage power transformer. The principal particulars of the furnaces are as follows:

Nominal capacity	20 tons
Maximum capacity	25 tons
Furnace transformer rating	10 000 kVA, 3-phase, 50 cycles
Charging capacity	20 cu m
Scrap charging	Top
Method of tilting	Hydraulic
Electrode dia	400 mm
Electrode control	Hydraulic or amplydine
Roof lift and swing	Hydraulic

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(continued)

The furnace shell is mounted on robust rockers which travel on the pedestal tracks fixed in the furnace foundation. The shell is lined with basic refractories and the roof is built with silica bricks.

The furnaces will have two doors, namely one slagging door and one side door. Ferro-alloys and additions are fed into the bath by the charger or manually through the slagging door. Temperature measurement is done through the side door. The furnace is fettled through both the doors.

The furnace transformer is connected on primary side directly to 33 kV bus and will be provided with automatic on-load tap changing gear.

Control panels

The main control panel for each furnace is located facing the furnace. It contains all switches, controls, metering instruments etc. Controls for the furnace tilting and door operation are mounted on two control desks, one near the slagging door and the other near the tapping spout.

Fume control

For satisfactory working conditions in the electric furnace steelmelt shop, the need for dust and fume control is being recognised. The system operates on the principle of leading dust and gases from the furnace roof and exhausting the gases with the aid of a fan.

28 - Production facilities (cont'd)

Slag handling

An opening in the charging platform has been provided near the furnace slagging door to receive molten furnace slag in a slag pot which is carried on a rope and winch operated slag car running on a track below the charging platform. The loaded slag pots are then transferred to the teeming aisle where they will be removed by the overhead crane and kept in the teeming aisle for cooling as required. The cooled slag cake from the slag pot will be conveyed in a dump truck and removed to the slag and debris dump. Eight slag pots of 2 cu m capacity each are provided.

Kitchen floor space

The floor space on the kitchen floor can be conveniently utilised for the storage of refractories, graphite electrodes and nipples, ferro-alloys and miscellaneous stores such as fluorspar, petroleum coke etc. Two forklift trucks are provided for handling these materials.

Teeming aisle

The teeming aisle is 132 m long and 24 m wide between crane rails and is served by two 50/10-ton EOT hot metal cranes for handling steel ladles, slag pot and other miscellaneous works, and one 15-ton crane for stripping operations.

Ingot cars

Two standard gauge tracks with cross-overs run through the length of the aisle near the northern side. The teeming platform, about 100 m long and 3 m wide, is provided along the north side column row of the teeming aisle. The ingot moulds with hot tops rest on cars. Each car accommodates 6 to 8 ingot moulds depending upon the size. On an average 3 cars are sufficient for pouring one 25-ton heat.

Other facilities

The other facilities provided in the teeming aisle are ladle preheating station, stopper rod drying oven, ladle stands, and ladle relining pit. The ladle relining pit and stopper rod oven are located towards the east end of the teeming aisle whereas the ladle preheating stations are located towards the west end of the aisle.

Ladle relining and preparation

After each heat is poured, the slag from the ladle is drained, the ladle cooled by compressed air, adhering slag chipped off, and the ladle repaired with refractory materials. The ladle is then dried and heated to about 900 to 1000°C before the next heat is taken.

Mould preparation building

The mould preparation building, 48 m long and 18 m wide between crane rails, is served by one 5-ton EOT crane. The area occupied by the mould preparation building is 1,000 sq m. Two standard gauge tracks run through this building. Adjacent to the track, necessary working platforms are provided.

The empty ingot moulds from the soaking pit building are received in this building through the west end. The moulds are cooled down and are prepared on the cars by coating to protect the mould surface from erosive action and splash of liquid steel. Exothermic hot tops are proposed to be used and these will be placed on the moulds in the mould preparation building. The prepared ingot mould train will be taken to the teeming aisle for casting ingots.

Calcining plant

The requirement of lime and burnt dolomite in the initial operation is estimated at 3,700 tons and 2,000 tons per year respectively. Freshly burnt and moisture-free lime and dolomite are required to be delivered to the plant. These materials may need to be sent in specially closed containers. It is proposed to install limestone calcining plant during the initial phase of plant operations.

In order to keep the initial investment low, dolomite calcining facilities are omitted. Burnt magnesite (pea size and powder mix) can be used as a substitute and is a better fettling material than burnt dolomite. Though burnt magnesite is more expensive than burnt dolomite, its consumption is only half and it can be stored for long periods. It can readily be imported, thus obviating the need for additional investment on dolomite calcining facilities. The annual requirement of magnesite peas and powder would be about 1,000 tons.

The limestone calcining plant consists of one 25-ton of burnt lime per day capacity vertical shaft kiln together with necessary crushing, screening, charging and storage facilities. Natural gas will be used as fuel. The limestone will be stored in an open area adjacent to the calcining plant and after crushing and screening will be charged into the skip bucket for feeding into a storage hopper of the kiln. The discharged product of the kiln would be cooled, crushed, sized and conveyed to the storage bin provided near the kiln. The burnt lime would be drawn from the bottom opening storage bins into the portable bin and supplied in trucks to the steelmelt shop.

Melt shop/forge shop (Stage II)

For the production of high speed and tool steels, one steelmelt shop/forge shop is proposed to be installed north of the initial steelmelt shop.

Production programme

The initial capacity of forge shop would be 5,000 tons of finished steel, as in Table 28-2. The requirement of ingot steel for this production is estimated at 8 000 tons.

Table 28-2

PRODUCT-MIX FOR STAGE II

Category	Finished steel tons/yr
High speed steel (18/4/1)	200
Hotwork die steel (9% W, 4.5% W & 2.5% W) ..	300
Coldwork die steel (high carbon, high chrome and mould steel)	1 000
Low alloy tool steels (coldwork - tool steel, oil hardening & shock resisting) ..	1 000
Die block	500
Carbon tool steel:	
0.95 to 1.1% C	1 000
0.6 to 0.95% C	500
1.1 to 1.4% C	500
Total ..	5 000

The layout of the forge shop together with the steel-making facilities for feeding the ingots to the forge shop is shown in Drawing No. 5131-V-10.

Building

The building consists of three aisles - a furnace aisle (96 x 18 m), a middle aisle (96 x 10 m) and a forging aisle (120 x 28 m). The area covered by the building is 6,500 sq m. The furnace aisle is served by two 10/5-ton EOT cranes and one of these will be equipped with a magnet for handling scrap. At the east end of the aisle, entries for the rail track is provided for the incoming scrap. The forging aisle is served by one 30/10-ton EOT crane. Rail entry has been provided at the west end of the aisle for despatching the forged products to the mill area for further processing and also for shipping finished forged products.

Facilities

Steelmaking

For the production of about 8,000 tons of ingot steel, one 6-ton electric arc furnace with 3,000 kVA transformer is proposed. At the east end of the furnace aisle scrap storage bins are provided. The ingot teeming and stripping operations will be carried out at the west end of the aisle. Ancillary facilities consist of ladle preheating units, stopper rod dryer, ladle and roof relining, and slow cooling boxes for ingots.

Forge shop

The forging equipment proposed are one 1,000-ton hydraulic press and one 2-ton pneumatic hammer. Four batch type furnaces for reheating and one bogie hearth type preheating and annealing furnace are provided. The press is equipped with rail-bound manipulator. Ancillary facilities consist of chain turning gear, mobile charger for handling of ingots into and out of the furnaces, slow cooling boxes, and equipment for inspection and testing.

Soaking pits and blooming mill

The blooming mill is required to handle initially about 67,000 tons of ingots per year producing about 56,000 tons of billets.

The billets produced in the blooming mill are in the size range of 75 mm sq to 150 mm sq. The finished lengths of bloom/billet vary from 2 to 8 m. The average capacity of the blooming mill will be about 20 tons per hour based on the average ingot size of 375 mm sq x 1,200 mm ht weighing 1.3 tons and the billet size of 100 mm sq.

For the initial output of 56,000 tons of billets, the blooming mill will operate in two shifts. With the incorporation of in-line hot scarfer in future and limiting the bloom size to 150 mm sq and above, the blooming mill has capacity to roll 150,000 tons of ingots per year working three shifts.

Layout The layout of the blooming mill and soaking pits is shown in Drawing No. 5131-V-12. Equipment provided for soaking pits and blooming mill is listed in Appendix 28-2.

Soaking pits

Before the ingots are bloomed it is necessary to bring them to a uniform rolling temperature by heating in a soaking pit type furnace. Such soaking pits are generally fuel-fired, using either gas or oil. In recent years, however, electrically heated pits of the 'Elpit' type has been introduced. Considering the availability of natural gas in large quantities at cheap rates and the production of low alloy steels at the plant, only natural gas-fired pits have been proposed.

Soaking pit building

The soaking pit building is of a single aisle, 102 m long and 28 m wide between the crane rails. The covered area for the soaking pit building is 3,100 sq m. The soaking pit aisle is served by two 3/20-ton soaker cranes for charging of ingots into the soaking pits for heating, for charging hot ingots into the ingot buggy and for other miscellaneous works.

Main features of the soaking pits

For the initial plant output, three batteries of one-way top-fired pits are proposed, each battery having three holes. Each hole has holding capacity of 25 tons and dimensions as follows:

Length	..	5 000 mm
Width	..	2 200 mm
Depth	..	3 200 mm

The hourly output for the soaking pit installation is 20 tons while heating cold ingots and 30 tons while heating ingots with 800°C temperature. The heating temperature is 1300°C maximum using natural gas having a calorific value of 8,000 kcal per cu m.

The pits are one-way top-fired and each pit will have its own cover carriage. One metallic type recuperator for preheating the combustion air to about 600°C is provided for each hole, and one exhaust chimney for each battery. The controls for temperature, pressure and combustion air equipment are housed in an airconditioned control room to be located on a separate structural platform.

At the east end of the aisle one preheating furnace and four slow cooling pits have been provided. The preheating furnace is bogie-hearth type and will be fired with natural gas. The furnace will be designed for heating the ingots to about 1000°C and will have a charging capacity of about 20 tons. The slow cooling pits are required for slow cooling of the ingots. Each pit is 2 m wide x 4 m long x 2 m high.

Blooming mill

Blooming mill building

The main mill bay is 120 m long and 22 m wide between crane rails. The top of the crane rails is 9 m above floor level. The mill motor room is 60 m long and 15 m wide between crane rails. The top of the crane rails is 6 m above floor

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level. The covered area for the blooming mill building including the mill motor room is 4,100 sq m. The mill bay is served by one 40/10-ton EOT crane for handling crop buckets and for operation and maintenance requirements. One 15-ton EOT crane is provided in the motor room for maintenance. The ingot buggy, the ingot weighing scale and the mill are located at the east end of the mill bay whereas hot shear and saw are located at the west end of the mill bay. The cooling bed is installed in the billet receiving aisle of the conditioning department. The drive motor for the mill and mill controls are located in the motor room. The mill area substation is also located in the mill motor room.

Main features of blooming mill facilities

The 3-ton ingot buggy will be electrically driven and controlled from the main mill operating pulpit. The ingot is weighed on the weighing scale which will also have an ingot turning mechanism. The blooming mill is a 700 mm 2-high reversing mill with roll diameter of 700 mm and with a barrel length of 1,800 mm. The roll opening is 700 mm. The roll and the spindle are hydraulically balanced. The screwdown speed is 150 mm per second maximum. The mill is driven by a variable speed DC reversing mill motor, through a 2-high pinion stand. The design characteristics of the motor are as follows:

Motor rating - 1 800 kW
Speed - ± 60/120 RPM
Armature voltage - 750 volts
Torque - 225% frequently applied
275% occasionally applied
Motor control - Thyristor converter unit with anti-parallel connection for quick reversing duty

On either side of the mill, electrically driven manipulators of about 8 m length are provided. The front manipulators are provided with tilting fingers. The main mill pulpit will accommodate all operating controls for the mill, ingot buggy, and ingot weighing scale.

A scarfer shift table will be incorporated in the mill run-out table to facilitate addition of an in-line scarfer in future. Sufficient length has been kept on the mill run-out roller table for this.

The hot shear is of 500 ton capacity and is capable of cutting blooms of 150 mm sq size. The shear is electrically driven. An electrically driven hot saw with a blade diameter of about 1,600 mm is also provided for cutting finished lengths if required. A common control pulpit is provided for operation of shear and saw. The cooling bed located in the billet receiving aisle of the conditioning department is 8 m wide and 24 m long.

The road approach has been provided to the mill bay for removing the mill scrap, crop ends etc and also to bring in heavy maintenance equipment. A scale pit has been located north of the mill bay with necessary pumping facilities.

Billet conditioning department

The billets from the blooming mill are received on the cooling bed in the conditioning department.

Layout The billet conditioning building is shown in Drawing No. 5131-V-13. Equipment provided in conditioning department is listed in Appendix 28-3.

Building

The billet conditioning building consists of three aisles each of 156 m long and 21 m wide between crane rails. The covered area is 10,700 sq m. The top of the crane rails is 8 m above floor level. Road approaches have been provided at the north and south ends whereas the rail track is connected at the north end of the building.

Conditioning facilities

The billet receiving aisle accommodates the cooling bed, slow cooling covers, hand scarfing equipment, pickling and chipping facilities. The aisle is served by two 10-ton EOT cranes. One of the cranes is equipped with a magnet.

The middle aisle accommodates grinding facilities consisting of three automatic billet grinding machines and eight swing grinders. The aisle is served by one 10-ton EOT crane. Sufficient laydown area has been kept in this aisle. The fume extraction system will be provided for the grinding area.

The billet storage aisle is served by one 10-ton EOT crane. The equipment located in this aisle are flame cutting machine, weighing scale and charging facilities for the billet reheating furnaces of bar mills. Two transfer trolleys have been provided for transfer of billets between the aisles.

Bar mills

In stage I the bar mills will roll about 53,000 tons of billets to produce about 45 000 tons of bars per year. The bar mill No.1 is for rolling lighter bars up to 35 mm round or square. The bar mill No.2 will roll bars above 35 mm and heavy flats.

The average size of billets to be received from the blooming mill will be as follows:

Size - 100 mm sq for Bar Mill No.1
- 150 mm sq max for Bar Mill No.2
Length - 2 to 3 m

28 - Production facilities (cont'd)

The finished products to be rolled and their approximate tonnages are given in Table 28-3.

Table 28-3

PRODUCT SIZES

	Tons/year			
	Bar mill No. 1		Bar mill No. 2	
Size	Constructional steel	Spring steel	Constructional steel	Spring steel
Rounds & squares				
12-25 mm	3 500	7 000	-	-
26-35 mm	4 000	-	-	-
36-75 mm	-	-	8 000	-
80-125 mm	-	-	5 500	-
Flats (thickness)				
4-6 mm	-	5 000	-	-
6-12 mm	2 000	-	-	-
8-10 mm	-	5 000	-	-
13-18 mm	500	-	-	-
19-25 mm	300	-	-	-
12-15 mm	-	-	-	3 000
26-75 mm	-	-	1 200	-
Total	10 300	17 000	14 700	3 000

The bar mill No.1 will work in three shifts and the bar mill No.2 will work in two shifts.

The covered area for the bar mills is 15,000 sq m. Equipment provided for the bar mills is listed in Appendix 28-4 and mills layout is in Drawing No. 5131-V-14.

Bar mill building

The mill aisle for light section bar mill No.1 is 192 m long and 28 m wide between crane rails. The top of the crane rails is 9 m above floor level. This aisle is served by one 20-ton EOT crane for maintenance, roll changing and operation requirements.

The mill aisle for heavy section bar mill No.2 is 192 m long and 22 m wide between crane rails. The top of the crane rails is 9 m above floor level. This aisle is served by one 25-ton EOT crane for maintenance, roll changing, operation requirements and for handling rolled bars for inspection.

Motor room No.1 is 84 m long and 13.5 m wide between crane rails. The top of the crane rails is 6 m above floor level. This motor room is served by one 10-ton EOT crane for maintenance. The motor room No.2, for light section mill, 48 m long and 13.5 m wide between crane rails, is served by one 10-ton EOT crane for maintenance. The top of the crane rails is 5 m above floor level.

Facilities in bar mill No.1

Reheating furnaces

The charging facilities for the reheating furnaces consist of billet depiler and roller tables. For billet reheating, two walking beam type furnaces each having a capacity of 10 tons per hour are provided. The billets are normally heated to a temperature of about 1250°C. Natural gas with a calorific value of 8,000 kcal/cu m is used for firing the furnace. The combustion air is preheated to about 400°C in metallic recuperators. The furnace is equipped with necessary instruments and controls to promote fuel economy, uniform heating and minimise scaling.

The billets from the furnace are discharged on to the roller tables feeding to the roughing mill.

Roughing mill train

The roughing mill train consists of two 450 mm 3-high stands with tilting tables on the delivery side. The roll size is 450 mm dia x 1,500 mm barrel length. The mills are driven by a common AC slip-ring induction motor with fly-wheel and through reduction gear and 3-high pinion stands. The design characteristics of the motor are as follows:

Motor rating - 1 200 kW
Speed - 750 RPM (Syn)
Voltage - 6.0 kV
Pull-out torque - 250%
Motor control - Reversing contact with electrical plugging for stator circuit
Automatic liquid slip regulator for rotor circuit

Transfer between the roller tables on the front side has been provided. The mill housings are of cast steel and open type. The screwdown mechanism for the top rolls is manually operated through a gear arrangement. The top roll is spring-balanced. Synthetic resin bearings are suggested for the roughing mill rolls.

Finishing train

The finishing mill train consists of two 380 mm 3-high stands, two 300 mm 3-high stands and one 280 mm 2-high stand. Normally, the 3-high stands will be operated with two rolls only. Repeaters are provided between the stands. The roll sizes are as follows:

380 mm mill - 380 mm dia x 1 000 mm barrel length
300 mm mill - 300 mm dia x 800 mm barrel length
280 mm mill - 280 mm dia x 600 mm barrel length

DC drives are proposed for the finishing stands. The two 380 mm 3-high stands and the two 300 mm 3-high stands are driven by variable speed DC motors each having the following design characteristics.

Motor rating - 750 kW
Speed - 300/750 RPM
Armature voltage - 750 volts
Motor control - Thyristor converter units both for armature voltage control up to base speed and field control above base speed

One 280 mm 2-high stand is driven by variable speed DC motor having the following design characteristics.

Motor rating	-	300 kW
Speed	-	300/750 RPM
Armature voltage	-	750 volts
Motor control	-	Thyristor converter units both for armature voltage control up to base speed and field control above base speed

The mill housings are of cast steel open top type with arrangement for manual roll adjustment. The finishing mill stand rolls are mounted with roller bearings.

Other facilities

For rolling of straight bars, roller tables with transfers and skew roller table between the last three finishing stands are provided. A cropping shear before the second 380 mm stand is provided to cut the front ends of the bars. A flying shear is provided on the mill run-out table before the cooling bed to cut the bars in length suitable for cooling beds. The cooling bed, about 40 m long, is of rake type. A cold shear on the delivery table of the cooling bed is of 350 tons capacity.

After shearing, the cut cold bars are collected in the cradles located in heat-treatment and finishing department. Space has been left near the cooling bed in the mill aisle for keeping spare stands for the finishing train. The guide conditioning shop of 15 m x 24 m size is adjacent to the spare mill stands area.

Facilities in bar mill No.2

Reheating furnace

The charging facilities for the reheating furnace consist of billet depiler and roller tables. For billet reheating, one walking beam type furnace of 15 tons per hour capacity is provided. The main features of the furnace are similar to those of the furnaces in bar mill No.1.

Mill

The mill train consists of three 550 mm 3-high stands with roll size of 550 mm dia x 1 600 mm barrel length. The first two stands will have tilting tables on the backside. The three stands are driven by one AC slip-ring induction motor with fly-wheel, and through reduction gear and 3-high pinion stand. The design characteristics of the motor are as follows:

Motor rating - 1 500 kW
Speed - 750 RPM (Syn)
Voltage - 6.0 kV
Pull-out torque - 250%
Motor control - Reversing contactor with electrical plugging for stator circuit. Automatic liquid slip regular for rotor circuit

TABLE OF CONTENTS - VOLUME V
(continued)

TABLES IN VOLUME V

The mill housings are of cast steel, open top type with manual adjustment for roll opening through reduction gears. Synthetic bearings are provided for the roll necks. The top rolls are spring-balanced.

Other facilities

Between the mill stands, roller tables with transfers are provided. There are two hot saws each of 1,600 mm dia for cutting bars in multiple lengths. Two cooling beds, each about 8 m long are shuffle-bar type. Slow cooling boxes are provided at the end of the cooling bed discharge roller table. At the west end of the mill aisle, area has been allocated for storage and inspection of rolled bars.

Heat-treatment and finishing department

Of the total initial output of 45,000 tons per year, 36,000 tons (about 80 per cent) of rolled bars will be supplied in 'as rolled' condition without any special treatment. However, surface inspection and testing will be carried out for the bars supplied in 'as rolled' condition. 20 per cent of the total output (amounting to 9,000 tons per annum) will be subjected to heat-treatment. About 6,000 tons of bars will be normalised, full-annealed or sub-critical annealed. About 3 000 tons will be fully heat-treated, the heat-treatment consisting of oil or water quenching from a temperature of 830°C to 880°C followed by tempering at 550°C to 650°C.

Layout

The heat-treatment and finishing department including warehouse is shown in Drawing No. 5131-V-15. Equipment provided is listed in Appendix 28-5.

Building

Each aisle for the heat-treatment and finishing is 132 m long and 21 m wide between crane rails. The warehouse aisle is 72 m long and 21 m wide between crane rails. The area covered by this department is 7,700 sq m. The top of the crane rails is 6.5 m above floor level. Each aisle for the heat-treatment and finishing is served by one 10-ton EOT crane for handling rolled products. The warehouse aisle is served by one 5-ton EOT crane.

Heat-treatment and finishing facilities

For the bars supplied in 'as rolled' condition, equipment for surface inspection and testing are provided. The internal flaws are detected by ultrasonic equipment and surface flaws are detected by magnaflux crack detectors. Hardness testing equipment, hand-grinders, straighteners and saw are provided for finishing and testing as required.

28 - Production facilities (cont'd)

For normalising, quenching and full annealing treatments, two car bottom furnaces each with a hearth size of 7 m x 1.5 m are provided. The holding capacity of each furnace is 10 tons per charge and the maximum heating temperature is 950°C. For tempering and subcritical annealing, one car bottom furnace with a hearth size of 7 m x 1.5 m is provided. The furnace is excess air circulation convection heating type capable of heating to a temperature of 700°C maximum. For quenching, one water quenching tank of 8 m x 2.5 m x 2.5 m size and one oil quenching tank also of 8 m x 2.5 m x 2.5 m size with provision for oil recirculation and cooling by means of heat exchangers are included. The charge handled at a time for quenching will normally not exceed 3 tons. The heat-treated bars will be straightened and will be subjected to full inspection and testing as in the case of bars supplied in 'as rolled' condition. The straightening equipment provided is as follows:

Two multi-roll rotary straighteners - one for handling bars of 10 to 30 mm dia and the other for bars of 25 to 100 mm dia

One roller type shape straightener for flats and squares up to 30 mm maximum

28 - Production facilities (cont'd)

One horizontal crank operated mechanical straightener for bars up to 100 mm size

One horizontal oil-hydraulic straightening press of 200 tons capacity for bars over 100 mm size

Materials against large orders will be shipped directly in wagon loads from the finishing end. The excess against particular orders will be sent to the warehouse from the finishing end. Small orders will generally be met from ready stock maintained in the warehouse.

29 - PLANT UTILITIES AND AUXILIARY FACILITIES

Plant utilities such as power, water, compressed air, natural gas, oxygen, acetylene and argon; and auxiliary facilities such as works transport, plant laboratory, roll turning and maintenance shop, storages, general works and administration building and works security, are discussed in this chapter.

Electric power system

Analysis of power requirements

The plant electrical loading conditions for the stages I and II are estimated to be as follows:

	Stage I	Stage II
Average load based on full calendar year ..	7 100 kW	7 900 kW
Annual energy consumption	62.2 mill kWh	69.2 mill kWh
Maximum demand on basis of 15-min synchronised operation at any one period	18 000 kW	20 400 kW
Maximum peak load based on one minute period ..	22 000 kW	24 500 kW

The extent of power to be purchased will be determined by the 15-min maximum demand. However, to ensure stable operation free from voltage and frequency fluctuations the power system should be able to meet the peak demands over a period of about one minute. The power system feeding the plant should be such as to meet the demand of the synchronised operations of the plant as a whole.

Availability of power

Iran will have a national power grid by the end of Fourth Plan (Volume I). This network is likely to be further extended during subsequent Plan periods connecting all major generating stations.

It is understood from the discussions held with the Ministry of Water and Power that 20 MW of power could be made available in Ahwaz area provided advance intimation is given to them to make suitable adjustments to load flow conditions in that area.

Characteristics of plant load

The electric arc furnaces which will be installed in the plant will be basically high fluctuating power consumers, specially during the initial melting cycle. The problems of reactive power demands, voltage fluctuations and light flickers will therefore have to be considered during the engineering of the plant.

29 - Plant utilities and auxiliary facilities (cont'd)

With sensitive furnace electrode regulating system it will be possible to control power surges up to a certain level. However, momentary peaks cannot be avoided. There is likelihood of the two 20/25-ton furnaces being simultaneously on melting cycle and in such a case it is estimated that the power system short-circuit level will have to be about 1,200 MVA to keep voltage fluctuations within permissible limits. If the system short-circuit level is not high enough, it will become necessary in the planning stage to consider installation of flicker compensating equipment.

Selection of power system voltages

KWPA will be setting up a major 230/33 kV step-down in the vicinity of Iranian Rolling Mills Company to feed the industries located in this area. Power to this plant can be fed from this substation provided a firm capacity of about 26 MVA is available initially. Otherwise it would be necessary for the supply company to bring in power at 230 kV and install their own 230/33 kV step-down substation inside the plant boundary.

The following power voltages have been proposed for this plant.

B-389

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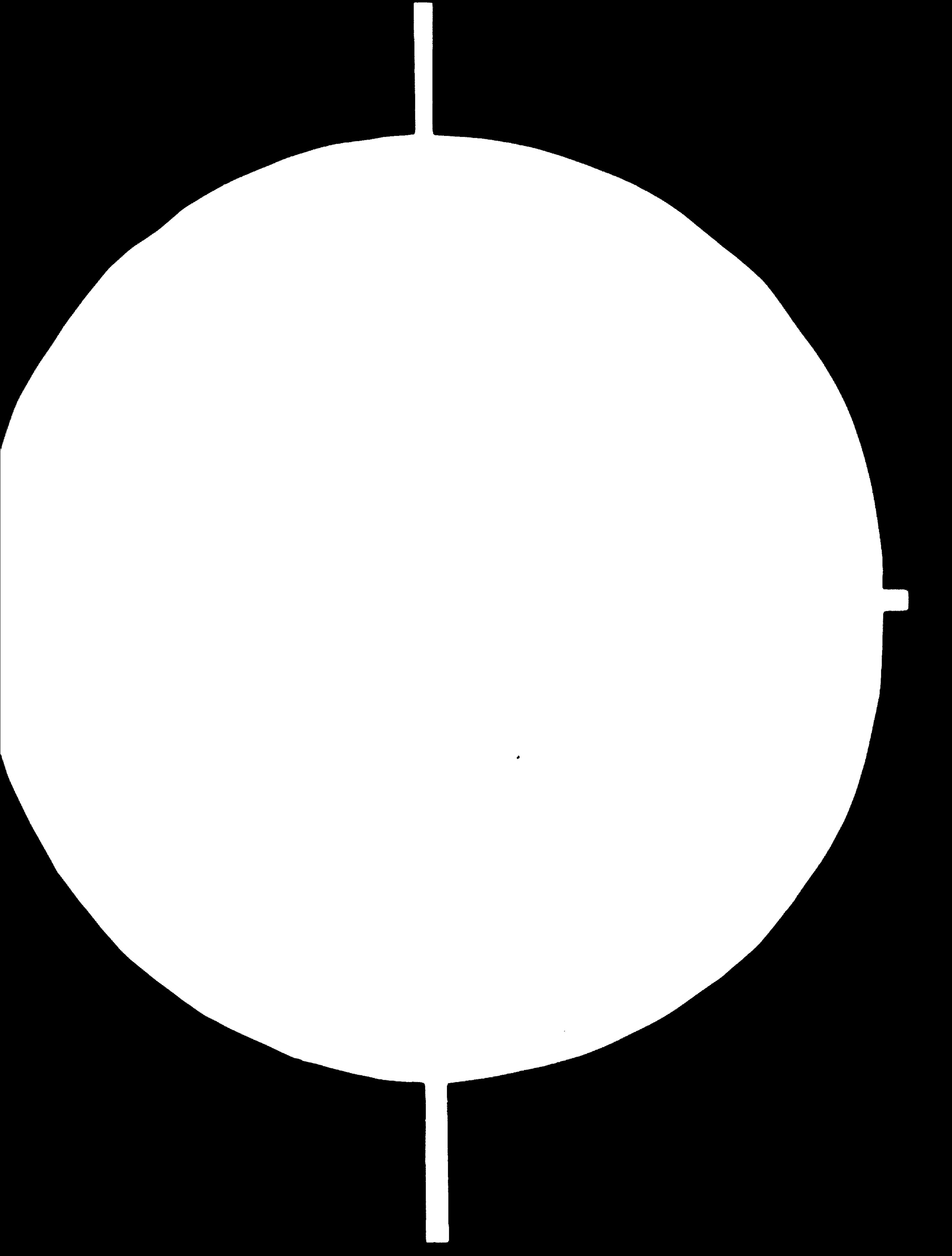
84.04.16
AD. 85.03
ILL 5.5



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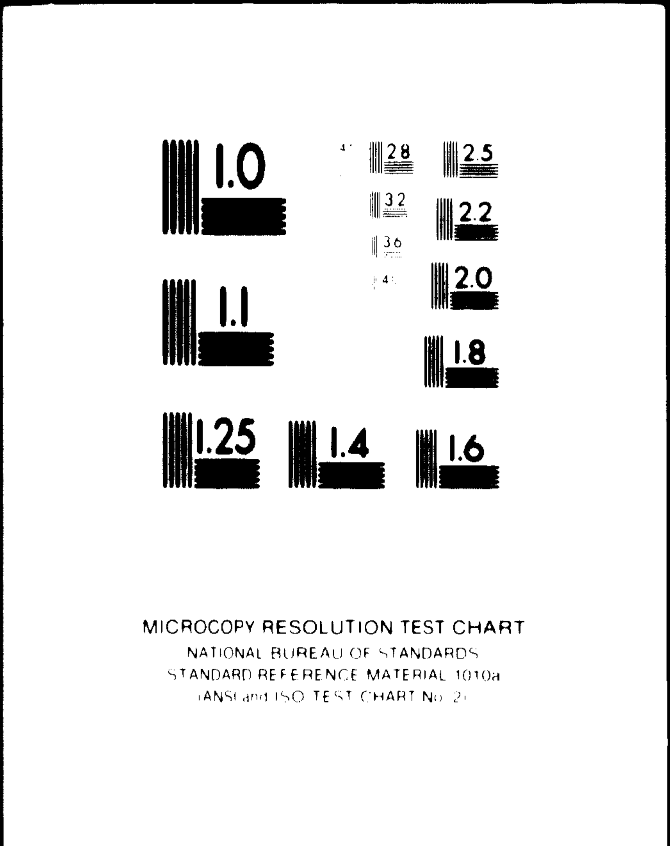


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

24x
F

circulating systems. The make-up system comprises a ground storage reservoir with a holding capacity of about one day's requirement, necessary treatment units and a pumphouse. A part of the make-up water is sterilized to cater to drinking and sanitary needs.

Recirculating system

Two independent recirculating systems have been envisaged, one for supply of cooling water to arc furnaces with fume extraction, transformers, reheating furnaces, motor and motor control rooms, oil coller and heat treatment section and the other for mill cooling and scale flushing. The first recirculating system is for clean water and the second for contaminated water.

The clean water recirculating system comprises a hot well, a multi-cell cooling tower, a cold well and pumps to supply cold water to various consuming units and hot water to the cooling tower to render it fir for recirculation. The contaminated water recirculating system comprises scale pits where the water is collected and pumped to treatment unit including settling tank and clarifier. The relatively clean water is then collected in hot well, cooled in a multi-cell cooling tower and pumped to the consuming units. The scale collected in the scale pits and settling tanks is removed and disposed off. All the pumps for clean as well as contaminated water recirculating systems are proposed to be housed in a centralised pumphouse having one crane for erection and maintenance. The electrical switchgear for the pump controls is also located in the pumphouse.

An overhead tank of adequate capacity is provided for emergency water supply to the various vital units in case of power or water supply failure. The overhead tanks is kept floating on the circulating system.

Drinking water system

To meet the drinking and sanitary water needs of the plant personnel, treated potable quality water is supplied at the rate of 150 litres per capita per day. The water is stored in an overhead tank and distributed to various consuming points through a separate drinking water network. Hydrants for fire-fighting will be installed on the drinking water network. Two extra pumps are provided to meet fire-fighting water requirements in addition to the overhead tank. All the pumps will be started and stopped automatically either by level or pressure switches according to the plant demand.

Compressed air

Requirement

Compressed air is required for operating various types of equipment and for cleaning purposes. The estimated requirement is shown in Table 29-1.

Table 29-1

ESTIMATED COMPRESSED AIR CONSUMPTION

	Consumption (free air at 7 kg/sq cm) cu m/hr
Steelmelt shop ..	100
Calcining plant ..	100
Mould yard	50
Laboratory	100
Soaking pit and blooming mill	100
Billet conditioning ..	200
Bar mills	100
Heat-treatment and bar finishing	50
Maintenance shop, garage etc	200
Minor consumers and losses ..	100
Total ..	1 100

A small quantity of filtered compressed air is also required for running various panel instruments such as automatic recorders etc. This can be made available from the proposed supply system by providing suitable filters.

Proposed supply system

A centralised supply system for compressed air has the advantages of lower operating cost and smooth and continuous air supply without excessive pressure variations, but involves higher initial cost and lacks flexibility. In order to obtain the advantages of a centralised system without some of its disadvantages, it is proposed to use a zonal supply system for compressed air. The plant is divided into two zones and a compressor station is provided in each zone.

Compressor station No. 1

Zone 1 includes the steelmelt shop, calcining plant, mould yard, maintenance shop and laboratory. Compressor station No. 1 catering to these departments is located near the laboratory building. Two compressors each rated at 750 cu m per hr free air at 7 kg per sq cm gauge are installed, one being a standby unit.

The compressors should be suitable for continuous 24-hour operation per day. Standard equipment consisting of inter-cooler, after cooler, air receivers, constant speed control, pressure lubrication for cylinders and frame, metallic packing, low pressure control switch etc will be provided. Motor shall be capable of working on 380 volt, 3 phase, 50 cycles.

Compressor station No. 2

Zone No. 2 includes the rolling mills, heat-treatment and bar finishing department. Compressor station No. 2 is located near the conditioning department. Two compressors each rated at 750 cu m per hr free air at 7 kg per sq cm gauge are installed, one being a standby unit. The compressors may be similar to those in the compressor station No. 1.

Inter-departmental piping is of 25 mm (or 1 inch) seamless carbon steel tubes, and 12 mm (or ½ inch) piping leading to consuming points in each department. Piping is over ground and suitable slope is provided. Drain cocks are located at low points to facilitate removal of condensed water.

Substantial quantity of compressed air will be required for the forge shop in stage II. Compressor for this unit would be installed in a separate compressor station adjacent to the forge shop building.

Natural gas

For the soaking pit and re-heating and heat-treatment furnaces, it is proposed to use natural gas as fuel as it is available in abundance at low price.

Requirement The gas requirements are given in Table 29-2.

Table 29-2

ESTIMATED NATURAL GAS REQUIREMENTS a/

		Average consumption cu m/hr x 10^3
Steelmelt shop	..	0.70
Reheating furnaces:		
Soaking pits	..	2.25
Billet conditioning	..	0.20
Bar mills	..	2.25
Heat-treatment shop	..	0.25
Miscellaneous and losses		0.60
Total	..	6.25

a/ Based on calorific value of 8,000 Kcal/cu m of gas.

Oxygen, acetylene and argon

Oxygen

Oxygen is an essential utility in the alloy steel plant required in the steelmaking process for carbon elimination in the electric furnace. In addition, it finds numerous uses in processes such as scarfing, flame cutting, welding etc. In Iran, liquid oxygen is not available and for the initial plant capacity it is proposed not to install oxygen plant in order to keep down the capital investment. The requirement of oxygen for flame cutting, welding etc can be met by supply in cylinders.

Acetylene

Acetylene is used all over the plant for scarfing, cutting, welding etc. The requirement is proposed to be obtained in cylinders.

Argon

In recent steelmaking practice argon is used for stirring bath as well as for flushing out the ingot moulds. Due to the high cost of generating the small quantity of argon required, this practice can be deferred to the future.

Works transport

About 500,000 tons of incoming and outgoing traffic and works internal traffic will be handled at the alloy steel plant.

Incoming wagons would be received at the railway station yard and from there shunted to the plant by the plant locomotives. One track weighing machine of 50-ton capacity is provided near the stores building for weighment of finished products and some of the incoming materials.

Incoming trucks would deliver materials direct to the respective storages after weighment. One truck weighbridge also of 50-ton capacity is located near the main gate house.

The internal traffic at the alloy steel plant would be mostly for the movement of ingots (hot and cold), billets, bars, finished products and miscellaneous stores.

Hot material traffic

The hot material traffic is mainly the movement of ingots from the steelmelt shop to soaking pits. The other traffic is the movement of moulds and mould cars between soaking pits, mould preparation building and steelmelt shop. All hot material traffic between the steelmelt shops, soaking pits and mould preparation building will be on special rail cars.

Most of the internal traffic involves frequent movement of small lots of materials. The combination of low traffic volume and more handling operations, favours use of trucks rather than wagons. It is proposed that the lighter materials traffic be handled mainly by truck and other mobile equipment such as forklift, platform truck and trailer which have been provided. Provision for both railway and road network provides flexibility, freedom of movement, better utilisation of equipment and the capacity to handle the variety of traffic involved.

Transport between departments

The transport equipment proposed for handling inter-departmental traffic is given in Table 29-5.

Table 29-3

TRANSPORT EQUIPMENT PROPOSED FOR INTER-DEPARTMENTAL TRAFFIC

		Number
Wagons	..	5
Trucks	..	8
Platform truck	..	1
Forklift truck	..	2
Locomotives	..	2
Rear dump truck	..	2
Yard crane	..	1
Tractor	..	1
Trailers	..	2
	Total	24

Plant laboratory

The nature of the products made in an alloy steel plant is highly specialised and great care must be taken in their manufacture. The plant laboratory and inspection department exercise control at all important stages in the manufacturing process to ensure strict quality control on every type of product.

Functions of the laboratory

The basic function of the laboratory is routine analysis, quality control necessary for the proper operation of the plant, together with a certain amount of developmental work.

The plant laboratory will have three main divisions - the chemical laboratory, the metallurgical laboratory and inspection. A list of equipment proposed for these divisions is given in Appendix 29-1.

Chemical laboratory

The functions of the chemical laboratory are to provide:

i) A routine chemical analysis of the samples of the molten metal while it is in the furnace, in order that the melter may be able to control the melting operation, determine additions etc.

ii) Routine chemical analysis of final samples and other specimens from heats as they are made.

iii) Analysis of the raw materials used in the plant and checks on the quality of various supplies.

iv) Development of analytical techniques necessary for the analysis of alloying elements in new products and preparation of standards for calibration of the spectrometers.

The main equipment provided in the chemical laboratory are carbon and sulphur determinator, spectrometer, balances, calorimeter, viscosimeter, titration equipment etc. Samples of the steelmelt shop will be received by pneumatic tube system.

Metallurgical laboratory

The functions of the metallurgical laboratory are to perform:

i) Metallographic examination of the microstructure of alloy steel samples

ii) Mechanical tests on mill products for trouble shooting quality control and product specification

iii) Special investigations for the development of new and better alloy steels.

The main equipment provided for metallography and testing are microscopes, camera, hardness testing equipment, grinders, ultrasonic flaw detector, muffle type furnaces, oven and hot plates, power hack saw etc.

Roll turning and maintenance shops

The roll turning and maintenance shops are provided to undertake mechanical and electrical maintenance work and to supply spare parts and replacements for equipment. In general, the shops have been designed for light work and no foundry or structural shops have been provided. All castings, heavy structural fabrication and large special parts which are not within the capacity of the shops will be obtained from outside suppliers.

Only small parts which need frequent and quick replacement would be manufactured and assembled, and stored so that they are readily available. Also, the equipment for roll turning will be installed in this shop as no separate roll turning shop is provided because of the small scale of operations.

29 - Plant utilities and auxiliary facilities (cont'd)

33 kV - For main power distribution and for feeding 20/25-ton arc furnaces

6 kV - For sub-distribution and for motors rated above 300 kW

380 V - For secondary distribution and motors rated below 300 kW

230 V - DC for feeding all constant potential DC drives

In view of the advantages enumerated below it is recommended that power be purchased at 33 kV and provide 33 kV bus at the plant main receiving station.

i) 30 MVA is an economical block of power which can be carried at 33 kV for short distances either by cables or overhead lines

ii) 33 kV is one of the voltages adopted by KWPA for this region

iii) 20/25-ton arc furnace transformers having 10,000 kVA rating can be economically designed to operate directly from 33 kV. This will eliminate voltage disturbance being reflected on the rest of the plant loads which will be at lower voltage over step-down transformer thereby giving a choking effect.

iv) 33 kV permits use of insulated underground cables. With higher power carrying ability of 33 kV cables as compared to 20, 11 or 6 kV, the number of cables in parallel for the main feeders will be less, thereby reducing the installation cost.

v) Indoor metal-clad switchgear is available for 33 kV up to 2,500 MVA and hence use of such a type of gear will enable the switchboards to be located in the vicinity of the steelmelt shop. Also maintenance problems are reduced compared to outdoor substations.

For maintenance work, main equipment provided are three lathes, three drills, one pedestal grinder, two blade sharpeners, welding and cutting equipment, batch type reheating furnace, electro-pneumatic hammer of 200 kg capacity, forging hearth for smithy work, shaft grinder, hack saw, small tools, gauges, etc. The roll turning equipment comprises of seven roll lathes, two double-ended pedestal grinders, and one set of racks for different rolls.

The list of equipment in roll turning and maintenance shop is given in Appendix 29-2.

Storage facilities

The cost of carrying and storing a large inventory of spares and supplies is considerable. On the other hand, if the raw materials and spares cannot be supplied on time, serious production delays would occur resulting in financial loss. Therefore, in designing the storage facilities, the objective is to minimise storage cost, but at the same time, to avoid losses resulting from the non-availability of supplies.

The main storage areas and facilities to be provided for the alloy steel plant fall into five categories as follows:

29 - Plant utilities and auxiliary facilities (cont'd)

i) Centralised storage for spares and supplies

ii) Raw materials and supplies for steelmaking

iii) Miscellaneous storages inside various departments

iv) Storage of in-process materials

v) Storage of finished products.

Central stores for spares and supplies

The central stores are located north of the steel-melt shop building. It will have a covered area of about 5,000 sq m and an open fenced area of about 1,000 sq m. The covered area is divided into separate bays for stocking heavy and light materials. The heavy storage bay is intended for items such as heavy mechanical and electrical equipment and accessories, metal products, heavy fittings, machine tools and abrasives, welding equipment, heavy spares etc. The bay is served by one 5-ton EOT crane for handling purpose. The light storage bay is intended for materials such as light mechanical and electrical fittings, maintenance materials, working clothes, footwear, asbestos, paper and cardboard articles, hemp, jute, lubricants etc.

Scrap storage

It is proposed to stock about three to four months' requirements of scrap. About two months' stock would be stored in a covered scrap aisle and open scrap yard. The balance would be stocked in the open area along the eastern boundary of the plant.

Ferro-alloys storage

All ferro-alloys required have to be imported and it is suggested to maintain about four to six months requirements. These will be arriving in drums which can be kept in an open area adjacent to the central stores building. However, costly items such as nickel and aluminium would be stored inside the stores building and partly in the meltshop itself.

Storage of fluxes, additions etc

Limestone and iron ore would be stored in an open area east of the steelmelt shop building, whereas petroleum coke and fluorspar will be stored in drums in an open area adjacent to the central stores building.

Refractories and electrodes required for the steelmelt shop would be stored in the kitchen floor.

Misc stores

In addition to the central stores, space has been provided in each department to stock short term requirements of miscellaneous supplies and consumable materials. These will be under the supervision of the store-keeper incharge of the central stores and cater to the local departments only.

Warehousing of finished products

The finished products would be despatched either from the finishing end of the heat-treatment department or from the warehouse. The finished goods against small orders and excess against large orders would be stocked in the warehouse from where the despatches would be made. Necessary area and racks have been provided in the warehouse for storage of large varieties of finished products.

General and works administrative building

The general administrative office building shall have a plinth area of 1,000 sq m. This is a single storeyed building with the provision of vertical as well as horizontal extensions at a later date. Provision has been made for small window type air-conditioners wherever necessary and in general electric fans shall be provided.

The general superintendent's office building has a plinth area of about 600 sq m with provision for vertical as well as horizontal expansion in future. This office is located centrally within the works. The building is single storeyed with all modern amenities.

The facility of a canteen and change room has been provided near the G.S. office inside the works. This building is single storeyed with a plinth area of 400 sq m. This canteen will have a floor area of 300 sq m and is designed to cater for 50 persons at a time and will be equipped with a modern kitchen. The building will comprise of load bearing walls with r.c. roof over it.

Amongst the other ancillary works facilities, a first aid station near the G.S. office has been provided. This building will have a floor area of 120 sq m and shall be single storeyed. The building will have a r.c. roof over load bearing brick walls.

It is proposed to have a fire brigade station near the main gate of the works. This fire station shall have an operation bay and shall have a plinth area of 300 sq m. This will be a single storeyed building with a hose drying tower. The structures shall comprise of r.c. roof over load bearing brick walls.

Hydrants encased in fire boxes are at all auxiliary buildings such as administrative and office buildings, laboratory, canteen, change rooms, etc.

Works security

The facilities to be provided for works security comprise of gate, gate house and boundary wall. The gate house provided has a plinth area of 200 sq m. This is a single storeyed building with r.c. roof supported over load bearing brick walls. Suitable sanitary facilities are provided at the gate house.

The boundary wall encompasses the whole acquired area for the works. It is a large repetitive construction item amenable to mass production techniques. Therefore, a precast concrete design is proposed.

30 - PLANT CONSTRUCTION

The activities involved in the installation of the proposed alloy steel plant and the various steps to be taken for expeditious completion of construction, are discussed in this Chapter. A construction schedule and a network (Drawing Nos. 5131-V-18, -19 and -20) have been prepared on the basis that the following preliminary steps will be completed prior to the commencement of the project.

i) Decision on plant location;

ii) sub-soil investigation and contour survey to enable layout to be finalised;

iii) arrangements for engineering services and production know-how;

iv) arrangements for requisite financing including the foreign exchange needed; and

v) the required site organisation is set up to implement the project based on designs and overall supervision by the consulting engineers.

The major functions involved in the design and construction of the plant are:

i) Finalisation of layouts, process and equipment;

ii) construction facilities at site;

iii) selection and procurement of equipment and supply of equipment foundation data for preparation of construction drawings;

30 - Plant construction (cont'd)

iv) structural designs, procurement of steel, fabrication and erection of structural steelwork;

v) design and construction of civil engineering work including ancillary buildings;

vi) design and construction of utilities such as water, power, railway sidings, roads etc; and

vii) erection and commissioning of equipment and facilities.

Equipment procurement and erection

The major equipment required for the plant consists of electric furnaces, blooming mill, bar mills, forging press and hammer, heat-treatment furnaces, straightening machines, plant electricals, heavy duty cranes, laboratory equipment, etc which will have to be imported. Currently the delivery period for major equipment (such as electric furnaces, forging press and rolling mills) varies from 15 to 18 months, and another two to three months will be required for shipping, clearing and transportation to plant site.

Stage I completion in 5½ years

Early action is required on finalisation of specifications for major equipment and invitation of tenders. In order that stage I can be constructed in a period of about 5½ years, as visualised, final orders for all major equipment should be placed within eight months from the date of commencement of engineering.

30 - Plant construction (cont'd)

With stage I construction completed, work on stage II would be continued one after commissioning of stage I facilities and completed in a further period of two years.

Indigenous equipment to the extent available in Iran will be procured. For this, tenders will be invited in order of priority. Items with long delivery periods such as EOT cranes, crushers, conveyors, etc are to be dealt with first. Early invitation of tenders and placement of orders will have considerable bearing on the early completion of work.

It is essential that arrangements are made such that final equipment drawings and foundation data are received from equipment suppliers within three to 4 months from placement of orders, otherwise, equipment is likely to be at site before local foundations and structural work are completed.

Structural steelwork

Fabrication and erection of structural steelwork in the plant buildings and various technological structures will constitute a siseable portion of the construction activities. The total requirement of structural steel for the plant construction is estimated at 9,800 tons. This has to be fabricated and erected within a period of 21 months. Due to shortage of structural steel and capable fabricators and erectors in Iran, the activities relating to structural steelwork are likely to be critical.

In view of the above, it is assumed that practically all the structural steel required will be imported on a priority basis by the project authorities and supplied to the fabricators. Enquiries should be made with all the major structural fabricators and erectors in the country in order to assess their fabricating and erecting capacities, present orders in hand, anticipated orders in the course of next few years, and the portion of their capacities likely to be available for this project.

Civil engineering

The proposed plant site at Ahwaz is fairly flat and no major site levelling will be necessary. Subsoil investigation and compound wall should be taken up first. To start with, base line and zero lines will be established at site with permanent reference pillars, together with bench marks indicating reference levels at convenient locations. Grid lines at 50 metres or 10 metres intervals will be marked to facilitate layout of the plant buildings and other facilities.

With the adoption of 33 kV as the main distribution voltage within the plant 6 or 6.6 or 6.9 kV can be adopted as the most economical voltage for sub-distribution within the plant based on the following considerations:

i) While none of these three voltages is standard in Iran, 6 kV has been adopted as sub-distribution voltage in the Isfahan Steel Plant as well as Ahwaz Rolling Mills. Also, one of the local firms has facilities for assembling 6 kV switchgear on locally fabricated cubicles. 6 kV, which is the preferred system voltage in Europe and USSR, is therefore considered for adoption as the plant sub-distribution voltage.

ii) 3 or 3.3 or 4.8 kV is the most suitable voltage for motors rated between 75 kW and 1 500 kW. However, taking into consideration the current ratings and short-circuit levels of the selected switchgear as well as the current carrying capability of cables 6 kV will be more economical than 3 kV system.

iii) With the selection of 6 kV all motors above 300 kW can be directly connected to 6 kV supply.

For feeding various plant auxiliary loads including AC motors up to 300 kW, 380/220 volts is proposed as plant secondary distribution voltage, this being the standardised distribution voltage in Iran.

Plant power distribution system

The proposed power distribution system as shown in Drawing No. 5131-V-16 indicates the main system interconnection in the form of a single line diagram for the initial stage. The arrangement permits smooth expansion when future

30 - Plant construction (cont'd)

Soil investigation work would include boreholes taken at suitable locations particularly where deep and heavy foundations are likely. In addition, load bearing tests should be carried out at selected locations at various depths below finished ground level, together with collection and testing of disturbed and undisturbed samples of the subsoil. The soil investigation work should be completed well in advance so that the results are available before commencement of foundation design.

The major equipment foundations are for the electric furnaces, forging press, blooming mill and bar mills. The total volume of concrete work in building and equipment foundation is estimated to be 4,300 cu m. The construction of plant buildings and equipment foundations shall be entrusted to selected parties who have previous experience on major civil work and also have adequate construction plant personnel.

In addition to equipment foundations, a number of ancillary buildings are to be constructed. As some of these buildings will be required during the construction stage itself, it is desirable that these be taken up on a priority basis.

Utilities

The utilities to be designed and constructed include the water system, power system, gas distribution system, compressed air system, steam system, ventilation system, rail system, road system, severage and drainage.

A railway siding is to be taken from the adjoining railway line connecting Ahwas to Khorramshahr. A new station is to be built near the existing rolling mill plant about 1½ km from the site, and therefore, a suitable siding can be constructed. This will be useful for receiving heavy equipment at the plant site. It would also be possible to transport equipment in barges on the Karun river.

Most roads planned in the layout will also be required during the construction stage. As such the alignment of permanent roads will be used during the construction period, with a permanent base and a water bound macadam surface adequate for construction traffic. After construction, these roads will be surfaced with bitumen topping for operational use.

Construction facilities

The source of construction water supply for the plant is the Karun river, about 2 km away. A temporary intake with pumps has to be located on the river bank and a temporary water main laid up to the plant site. Provision should be made for at least one day's storage in the plant site. Construction and drinking water pipelines will require to be laid to suitable points in the plant area. Procurement of necessary pumps, pipes, fittings, valves etc for conveyance of water, needs to be taken in hand early.

Construction power can be arranged from the existing power supply system. The bulk requirement of construction power will be at 380 V. For this a temporary substation has to be constructed at site with necessary step-down arrangements. A temporary electrical distribution network will be installed in the plant area to make power available at convenient points.

Generally, drains have to be cut in the plant area at early stages of the project to prevent water from flooding the construction site. Since there is not much rainfall in the area and ground absorption is high, no elaborate arrangement is required.

A temporary site office for engineering personnel together with a construction store is to be provided before the construction work initiated. One of the plant ancillary buildings may be constructed early for this purpose.

Accommodation for the client's staff and the consulting engineers' personnel has to be provided. Temporary quarters may be built by the contractors on the outskirts of the plant site for housing their construction labour.

Sources of supply of materials and of stores required for the construction of the plant are to be investigated and supplies arranged well in time.

Management of construction

The consulting engineers will depute a Resident Engineer and adequate technical personnel for overall supervision of construction at site.

The client's site organisation will include administrative and technical staff for overall coordination of the project. The work undertaken by them will include clearing of site, obtaining sanctions, permits, authorisation from local bodies, arranging import and local licenses, procurement of railway wagons, clearing of equipment, stores keeping, security, as well as for arrangements outside the plant boundary and the payment of contractors bills etc.

31 - ESTIMATE OF CAPITAL COST

Capital cost - stage I

Particulars of the estimated cost for stage I are given in Appendix 31-1 and summarised in Table 31-1. The foreign exchange component is $ 23 million or about 55 per cent of the plant cost.

Table 31-1

PLANT CAPITAL COST ESTIMATE (STAGE I)
(thousand dollars)

Particulars	Foreign currency	Local currency	Total
A. Land	-	550	550
B. Civil and structural work	1 547	9 933	11 480
C. Plant and equipment ..	16 070	1 785	17 855
D. Other costs			
1. Spares ..	804	90	894
2. Freight and insurance	1 687	-	1 687
3. Port charges and inland transport	-	595	595
4. Equipment erection	536	2 144	2 680
E. Engineering, supervision and construction admin.	1 267	2 957	4 224
F. Contingencies ..	1 100	900	2 000
Total ..	23 011	18 954	41 965
Say, ..	23 000	19 000	42 000

Civil and structural work

The cost of civil and structural work estimated at about $ 11.50 million is inclusive of site development, buildings, equipment foundations, railway tracks, roads and drainage within the plant boundary. It also includes off-site facilities comprising faecal and storm water disposal, approach road, rail link and water supply from Karun river. Electric power connection is assumed to be given by the Electric Supply authorities at their cost. No provision is made for township as the plant is located at Ahwaz, a well-developed city. The estimates are based on the cost of local building materials and prevalent labour rates in Ahwaz.

The foreign exchange component of about $ 1.55 million includes the cost of imported structurals, sheeting and shuttering. Of the total estimated requirement of about 9,800 tons of structural steel, it has been assumed that 25 per cent will be available locally. The price of local steel at site has been taken at the same rate as that of the imported steel. The price of imported steel at site has been arrived at by taking the f.o.b. steel price at $ 140 per ton and adding freight, insurance, customs duty, handling and transport charges.

The prices of steel and construction materials delivered at Ahwaz have been taken as follows:

31 - Estimate of capital cost (cont'd)

	Unit	Price $
Structural steel	ton	240
Cement ..	ton	26
Gravel ..	cu m	3.3
Washed sand ..	cu m	4

Preliminary designs for steel-framed buildings have been prepared on the basis of widths, heights, column spacings, crane loads, etc required for the plant operations. From these preliminary designs, estimates have been made of steel quantities in columns, gantry girders, trusses, bracings, purlins, girts, gutters, down pipes, staircases, bunkers etc.

Quantities of various items of work involved in site development, buildings and ancillary facilities as well as equipment foundations are estimated on the basis of preliminary designs.

Plant and equipment

The cost of plant and equipment estimated at about $ 17.85 million comprises all furnaces, furnace auxiliaries, rolling mills, conditioning equipment, heat treatment furnaces, EOT cranes, transport, laboratory, repair and maintenance and utility equipment.

Power supply and distribution cost covers mainly equipment required for receiving station, sub-station, HT and LT distribution cables, distribution boards, indoor and outdoor light fittings etc.

31 - Estimate of capital cost (cont'd)

Bulk of the equipment will be imported involving a f.o.b. price of about $ 16 million. The local supply cost works out to $ 1.8 million, ex-works. However, at the engineering stage, it may be possible to include a larger component of local supply depending upon the availability, thereby reducing the foreign exchange component correspondingly. Cost estimates for the major production equipment are based on international equipment prices.

Other costs

Under this head, commissioning and capital costs, freight and insurance on imported plant and equipment, equipment erection cost, and port charges and inland transport are included.

Spares

Spares have been taken at 5 per cent of the f.o.b. cost for the imported items and 5 per cent of the ex-works cost for indigenous supply.

Freight and insurance

A provision of 10 per cent of the f.o.b. cost of imported equipment and spares has been made to cover ocean freight and insurance, all in foreign exchange. Three per cent on the c.i.f. value of imported equipment is provided to cover port charges and inland transport for imported items. For local supplies, 2 per cent is allowed on ex-works price for inland transport.

31 - Estimate of capital cost (cont'd)

Equipment erection

Cost of equipment erection has been taken at 15 per cent of the total cost of equipment comprising f.o.b. cost for imported items and ex-works cost for local supplies. This comes to $ 2.7 million, out of which 20 per cent has been allocated in foreign exchange to cover the foreign currency requirement of foreign erectors.

Import duty

No provision towards customs duty on imported equipment has been made, as it is understood that exemption of duty is allowed in case of new installations, for which approval from the Government would be needed.

Engineering, supervision and construction administration

Fees for design, engineering, supervision of construction and erection, and expenses in connection with administration during construction are included under this head. Construction administration comprises expenses in connection with security, store-keeping, obtaining sanctions, permits and authorisation from local bodies, providing import and local licences, clearing of equipment, arrangement for payment, etc. A provision of 12 per cent of the plant cost (excluding the cost of land) has been made towards these expenses. Of the total amount of $ 4.23 million, 30 per cent is allowed in foreign currency to cover the foreign exchange component of consultant's services.

31 - Estimate of capital cost (cont'd)

Contingencies

A provision of 5 per cent on the total plant cost has been made and this works out to $ 2 million, including a foreign exchange component of $ 1.1 million.

Capital cost - stage II

The additional capital cost for the stage II facilities is estimated at $ 5.0 million as detailed in Appendix 31-2. The total plant costs for stage I, stage II and stages I and II combined are summarised in Table 31-2.

Table 31-2

SUMMARY OF TOTAL PLANT CAPITAL COST STAGES I & II

		Estimated cost		
		Stage I	Stage II	Stages I & II combined
		$ mill	$ mill	$ mill
A.	Land	0.55	-	0.55
B.	Civil and structural work	11.48	1.30	12.78
C.	Plant and equipment ..	17.86	2.20	20.06
D.	Other costs			
	1. Spares ..	0.90	0.11	1.01
	2. Freight and insurance	1.69	0.22	1.91
	3. Port charges and inland transport	0.60	0.07	0.67
	4. Equipment erection	2.69	0.33	3.02
E.	Engineering, supervision and construction administration	4.23	0.52	4.75
F.	Contingencies ..	2.00	0.25	2.25
	Total ..	42.00	5.00	47.00
	Foreign currency ..	23.00	2.5	25.50
	Foreign currency as % of total ..	55	50	54.3

29 - Plant utilities and auxiliary facilities (cont'd)

arc furnace and forging press are added in stage II.

The main features of the system are briefly discussed below:

i) Power will be purchased from KWPA at 33 kV and brought in from the south side of the plant boundary over two full capacity 30 MVA overhead feeders and terminated to the outdoor type disconnecting switches. From this point power will be taken to the plant main receiving station by means of underground cables.

ii) The plant main receiving station will be located on the south side of the steelmelt shop where the incoming feeders will be terminated to 33 kV indoor metal-clad switchboard with main busbars sectionalised over an automatic circuit-breaker.

iii) The two arc furnaces will be connected to the 33 kV system over separate 630 amp circuit-breakers and the other two 630 amp circuit-breakers will feed each of the two 8/10 MVA 33/6 kV power transformers to be located outside this main receiving station.

iv) The two 8/10 MVA transformers which will have self-cooled rating of 8 MVA and forced cooled rating of 10 MVA will be connected to main 6 kV switchboard located in the main receiving station.

v) Duplicate 6 kV feeders to the blooming mill switching station will be taken from this main 6 kV switchboard. The blooming mill motor room thus becomes mills area 6 kV substation.

vi) Power to SMS auxiliary load and future forge shop will be taken directly from the main 6 kV switchboard.

vii) The mills area 6 kV substation will feed power to blooming mill, conditioning department, water treatment plant, maintenance shop and 6 kV switching station of bar mills.

31 - Estimate of capital cost (cont'd)

The capital cost for stage II is estimated on the same basis as discussed for stage I. The foreign exchange component is estimated at 50 per cent of the total cost, as against 55 per cent in stage I.

The total cost for stages I & II combined comes to $ 47 million including a foreign exchange component of $ 25.5 million.

32 - PLANT ORGANIZATION AND KNOW-HOW REQUIREMENTS

Plant organization

This Chapter discusses some of the special features which have to be given adequate consideration while organising the management structure for the proposed alloy steel plant. As this plant will be the first producer of alloy steels in Iran, the management of the new plant will require emphasis on the following important functions.

i) Production planning: This would be an important functional activity as it involves the scheduling of operations for a large number of products with rigid specifications, in small lot sizes, and for expediting orders to ensure that all materials and facilities to meet the pre-determined schedule are available at the right place and at the right time.

ii) Inspection and quality control: Rigid metallurgical control and inspection at a number of stages are required to build reputation for quality, which is essential for any successful alloy steel producer. Accordingly, the quality control function must receive due recognition and status from top management, and the inspection department must be strong and independent. Indeed, the concept of quality must permeate the whole organisation.

iii) Research and development: Development of new steels for better performance or more economical use, steels for entirely new uses, import substitution by use of indigenous supplies and the improvement of production methods would in due course require a strong research department, which would work in cooperation with other research organisations.

iv) Training: The high degree of skills required throughout the new plant would necessitate a comprehensive training programme to meet the continuing operating requirements as well as the increasing requirements for expansion.

v) Sales and service: Unlike the large steelworks producing plain carbon mild steels, the alloy steel plant requires an effective after-sales service organisation to advise customers, on the proper steels to be used and the after-treatment of the steels for specific applications.

Keeping in view the plant requirements, a tentative organisation structure is suggested in Drawing No. 5131-V-21. It may be pointed out that this structure based on general considerations broadly applicable to countries engaged in rapid build up of their industrial base would need further study and elaboration to suit the particular conditions prevailing in Iran.

Production know-how

The alloy steel plant has to produce a large variety of products in a number of sizes and finishes for specific applications. These high cost products are required in smaller lots than ordinary plain carbon steels and are therefore produced in smaller batches. A considerable amount of inspection and conditioning at intermediate stages is necessary to ensure that steels of consistent good quality are produced with a minimum of rejections.

32 - Plant organisation and know-how requirements (cont'd)

The plant requires specialised techniques of steelmaking, metallurgical control, conditioning, heat-treatment, production planning, etc which are peculiar to alloy steels production. As there is no such know-how currently available in the country, it will be desirable to secure specialised 'production know-how' and training services from outside during the early years of plant operation. For this purpose, the foreign production adviser to be selected should have experience in producing the complete range of alloy steels proposed for the new plant and should have production facilities comparable to those at the new plant.

Training

For the expeditious and successful operation of the first alloy steel plant in the country, it is vital that an effective training scheme is initiated even in the planning stage of the project. Both the speed at which the project can be completed and the ultimate success of the plant depend on the ready availability in time of qualified men to fill all the posts in the plant, and for keeping sufficient number of trained men ready for further expansion.

In view of the acute shortage of technical personnel in Iran, it is essential that bulk of the staff for the project are recruited at the commencement of the engineering of the plant and trained at various existing units - in Iran and abroad.

32 - Plant organisation and know-how requirements (cont'd)

It is proposed that about 50 technical personnel be specially trained abroad for stage I as given in Appendix 32-1. Normally, all expenditures incurred during training abroad including wages, living expenses, and to and fro travel will have to be borne by the organisation sending the trainees. Technical and supervisory personnel numbering 16 may have to be trained for at least six months, and operators and skilled workers numbering 34 for at least three months. The total expenditure incurred on this account is estimated at $ 120,000. For stage II, the expenses on training is estimated at $ 30,000.

Technical <u>collaboration</u>

Alloy and tool steel manufacturing firms in USA, Canada, UK, Germany, India, and Japan would be interested in entering into technical collaboration and production know-how agreement. Reputed equipment suppliers and consultants are also in a position to arrange for supply of technical know-how and production advice.

Cost of imported <u>know-how</u>

The fee for imported know-how could be either a lump-sum payable in four or five instalments, commencing with signing of the agreement and terminating three or four years after commissioning of the plant, or a fee plus royalty on tonnage basis for using brands, patents and licensing rights.

For stage I, with an annual production of 45,000 tons of carbon and alloy constructional steels and spring steels,

32 - Plant organisation and know-how requirements (cont'd)

it is assumed that the know-how fee would be $ 1,000 000. For stage II when forging and other facilities for the production of tool steels and forgings would be installed, a technical collaboration fee of about $ 300,000 has been assumed.

Fee for production advice

The know-how agreement and fee should cover the deputation of 6 to 8 experts, one in each specialised field, for a period of six to twelve months during the commissioning and initial operations of the particular unit in which he is a specialist, and project coordinators for two to three years for necessary on-the-spot technical advice, supervision and training of workers. Salary, living and travel expenses for these experts are estimated at $ 300,000.

A financial provision of $ 1.75 million has been made for these arrangements.

33 - MANPOWER AND PRODUCTION COST ESTIMATES

The main considerations for estimating manpower, wage structure etc have been discussed in Volume III. This chapter presents estimates of labour and supervision requirements, and production cost of finished products.

Manpower requirements (stage I)

Departmental manning

Particulars of technical personnel, administrative and clerical staff, supervisory personnel and labour force required for plant operation and maintenance as well as general administration (including stores, purchase, sales and services) for stage I are given in the following appendices.

General administration & services	-	App 33-1
Steelmelt shop	-	App 33-2
Blooming mill	-	App 33-3
Billet conditioning	-	App 33-4
Bar mills	-	App 33-5
Heat treatment, bar finishing, inspection, warehouse & shipping	-	App 33-6

The total manpower requirement is estimated at 1,270 based on examination of the operations involved. The main purpose of this estimate is to arrive at the labour components of the production cost, and to draw up a tentative recruitment and training programme. Further work study would have to be undertaken to arrive at the standard force based on the actual facilities when the project is implemented.

Salaries and benefits

Wage scales

Manpower has been classified into four groups according to nature of job - Executive (E), Supervision (S), Workers (W) and Administrative (A). Each group has been further sub-divided and based on the remuneration rates now prevailing in rolling mills and other industrial plants, average salary for each category has been assumed as follows:

Table 33-1

AVERAGE SALARY FOR DIFFERENT CATEGORIES
OF STAFF AND LABOUR

Salary group	Average salary $/month
Executive	
E1	1 000
E2	900
E3	700
Supervision	
S1	700
S2	600
S3	500
S4	300
Worker	
W1	120
W2	80
W3	60
Administrative	
A1	300
A2	200
A3	100
A4	60

Fringe benefits

Depending upon the nature and profit potential of the industry, an Iranian worker generally enjoys various benefits, such as compulsory social insurance (13 per cent contribution by the Company and 5 per cent by the worker), free transport, free or subsidised lunch, house rent allowance, 10 per cent extra payment for shift workers, bonus, etc. These are discussed in earlier volumes. For the two plants at Ahwas, that is, Iranian Rolling Mills Co and Ahwas Pipe Mill Co, the fringe benefits come to about 30 to 40 per cent of the salary bill. For the proposed plant an amount of 50 per cent to cover expenses on fringe benefits has been provided on the monthly salary bill to arrive at the total cost of manpower.

Provision for weekly-off, leave and absenteeism

Where departments of the plant work only 6 days in a week no extra provision has been made for taking care of continuous operation in the total force (except for steelmelt shop where additional manpower is provided to allow continuous operation).

Besides the weekly day off, workers have annual leave. According to existing regulations each worker is entitled to 24 days annual leave in Ahwas. Fifteen per cent extra labour has been provided only in the Operation and Maintenance Group (W) to take care of this as well as absenteeism and other contingencies; it is assumed that absence in other personnel groups would not affect the working of the plant.

Monthly salary bill

Manpower requirements of the different departments and their monthly wage bill taking into consideration all the above provisions are shown in Appendix 33-7 and summarised in Table 33-2.

Table 33-2

MANPOWER AND WAGE BILL FOR STAGE I

		Total staff	Total monthly wage bill $
General administration and services	..	265	79 240
Steelmelt shop	..	290	46 020
Blooming mill	..	130	25 305
Conditioning	..	180	19 530
Bar mills	..	260	42 585
Heat-treatment, inspection and finishing	..	145	21 120
Total	..	1 270	233 800

Production cost estimate (stage I)

It is general steel plant accounting practice to estimate production cost under two heads 'Materials Cost' and 'Cost Above Materials'. Materials Cost is cost of all raw materials per ton of product. Cost Above Materials comprises cost of departmental supervision and labour, power, fuel, utilities such as water, compressed air, repair and maintenance materials and consumables. The General Plant Expense (inclusive of the cost of general administration and services) is apportioned suitably to each individual production unit while arriving at the production cost.

viii) A second 6 kV switchboard will be installed in the bar mill motor room to feed all loads in the bar mill as well as heat-treatment and finishing department.

ix) Load centre unit substations with combined 6/0.38 kV step-down transformers and cubicle type circuit-breaker boards will be provided at the following areas which will have a sizable concentration of 380 volts AC loads.

Department	No. and size of load centre transformer
a) SMS and future forge shop	2 x 1 000 kVA
b) Blooming mill	2 x 1 000 kVA
c) Billet conditioning area	2 x 630 kVA
d) Bar mill	2 x 1 000 kVA
e) Heat-treatment plant	2 x 630 kVA
f) Maintenance shop	1 x 630 kVA
g) Water treatment plant	2 x 630 kVA

x) For services which require 230 volts constant potential DC, factory assembled DC load centre unit will be provided comprising transformer-silicon rectifier unit and cubicle type DC circuit-breaker boards.

xi) In case of total power failure at the main receiving station cooling water pumps, emergency lighting and other vital services will have to be fed from automatic mains failure type diesel generating sets connected to plant 380 V system.

Plant electrical equipment

Switchgear: All switchgear installation for the plant will be of indoor metal-clad design. For 33 kV air blast or low oil content type breakers of cubicle

33 - Manpower and production cost estimates (cont'd)

Materials cost

The alloy steel plant consists of five major production units viz., Steelmelt shop, Blooming mill, Conditioning, Bar mills and Heat-treatment and finishing. The quantities of materials required per ton of product depend on the yield at successive stages of operation. The yields expected at each of the major production stages are given in Table 33-3.

Table 33-3

ESTIMATED YIELDS

		Yield %
Steelmaking	- metallic charge to ingot	90
Blooming	- ingot to rolled billet	84
Conditioning	- rolled billet to conditioned billet	94
Bar rolling	- conditioned billet to rolled bar	91
Heat-treatment & finishing	- rolled bar to finished, tested & inspected bar	94

Based on present prices, the estimated unit prices of major raw materials and supplies at Ahwas are given in Appendix 33-8. Ferro-alloys, scrap, electrodes, petroleum coke, fluorspar etc will have to be imported. The materials cost per ton of ingot for eight typical grades of carbon constructional, alloy constructional, spring and free cutting steels are given in Appendix 33-9.

33 - Manpower and production cost estimates (cont'd)

Cost above materials

Estimates of Cost Above Materials are given in the following appendices:

App 33-10 Steelmaking
App 33-11 Blooming
App 33-12 Conditioning
App 33-13 Bar mill
App 33-14 Heat-treatment and finishing

'General Plant Expenses' covering salaries and other expenses incurred outside the production units are estimated at $ 150,000 per month and have been distributed to major production departments in proportion to their Cost Above Materials.

Based on the Materials Cost and Cost Above Materials for the various stages, the production cost estimates for the eight grades of steels are given in Appendices 33-15 and 33-16 and summarised in Table 33-4.

Table 33-4

WORKS PRODUCTION COST OF BARS (STAGE I)

Steel	Production cost per ton	
	Rolled $	Heat-treated $
Carbon constructional (En-8) ..	261	279
Low alloy constructional (En-19) ..	290	308
Medium alloy constructional (En-25) ..	426	444
Case hardening constructional (En-36)	427	445
High carbon spring (En-44) ..	263	-
Silico-manganese spring (En-45) ..	270	-
Chromo-vanadium spring (En-47) ..	291	-
Free cutting (En-1A) ..	261	-

Production cost (stage II)

Production of 5,000 tons of tool and die steel is envisaged in stage II for which additional manpower requirement is estimated at 250 for the new steelmelt shop, forge shop, and hand operated mill as well as extra manpower for conditioning, heat-treatment and finishing. The monthly wage bill will increase by about $ 44,000.

Based on Materials Cost and Cost Above Materials for each operation, production costs for typical tool and die steels are calculated in Appendices 33-17 and 33-18 and summarised in Table 33-5.

Table 33-5

WORKS PRODUCTION COST OF TOOL & DIE STEELS (STAGE II)

	Production cost per ton (rolled or forged products)	
	Hand mill rolled or forged $	Bar mill rolled $
High speed steel (AISI-T1) ..	2 744	
Hot die steel (AISI-H21) ..	1 592	
Cold work die steel (AISI-D3) ..	758	
Low alloy tool steel (AISI-S1)	562	542
Die blocks (1.45 Ni, 0.65 Cr) ..	564	
Carbon tool steels (AISI-W1) ..	338	319

Some of the low alloy and carbon tool steels can be rolled in the bar mill and the production cost per ton for these steels rolled in bar mill will be lower by about $ 20 per ton.

34 - FINANCIAL ANALYSIS

The financial and economic aspects of the project are discussed in this chapter.

Phased implementation of the project

As discussed earlier, stage I envisages an annual production of 45,000 tons of constructional and spring steels; and in stage II an additional 5,000 tons of tool and die steels is expected to be produced. Stage I facilities are scheduled to be completed and commissioned in 3½ years; stage II construction is proposed to begin one year after commissioning stage I facilities and completed in two years' time.

As this will be the first alloy steel plant in Iran, constructional and spring steels (which are relatively easier to make) have been included in the product-mix of stage I, while the more difficult alloy tool and die steels will follow in stage II, when the normal production in the first phase is achieved. The experience acquired in respect of operation and plant maintenance over the initial period of three years will be valuable for producing high grade tool and die steels later. It is expected that the demand for tool and die steels (at present about 2,000 tons per year) will develop to about 5,000 tons per year within the next 8 to 10 years.

The full production against stage I capacity is expected to be reached in the third year of operation and that of stage II in the second year of integrated operation. Accordingly, the full rated capacity of the plant is expected to be realised in a period of 8½ years from the start of construction as shown in Fig. V-1.

Estimate of total project cost

Besides the capital cost estimates presented in chapter 31, additional funds to meet expenses on preliminary work, know-how, training, plant start-up and interest on loan during construction would be needed. The total project cost amounts to about $ 46 million including $ 26.5 million in foreign currency for stage I and about $ 6 million including $ 2.8 million in foreign currency for stage II as given in Tables 34-1 and 34-2 respectively.

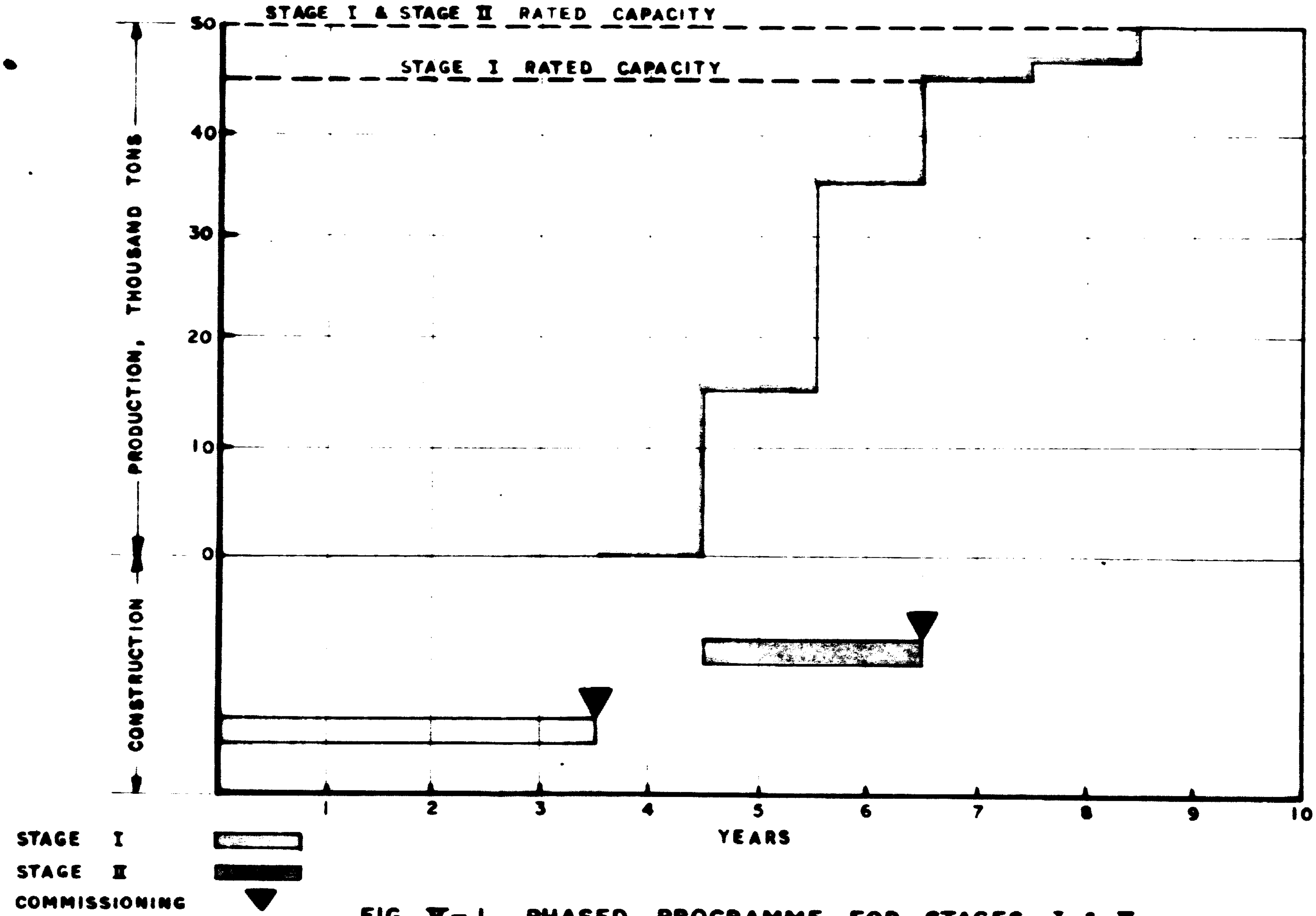


FIG. V-1. PHASED PROGRAMME FOR STAGES I & II

Table 34-1

ESTIMATE OF TOTAL PROJECT COST - STAGE I

(Thousand dollars)

		Foreign currency	Local currency	Total
1. Plant cost	..	23 000	19 000	42 000
2. Preliminary expenses	..	-	300	300
3. Start-up expenses	..	-	70	70
4. Training expenses	..	60	60	120
5. Know-how expenses	..	1 090	210	1 300
6. Interest during construction		2 200	-	2 200
Total	..	26 350	19 640	45 990
Say	..	26 500	19 500	46 000

Table 34-2

ESTIMATE OF TOTAL PROJECT COST - STAGE II

(Thousand dollars)

		Foreign currency	Local currency	Total
1. Plant cost	..	2 500	2 500	5 000
2. Start-up expenses	..	-	20	20
3. Training expenses	..	10	20	30
4. Know-how expenses	..	270	30	300
5. Interest during construction		-	600	600
Total	..	2 780	3 170	5 950
Say	..	2 800	3 200	6 000

34 - Financial analysis (cont'd)

Additional funds required for preliminary expenses, training, know-how, start-up, and interest on loan capital during construction are estimated as follows:

Preliminary expenses

A provision of $ 300,000 has been made in stage I to cover promotional expenditure involved in the registration of the company, issue and collection of equity capital, arranging finance and other preliminary expenses. The entire amount is expected to be spent in local currency. No such provision is made for stage II.

Know-how expenses

As explained in chapter 32, the know-how fee has been estimated at $ 1,000,000 for stage I. This entire sum will be payable in foreign exchange. In addition, services of foreign experts will be required for commissioning and assisting in the initial operations of the plant. A provision of $ 300,000 is made to cover these expenses, 50 per cent of which will be paid in foreign exchange.

For stage II, a sum of $ 300,000 including $ 270,000 in foreign currency has been provided towards these expenses.

34 - Financial analysis (cont'd)

Training expenses

As mentioned earlier in chapter 32, it is estimated that the total expenses for training 50 engineers and operatives abroad would be $ 120,000 (excluding their home salary during their training period abroad which is included in the expenses for administration during construction). This amount comprises $ 60,000 in local currency towards travel, and $ 60,000 in foreign currency towards living expenses abroad.

For stage II, a lumpsum amount of $ 30,000 including $ 10,000 in foreign currency has been provided.

Start-up expenses

A lumpsum provision of $ 90,000 in local currency has been made towards initial expenses in connection with trial runs and start-up of operations of which $ 70,000 is for stage I and $ 20,000 for stage II.

Interest during construction

The interest on loan capital during construction has been computed at 8 per cent per annum. Based on the phasing of the borrowings, the interest on loan capital during construction works out to $ 2.2 million for stage I. The interest charges on loan capital during construction for stage II are estimated at about $ 0.6 million based on the loan amount of $ 2.4 million in the first year of construction and the balance amounting to $ 3.0 million in the second year.

Financing pattern of the project

The capital structure for stage I is envisaged on an equity:loan ratio of about 50:50, involving an equity capital of $ 23 million, the remaining $ 23 million being raised as a long-term loan bearing 8 per cent interest per annum. The loan amount would be repaid over a period of 10 years in equal instalments commencing from the third year of plant operation when full production of stage I is expected to be achieved.

Stage I financing pattern

The phasing of the financing for stage I, based on the construction schedule visualised, is given in Table 34-3.

Table 34-3

FINANCING PATTERN FOR STAGE I

(Thousand dollars)

		1st year	2nd year	3rd year	4th year	Total
Equity Capital	..	6 000	12 000	5 000	-	23 000
Loan amount	..	-	-	17 000	3 800	20 800
Interest on loan during construction at 8%	..	-	-	-	2 200	2 200
Total capital	..	6 000	12 000	22 000	6 000	46 000

design are proposed, and for 6 kV and 380 volts air-circuit-breakers are proposed having standardised current ratings of 400, 630, 1,250, 2,000 amps these being the preferred IEC ratings.

Transformers: The two main 8/10 MVA, 33/6 kV step-down transformers will be oil-immersed outdoor type with natural/forced air cooling. For the load centre transformers it is proposed to standardise on two sizes of natural cooled transformers, viz. 630 and 1 000 kVA.

Main drives: As far as adjustable voltage DC drives are concerned the modern trend is to use thyristors both for reversing and non-reversing drives with closed loop speed control over static regulating amplifiers.

Auxiliary drives: The various mill auxiliary equipment such as roller table, shears, saws, pinch rolls etc will be powered with steel mill duty AC slip-ring motors or mill type DC motors. Those drives which operate in synchronism with the mill rolls will have DC motors with adjustable voltage control over thyristor convertors.

Taking into consideration the ambient temperature conditions all main drive motors will have to be forced cooled with closed circuit ventilation. The motor rooms

Stage II financing pattern

Stage II construction is planned to start one year after commissioning of stage I and completed in two years (i.e. by the end of the third year of stage I operation). The total capital requirement of about \$ 6 million for stage II (\$ 2.4 million in the first year and \$ 3.0 million in the second year) is proposed to be raised entirely through loang-term loans to be paid back in equal instalments over a period of 10 years, starting from the fifth year of plant operation (stage I) when the stage II production is expected to be achieved.

Profit and loss statement

The operational net profit as given in the profit and loss statement is arrived at by taking into account sales receipt, manufacturing expenses, depreciation, interest on working capital and loan capital, deferred charges, selling expenses and taxation as discussed below.

i) **Production:** As discussed under phased implementation of the project, the stage I rated production is expected to be realised in the third year from the date of commissioning of the plant. Stage II facilities are expected to be commissioned in the fourth year from the date of commissioning of stage I facilities. Yearwise finished alloy steel production for both stages is expected to be realised as follows:

Yearwise production		Stage I tons/yr	Stage II tons/yr	Total tons/yr
1st year	..	15 000	-	15 000
2nd year	..	35 000	-	35 000
3rd year	..	45 000	-	45 000
4th year	..	45 000	2 000	47 000
5th year	..	45 000	5 000	50 000

ii) Estimate of sales receipt: At present the alloy steel consumption in Iran is about 7,000 tons per year. The steel is partly imported direct by the consumers and partly through the trading houses. Present selling prices for alloy steels in Iran are high. The main reason for such high prices is the very small current consumption with correspondingly high expenses for selling, warehousing, credit arrangements etc.

According to the present structure of customs tariffs, the duties on ordinary mild steel range from about $ 50 to $ 100 per ton for different categories, whereas the duties on

34 - Financial analysis (cont'd)

the more valuable alloy steels are around $ 27 per ton. The selling prices of ordinary steels are high in Iran, and this in turn also raises the prices of alloy steels (in spite of the lower customs duties).

Selling prices

The prevailing selling prices of imported alloy steels and the selling prices assumed for the financial analysis in this study are given in Table 34-4 below:

Table 34-4

SELLING PRICES FOR PROPOSED PLANT AND PREVAILING ALLOY STEEL PRICES IN IRAN

	Iran prices $/ton	Assumed selling prices a/ $/ton
Stage I		
Constructional		
Carbon (En-8)	600	400
Low alloy (En-19)	1 000	550
Medium alloy (En-25)	1 000	700
Case hardening (En-36B)	1 000	700
Free cutting (En-1A)	-	400
Spring steel		
High carbon (En-44)	-	450
Silico-manganese (En-45)	1 350	500
Chrome-vanadium (En-47)	-	550
Stage II		
Alloy tool and die steel		
High speed steel (AISI-T1)	5 500	4 000
Hot die steel (AISI-H21)	3 500	2 500
Coldwork die steel (AISI-D3)	1 860	1 500
Low alloy tool steel (AISI-S1)	1 500	1 000
Die blocks (1.45% Ni, 0.65% Cr)	-	900
Carbon tool steel (AISI-W1)	950	700

a/ Ex-works Ahwaz

It is to be noted that the selling prices assumed are lower than present prices in the Iran market, but higher than international prices, because major raw materials such as scrap, ferro-alloys, refractories, electrodes, rolls etc will have to be imported initially.

When the new alloy steel plant goes into production the customs duty tariff would need to be rationalised. It is suggested that duties on imported low alloy steels (whose c.i.f. values are under $ 300 per ton) be raised to 30 per cent (against this the present duties on ordinary steel are as much as 30 per cent to 60 per cent of value), while duties on high alloy steels (c.i.f. values over $ 300) to 20 per cent.

Protection of this order is required to enable the new plant to sell its products in the Iranian market in the initial years of operation.

Sales receipt

Based on the estimated selling prices, the total sales receipts are worked out in Table 34-5 at $ 23.2 million per annum in stage I, and $ 29.1 million per annum after reaching the full rated production of both stages I and II.

34 - Financial analysis (cont'd)

Table 34-5

ESTIMATED SALES RECEIPT

		Quantity Tons/yr	Selling price $/ton	Total value '000 $
A. Stage I				
Constructional				
Carbon (En-8)	..	8 000	400	3 200
Low alloy (En-19)	..	8 000	550	4 400
Medium alloy (En-25)	..	2 000	700	1 400
Case hardening (En-36B)	..	5 000	700	3 500
Free cutting (En-1A)	..	2 000	400	800
Spring steel				
High carbon (En-44)	..	5 000	450	2 250
Silico-manganese (En-45)	..	12 000	500	6 000
Chrome-V (En-47)	..	3 000	550	1 650
Total	..	45 000		23 200
B. Stage II				
High speed steel (AISI-T1)	..	200	4 000	800
Hot die steel (AISI-H21)	..	300	2 500	750
Cold work die steel (AISI-D3)		1 000	1 500	1 500
Low alloy tool steel (AISI-S1)		1 000	1 000	1 000
Die blocks (1.45% Ni, 0.45% Cr)		500	900	450
Carbon tool steel	..	2 000	700	1 400
Total	..	5 000		5 900
Total (A + B)		50 000		29 100

iii) **Manufacturing expenses:** These include cost of raw materials, labour and supervision, power, fuel and utilities, refractories, rolls, electrodes and supplies, repair and maintenance and other miscellaneous and general plant expenses. The different components of costs per ton of production at various stages have been discussed in chapter 33. The total manufacturing expenses for each item are computed on the basis of annual production and cost for each item per ton of production.

During the first year of production the expenditure on raw materials has been taken at 10 per cent higher than that which would be incurred when operations are stabilised. This allowance has been made to take care of losses and lower yield due to initial operational problems. Similarly, an allowance of 5 per cent on raw materials expenditure has been made during the second year of production. Likewise, in stage II, an allowance of 10 per cent on raw materials expenditure has been made on the production of 2,000 tons of tool and die steels during the first year of operation.

iv) Depreciation: The overall life of a plant of this type is considered well over 20 years and hence depreciation at about 5 per cent per annum on a straightline basis can be assumed to be a fair charge. However, as suggested by the Ministry of Economy, Iran, depreciation has been calculated on straightline basis at 8 per cent per annum on the total plant cost excluding the cost of land. On this basis, the depreciation amount per annum is estimated at about $ 3.3 million for stage I and $ 3.7 million for the integrated facilities of stage I and stage II.

v) *Interest on working capital:* Working capital requirements have been estimated at three months' total of manufacturing expenses, and a rate of 12 per cent per annum has been assumed for calculating interest charges.

vi) *Interest on loan capital:* For a capital requirement of $ 46 million in stage I, the long-term loan amount is $ 23 million. The stage II capital requirement of $ 6 million will be entirely raised through long-term borrowings. Interest has been calculated at 8 per cent per annum on these long-term borrowings.

vii) *Deferred charges:* Deferred charges include expenses on preliminary work, know-how, training, plant start-up and interest on loan during construction.

These charges work out to about $ 4 million for stage I and $ 1 million for stage II, and have been amortized in full in equal instalments over the first 10 years of the respective operations of stage I and stage II.

viii) Selling expenses: Besides the expenses of the general sales organization provided under general plant expenses, additional selling expenses would have to be incurred for warehouses, selling agent's commission, advertisement and service to customers. To cover these expenses, a provision of 3 per cent of sales receipt has been made.

ix) Taxation: According to the Inland Revenue Act 1967, corporations are taxed on their gross profits, less exemptions. Exemptions which could be availed of are:

i) 5 to 100 per cent of the gross profit for 5 years depending on the importance, nature and geographical location of the proposed industry;

ii) 20 to 100 per cent of the gross profit for 10 years for enterprises located outside the principal cities, near the geographic boundaries of the country; and

iii) export incentive in the form of full exemption on profits earned from exports.

As the proposed project at Ahwaz in Khuzestan is in an underdeveloped area, it is assumed that this project will benefit from 100 per cent tax exemption for the first five years. Thereafter, the project may get further tax benefit since it is located away from the principal city (that is about 10 km from Ahwaz city) and near the geographical boundary of the country. It will be observed that tax will be payable only from the sixth year of operation. For the purpose of this exercise, an ad hoc tax rate of 35 per cent of the total income from the project from the sixth year onwards has been assumed.

Profit and loss statement

In Table 34-6 is shown the statement of estimated profit and loss after tax resulting from the operation of the plant over a period of 15 years.

The results of the first year show a loss of about $ 6 million while all subsequent years reveal profits. The profits improve over the years as the long-term loans are gradually repaid and interest charges are progressively reduced. Also, the major portion of deferred charges is

Table 34-6

PROFIT AND LOSS STATEM

(Thousand dollars)

	I	II	III	IV	V	VI
Production (tons)	15 000	35 000	45 000	47 000	50 000	50 000
A. Income						
Sales receipt	7 733	18 044	23 200	25 560	29 100	29 100
B. Manufacturing expenses						
Raw materials	1 832	4 082	5 000	5 800	6 817	6 817
Labour and supervision	1 855	1 855	1 855	2 355	2 355	2 355
Power, fuel and utilities	345	806	1 037	1 116	1 235	1 235
Refractories, rolls, electrodes and supplies	438	1 023	1 315	1 416	1 567	1 567
Repair and maintenance	1 400	1 400	1 400	1 663	1 663	1 663
Other miscellaneous expenses	367	855	1 100	1 170	1 275	1 275
General plant expense	1 550	1 550	1 550	1 622	1 622	1 622
Total (B)	7 787	11 571	13 257	15 142	16 534	16 534
C. Gross profit (A-B)	-54	6 473	9 943	10 418	12 566	12 566
D. Other expenses						
Depreciation	3 316	3 316	3 316	3 716	3 716	3 716
Interest on working capital	240	360	396	456	504	504
Interest on loan capital	1 840	1 840	1 840	2 136	1 952	1 720
Deferred charges	400	400	400	500	500	500
Selling expenses	232	541	696	767	873	873
Total (D)	6 028	6 457	6 648	7 575	7 545	7 313
E. Net profit or loss before tax (C-D)	-6 082	16	3 295	2 843	5 021	5 253
F. Income tax a/	-	-	-	-	-	1 839
G. Net profit or loss after tax - current(E-F)	-6 082	16	3 295	2 843	5 021	3 414
- cumulative	-6 082	-6 066	-2 771	72	5 093	8 507

a/ Tax - first five years exempted. From 6th year 35% of net profit paid as tax.

will have to be pressured with filtered and washed air system to keep out the dust and dirt prevalent in Ahwaz area.

Power rate

KWPA has no established power tariff for such bulk consumers and the actual tariff to be applied will have to be negotiated. It is considered reasonable that for a load of this size and type, the tariff should be such that the overall unit rate does not exceed $ 0.011 per kWH (i.e. about Rials 0.85 per kWH).

To compensate for the reactive power of the arc furnaces as well as for the rest of the plant, specially with the use of modern static power convertors for the rolling mills, it would become necessary to install power factor correction equipment to bring the average monthly power factor within the limits acceptable to the power supply authority. This aspect would be studied during the engineering stage.

Plant communication system

One of the essential requirements in the operation of a modern steel plant is efficient intercommunication between different departments as well as between various sections within a department. The following communication systems are proposed for this alloy steel plant.

Table 34-6

PROFIT AND LOSS STATEMENT

(Thousand dollars)

Year of operation											
IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
7 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000	50 000
5 560	29 100	29 100	29 100	29 100	29 100	29 100	29 100	29 100	29 100	29 100	29 100
5 800	6 817	6 817	6 817	6 817	6 817	6 817	6 817	6 817	6 817	6 817	6 817
2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355	2 355
1 116	1 235	1 235	1 235	1 235	1 235	1 235	1 235	1 235	1 235	1 235	1 235
1 416	1 567	1 567	1 567	1 567	1 567	1 567	1 567	1 567	1 567	1 567	1 567
1 663	1 663	1 663	1 663	1 663	1 663	1 663	1 663	1 663	1 663	1 663	1 663
1 170	1 275	1 275	1 275	1 275	1 275	1 275	1 275	1 275	1 275	1 275	1 275
1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622	1 622
5 142	16 534	16 534	16 534	16 534	16 534	16 534	16 534	16 534	16 534	16 534	16 534
0 418	12 566	12 566	12 566	12 566	12 566	12 566	12 566	12 566	12 566	12 566	12 566
3 716	3 716	3 716	3 716	3 716	3 716	3 716	3 716	3 716	2 058	400	400
456	504	504	504	504	504	504	504	504	504	504	504
2 136	1 952	1 720	1 488	1 256	1 024	792	560	328	96	48	-
500	500	500	500	500	500	500	100	100	100	-	-
767	873	873	873	873	873	873	873	873	873	873	873
7 575	7 545	7 313	7 081	6 849	6 517	6 385	5 753	5 521	3 631	1 825	1 777
2 843	5 021	5 253	5 485	5 717	5 949	6 181	6 813	7 045	8 935	10 741	10 789
-	-	1 839	1 920	2 001	2 082	2 163	2 385	2 466	3 127	3 759	3 776
2 843	5 021	3 414	3 565	3 716	3 867	4 018	4 428	4 579	5 808	6 982	7 013
72	5 093	8 507	12 072	15 788	19 655	23 673	28 101	32 680	38 488	45 470	52 483

. tax.

SECTION 2

amortized in the first 10 years of operation and as their incidence is reduced substantially from the eleventh year, there is a marked improvement in profitability from that year.

The cumulative net profits over the fifteen year period are of the order of about $ 52 million yielding an annual average net profit after tax of $ 3.5 million which is equivalent to about 6.5 per cent return on the initial capital investment of $ 52 million or about 15 per cent return on the equity capital of $ 23 million.

The above criterion, however, is not a very satisfactory measure of profitability and, therefore, the project has been evaluated on the basis of other criteria such as the internal rate of return, excess present value analysis and the pay-back period. The contributory margin, break-even points, estimated foreign exchange savings, rate of return of foreign exchange, and social benefits to the national economy resulting from the establishment of the proposed project are also discussed.

Cash flow

Estimates of cash flow generated by the project operations over a period of 15 years are presented in Table 34-7.

Table 34-7

CASH FLOW STATEMENT

(Thousand dollars)

							Ye
	I	II	III	IV	V	VI	VII
Sources of cash							
Net profit or loss after tax ..	-6 082	16	3 295	2 843	5 021	3 414	3 565
Add - depreciation ..	3 316	3 316	3 316	3 716	3 716	3 716	3 716
- deferred charges ..	400	400	400	500	500	500	500
Surplus/deficiency from operation	-2 366	3 732	7 011	7 059	9 237	7 630	7 781
Disposition of cash							
Repayment of loan ..	-	-	2 300	2 300	2 900	2 900	2 900
Estimated cash balance/deficiency							
- current ..	-2 366	3 732	4 711	4 759	6 337	4 730	4 881
- cumulative ..	-2 366	1 366	6 077	10 836	17 173	21 903	26 784

Table 34-7

H FLOW STATEMENT

ousand dollars)

	Year of operation									
	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
21	3 414	3 565	3 716	3 867	4 018	4 428	4 579	5 808	6 982	7 013
16	3 716	3 716	3 716	3 716	3 716	3 716	3 716	2 058	400	400
00	500	500	500	500	500	100	100	100	-	-
37	7 630	7 781	7 932	8 083	8 234	8 244	8 395	7 966	7 382	7 413
00	2 900	2 900	2 900	2 900	2 900	2 900	2 900	600	600	-
37	4 730	4 881	5 032	5 183	5 334	5 344	5 495	7 366	6 782	7 413
73	21 903	26 784	31 816	36 999	42 333	47 677	53 172	60 538	67 320	74 733

SECTION 2

It is observed that sufficient funds are available from the third year of operation for repayment of long-term loans at a fairly steady rate. The entire amount of long-term loans is repaid by the 14th year. After the repayment of long-term loans it will be noted that at the end of the 15th year there is a cumulative net surplus of about $ 75 million as against the shareholders' investment of about $ 23 million.

Contributory margin

The difference between the annual sales receipt and the sum of annual costs of raw materials; power, fuel and utilities; and consumables such as refractories, rolls electrodes and other supplies, represents the "contributory margin". This amounts to about $ 19.5 million from the fifth year onwards when the full combined production of stage I and stage II is achieved, giving a contributory margin to sales ratio of about 0.67.

Break-even chart

Figure V-2 is the break-even chart indicating the fixed cost, total cost and sales receipt at different levels of output. The fixed cost includes the following

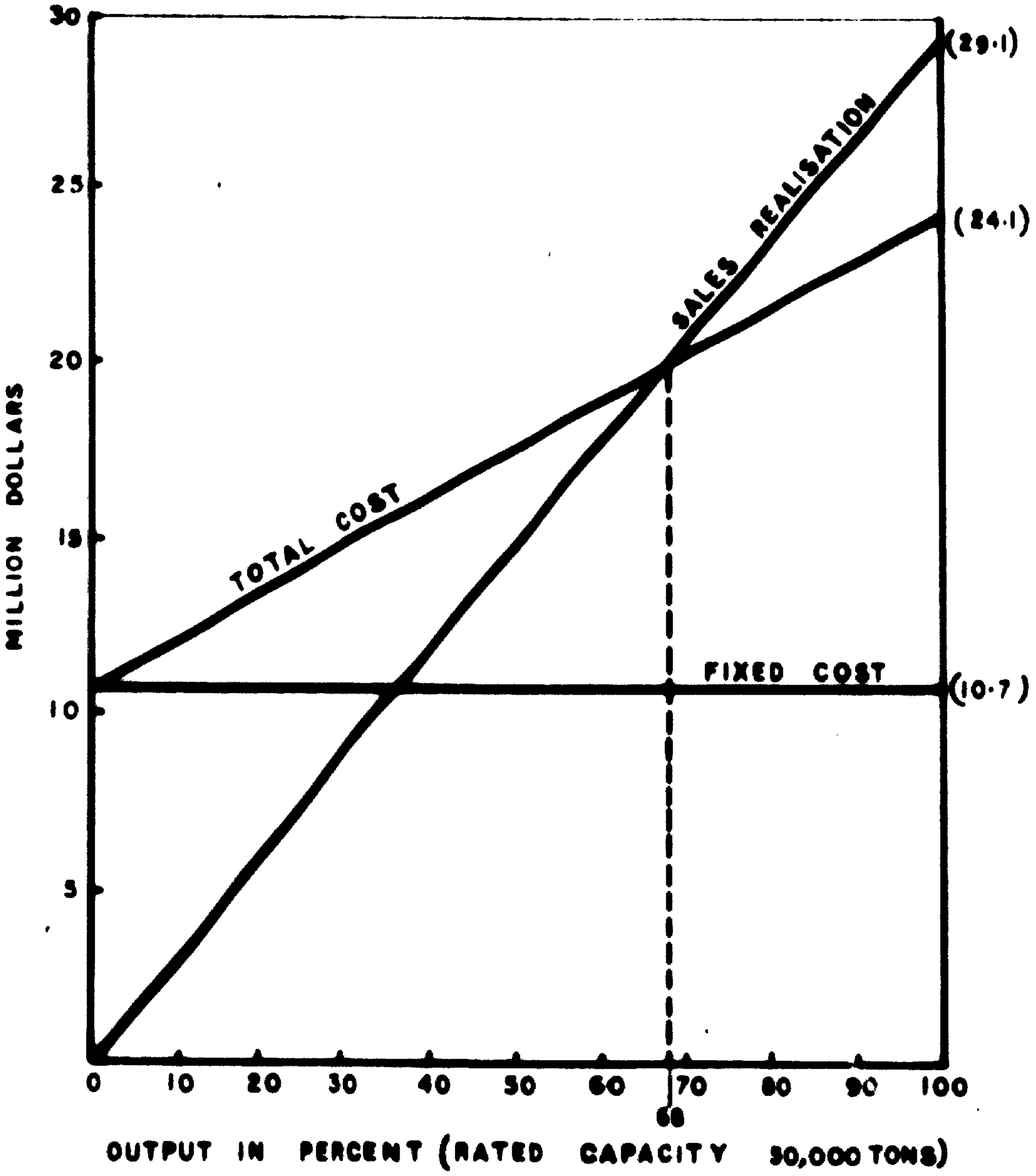


FIG. V-2. BREAK-EVEN CHART

expenses:

i) labour and supervision,

ii) general plant expenses,

iii) depreciation

iv) deferred charges, and

v) interest on working and loan capital

This works out to about $ 10.7 million in the fifth year of operation when both stage I and stage II will attain the rated output level.

The total cost is sum of the fixed cost plus the variable cost. The variable cost comprises the following items:

i) raw materials

ii) power, fuel and utilities,

iii) refractories, rolls, electrodes and other supplies,

iv) repairs and maintenance,

v) selling expenses and

vi) other miscellaneous expenses.

The cost of these items amounts to about $ 13.4 million for the full output of 50,000 tons, thus bringing the total cost to about $ 24.1 million. The sales realisation in the fifth year at full output amounts to $ 29.1 million.

34 - Financial analysis (cont'd)

From figure V-2 it will be seen that the plant can be expected to break-even when operating at about 68 per cent of the rated capacity. It may be noted that there is some in-built capacity in the plant design and utility systems which would improve the plant economics - and lower the break-even point - when it expands beyond 50,000 tons capacity.

Internal rate of return

In Table 34-8, the cash flow figures are adjusted to find out the real cash surplus generated by plant operation for working out the internal rate of return and the excess present value.

Table 34-8

ADJUSTED CASH FLOW
(Thousand dollars)

Year of operation	Operating surplus a/	Add interest on Working capital	Add interest on Loan capital	Residual value of equipment	Salvaged working capital	Real cash surplus
I	-2 366	240	1 840			-286
II	3 732	360	1 840			5 932
III	7 011	396	1 840			9 247
IV	7 059	456	2 136			9 651
V	9 237	504	1 952			11 693
VI	7 630	504	1 720			9 854
VII	7 781	504	1 488			9 773
VIII	7 932	504	1 256			9 692
IX	8 083	504	1 024			9 611
X	8 234	504	792			9 530
XI	8 244	504	560			9 308
XII	8 395	504	328			9 227
XIII	7 966	504	96			8 566
XIV	7 382	504	48			7 934
XV	7 413	504	-	5 000	4 200	17 117

a/ From Table 34-7

Adjusted cash flow

For this adjustment, apart from adding back depreciation and deferred charges (which items do not involve actual cash outflows during the operation period), interest on long-term loans and interest on working capital have also been added back to net surplus from operation. Interest charges are added back since it is considered desirable to work out the profitability of the entire capital invested in the project including the working capital. In the 15th year of operation, the residual value of the project which is estimated at about 10 per cent of the original plant is added back. The plant cost is estimated at $ 47 million and the residual value is therefore estimated as $ 5 million. The working capital requirement of about $ 4.2 million is also shown as fully salvaged at the end of 15 years and for the purpose of this exercise, shown as an inflow in the 15th year.

Internal rate of return

The total investment in the project including investment in working capital but excluding interest charges during construction is about $ 53.4 million (fixed facilities $ 49.2 million - working capital $ 4.2 million). The beginning of the first year of operation is taken as the zero point for the purpose of working out present values and and therefore all fixed investment outflows during the three-and-half year construction period have been compounded. Outflows by way of fixed investment and working capital during the first three years of operation are discounted and all cash inflows representing net operational surplus after tax as derived from Tabl 34-8 have been discounted. All outflows are assumed to be occurring at the beginning of each year and inflows to accrue at the end of each year. In Table 34-9 the present values of the outflows and inflows have been arrived at by adopting four different rates - 5 per cent, 10 per cent, 15 per cent and 20 per cent and in each case the ratio of total investment to capital recovery is worked out. The ratios are thereafter plotted on the interpolation chart (Fig. V-3) from which the internal rate of return works out at about 10 per cent.

<u>Excess present value analysis</u>

The adjusted net cash flows (given in Table 34-8) have been discounted at a rate of 8 per cent to work out the estimated present value of the net inflows over the 15 year period. This working is given in Table 34-10 from which it will be noted that the total present value of net inflows at 8 per cent amounts to about $ 72.5 million as against a corresponding total outflow of $ 60 million including working capital. The excess present value on this basis amounts to about $ 12.5 million ($ 72.5 million -60.0 million).

i) Private automatic telephone exchange: For general communication within the plant it is proposed to provide a private automatic exchange having a capacity of 100 lines. This system will have direct dialling facility for private communication between extensions. In addition conference calling facilities can also be incorporated at required points.

ii) Departmental audio communication systems: Ring-type audio amplifier systems are proposed for installation in various departments to provide two-way communication between a number of control points within each department. The system arrangement will be such that any person speaking into a microphone at any control point will be heard at all other points connected to that ring system.

iii) Signalling and alarm systems: A fire alarm system is proposed for the plant with facility for exact location of fire on a central indicator panel. The system will comprise fire alarm contacts, bells and central indicator board.

A controlled electric clock system is proposed to indicate synchronised time throughout the plant and provide impulses to the time recorders from a master clock.

Water supply system

Assured continuous supply of water through a well designed system is required for cooling the arc furnaces, transformers, reheating furnaces, mill bearings and rolls. It is also required for drinking and sanitary uses and fire-fighting.

Water requirement

The total water requirement is estimated at about 2,200 cu m per hour in circulation, with a make-up of 300 cu m

Table 34-9

INTERNAL RATE OF RETURN

		Fixed investment million $	Working capital million $	Present value 5%	Present value 10%	Present value 15%	Present value 20%	Internal rate of return (see interpolation chart) 10%
A. Cash outflow								
Construction period								
Year	I	6.0		7.11	8.39	9.81	11.41	8.39
	II	12.0		13.56	15.25	17.06	19.01	15.25
	III	22.0		23.68	25.41	27.20	29.04	25.41
	IV (six months)	3.8		3.90	3.99	4.09	4.18	3.99
Operation period (zero point)								
Year	I	-	2.0	2.00	2.00	2.00	2.00	2.00
	II	2.4	1.0	3.24	3.09	2.96	2.83	3.09
	III	3.0	1.2	3.81	3.47	3.18	2.91	3.47
	Total (A)	..		57.30	61.60	56.30	71.38	61.60
		Operating adjusted cash surplus million $ a/						
B. Cash inflow								
Year	I	(-) 0.29		(-) 0.28	(-) 0.26	(-) 0.25	(-) 0.24	(-) 0.26
	II	5.93		5.38	4.90	4.48	4.12	4.90
	III	9.25		8.00	6.95	6.09	5.36	6.95
	IV	9.65		7.94	6.59	5.52	4.65	6.59
	V	11.69		9.16	7.26	5.81	4.70	7.26
	VI	9.85		7.35	5.56	[illegible]	[illegible]	5.56

Year	I	(-) 0.29	(-) 0.28	(-) [illegible]	(-) [illegible]	(-) [illegible]	(-) [illegible]
	II	5.93	5.38	4.90	4.48	4.12	4.90
	III	9.25	8.00	6.95	6.09	5.36	6.95
	IV	9.65	7.94	6.59	5.52	4.65	6.59
	V	11.69	9.16	7.26	5.81	4.70	7.26
	VI	9.85	7.35	5.56	4.26	3.30	5.56
	VII	9.77	6.95	5.01	3.67	2.73	5.01
	VIII	9.69	6.56	4.53	3.17	2.26	4.53
	IX	9.61	6.20	4.07	2.73	1.86	4.07
	X	9.53	5.85	3.68	2.35	1.54	3.68
	XI	9.31	5.45	3.26	2.00	1.26	3.26
	XII	9.23	5.14	2.94	1.73	1.03	2.94
	XIII	8.57	4.54	2.49	1.40	0.80	2.49
	XIV	7.93	4.00	2.09	1.12	0.62	2.09
	XV	17.12	8.33	4.09	2.11	1.11	4.09
	Total (B) ..		90.47	63.16	46.12	35.10	63.16
	Ratios (A/B) ..	..	0.63	0.98	1.44	2.03	

a/ From Table 34-7

SECTION 2

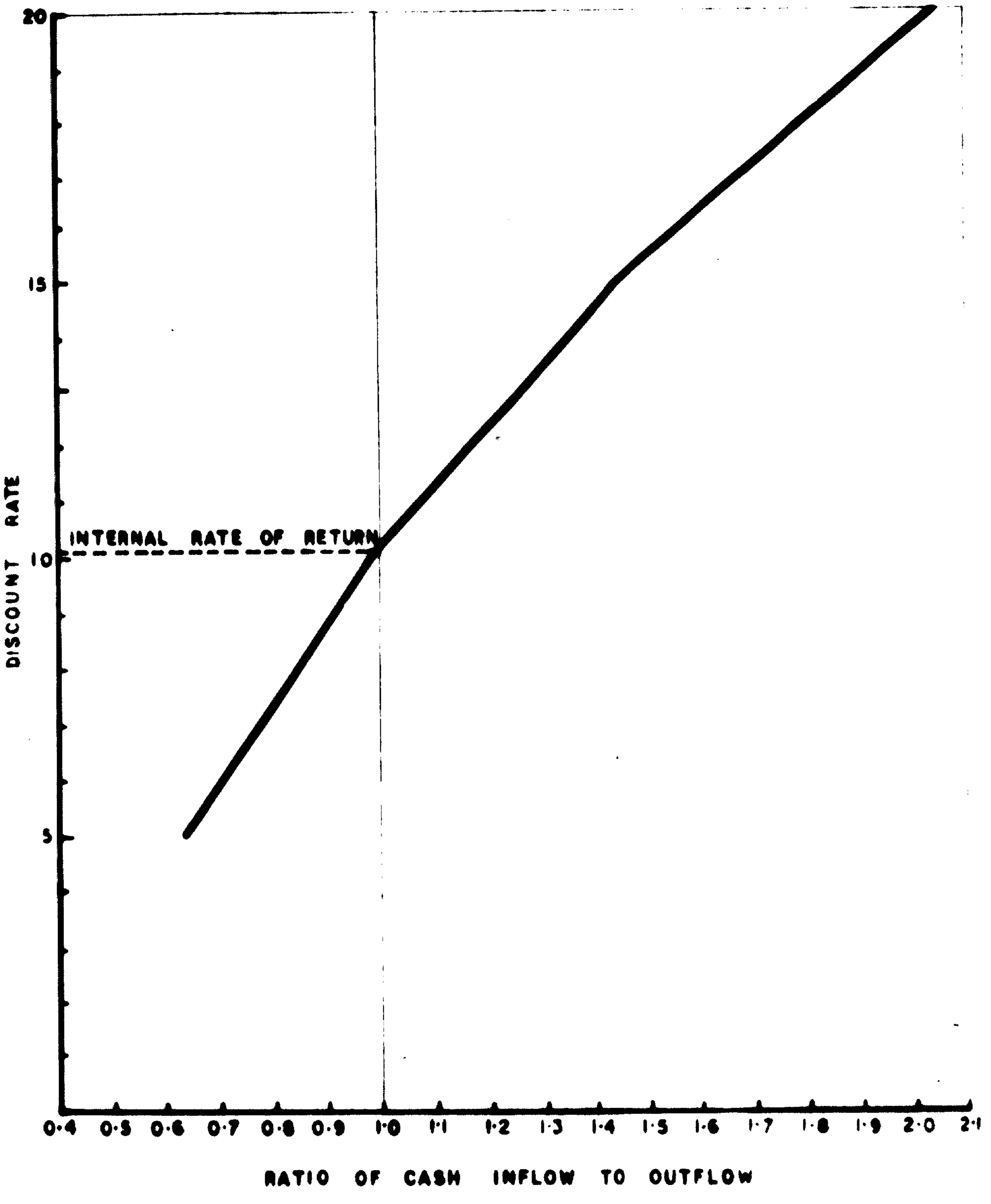


FIG. V–3. INTERPOLATION CHART FOR INTERNAL RATE OF RETURN

34 - Financial analysis (cont'd)

Table 34-10

EXCESS PRESENT VALUE
(Thousand dollars)

Year of operation	Adjusted cash surplus a/	Present value at 8%
I	-286	-265
II	5 932	5 084
III	9 247	7 342
IV	9 651	7 093
V	11 693	7 963
VI	9 854	6 208
VII	9 773	5 698
VIII	9 692	5 234
IX	9 611	4 806
X	9 530	4 412
XI	9 308	3 993
XII	9 227	3 663
XIII	8 566	3 152
XIV	7 934	2 698
XV	17 117	5 392
	Total ..	72 473

a/ From Table 34-7

The present value index which is worked out as the ratio of the total present value ($ 72.5 million) of net inflows divided by total outflow ($ 60.0 million) is 1.21.

Pay-back period

The pay-back period is worked out on the traditional basis of actual net inflows and also on the basis of discounted net inflows. For the traditional method, fixed investment of $ 52 million (including interest during construction) has been taken into consideration, and for the discounted method the fixed investment (excluding interest during construction) of $ 49.2 million has been considered. Investment in working capital is ignored. Interest on long-term loans is added back for working out the present value at 8 per cent of the total cash outflows and inflows. The working is shown in Table 34-11.

Table 34-11

PAY-BACK PERIOD

(Thousand dollars)

A. CASH INFLOW

Year of operation (1)	Current (2)	Cumulative (3)	Adjusted cash flow Add interest of loan (4)	Adjusted cash flow Adjusted inflow (5)=(2)+(4)	Present value of (5) at 8% discount Current (6)	Present value of (5) at 8% discount Cumulative (7)
I	(-) 2 366	-	1 840	(-) 526	(-) 487	
II	3 732	1 366	1 840	5 572	4 775	4 288
III	7 011	8 377	1 840	8 851	7 028	11 316
IV	7 059	15 436	2 136	9 196	6 758	18 074
V	9 237	24 673	1 952	11 189	7 620	25 694
VI	7 630	32 305	1 720	9 350	5 [illegible]	31 585
VII	7 781	40 084	1 488	9 269	5 404	36 989
VIII	7 932	48 016	1 256	9 188	4 962	41 951
IX	8 083	56 099	1 024	9 107	4 554	46 505
X	8 234		792	9 026	4 179	50 684
XI	8 244		560	8 804	3 777	54 461
XII	8 395		328	8 723	3 463	57 924
XIII	7 986		96	8 082	2 967	
XIV	7 382		48	7 430	2 526	
XV	7 413		-	7 413	2 335	

B. CASH OUTFLOW

	Estimate for the period	Present value compounded at 8%
Construction period		
Year 1	6 000	7 860
2	12 000	14 560
3	22 000	24 710
4 (six months)	3 800	3 950
Interest during constn	2 200	-
Sub-total	46 000	51 080

Estimate for

Construction period		
Year 1	6 000	7 860
2	12 000	14 560
3	22 000	24 710
4 (six months)	3 800	3 950
Interest during constn	2 200	-
Sub-total	46 000	51 080

	Estimate for the period	Present value discounted at 8%
Operation period (zero point)		
Year 1	-	
2	2 400	2 050
3	3 000	2 380
Interest during constn	600	-
Sub-total	6 000	4 430
TOTAL	52 000	55 510

C. PAY-BACK PERIOD

(a) Conventional method: $8 + \frac{(52\ 000 - 48\ 016) \times 12}{7\ 982} = 8.5$ years

(b) Present value basis: $11 + \frac{(55\ 510 - 54\ 461) \times 12}{3\ 777} = 11.3$ years

SECTION 2

On the traditional basis, the pay-back period is worked out at 8.5 years and on discounted basis at 8 per cent per annum it works out to 11.3 years.

Savings in foreign exchange

For the establishment of the proposed plant, the total foreign exchange requirement will be about $ 26.5 million for stage I, with an additional amount of about $ 2.8 million for stage II. As against this, Iran will be self-sufficient to a fair extent in respect of its requirements of alloy steels which are vital for heavy engineering and metal processing industries. Besides, as shown in Table 34-12, there will be a foreign exchange savings of about $ 1.82 million at the full level production of integrated operations in the second year, gradually increasing to about $ 4.17 million in the fifteenth year when capital charges on account of depreciation and deferred charges have been almost fully recovered. The total net savings in foreign exchange in the first 15 years of operation amount to about $ 28 million.

Table 34-12

SAVINGS IN FOREIGN EXCHANGE

(Thousand dollars)

Year of operation	Production a/ tons/yr	Cost of b/ imported alloy steels	Expenses on				Net savings
			Import of materials	Capital charges		Total	
				Depreciation	Deferred charges		
I	15 000	3 065	2 097	1 840	335	4 272	-1 207
II	35 000	7 151	4 892	1 840	335	7 067	- 84
III	45 000	9 195	6 290	1 840	335	8 465	730
IV	47 000	10 495	7 065	2 040	363	9 466	1 027
V	50 000	12 450	8 227	2 040	363	10 630	1 820
VI	50 000	12 450	8 227	2 040	363	10 630	1 820
VII	50 000	12 450	8 227	2 040	363	10 630	1 820
VIII	50 000	12 450	8 227	2 040	363	10 630	1 820
IX	50 000	12 450	8 227	2 040	363	10 630	1 820
X	50 000	12 450	8 227	2 040	363	10 630	1 820
XI	50 000	12 450	8 227	2 040	28	10 295	2 155
XII	50 000	12 450	8 227	2 040	28	10 295	2 155
XIII	50 000	12 450	8 227	51	28	8 306	4 144
XIV	50 000	12 450	8 227	51	-	8 278	4 172
XV	50 000	12 450	8 227	50	-	8 277	4 173
							28 185

a/ At reduced production level in first second and fourth years, pattern of product-mix assumed is the same (though in actual practice all types of steels required may not be taken up during these years; and therefore on the proportionate basis, cost of imported alloy steels and expenses on materials required for production, have been worked out.

b/ Estimated on the basis of current c.i.f. prices.

From Table 34-12, it will be noted that expenses on import of materials (namely steel scrap, ferro-alloys, electrodes, refractories, rolls etc) are estimated at about $ 8.23 million. When imported scrap is substituted by local scrap/sponge iron and when some of imported ferro-alloys such as ferro-chrome, ferro-manganese and ferro-silicon are supplied from the proposed indigenous plants, the expenditure on imported materials would decrease with corresponding increase in foreign exchange savings each year.

Rate of return of foreign exchange

For working out the rate of return, the foreign exchange cash flows have been adjusted. The foreign exchange outflows during construction period have been estimated. The annual foreign exchange inflows have been derived by adding back the expenses on capital charges to the net savings given in Table 34-12.

All outflows are assumed to be occurring at the beginning of the year and all inflows at the end of the year. The start of operation has been considered as the zero point. The present values of inflows have been calculated at different rates and given in Table 34-13. The analysis indicates that the rate of return of foreign exchange is about 10 per cent.

34 - Financial analysis (cont'd)

Table 34-13

RATE OF RETURN OF FOREIGN EXCHANGE

(Thousand dollars)

	Cash outflows (capital expenditure)			Cash inflows (operating surplus)		
	Estimated for the period	Compounded/discounted at 10% - 15%		Estimated a/ for the year	Discounted at	
					10%	15%
Construction period						
0 to 12 months	Nil					
13 to 24 months	Nil					
25 to 36 months	17 000	19 635	21 016			
37 to 42 months	3 800	3 990	4 085			
Year of operation						
I	Nil	-	-	968	880	842
II	300	248	227	2 259	1 866	1 708
III	1 900	1 427	1 250	2 905	2 182	1 911
IV				3 430	2 343	1 962
V				4 223	2 622	2 099
VI				4 223	2 382	1 824
VII				4 223	2 166	1 588
VIII				4 223	1 972	1 381
IX				4 223	1 791	1 199
X				4 223	1 630	1 043
XI				4 223	1 478	908
XII				4 223	1 347	790
XIII				4 223	1 225	688
XIV				4 223	1 111	595
XV				4 223	1 009	519
Total	23 000	25 300	26 578	56 015	26 004	19 057

a/ Including foreign exchange amount of depreciation, and deferred charges.

Computation of average rate of return:

Excess at lower trial rate (10%) = 26 004 - 25 300 = 704

Deficit at higher trial rate (15%) = 26 578 - 19 057 = 7 521

$$\text{Average rate of return} = 10 + 5 \left(\frac{704}{(704 + 7\ 521)} \right) = \underline{10.43\%}$$

per hour inclusive of drinking water (55 cu m per hour). The water requirement for the various units is shown in the schematic flow diagram (Drawing No. 5131-V-17) which depicts also the complete water system, from the source to the plant site including recirculation as well as drinking, sanitary and fire-fighting requirements.

Available reports on the analysis of Karun river water indicate periodically high turbidity and total hardness up to 300 ppm. Water from the same source is being used by Iranian Rolling Mills Company after necessary treatment.

Offsite facilities

Water for the alloy steel plant, including drinking and sanitary requirements, will be tapped from the river through an intake pumphouse accommodating the pumps including standby units. The intake pumphouse will have space for installing additional pumps for the future expansion of the plant. Water from this intake pumphouse will be delivered through a steel pipeline to the plant site for treatment and use.

Make-up water system

At the plant site, provision is made for settling, clarification with chemical additives, and softening before the water is rendered fit for supply as make-up to the

Social benefits to the national economy

In addition to commercial gain there will also be social benefits to the economy. Important strategic materials - alloy and special steels - will be available indigenously for development and defence needs. This in turn would accelerate the indigenous production of engineering goods, transport equipment, consumer durables etc. It would also help in the export of such engineering goods. The establishment of the alloy steel plant would provide the impetus for the installation of various ancillary and auxiliary industries - both for feeding the plant with supplies and services as well as for processing the products and by-products. The alloy steel plant would thus create direct employment and indirect employment for a large number of people. The plant will also contribute to government revenues year after year by way of corporate tax and other levies on materials and supplies.

APPENDICES - VOLUME V

Appendix 24-1

SOME TYPICAL ALLOY STEELS FOR INITIAL PR

	Specification BS:970-1955	Carbon	Silicon	Manganese	Phosphorus max	Sulphur max
STAGE - I						
Constructional steels						
Carbon constructional	En-8	0.35/0.45	0.05/0.35	0.60/1.00	0.05	0.05
Low alloy constructional	En-19	0.35/0.45	0.10/0.35	0.50/0.80	0.05	0.05
Medium alloy constructional	En-25	0.27/0.35	0.10/0.35	0.50/0.70	0.05	0.05
Case hardening constructional	En-36B	0.12/0.18	0.10/0.35	0.30/0.60	0.05	0.05
Free cutting	En-1A	0.07/0.15	0.10 max	0.80/1.20	0.07	0.20/0.
Spring steels						
High carbon	En-44	0.90/1.20	0.30 max	0.45/0.70	0.05	0.05
Silico-manganese	En-45	0.50/0.60	1.50/2.00	0.70/1.00	0.05	0.05
Chrome-vanadium	En-47	0.45/0.55	0.50 max	0.50/0.80	0.05	0.05
STAGE - II						
Tool and die steels						
High speed	AISI-T1	0.70	0.25	0.40	0.03	0.03
Hot work die	AISI-H21	0.30	0.25	0.40	0.03	0.03
Cold work die	AISI-D3	2.20	0.25	0.40	0.03	0.03
Low alloy tool	AISI-S1	0.45	0.25	0.40	0.03	0.03
Die block	-	0.55	0.25	0.65	0.03	0.03
Carbon tool	AISI-W1	1.00	0.20	0.25	0.03	0.03

SECTION 1

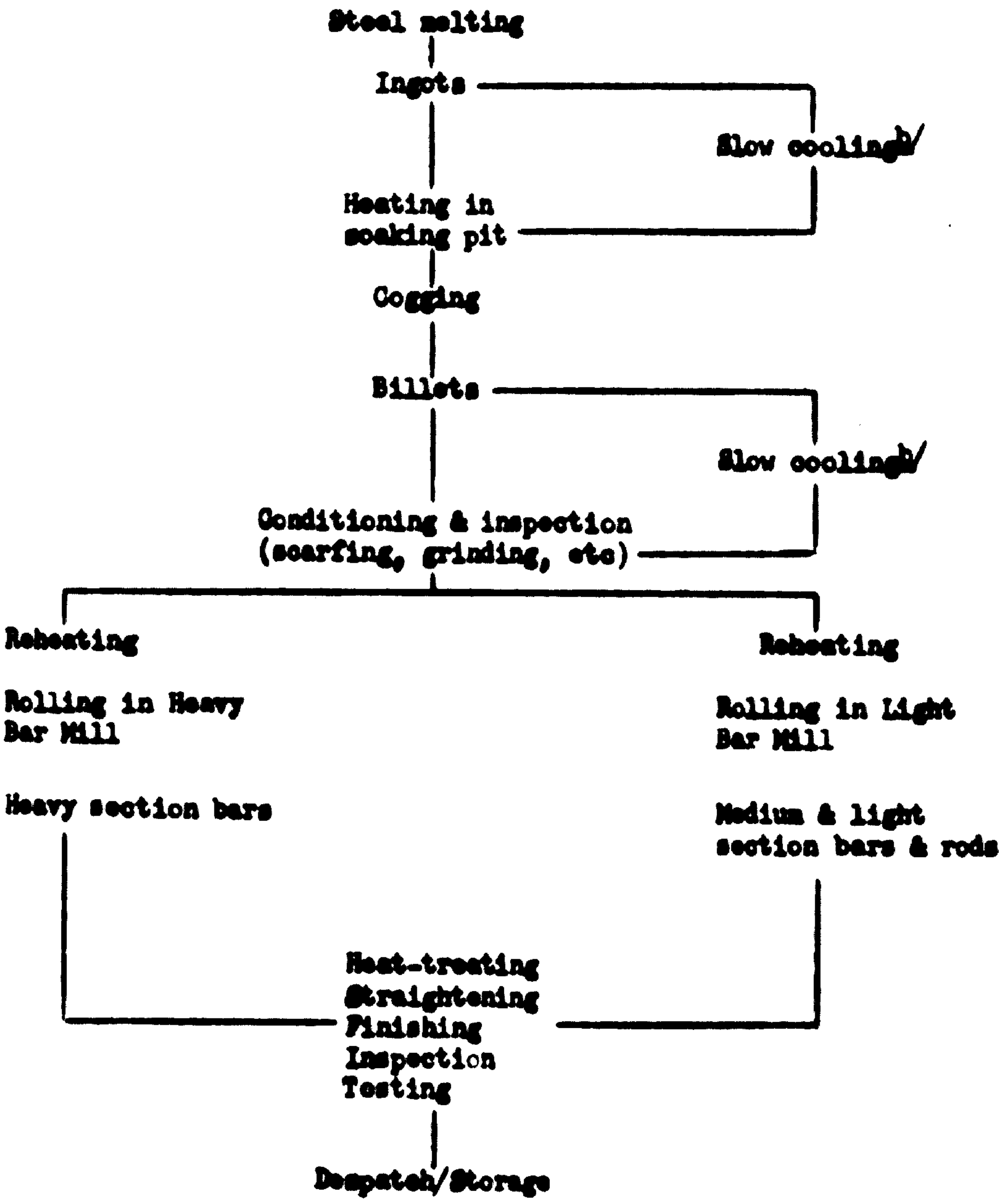
EELS FOR INITIAL PRODUCTION

hosphorus max	Sulphur max	Nickel	Chromium	Others	Other equivalent specification			
					AISI	DIN	IS-1570	JIS
0.05	0.05	-	-	-	1040	40 Mn4	-	G4051-S40C
0.05	0.05	-	0.90/1.50	Mo-0.20/0.40	4140	42 CrMo4	40Cr1Mo28	-
0.05	0.05	2.30/2.80	0.50/0.80	Mo-0.40/0.70	-	-	-	-
0.05	0.05	3.00/3.75	0.60/1.10	-	-	14NiCr14	13Ni3Cr80	-
0.07	0.20/0.30	-	-	-	-	-	-	-
0.05	0.05	-	-	-	-	MK101	-	-
0.05	0.05	-	-	-	9255	55Si7	55Si2Mn90	-
0.05	0.05	-	0.80/1.20	V-0.15 min	6150	50CrV4	50Cr1V23	-
						Werkstoff		
0.03	0.03	-	4.10	W18.25, V1.2	-	1.335	-	-
0.03	0.03	-	3.25	W19.50, V0.40	-	1.2581	-	-
0.03	0.03	0.5 (Optional)	12.00	- V0.40	-	1.2080	-	-
0.03	0.03	-	1.40	W2.25, V0.20	-	1.2541	-	-
0.03	0.03	1.45	0.65	- -	-	-	-	-
0.03	0.03	-	-	- -	-	1.2004	1.2005	-

SECTION 2

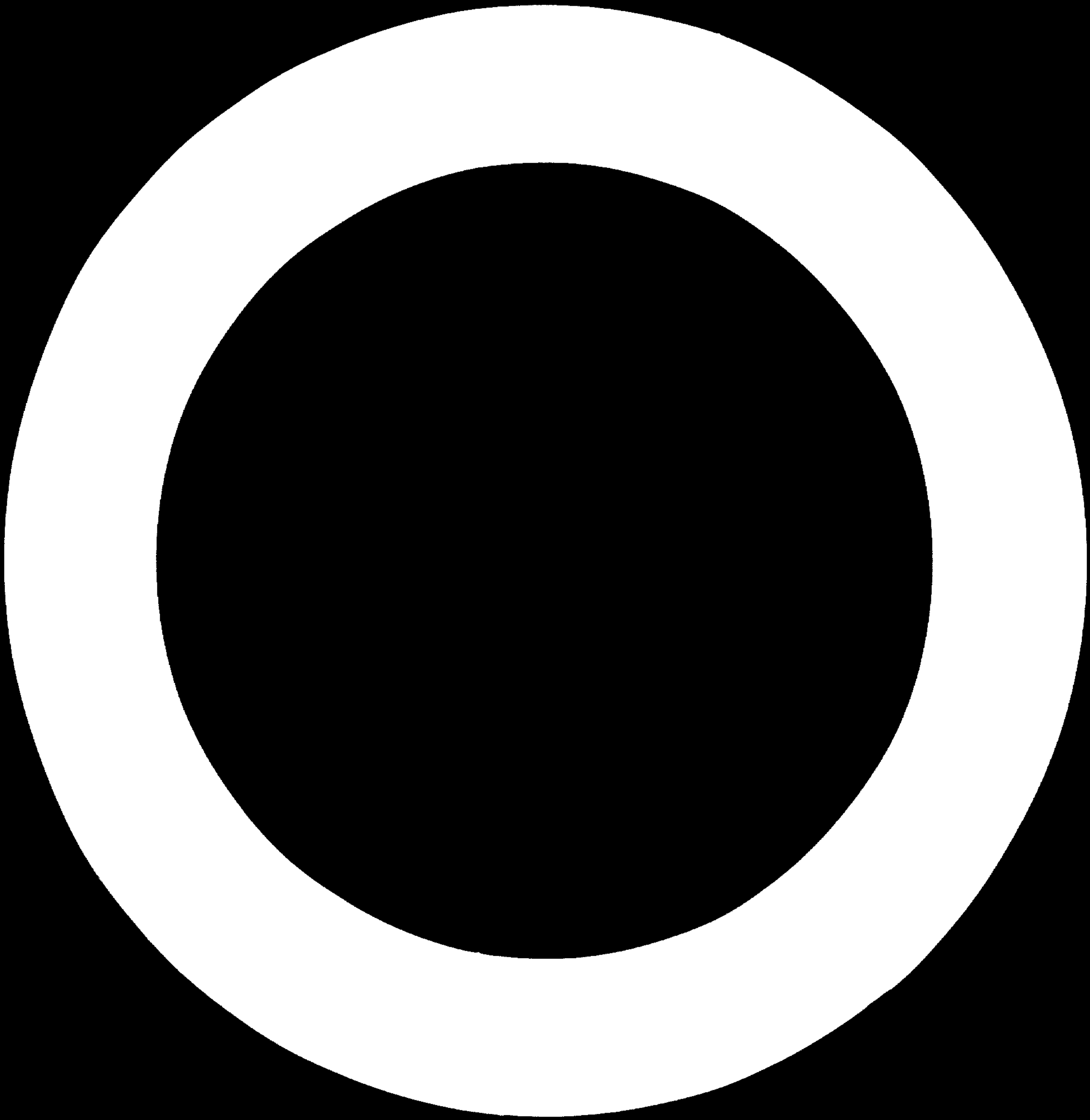
Appendix - 25-1

PROCESS FLOW SHEET FOR PROPOSED ALLOY & SPECIAL STEELS[a]



[a] Steels included are carbon and alloy constructional steel, case hardening steel and spring steel as well as tool and die steels as discussed under product-mix chapter.

[b] Those steels which need slow cooling such as Ni-Cr or Ni-Cr-Mo constructional steels and tool steels are slow cooled at each stage of manufacture.



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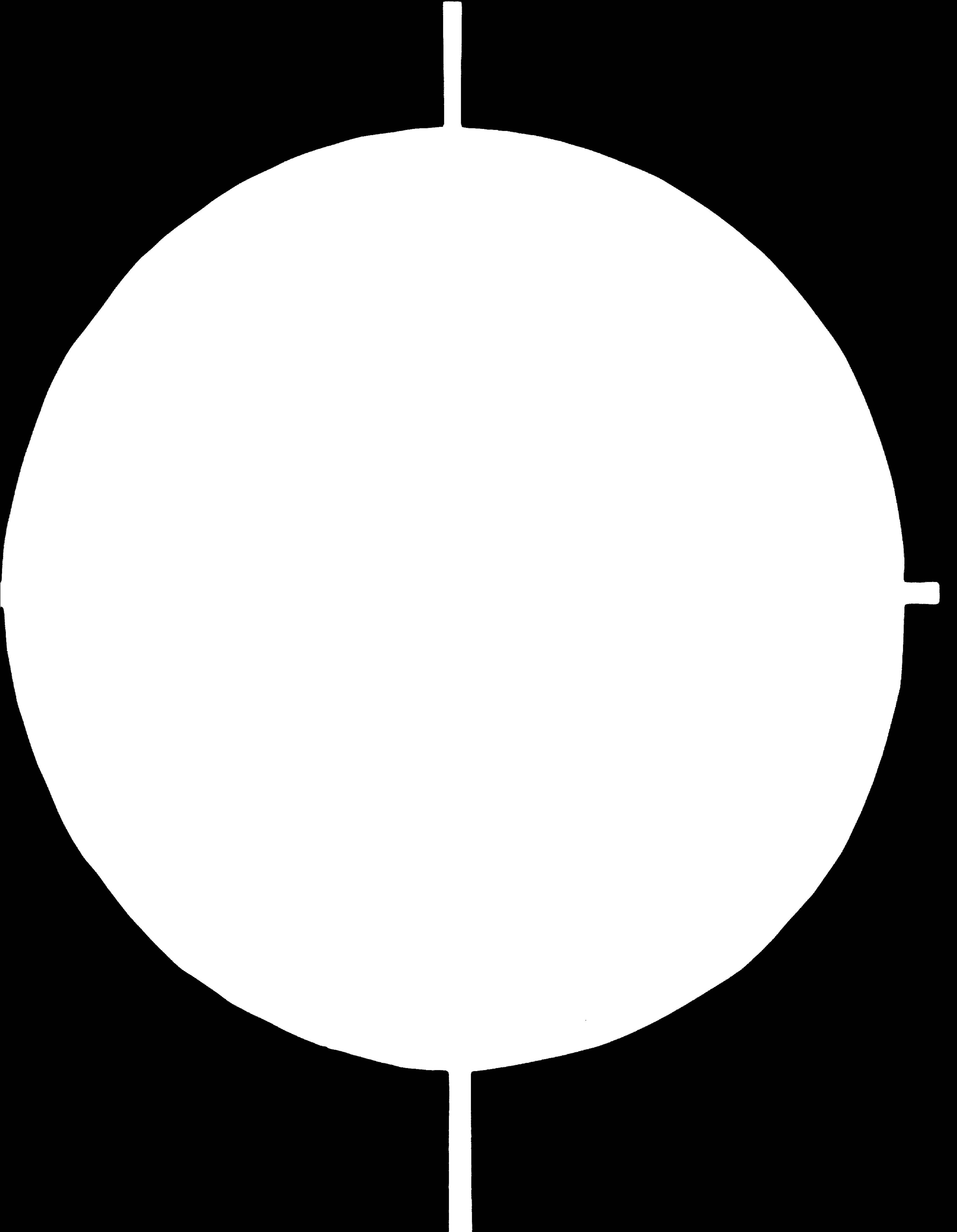

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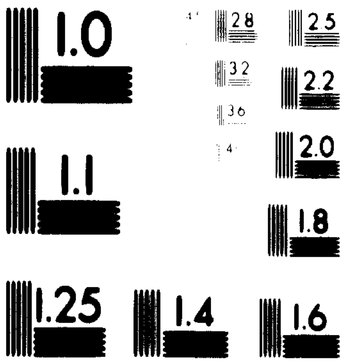

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

24x
F

	Quantity tons/yr	TABRIZ[b] Source of supply	TABRIZ[b] Distance km	TABRIZ[b] Freight $/ton
Raw materials assembly				
Purchased scrap - imported ..	62 100	Khorramshahr port	1 640	13.2
Ferro-alloy and additions ..	2 830	Khorramshahr port	1 640	26.4
Iron ore	3 020	Chowgart	1 850	14.8
Limestone	11 500	Nearby Tabriz	100	2.7
Fluorspar	770	Khorramshahr port	1 640	13.2
Petroleum coke	1 200	Khorramshahr port	1 640	17.4
Electrodes	545	Khorramshahr port	1 640	39.5
Moulds, stools[d] and hot tops ..	2 500	Teheran	700	11.2
Refractories	6 000	Khorramshahr port	1 640	26.4
Sub-total ..				

	Quantity tons/yr	TABRIZ[b] Main consuming centres	TABRIZ[b] Distance km	TABRIZ[b] Freight $/ton
Finished products distribution[e]	38 500	Teheran	700	11.2
	6 000	Tabriz	-	-
	2 750	Arak	1 020	16.3
	1 750	Ahwas	1 520	24.3
	1 000	Isfahan	1 350	21.6
Sub-total ..				
Total ..				

[a] There is much heavier traffic from south to north i.e. from Khorramshahr/Abadan to Teheran compare concessions in freight rates for transport of goods from north to south, but this has not been t

[b] Part of imported raw materials may be purchased from USSR via Zulfa port; the distance will be redu will be restricted to one source i.e. USSR.

[c] Approximate freight rates by rail transports for different materials in Rials per ton/km are takon alloy steels, ferro-alloys, refractories and moulds, stools and hot tops and 1.8 for electrodes. cost for short distance with 150 km has been taken at Rials 2 per ton por km.

[d] It is presumed that moulds, stools and hot tops required for the plant, will be procured from the for Isfahan from Isfahan Stool Plant, for Arak from Arak Machine Building Plant and for Ahwas fr

[e] Finished product distribution has been estimated based on the prosent consumption and future likely

SECTION 1

Appendix 26-3

COMPARISON OF TRANSPORT COSTS a/ FOR RAW MATERIAL ASSEMBLY AND FINIS

Freight c/		ARAK				
		Source of supply	Distance	Freight c/		Source of suppl
$/ton	$/yr		km	$/ton	$/yr	
13.2	819 720	Khorramshahr port	620	5.0	310 500	Khorramshahr por
26.4	74 712	Khorramshahr port	620	9.9	28 017	Khorramshahr por
14.8	44 696	Chowgart	1 120	9.0	27 180	Chowgart
2.7	31 050	Nearby Arak	100	2.7	31 050	Nearby Isfahan
13.2	10 164	Khorramshahr port	620	5.0	3 850	Khorramshahr por
17.4	20 880	Khorramshahr port	620	6.6	7 920	Khorramshahr por
39.5	21 528	Khorramshahr port	620	14.9	8 120	Khorramshahr por
11.2	28 000	Arak machine bldg.plant	-	-	-	Isfahan Steel Pl
26.4	158 400	Khorramshahr port	620	9.9	59 400	Khorramshahr por
	1 209 150				476 037	

Freight c/		ARAK				
		Main consuming centres	Distance	Freight c/		Main consuming centres
$/ton	$/yr		km	$/ton	$/yr	
11.2	431 200	Teheran	320	5.1	196 350	Teheran
-	-	Tabris	1 020	16.3	97 800	Tabris
16.3	44 825	Arak	-	-	-	Arak
24.3	42 525	Ahwas	500	8.0	14 000	Ahwas
21.6	21 600	Isfahan	620	9.9	9 900	Isfahan
	540 150				318 050	
	1 749 300				794 087	

heran compared to the traffic from north to south; and therefore, railways offer some
as not been taken into account.

e will be reduced to 145 km with consequent reduction in assembly cost. However, supply

/km are taken as 0.60 for scrap, iron ore and fluorspar, 0.8 for petroleum coke, 1.2 for
r electrodes. For limestone expected to be available from nearby source, truck transport

ured from the foundries in Iran i.e. moulds, stools and hot tops for Tabris from Teheran,
d for Ahwas from Arak Machine Building Plant.
n future likely requirement.

SECTION 2

26-3

ERIAL ASSEMBLY AND FINISHED PRODUCTS DISTRIBUTION

	ISFAHAN			
, yr	Source of supply	Distance km	Freight c/ $/ton	$/yr
500	Khorramshahr port	1 240	9.9	614 790
017	Khorramshahr port	1 240	19.8	56,014
180	Chowgart	500	4.0	12 080
050	Nearby Isfahan	50	1.3	14 950
850	Khorramshahr port	1 240	9.9	7 623
920	Khorramshahr port	1 240	13.1	15 720
120	Khorramshahr port	1 240	29.8	16 241
-	Isfahan Steel Plant	-	-	-
400	Khorramshahr port	1 240	19.8	118 800
037				856 218

AHW.	
Source of supply	Dist. k
Khorramshahr port	1
Khorramshahr port	1
Chowgart	1 6
Nearby Ahwas	1
Khorramshahr port	1
Khorramshahr port	1
Khorramshahr port	1
Arak	5
Khorramshahr port	1

	ISFAHAN			
, yr	Main consuming centres	Distance km	Freight c/ $/ton	$/yr
350	Teheran	650	10.4	400 400
800	Tabris	1 350	21.6	129 600
-	Arak	620	9.9	27 225
000	Ahwas	1 120	17.9	31 325
900	Isfahan	40	0.6	600
050				589 150
087				1 445 368

AHW.	
Main consuming centres	Dist. k
Teheran	82
Tabris	1 5
Arak	5
Ahwas	-
Isfahan	1 1

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SECTION 3

Appendix - 26-3

ightc/ $/yr
614 790
56,014
12 080
14 950
7 623
15 720
16 241
-
118 800
856 218

AHWAZ

Source of supply	Distance km	Freightc/ $/ton	Freightc/ $/yr
Khorramshahr port	120	1.0	62 100
Khorramshahr port	120	2.0	5 660
Chowgart	1 620	13.0	39 260
Nearby Ahwas	100	4.0	46 000
Khorramshahr port	120	1.0	770
Khorramshahr port	120	1.3	1 560
Khorramshahr port	120	2.9	1 580
Arak	500	8.0	20 000
Khorramshahr port	120	2.0	12 000
			188 930

ightc/ $/yr
400 400
129 600
27 225
31 325
600
589 150
445 368

AHWAZ

Main consuming centres	Distance km	Freightc/ $/ton	Freightc/ $/yr
Teheran	820	13.1	504 350
Tabris	1 520	24.3	145 800
Arak	500	8.0	22 000
Ahwas	-	-	-
Isfahan	1 120	17.9	17 900
			690 060
			879 090

SECTION 4

Appendix 28-1

LIST OF EQUIPMENT - STEELMELT SHOP

Scrap preparation

One (1) no. Baling press, capacity 2 tons/hour
One (1) no. Alligator bar shear
Three (3) nos. Oxy-acetylene torches

Furnace and accessories

Two (2) nos. 4 300 mm shell diameter, swing roof, top charge arc furnaces complete with 10 000 kVA transformer, electrical & controls etc for 20/25-ton heats
Two (2) nos. Spare roof rings
One (1) set Fume extraction system
Six (6) nos. 20 cu m capacity clam-shell buckets
One (1) no. Immersion pyrometer assembly with recorder
Two (2) nos. Slag cars
Eight (8) nos. Slag pots, each of 2 cu m capacity
One (1) no. Refractory gun
Two (2) sets Spoons, rods, water troughs etc
One (1) no. Jaw crusher
One (1) no. Additions drying furnace

Pit side

Eight (8) nos. 25-ton ladles
Three (3) nos. Ladle heaters (burners with stands)
One (1) no. Stopper rod heating oven
One (1) no. Optical pyrometer
One (1) set Inspection lamps, debris bins etc
Twenty-five (25) nos. Mould cars

Refractories

Two (2) sets Furnace refractories
One (1) set Ladle refractories
One (1) set Hot tops, pouring refractories, plug bricks etc

Appendix 28-1 (continued)

EOT cranes

Two	(2)	nos.	10/5-ton magnet cranes (covered scrap aisle and open scrap yard in steelmelt shop)
One	(1)	no.	50/10-ton furnace charging crane
Two	(2)	nos.	50/10-ton hot metal cranes
One	(1)	no.	15-ton crane for ingot stripping
Two	(2)	sets	Ladle bales for 50/10-ton EOT cranes

Mould preparation

			500 tons ingot moulds
Four	(4)	nos.	Mould heating burners
One	(1)	no.	Clay mixer

Calcining plant

One	(1)	no.	25-ton/day vertical shaft kiln for limestone
One	(1)	no.	Crusher and screen
One	(1)	set	Steel bins
One	(1)	set	Bottom opening type containers

Miscellaneous

Two	(2)	nos.	Portable type ingot stripping mechanisms
Two	(2)	nos.	50-ton weighbridges
Two	(2)	nos.	Transfer cars
One	(1)	set	Scrap preheating facilities
One	(1)	no.	2-ton platform weighing scale
One	(1)	no.	½-ton platform weighing scale
Two	(2)	nos.	1-ton floor chargers (diesel with solid tyres)
One	(1)	no.	Clay mixer
Eight	(8)	nos.	Man coolers
One	(1)	set	Tools, tackles, bales for ladles etc

Appendix 28-2

LIST OF EQUIPMENT - SOAKING PITS AND BLOOMING MILL

Soaking pits

Three (3) nos.	Batteries of 3 holes each, one way top fired soaking pits
Four (4) nos.	Ingot slow cooling pits (2 m x 4 m x 2 m)
One (1) no.	Preheating furnace, 20-tons capacity

Cogging mill

One (1) no.	700 mm dia x 1 800 mm, 2-high reversing mill including pinion stand and coupling, mill drive motor 1 800 kW DC complete with ingot buggy, ingot turning and weighing scale, approach roller table, feed rollers, working roller table, manipulators, grip tilter etc
One (1) no.	Hot saw, 1 600 mm dia
One (1) no.	Hot shear, 500-ton capacity
One (1) no.	Cooling bed

EOT cranes

Two (2) nos.	3/20-ton Soaker cranes, 28 m span
One (1) no.	40/10-ton mill bay crane, 22 m span
One (1) no.	15-ton motor room crane, 15 m span

Appendix 28-3

LIST OF EQUIPMENT - BILLET CONDITIONING DEPARTMENT

Billet conditioning

Three (3) nos. Automatic billet grinders
Eight (8) nos. Swing grinders
One (1) no. Pickling equipment
Eight (8) nos. Slow cooling covers
Two (2) nos. Billet preheating furnaces
Five (5) nos. Slow cooling boxes
Four (4) nos. Hand scarfing torches
Ten (10) nos. Chipping chambers
Eight (8) nos. Portable grinders
One (1) no. Oxy-acetylene flame cutting machine
Four (4) nos. 10-ton EOT cranes, 21 m span
One (1) no. 20-ton transfer trolley
Two (2) nos. 10-ton weighing scales

Appendix 28-4

LIST OF EQUIPMENT - BAR MILLS

Furnaces

Two (2) nos. Walking beam type furnaces, 10-tons/hour capacity each
One (1) no. Walking beam type furnace, 15-tons/hour capacity

Light section bar mill No. 1

One (1) no. 450 mm dia x 1 500 mm, 3-high, 2 stand roughing mill including pinion stand and reduction gear, mill drive motor 1 200 kW AC, complete with tilting tables, transfers etc
One (1) no. Finishing mill train consisting of five stands - two 380 mm dia x 1 000 mm, 3-high stands driven by a 750 kW DC motor, two 300 mm dia x 800 mm 3-high stands driven by a 750 kW DC motor and one 280 mm dia x 600 mm 2-high stand driven by a 300 kW DC motor - and complete with transfers, repeaters, roller tables, skew roller table etc
One (1) no. Cropping shear
One (1) no. Flying shear
One (1) no. Rake type cooling bed, about 40 m long
One (1) no. 350-ton cold shear

Heavy section bar mill No. 2

One (1) no. 550 mm dia x 1 600 mm, 3-high, 3 stand mill including pinion stand and reduction gear, mill drive motor 1 500 kW AC, complete with tilting tables, roller tables, transfers etc
Two (2) nos. Hot saws of 1 600 mm dia size
Two (2) nos. Cooling beds, each about 8 m long

EOT cranes

One (1) no. 20-ton mill bay crane, 28 m span
One (1) no. 25-ton mill bay crane, 22 m span
Two (2) nos. 10-ton motor room cranes, 13.5 m span

Appendix 28-5

LIST OF EQUIPMENT - HEAT-TREATMENT AND FINISHING DEPARTMENT

Heat-treatment facilities

Two	(2) nos.	Car bottom furnaces, 7 m x 1.5 m hearth size, each with holding capacity of 10-tons per charge for normalising, quenching and annealing
One	(1) no.	Car bottom furnace, 7 m x 1.5 m hearth size, with holding capacity of 10-tons per charge for tempering and sub-critical annealing treatment
One	(1) no.	8 m x 2.5 m x 2.5 m oil quenching tank including heat exchangers and oil recirculation equipment
One	(1) no.	8 m x 2.5 m x 2.5 m water quenching tank slow cooling boxes

Straighteners

Two	(2) nos.	Multi-roll rotary straighteners - one for bars 10 mm to 30 mm and other for bars 25 mm to 100 mm
One	(1) no.	Roller type shape straightener
One	(1) no.	Horizontal crank operated mechanical straightener for sections up to 100 mm
One	(1) no.	200-ton oil hydraulic straightening press for sections over 100 mm

Finishing and inspection

Two	(2) nos.	Power hacksaws
Two	(2) nos.	Horizontal band saws
One	(1) no.	Brinell hardness tester
Two	(2) nos.	Magnaflux crack detectors
Two	(2) nos.	Ultrasonic testers
One	(1) no.	Hydraulic marking machine

Ware house

Racks - 200 tons of steelwork

Appendix 26-1

COMPARISON OF POSSIBLE PLANT

	TABRIZ		ARAK
A. Climatology a/			
Temperature - Maximum (average, highest)	33°C (July)	38.4°C (Aug)	36.1°C (Aug)
- Minimum (average, lowest)	-17°C (Jan)	-25°C (Jan)	-17.5°C (Jan)
- Mean (highest, lowest)	26.2°C (July)	-12.4°C (Jan)	26.9°C (Aug)
Rainfall - Annual	450 mm		205.8 mm
- Maximum during the month	209.8 in March, 129.3 in April		63 mm in Dec, 45. and 43.1 mm in
- Maximum in 24 hours	97.6 mm in March		30 mm in December
Seismic conditions	The whole of Iran is subject to seismic conditions. Quazvin and Khorasan. Arak being in the south of Ir the same as for Teheran, that is 12 of internationa		
Humidity - % (at 6 & 9 GMT)			
- Average for the year	65	45	51
- Maximum during the month	85 (Feb)	78 (Feb)	79 (Dec)
Snowfall	Heavy snow fall 4 days in Dec, 12 days in Jan, 9 days in Feb, 13 days in March and 7 days in April.		Heavy snow fall 8 4 days in Jan & 9
B. Site features			
Location	Latitude 38°05'N 1362 m above Longitude 46°17'E MSL		Latitude 34°06'N Longitude 49°42'E
Nearest railway station	About 1 km from the site		About 4 km from
Road connection	No convenient road nearby. About 3 to 4 km road with an overbridge or railway level crossing necessary		Adjoining the roa
Land - acquisition problems	No problem. Enough free land available near main road		No problem. Enoug available
- cost	$ 0.9 to 1.2 per sq m		$ 0.50 per sq m
Topography	Fairly flat		Somewhat sloping and away from the is evenly sloped 1

SECTION 1

Appendix 28-5 (continued)

EOT cranes

Two (2) nos. 10-ton cranes, 21 m span
One (1) no. 5-ton crane, 21 m span

Transport facilities

Two (2) nos. Diesel locomotives - 250 HP
Five (5) nos. Wagons
Eight (8) nos. Trucks
One (1) no. Platform truck
Seven (7) nos. Forklift trucks
Two (2) nos. Rear dump trucks
One (1) no. Yard crane - 10-ton mobile
One (1) no. Tractor
Two (2) nos. Trailers - 2-ton

Appendix 29-1

LIST OF EQUIPMENT - CHEMICAL, METALLOGRAPHY & TESTING LABORATORY

Chemical laboratory

One	(1) no.	Direct reading optical spectrometer with accessories for sample preparation and a set of standard samples
One	(1) no.	Volumetric 'C' and 'S' determinator
One	(1) no.	Colorimeter
One	(1) no.	Potentiometric titration equipment for Cr, V, Mo, Ni etc
One	(1) no.	Vacuum fusion and hot extraction apparatus
One	(1) no.	Viscosimeter
One	(1) no.	Flashpoint apparatus
One	(1) no.	Gas calorimeter
One	(1) no.	Bomb calorimeter
One	(1) no.	Water testing apparatus
One	(1) no.	Water distillation apparatus
Three	(3) nos.	Analytical balances
One	(1) no.	Semi-micro balance
One	(1) no.	350 mm vertical drill press (25 mm hole in steel)
One	(1) set	Laboratory furniture
One	(1) set	Laboratory ware
One	(1) set	Laboratory supplies including chemicals

Metallography and testing laboratory

One	(1) no.	Bench microscope 100 x
One	(1) no.	Table microscope with photomicrographic attachment
One	(1) no.	35 mm camera
One	(1) set	Dark room equipment
Two	(2) nos.	100 mm belt grinders
Two	(2) nos.	Grinding wheels
Two	(2) nos.	Polishing wheels
One	(1) no.	Specimen mounting press
Four	(4) nos.	Glass plates 9" x 14" x $\frac{1}{4}$"
Two	(2) sets	Tanks, trays, tongs etc each
One	(1) set	Shepherd fracture grain size standards
One	(1) set	Charts for inclusion, segregation, porosity etc

Appendix 29-1 (continued)

Metallography & testing laboratory (cont'd)

Two	(2)	nos.	Rockwell hardness tester B and C scales
One	(1)	no.	Brinell hardness tester (with provision for vickers hardness testing)
One	(1)	no.	Portable brinell hardness tester
One	(1)	no.	Hardenability tester with tank etc
One	(1)	no.	Magnetic particle tester
One	(1)	no.	Portable ultrasonic flaw detector
One	(1)	no.	250 mm precision lathe
Two	(2)	nos.	100 mm electric hand grinders
One	(1)	no.	Power hacksaw (200 mm sq or round section)
One	(1)	no.	Vibro-graver kit
One	(1)	set	Numerals and alphabet stamps ¼"
Two	(2)	nos.	Muffle furnace 1 000°C 200 x 200 x 400 mm
One	(1)	no.	Tempering furnace 600°C 300 mm dia x 450 mm
One	(1)	no.	Water quench tank 1 m x 0.8 x 1.2 m
One	(1)	no.	Oil quench tank 1 m x 0.8 x 1.2 m
One	(1)	no.	Drying oven 300°C max, 400 x 400 x 500 mm
Two	(2)	nos.	Hot plates 300 x 500 mm, 3 kW

Appendix 29-2

LIST OF EQUIPMENT - ROLL TURNING & MAINTENANCE SHOP

Roll turning shop

One	(1) no.	Roll lathe for 700 mm dia rolls
Two	(2) nos.	Roll lathes for 550 mm dia rolls
Two	(2) nos.	Roll lathes for 400 mm dia rolls
Two	(2) nos.	Roll lathes for 300 mm dia rolls
Two	(2) nos.	Double-ended pedestal grinders for tools
One	(1) set	Racks for different rolls

Maintenance shop

One	(1) no.	Lathe 300 mm centre height x 4 000 mm distance between centre
One	(1) no.	Lathe 250 mm centre height x 3 000 mm distance between centre
One	(1) no.	Lathe 175 mm centre height x 1 000 mm distance between centre
One	(1) no.	600 mm tools shaper
One	(1) no.	Radian drill - capacity 50 mm dia in steel
One	(1) no.	Roller drill - capacity 40 mm dia hole in steel
One	(1) no.	Bench drill - capacity 10 mm dia hole in steel
One	(1) no.	Double wheel pedestal grinder 230 mm dia wheel
One	(1) no.	Shear blade sharpener
One	(1) no.	Saw blade sharpener
One	(1) no.	Portable electric welding machine with accessories
One	(1) no.	Gas welding set
Two	(2) nos.	Oxy-acetylene welding and cutting torches
One	(1) no.	200 kg self contained electro-pneumatic hammer
One	(1) no.	1 m x 1 m batch type gas fired heating furnace
One	(1) no.	Forging hearth with hood for smithy work
One	(1) no.	Smithy anvil block
One	(1) no.	Hacksaw, 230 mm stroke
Two	(2) nos.	Flexible shaft grinders, 150 mm dia wheel
Two	(2) nos.	Fitters vices
One	(1) no.	Marking table size, 600 mm x 900 mm
One	(1) set	Small tools, gauges etc
One	(1) set	Furniture, racks, fitters benches etc
One	(1) no.	2-ton hand operated crane

SECTION 1

Appendix 31-1

PRELIMINARY CAPITAL COST ESTIMATE - STAGE I

Basis: Two 20/25-ton arc furnaces, 700 mm dia 2-hi reversing mill and bar mills
Production - 45 000 tons of constructional and spring steels

	Thousand $		
	Foreign currency	Local currency	Total amount
A. Land			
(110 hectares @ $ 5 000 per hectare)	-	550	550
B. Civil and structural work			
Including land development, structural work as erected for buildings, civil work in footings, equipment buildings, utility structures, plant boundary and off-site facilities	1 547a/	9 933b/	11 480
C. Plant and equipment			
1) Steelmelt shop	1 566		
2) Soaking pits and cogging mill	4 914		
3) Billet conditioning	562		
4) Bar mills	5 328		
5) Heat-treatment and finishing	870		
6) Chemical and testing laboratory	137		
7) Roll turning and maintenance shop	60		
8) Transport equipment	473		
9) Equipment for power, water, gas, air, etc	2 160		
Sub-total (C)	16 070c/	1 785d/	17 855
D. Other costs			
1) Spares at 5% of C	804c/	90d/	894
2) Freight and insurance on imported			

9) Equipment for power, water, gas, air, etc ..	2 160		
Sub-total (C) ..	16 070[c]	1 785[d]	17 855
D. Other costs			
1) Spares at 5% of C	804[c]	90[d]	894
2) Freight and insurance on imported equipment and spares at 10% of $C+D_1$ (\$ 16.87 mill)	1 687	-	1 687
3) Port charges and inland transport at 3% of CIF value $C+D_1+D_2$ (\$ 18.56 mill) and inland transport at 2% of local equipment and spares $C+D_1$ (\$ 1.88 mill) ..	-	595	595
4) Equipment erection at 15% of C (\$ 17.85 mill)	536[e]	2 144	2 680
Sub-total (D) ..	3 027	2 829	5 856
E. Engineering, supervision, construction administration, etc			
at 12% of B+C+D (\$ 35.20 mill) ..	1 267[f]	2 957	4 224
Sub-total (A to E) ..	21 911	18 054	39 965
F. Contingencies			
at 5% of A to E (\$ 40.00 mill) ..	1 100	900	2 000
Total (A to F) ..	23 011	18 954	41 965
Say \$ mill:	23.0	19.0	42.0

a/ Includes ocean freight and insurance on imported structural steel, sheeting and shuttering.

b/ Includes \$ 500 000 for off-site facilities comprising approach road, rail link, water supply and faecal and storm disposal. Power connection assumed to be on Electric Supply Company account.

c/

d/ Ex-works cost of indigenous equipment - 10 per cent of the total cost of plant and equipment assumed as indigenous supply.

e/ 20% of the total erection charges assumed as foreign currency expenditure for foreign erectors' services.

f/ 30% of the total fees for engineering, supervision and construction administration assumed as foreign currency expenditure for foreign consultant's services.

SECTION 1

Appendix 31-2

PRELIMINARY CAPITAL COST ESTIMATE - STAGE II

Basis: One 6-ton arc furnace, one 1 000 ton forge press, one 2-ton hammer, one 250 mm 4 stand, 3-hi hand mill and heat-treatment furnaces

Production - 5 000 tons of finished tool and die steels

	Estimated cost '000 $
A. Land	
Cost already included in Stage I	-
B. Civil and structural work	
Including site preparation, civil work in plant building (SMS 96 x 18 m, lean-to 96 x 10 m, press bay 120 x 28 m, hydraulic station 24 x 18 m and hand rolling mill bay; equipment foundations etc	1 300
C. Plant and equipment	
One 6-ton arc furnace with accessories, one 1 000-ton forge press, one 2-ton hammer, one 3-ton manipulator for press and one mobile crane operated chain sling rotor with porter bar and other handling mechanism for [illegible] for integrated operation with press, one 1-ton mobile manipulator for 2-ton hammer, one 250 mm, 4-stand, 3-hi, slow speed hand operated mill for light sections, one 3-ton mobile charger, three shop heating furnaces, three spheroidise annealing furnaces, EOT cranes, one automatic billet grinder, 2 swing grinders and other miscellaneous equipment and utilities such as power supply, water supply, gas, compressed air, etc	2 200 a/
D. Other costs	
1) Spares at 5% of C	110
2) Freight and insurance at 10% of C	220

cranes, one automatic billet grinder, 2 swing grinders and other miscellaneous equipment and utilities such as power supply, water supply, gas, compressed air, etc	2 200 a/
D. Other costs	
1) Spares at 5% of C	110
2) Freight and insurance at 10% of C	220
3) Port charges and inland transport	70
4) Equipment erection at 15% of C	330
Sub-total (D)	730
E. Engineering, supervision, construction administration, etc	
at 12% of B+C+D	510
Sub-total (A to E)	4 630
F. Continengencies	
at 5% of A to E	240
Total (A to F)	4 870
	Say $ 5.00 million

It is assumed that the foreign exchange component would be 50 per cent of total cost as compared to 55 per cent in Stage I.

a/ Includes FOB cost for the imported equipment and ex-works price for local equipment.

Appendix 32-1

LIST OF SKILLED PERSONNEL TO BE TRAINED ABROAD

1.	**Steelmaking**		
	General foreman - furnaces	1	
	Melters	2	
	Pitside - General foreman & foremen	3	
	Mould preparation - foreman	1	7
2.	**Blooming mill**		
	General foreman	1	
	Mill foreman	1	
	Soaking pit heaters	2	
	Coggers	4	
	Recorder	1	
	Roll designers	2	11
3.	**Billet conditioning**		
	Foreman	1	
	Grinding machine operators	2	3
4.	**Bar mills**		
	General foreman	1	
	Foreman	1	
	Heater	1	
	Roller	1	
	Roll designer	1	5
5.	**Heat treatment & bar finishing**		
	General foreman	1	
	Straightener	1	
	Heat treatment	2	4
6..	**Laboratory**		
	Spectrographer	1	
	Chief metallurgist	1	
	Metallurgists	2	
	Metallographer	1	5
7.	**Inspection**		
	Chief inspector	1	
	Inspectors	2	
	Spark & Ultrasonic tester	1	4
8.	**Maintenance**		
	Foreman - Mechanical	2	
	- Electrical	2	4
9.	**Sales**		
	Service engineers	2	2
10.	**Production planning**	2	2
11.	**Others**	3	3
	Total		50

SECTION 1

Appendix 33-1

PRELIMINARY MANPOWER ESTIMATE - GENERAL ADMINISTRATION & SERVICES

Basis: 6 days/week, 300 days/year

	Salary group	Shifts G	I	II	III	Total on pay roll
General administration						
General manager	E1	1	-	-	-	1
Personal assistant to general manager ..	E3	1	-	-	-	1
Managers - personnel & welfare ..	E3	1	-	-	-	1
- wages, accounts, time-keeping & general ..	E3	1	-	-	-	1
- sales & service	E3	1	-	-	-	1
- purchase & stores	E3	1	-	-	-	1
Officers - personnel & welfare ..	A1	2	-	-	-	2
- accounts & law	A1	4	-	-	-	4
- sales & service	A1	4	-	-	-	4
- purchase & stores	A1	4	-	-	-	4
Chief timekeeper	A1	1	-	-	-	1
Assistant timekeeper	A2	4	-	-	-	4
Time checkers	A3	2	2	2	2	8
Watch & ward - inspector	A1	1	-	-	-	1
- supervisor	A2	1	1	1	1	4
- guard	A4	3	5	5	5	18
Clerks, stenographers and typists ..	A2	52	-	-	-	52
Nomeresan & roftegar (for all depts) ..	A4	20	-	-	-	20
Total general administration		104	8	8	8	128
Plant general services						
General (plant) superintendent ..	E2	1	-	-	-	1
Chief metallurgist	S1	1	-	-	-	1
Metallurgist	S2	2	-	-	-	2
Electrical superintendent	S1	1	-	-	-	1
Mechanical superintendent	S1	1	-	-	-	1
Utilities superintendent	S1	1	-	-	-	1
Chief inspector	S2	1	-	-	-	1
Inspectors	S4	2	-	-	-	2
Assistant engineers	S3	8	-	-	-	8
Training superintendent	S2	1	-	-	-	1
Clerks, stenographers and typists ..	A2	6	-	-	-	6
Total plant general services		25				25
Production planning & control						
Production & planning superintendent ..	S1	1	-	-	-	1
Planners	S2	3	-	-	-	3
Assistants	A2	5	-	-	-	5
Total production planning & control ..		9				9

POSSIBLE PLANT LOCATIONS

ARAK		ISFAHAN		AHWAZ	
.1°C (Aug)	40.5°C (July)	38.3°C (July)	40.2°C (July)	45.2°C (July)	48°C (Aug)
.5°C (Jan)	-25.5°C (Jan)	-8.3°C (Jan)	-16°C (Jan)	0.3°C (Jan)	-7°C (Jan)
.9°C (Aug)	-11.2°C (Jan)	30.4°C (July)	-2.5°C (Jan)	36.1°C (July)	7.1°C (Jan)
5.8 mm		62.6 mm		75.3 mm	
mm in Dec, 45.3 mm in Nov and 43.1 mm in February		23.6 mm in Dec, 26.6 mm in March		61.5 mm in Dec, 7 mm in February and 6 mm in March	
mm in December		9.1 mm in March		32 mm in December	

mic conditions. However, the severe earthquakes occur in north and north-east of Iran, that is the south of Iran, may be relatively free of earthquake. Seismic conditions for Arak will be of international scale.

	33	45	26	56	26
(Dec)	68 (Dec)	71 (Jan)	81 (Dec)	81 (Dec)	57 (Dec)
avy snow fall 8 days in Dec, days in Jan & 9 days in Feb.		5 days in Dec, 2 days in Jan, and 1 day in February.		No snowfall	
titude 34°06'N ngitude 49°42'E	1753 m above MSL	Latitude 32°27'N Longitude 51°40'E	1590 m above MSL	Latitude 31°20'N Longitude 48°40'E	20 m above MSL
out 4 km from the site		About 2.5 km from the existing railway siding of Isfahan Steel Plant		About 2 km from the proposed railway station near Iranian Rolling Mill Co.	
joining the road to Teheran		Connected by road to Isfahan		Close to Ahwas-Khorramshahr highway	
o problem. Enough free land vailable		No problem, but confirmation from Isfahan Steel Authorities will be necessary		No problem. A big stretch of flat land available	
0.50 per sq m		-		$ 0.50 per sq m	
omewhat sloping towards railway nd away from the road. The land is ovenly sloped 1 to 1.5%		Fairly flat		Practically flat land	

Appendix 33-1

Production planning & control						
Production & planning superintendent	S1	1	-	-	-	1
Planners	S2	3	-	-	-	3
Assistants	A2	5	-	-	-	5
Total production planning & control		9				9
Industrial engineering						
Chief industrial engineer	S2	1	-	-	-	1
Assistant engineers	S3	4	-	-	-	4
Clerk	A2	1	-	-	-	1
Total industrial engineering		6				6
Works maintenance shop						
General foreman	S2	1	-	-	-	1
Foreman	S3	2	-	-	-	2
Chargehand - machining section	W1	2	-	-	-	2
- fitting section	W1	2	-	-	-	2
Machinists	W2	20	-	-	-	20
Fitters	W2	6	-	-	-	6
Welders (gas & electric)	W2	4	-	-	-	4
Forge smiths	W2	4	-	-	-	4
Helpers	W3	8	-	-	-	8
Total works maintenance shop		49				49
Stores						
Chief storekeeper	S2	1	-	-	-	1
Assistant storekeeper	A2	1	-	-	-	1
Clerk	A2	1	-	-	-	1
Store issuers	A3	1	1	1	1	4
Total stores		4	1	1	1	7
Works transport						
Transport-in-charge	S2	1	-	-	-	1
Drivers (loco & mobile crane)	W2	1	2	2	2	7
Drivers (trucks, dumpers, forklift)	W2	5	3	3	3	14
Couplers, slingmen, etc	W3	1	2	2	2	7
Total works transport		8	7	7	7	29
Total		205	16	16	16	253
Add 15% for leave and absenteeism in group 'W' only		..			..	12
GRAND TOTAL		..			..	265

SECTION 2

SECTION 1

Appendix 33-2

PRELIMINARY MANPOWER ESTIMATE - STEELMELT SHOP

Basis: Two 25/30-ton arc furnaces
Production - 67 000 tons of ingots/year
Operation - 3 shifts/day, 7 days/week,
330 working days/year.

	Salary group	Shifts G	Shifts I	Shifts II	Shifts III	Total on a/ pay roll
Supervision & clerical						
Superintendent	S1	1	-	-	-	1
Technical assistant	S2	1	-	-	-	1
General foreman	S2	1	-	-	-	1
Clerical and office	A2	3	-	-	-	3
Total supervision & clerical ..		6				6
Operation labour						
Furnaces						
Foreman	S3	-	1	1	1	4
Melters	S4	-	1	1	1	4
Assistant melters	W1	-	2	2	2	7
Furnace hands	W3	-	4	4	4	14
EOT crane drivers	W2	-	1	1	1	4
Floor charger operators ..	W2	-	2	2	2	7
Forklift operators	W2	-	1	1	1	4
General labour	W3	-	2	2	2	7
Sub-total - furnaces			14	14	14	51
Scrap yard (covered & open)						
Foreman	S4	-	1	1	1	3
EOT crane drivers	W2	-	2	2	1	6
Shear operators	W3	-	1	1	-	2
Bale press operators	W3	-	1	1	-	2
Gas cutters	W3	-	2	2	1	5
General labour	W3	-	2	2	1	5
Sub-total - scrap yard ..			9	9	4	23
Pit side						
Foreman	S4	-	1	1	1	4
Pourers	W2	-	1	1	1	4
Pourer helpers						

General labour	W3	-	2	2	1	5
Sub-total - scrap yard ..			9	9	4	23
Pit side						
Foreman	S4	-	1	1	1	4
Pourers	W2	-	1	1	1	4
Pourer helpers	W3	-	2	2	2	7
EOT crane drivers	W2	-	3	3	3	10
Heat recorder	W2	-	1	1	1	4
General labour	W3	-	2	2	2	7
Sub-total - pit side			10	10	10	36
Mould & stripper yard						
Foreman	S4	1	-	-	-	1
Chargehand	W1	-	1	1	1	4
EOT crane drivers	W2	-	3	3	3	11
Mould inspectors	W2	-	1	1	1	4
Mould cleaners	W3	-	2	2	2	7
Hot top repairs men	W3	-	3	3	3	11
General labour	W3	-	2	2	2	7
Sub-total - mould & stripper yard ..		1	11	11	11	45
Calcining plant						
Chargehand	W1	1	-	-	-	1
Operators	W2	-	2	2	2	7
General labour	W3	-	3	3	3	11
Sub-total - calcining plant ..		1	5	5	5	19
Chemical laboratory						
Chief chemist	S3	1	-	-	-	1
Chemist b/	S4	-	2	2	2	7
Laboratory assistants	W3	1	1	1	1	5
Sub-total - chemical laboratory ..		2	3	3	3	13
Total operation labour		4	52	52	47	187

SECTION 2

	Salary group	Shifts G	Shifts I	Shifts II	Shifts III	Total on pay roll [a]
Maintenance labour						
Mechanical						
Foreman	S4	1	-	-	-	1
Chargehand	W1	-	1	1	1	4
Mill wrights	W2	-	2	2	2	7
Gas cutter/welders	W2	-	1	1	1	4
Storekeepers	A3	-	1	1	1	4
Sub-total - mechanical		1	5	5	5	20
Refractories						
Chargehand	W1	-	1	1	1	4
Masons	W2	-	2	2	2	7
Ladle & stopper repairs men	W3	-	2	2	2	7
Mason helpers	W3	-	2	2	2	7
Sub-total - refractories			7	7	7	25
Electrical						
Foreman	S4	1	-	-	-	1
Chargehand	W1	-	1	1	1	4
Electricians	W2	-	1	1	1	4
Fitters	W2	-	1	1	1	4
Helpers	W3	-	2	2	2	7
Sub-total - electrical		1	5	5	5	20
Total maintenance labour		2	17	17	17	65
Total		12	67	67	64	258
Add 15% for leave and absenteeism in group 'W' only						32
GRAND TOTAL						290

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a/ Since the shop works 7 days per week, total on pay roll includes extra men to allow for weekly off day.

b/ One for standard analytical processes and one for quantometer (direct reading spectrometer).

GRAND TOTAL	..	..	..	..	290

a/ Since the shop works 7 days per week, total on pay roll includes extra men to allow for weekly off day.

b/ One for standard analytical processes and one for quantometer (direct reading spectrometer).

Appendix 33-3

PRELIMINARY MANPOWER ESTIMATE - BLOOMING MILL AND SOAKING PIT

Basis: One 700 mm 2-hi reversing blooming mill
Production - 56 000 tons of blooms and billets/year
Operation - 2 shifts/day, 6 days/week, 300 days/year

	Salary group	Shifts G	I	II	III	Total on pay roll
Supervision and clerical						
Superintendent a/	S1	1	-	-	-	1
General foreman	S2	1	-	-	-	1
Clerical & office b/	A2	5	-	-	-	5
Total supervision and clerical		7				7
Operation labour						
Blooming mill						
Foreman	S3	-	1	1	-	2
Coggers	S4	-	1	1	-	2
Assistant coggers	W1	-	1	1	-	2
Head heater	S4	-	1	1	-	2
Heater	W1	-	2	2	1	5
Operators	W3	-	3	3	1	7
Painters, stampers & checkers	W3	-	2	2	1	5
Recorder	W2	-	2	2	1	5
Crane drivers	W2	-	4	4	2	10
General labour	W3	-	5	5	2	12
Sub-total mill operation			22	22	8	52
Roll turning						
Roll designer c/	S2	1	-	-	-	1
Head roll turner	S4	1	-	-	-	1
Roll turners	W1	-	1	1	-	2
Tool and gauge makers	W2	1	-	-	-	1
Sub-total roll turning		3	1	1		5
Total operation labour		3	23	23	8	57

Maintenance bour

Sub-total mill operation			22	22	8	52
Roll turning						
Roll designer c/	S2	1	-	-	-	1
Head roll turner	S4	1	-	-	-	1
Roll turners	W1	-	1	1	-	2
Tool and gauge makers	W2	1	-	-	-	1
Sub-total roll turning		3	1	1		5
Total operation labour		3	25	25	8	57
Maintenance labour						
Mechanical a/						
General foreman	S3	1	-	-	-	1
Foreman	S4	-	1	1	1	3
Chargehand	W1	-	1	1	1	3
Mill wrights	W2	-	3	3	3	9
Gas cutter/welder	W2	-	1	1	1	3
Helpers and oilers	W3	-	2	2	2	6
Storekeeper	A3	-	1	1	1	3
Sub-total mechanical maintenance ..		1	9	9	9	28
Electrical a/						
General foreman	S3	1	-	-	-	1
Foreman	S4	-	1	1	1	3
Charge hand	W1	-	2	2	1	5
Electricians	W2	-	2	2	1	5
Fitters	W2	-	4	4	2	10
Sub-total electrical maintenance ..		1	9	9	5	24
Total maintenance labour		2	18	18	14	52
Total		12	41	41	22	116
Add 15% for leave and absenteeism in group 'W' only						14
GRAND TOTAL						130

a/ Common to blooming mill and conditioning
b/ Includes chasers, shipping and establishment clerks
c/ Common to blooming mill and bar mills

Appendix 33-4

PRELIMINARY MANPOWER ESTIMATE - BILLET CONDITIONING

Basis: Production - 53 000 tons of conditioned billets per year
Operation - 3 shifts/day, 6 days/week, 300 days/year

	Salary group	Shifts G	I	II	III	Total on pay roll
Supervision & clerical						
Superintendent[a]						
General foreman	S3	1	-	-	-	1
Clerical & typing	A2	2	-	-	-	2
Total supervision & clerical ..		3				3
Operation labour						
Foreman	S4	-	1	1	1	3
Automatic grinder operator ..	W2	-	3	3	3	9
Swing grinder operators ..	W3	-	9	9	9	27
Chippers	W3	-	8	8	8	24
Hand scarfers	W3	-	2	2	2	6
Picklers	W3	-	1	1	1	3
Crane operators	W3	-	4	4	4	12
Gas cutting machine operator ..	W2	-	1	1	-	2
Painters, stampers & checkers ..	W3	-	3	3	3	9
Operatives - slow cooling covers ..	W3	-	2	2	2	6
Operatives - preheating furnace ..	W2	-	1	1	1	3
Inspection assistants ..	W1	-	2	2	2	6
General labour	W3	-	15	15	15	45
Total operation labour ..			52	[illegible]	51	155
Total .. .		3	52	52	51	158
Add 15% for leave & absenteeism in group 'W' only ..						22
Grand total						180

[a] Common with blooming mill as shown in Appendix 31-3.

SECTION 1

Appendix 33-5

PRELIMINARY MANPOWER ESTIMATE - BAR MILLS

Basis: Heavy Bar Mills - Production: 19 000 tons per year
Operation : 2 shifts/day, 6 days/week, 300 days/year

Light Bar Mills - Production: 29 000 tons per year
Operation : 3 shifts/day, 6 days/week, 300 days/year

	Salary group	Shifts G	I	II	III	Total on pay roll
Supervision and clerical						
Superintendent a/	S1	1	-	-	-	1
General foreman	S2	1	-	-	-	1
Clerical and office b/	A2	7	-	-	-	7
Total supervision and clerical		9				9
Operation labour						
Mill						
Foreman	S3	-	2	2	1	5
Rollers	S4	-	2	2	1	5
Assistant rollers c/	W1	-	3	3	3	9
Heater	W1	-	2	2	1	5
Furnace hands	W3	-	3	3	2	8
Mill hands d/	W2	-	16	16	10	42
Operators	W3	-	9	9	5	23
Painters, stampers and checkers	W3	-	4	4	2	10
Recorders	W2	-	2	2	2	6
Crane drivers	W2	-	4	4	4	12
General labour	W3	-	7	7	7	21
Sub-total mill operation labour			54	54	38	146
Roll shop						
Head roll turner	S4	1	-	-	-	1
Roll turners	W1	4	-	4	-	8
Tool and gauge makers	W2	2	-	-	-	2

Recorders	W2	-	2	2	2	6
Crane drivers	W2	-	4	4	4	12
General labour	W3	-	7	7	7	21
Sub-total mill operation labour			54	54	38	146
Roll shop						
Head roll turner	S4	1	-	-	-	1
Roll turners	W1	4	-	4	-	8
Tool and gauge makers	W2	2	-	-	-	2
General labour	W3	1	2	2	-	5
Sub-total roll shop operation labour		8	2	6	-	16
Total operation labour		8	56	60	38	162
Maintenance labour a/						
Mechanical						
General foreman	S3	1	-	-	-	1
Foreman	S4	-	1	1	1	3
Charge hand	W1	-	2	2	1	5
Mill wrights	W2	-	6	6	4	16
Gas cutter/welder	W2	-	1	1	1	3
Storekeeper	A3	-	1	1	1	3
Sub-total mechanical maintenance		1	11	11	8	31
Electrical a/						
General foreman	S3	1	-	-	-	1
Foreman	S4	-	1	1	1	3
Charge hand	W1	-	2	2	2	6
Electricians	W2	-	3	3	3	9
Fitters	W2	-	3	3	3	9
Sub-total electrical maintenance		1	9	9	9	28
Total maintenance labour		2	20	20	17	59
Total		19	76	80	55	230
Add 15% for leave and absenteeism in group 'W' only			...			30
GRAND TOTAL						260

a/ Common for bar mills, bar finishing and heat-treatment.
b/ Includes chasers, shippers and establishment clerks.
c/ One for roll changing in each shift.
d/ Includes 4 in each shift for roll changing.

	TABRIZ	ARAK
Sub-soil conditions: Bearing capacity	2 kg/sq cm upto 50 mm depth	1.2 to 2 kg/sq cm
Ground water table	Average 3.5 m below ground level	-
Type of foundations/piling in nearby area	No piling necessary	No piling necessar
Snowfall/wind load	Buildings will have to be designed for heavy wind load and continuous snowfall	Buildings will have designed for heavy and continuous snow
C. Water		
Source and availability	Only wells; water is salty and unsuitable for boiler feed; also adequate water not available	Only well water at 100 m depth. Draw well 230 to 350 cu (850/1300 gpm). Th appears to be very
Cost	From own well water, hence no water charges. 4 Rls/cu m from the city supply	From own well water, water charges. Rls every 1" ø main pip
D. Power		
Probable source	From national grid (expected to be completed by 1972) with major generating stations at Tabriz, Arak dam, Karun dam and Shahpur dam, transmission line voltage 230-132-20 kV	From national grid 230-63-20 kV
Cost	With the installation of National Grid by 1972 as show be connected to the national grid. It is understood structure is still under preparation; and, with the n the sites.	
E. Labour (construction)		
Availability	No problem regarding availability of skilled labour	Availability of skil labour will be

SECTION 1

SECTION 1

Appendix 33-6

PRELIMINARY MANPOWER ESTIMATE - HEAT TREATMENT, BAR FINISHING, INSPECTION, WAREHOUSE & SHIPPING

Basis: Production - 45 000 tons of finished bars per year
Operation - Furnaces 3 shifts, rest 2 shifts/day, 6 days/week, 300 days/year

	Salary group	Shifts				Total on pay roll
		G	I	II	III	
Supervision and clerical						
Superintendent a/						
General foreman	S2	1	-	-	-	1
Clerical and office	A2	5	-	-	-	5
Total supervision and clerical ..		6				6
Heat treatment and bar finishing						
Foreman	S3	-	1	1	1	3
Furnace hands	W2	-	2	2	2	6
Crane drivers	W2	-	3	3	2	8
Saw operators	W3	-	3	3	1	7
Bar straightener operators ..	W3	-	3	3	-	6
General labour	W3	-	4	4	2	10
Total heat treatment and bar finishing ..			16	16	8	40
Inspection and testing						
Inspection assistants	W1	-	4	4	-	8
Operatives - Magnaflux and ultrasonic equip	W2	-	2	2	-	4
Operatives - Other testing equipment ..	W2	-	2	2	-	4
General labour	W3	-	8	8	-	16

Inspection assistants	W1	-	4	4	-	8
Operatives - Magnaflux and ultrasonic equip	W2	-	2	2	-	4
Operatives - Other testing equipment	W2	-	2	2	-	4
General labour	W3	-	8	8	-	16
Total inspection and testing			16	16		32
Warehouse and shipping						
Shipper	S3	1	-	-	-	1
Warehouse incharge	S4	1	-	-	-	1
Shipping assistants	A2	-	4	4	-	8
General labour	W3	-	20	20	-	40
Total warehouse and shipping		2	24	24	-	50
Total		8	56	56	8	128
Add 15% for leave and absenteeism in group 'W' only						17
GRAND TOTAL						145

a/ Common with bar mills as shown in Appendix 33-5.

SECTION 2

Appendix 33-7

CONSOLIDATED MONTHLY SALAR

Salary group		Average salary $/month	Administration and services Total pay roll No	Administration and services Total salary $	Steelmelt shop Total pay roll No	Steelmelt shop Total salary $	Blooming mil Total pay roll No	Tot sal $
Admin. executive								
E-1	..	1 000	1	1 000	-	-	-	
E-2	..	900	1	900	-	-	-	
E-3	..	700	5	3 500	-	-	-	
Sub-total	..		7	5 400				
Supervision								
S-1	..	700	5	3 500	1	700	1	
S-2	..	600	11	6 600	2	1 200	2	1
S-3	..	500	14	7 000	5	2 500	4	2
S-4	..	300	2	600	21	6 300	11	3
Sub-total	..		32	17 700	29	10 700	18	7
Operation workers								
W-1	..	120	4	480	24	2 880	17	2
W-2	..	80	55	4 400	87	6 960	43	3
W-3	..	60	15	900	111	6 660	30	1
Sub-total	..		74	5 780	222	16 500	90	7
Administrative								
A-1	..	300	16	4 800	-	-	-	
A-2	..	200	74	14 800	3	600	5	1
A-3	..	100	12	1 200	4	400	3	
A-4	..	60	38	2 280	-	-	-	
Sub-total	..		140	23 080	7	1 000	8	1
Total	..		253	51 960	258	28 200	116	15
Add 15% of 'W' for leave and absenteeism[a]			12	870	32	2 480	14	1
Grand Total	..		265	52 830	290	30 680	130	16
Add 50% for fringe benefits[b]			-	26 410	-	15 340	-	8
Total manpower and salary bill			265	79 240	290	46 020	130	25

[a] 15% extra of the pay-roll force has been provided to take care of leave and absenteeism only

[b] 50% extra has been provided for all other fringe benefits.

SECTION 1

pendix 33-7

MONTHLY SALARY BILL

Blooming mill		Billet conditioning		Bar mills		Heat-treatment and finishing		TOTAL	
Total pay roll	Total salary	Total pay roll	Total salary	Total pay roll	Total salary	Total pay roll	Total salary	Total pay roll	Total salary
No	$	No	$	No	$	No	$	No	$
-	-	-	-	-	-	-	-	1	1 000
-	-	-	-	-	-	-	-	1	900
-	-	-	-	-	-	-	-	5	3 500
								7	5 400
1	700	-	-	1	700	-	-	8	5 600
2	1 200	-	-	1	600	1	600	17	10 200
4	2 000	1	500	7	3 500	4	2 000	35	17 500
11	3 300	3	900	12	3 600	1	300	50	15 000
18	7 200	4	1 400	21	8 400	6	2 900	110	48 300
17	2 040	6	720	33	3 960	8	960	92	11 040
43	3 440	14	1 120	99	7 920	22	1 760	320	25 600
30	1 800	132	7 920	67	4 020	79	4 740	434	26 040
90	7 280	152	9 760	199	15 900	109	7 460	846	62 680
-	-	-	-	-	-	-	-	16	4 800
5	1 000	2	400	7	1 400	-	-	104	20 800
3	300	-	-	3	300	13	2 600	22	2 200
-	-	-	-	-	-	-	-	38	2 280
8	1 300	2	400	10	1 700	13	2 600	180	30 080
116	15 780	158	11 560	230	26 000	128	12 960	1 143	146 460
14	1 090	22	1 460	30	2 390	17	1 120	127	9 410
130	16 870	180	13 020	260	28 390	145	14 080	1 270	155 870
-	8 435	-	6 510	-	14 195	-	7 040	-	77 930
130	25 305	180	19 530	260	42 585	145	21 120	1 270	233 800

nteeism only in the category of operators and labour covered under group 'W'.

SECTION 2

Appendix 33-8

UNIT PRICES OF MAJOR MATERIALS & SUPPLIES DELIVERED AT AHWAZ

	Approx. Price	
	$	Equiv. in Rials
Purchased steel scrap		
Imported	50/ton	3 750/ton
Ferro-alloys & other additions		
High carbon ferro-chromium (65% Cr)	370/ton	26 250/ton
Low carbon ferro-chromium (67% Cr, 0.1% C)	0.67/kg	50/kg cont Cr
Ferro-molybdenum (70% Mo)	6/kg	450/kg cont Mo
Ferro-vanadium (50% V)	6.67/kg	500/kg cont V
Nickel pellets (99.8% Ni)	4.00/kg	300/kg
Standard ferro-manganese	215/ton	16 125/ton
Ferro-silicon (75% Si)	240/ton	18 000/ton
Iron ore (60% Fe)	15/ton	1 125/ton
Aluminium shots	0.8/kg	60/kg
Fluxes, carburisers, etc		
Limestone	5.4/ton	400/ton
Fluorspar	120/ton	9 000/ton
Silica sand	10/ton	750/ton
Petroleum coke	100/ton	7 500/ton
Electrodes	0.7/kg	53/kg
Natural gas	4/1 000 cu m	300/1 000 cu m
LP gas	0.09/kg	9.00/kg
Oxygen	0.4/cu m	30/cu m
Power	0.011/kWh	0.83/kWh

Appendix 33-9

ESTIMATE OF MATERIALS COST PER TON OF INGOT

Basis: Production unit - Two 20/25-ton arc furnaces for
Average yield (metallic to good ingots) - 90%

Materials	Price	Carbon Constl (En-8)		Low Alloy Constl (En-19)		Medium Alloy Constl (En-25)	
	$ per unit	Qty/T ingot kgs	Cost/T ingot $	Qty/T ingot kgs	Cost/T ingot $	Qty/T ingot kgs	Cost/T ingot $
Metallics							
Plant return scrap a/ (En-8) ..	35/ton	220	7.70				
" " " (En-19) ..	57/ton			220	12.50		
" " " (En-25) ..	173/ton					220	38.08
" " " (En-36) ..	173/ton						
" " " (En-44) ..	35/ton						
" " " (En-45) ...	35/ton						
" " " (En-47) ..	37/ton						
" " " (En-1A) ..	35/ton						
Purchased steel scrap - Imported	50/ton	850	42.50	830	41.50	815	40.75
Hi-carbon Fe-Cr (65% Cr) ..	370/ton	-	-	17.8	6.59	10.4	3.85
Low-carbon Fe-Cr (67% Cr, 0.1% C) ..	0.67/kg cont. Cr	-	-	-	-	-	-
Ferro-molybdenum (70% Mo) ..	6/kg cont. Mo	-	-	3.3	14.04	6.15	25.80
Ferro-vanadium (50% V) ..	6.67/kg cont. V	-	-	-	-	-	-
Nickel pellets (99.8% Ni) ..	4/kg	-	-	-	-	20.3	81.20
Standard Fe-Mn (75% Mn) ..	215/ton	11	2.37	9.5	2.04	8	1.72
Ferro-silicon (75% Si) ..	240/ton	4.2	1.01	4.2	1.01	4.2	1.01
Aluminium shots ..	0.80/kg	0.5	0.40	0.5	0.40	0.5	0.40
Iron ore (60% Fe) ..	15/ton	40.0	0.60	40.0	0.60	40.0	0.60
Sulphur (stick) ..	0.6/kg	-	-	-	-	-	-
Cost of metallics ..			54.58		78.68		193.41
Fluxes, carburisers etc							
Limestone ..	5.40/ton	40.0	0.22	40.0	0.22	40.0	0.22
Burnt lime ..	13.50/ton	55.0	0.74	55.0	0.74	55.0	0.74
Fluorspar ..	120/ton	10.0	1.20	10.0	1.20	10.0	1.20
Silica sand ..	10/ton	5.0	0.05	5.0	0.05	5.0	0.05
Petroleum coke ..	100/ton	10.0	1.00	10.0	1.00	10.0	1.00
Cost of fluxes, carburisers etc			3.21		3.21		3.21
TOTAL COST OF MATERIALS ..			57.79		81.89		196.62
Say ..			57.80		81.90		196.70

a/ Price for imported steel scrap delivered at plant site is taken at $ 50 per ton, and for the plant
steel scrap from the plant, is estimated based on the price of the recoverable alloy from the scrap

SECTION 1

Appendix 33-9

ST PER TON OF INGOT FOR DIFFERENT STEELS (STAGE I)

on arc furnaces for production of Constructional and Spring steels
od ingots) - 90%

y -19) t/T ot	Medium Alloy Constl (En-25)		Case Hardening Constl (En-36)		High Carbon Spring (En-44)		Silico-Mn Spring (En-45)		Chrome-V Spring (En-47)		Free-cutting (En1A)	
	Qty/T ingot kgs	Cost/T ingot $	Qty/T ingot kgs	Cost/T ingot $	Qty/T ingot kgs	Cost/T ingot $	Qty/T ingot kgs	Cost/T ingot $	Qty/T ingot kgs	Cost/T ingot $	Qty/T ingot kgs	Cost/T ingot $
.50												
	220	38.08										
			220	38.08								
					220	7.70						
							220	7.70				
									220	8.14		
											220	7.70
.50	815	40.75	815	40.75	855	42.75	825	41.25	790	39.50	842	41.10
.59	10.4	3.85	-	-	-	-	-	-	15	5.55	-	-
-	-	-	13	5.82	-	-	-	-	-	-	-	-
.04	6.[illegible]	25.80	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	5	16.67	-	-
-	20.3	81.20	26.6	106.40	-	-	-	-	-	-	-	-
.04	8	1.72	6.5	1.40	7.9	1.[illegible]	11.6	2.50	9.5	2.04	14	3.01
.01	4.2	1.01	4.2	1.01	3.4	0.81	30.0	7.20	5.8	1.40	0.8	0.20
.40	0.5	0.40	0.5	0.40	0.5	0.40	0.5	0.40	0.5	0.40	0.5	0.40
.60	40.0	0.60	40.0	0.60	40.0	0.60	40.0	0.60	40.0	0.60	40.0	0.60
-	-	-	-	-	-	-	-	-	-	-	3.2	1.92
.68		193.41		194.46		53.96		59.65		74.30		54.93
.22	40.0	0.22	40.0	0.22	40.0	0.22	40.0	0.22	40.0	0.22	40.0	0.22
.74	55.0	0.74	55.0	0.74	55.0	0.74	55.0	0.74	55.0	0.74	55.0	0.74
.20	10.0	1.20	10.0	1.20	10.0	1.20	10.0	1.20	10.0	1.20	10.0	1.20
.05	5.0	0.05	5.0	0.05	5.0	0.05	5.0	0.05	5.0	0.05	5.0	0.05
.00	10.0	1.00	5.0	0.50	30.0	3.00	20.0	2.00	20.0	2.00	5.0	0.50
.21		3.21		2.71		5.22		4.22		4.22		2.71
1.89		196.62		197.17		59.18		63.87		78.52		57.64
1.90		196.70		197.20		59.20		63.90		78.60		57.70

n, and for the plant return without alloys at $ 35 per ton; and the price of alloy
alloy from the scrap and the price of the mild steel scrap at $ 35 per ton.

SECTION 2

Appendix 33-10

ESTIMATES OF COST ABOVE MATERIALS FOR STEELMAKING

Basis: Two 20/25-ton arc furnaces
Production - 67 000 tons/year
Operation - 3 shifts/day, 330 days/year

	Price/unit $	Quantity/ton ingot units	Cost/ton ingot $
Cost above materials			
Labour & supervision ..			8.25[a]
Electric power ..	0.011/kWh	650 kWh	7.15
Electrodes & nipples ..	0.70/kg	7 kg	4.90
Auxiliary power (50 kWh/ton) & fuel ..	-	-	0.80
Repairs & maintenance materials ..	-	-	1.30
Tools, supplies & lubricants ..	-	-	0.50
Utilities - water, air, oxygen, acetylene ..	-	-	0.40
Transportation ..	-	-	0.60
Laboratory ..	-	-	0.50
Refractories - furnace and pitside ..	-	-	3.50
Reserve for roof & side wall relining ..	-	-	1.50
Moulds & stools ..	0.20/kg	30 kg	6.00
All others ..	-	-	1.20
General plant expenses[b] ..	-	-	9.80
Total cost above materials ..			46.40
		Say	46.40

[a] Based on Appendix 33-7.

[b] General plant expense: estimate of about $ 150 000 per month for overall general plant expense allocated to various production departments on the basis of total cost above for each department.

Appendix 33-11

ESTIMATE OF COST ABOVE MATERIALS FOR COGGING

Basis: One 700 mm 2-high reversing mill
Production - 56 000 tons of billets/year
Yield - Ingot of billet, about 84%
Operation - 2 shifts/day, 6 days/week,
300 days/year

			Cogging	
		Price/unit $	Quantity/ton bloom units	Cost/ton bloom $
Cost above materials				
Labour & supervision	..			5.45
Fuel - natural gas	..	0.50/10^6kcal	10^6kcal	0.50
Power	..	0.011/kWh	40 kWh	0.44
Utilities	..	-	-	0.90
Repair, maintenance & supplies (including refractories)	..	-	-	3.50
Provision for rolls	..	3.00/kg	0.5 kg	1.50
All others	..	-	-	1.50
General plant expense	..	-	-	3.80
Total cost above materials for cogging				17.59
				Say 17.60

Appendix 33-12

ESTIMATE OF COST ABOVE MATERIALS FOR BILLET CONDITIONING

Basis: Three automatic grinders
Eight swing grinders
Eight chippers
Three scarfing torches
Production - 53 000 tons of billets/year
Operation - 3 shifts/day, 6 days/week
300 days/year

			Conditioning	
		Price/unit $	Quantity/ton product units	Cost/ton product $
Cost above materials				
Labour & supervision	..			4.45
Power	..	0.011/kWh	40 kWh	0.44
Fuel - natural gas	..	$0.50/10^6$kcal	0.20×10^6 kcal	0.10
Utilities	..	-	-	0.30
Repair, maintenance and supplies	..	-	-	11.00
All others	..	-	-	2.50
General plant expense	..	-	-	5.10
Total cost above materials for billet conditioning				23.89
				Say 23.90

ARAK	ISFAHAN	AHWAZ
to 2 kg/sq cm	3 to 8 kg/sq cm. Russians took 2.5 kg/sq cm for design purposes	0.7 to 1.8 kg/sq cm; average 1.2 kg per sq cm
-	Sub-soil water level 1 to 1.5 m near river to 25 to 30 m near mountains	4.2 to 6.7 m below ground level
iling necessary	At some places soil contains sulphate, which is not good for concrete; hence special precautions for corrosion resistance necessary	No piling necessary
ldings will have to be igned for heavy wind load continuous snowfall	-	-
well water at about m depth. Draw from 230 to 350 cu m/hr /1300 gpm). This ars to be very high	From river Zayandeli about 6 km from the site; min flow of 10 cu m/sec water assured in this river from Shah Abbas Dam, by the Govt. Intake at river will be necessary. The pipeline could be reduced and intake eliminated if water can be supplied from the Isfahan Steel Plant water system.	From river Karun which is a perennial source. Pipeline required about 2 km from intake works to the plant.
own well water, hence no r charges. Rls 600/yr for ry 1" ø main pipeline	-	-
m national grid at -63-20 kV	From national grid with major generating stations at Isfahan Shahabbas Kabir dam and steel mill; transmission line voltage 230-63-20 kV	From national grid with major generating stations at Ahwaz Pahalvi dam, Rezashah dam and Karum dam
d by 1972 as shown in power grid map drawing . . . . Arak, Ahwaz, Tabriz & Isfahan will all is understood from the discussions with the Ministry of Water & Power that the tariff und, with the national grid, it is likely that uniform tariff rate may be charged at all		
ilability of skilled r will be a problem	No problem regarding availability of skilled labour	No problem regarding availability of skilled labour

SECTION 2

Appendix 33-13

ESTIMATE OF COST ABOVE MATERIALS FOR BAR MILLS

1. Heavy Bar Mill - 550 mm, 3-hi, 3-stand
   Production - 19 000 tons per year
   Operation - 2 shifts/day, 6 days/week, 300 days/year

2. Light Bar Mill - 450 mm, 3-hi, 2-stand roughing train
   380 mm, 3-hi, 2-stands
   300 mm, 3-hi, 2-stands
   280 mm, 2-hi, single stand
   Production - 29 000 tons per year
   Operation - 3 shifts/day, 6 days/week, 300 days/year

	Price/unit	Constructional steels a/	
	$	Quantity/ton bar units	Cost/ton bar $
Cost above materials			
Labour and supervision			10.70
Fuel - natural gas	0.50/10^6kcal	0.50x10^6kcal	0.25
Power	0.011/kWh	150 kWh	1.65
Utilities	-	-	1.60
Repair, maintenance and supplies	-	-	3.50
Provision for rolls	1.20/kg	3 kgs	3.60
All other	-	-	2.80
General plant expense	-	-	6.60
Total cost above materials	..	..	30.70
		Say:	30.70

a/ Rolling rate estimated at 7.5 tons/hour

Appendix 33-14

ESTIMATE OF COST ABOVE MATERIALS FOR HEAT-TREATMENT AND BAR FINISHING

Basis: About 9 000 tons of heat treated bars
45 000 tons finished, tested, inspected and shipped
Operation - Heat-treatment - 3 shifts/day, 6 days/week, 300 days/year
Bar finishing - 2 shifts/day, 6 days/week, 300 days/year

		Heat-treatment			Bar finishing	
	Rate $/unit	Quantity/ton units	Cost/ton $	Rate $/unit	Quantity/ton units	Cost/ton $
Cost above materials						
Labour and supervision ..			2.85			5.20
Power ..	0.011/kWh	90.00 kWh	0.99	0.011/kWh	50.00 kWh	0.55
Fuel ..	0.50/10^6kcal	1.50x10^6kcal	0.75	-	-	-
Utilities ..	-	-	3.50	-	-	1.90
Repairs, maintenance and supplies ..	-	-	6.50	-	-	6.50
All others ..	-	-	2.50	-	-	12.50[a]
General plant expense ..	-	-	0.50	-	-	7.50
Total cost above materials..		..	17.59			34.15
		Say:	17.60			34.20

a/ Includes painting and packing charges.

Appendix 33-15

PRODUCTION COST ESTIMATE OF FINISHED BARS - CONSTRUCTIONAL STEELS

(For En-8, En-19, En-25 and En-36 Steels)

		Cost per ton product ($/ton)			
		Carbon constructional (En-8)	Low alloy constructional (En-19)	Medium alloy constructional (En-25)	Case hardening constructional (En-36)
Steelmelt shop					
Materials cost ..	..	57.8	81.9	196.7	197.2
Cost above materials ..	..	46.4	46.4	46.4	46.4
Total cost of ingot	..	104.2	128.3	243.1	243.6
Blooming mill					
Billet rolling - 84% yield to billets					
Ingot cost	..	124.0	152.7	289.4	290.0
Less credit for scrap (12% by weight) ..	..	5.0	8.1	24.7	24.7
Net cost of materials	..	119.0	144.6	264.7	265.3
Cost above materials ..	..	17.6	17.6	17.6	17.6
Total cost of cogged billets	..	136.6	162.2	282.3	282.9
Billet conditioning (Yield 94%)					
Cost of materials ..	..	145.3	172.5	300.3	301.0
Cost above materials (no scrap recovery) ..	..	23.9	23.9	23.9	23.9
Production cost of conditioned billets	..	169.2	196.4	324.2	324.9
Bar rolling (91% yield to bar)					

Cost of materials	145.3	172.5	300.3	301.0
Cost above materials (no scrap recovery)	23.9	23.9	23.9	23.9
Production cost of conditioned billets	169.2	196.4	324.2	324.9
Bar rolling (91% yield to bar)				
Billet cost	185.9	215.8	356.2	357.0
Less credit for scrap (6% by weight)	2.3	3.8	11.4	11.4
Net cost of materials	183.6	212.0	344.8	345.6
Cost above materials	30.7	30.7	30.7	30.7
Production cost of bar	214.3	242.7	375.5	376.3
Heat treatment and finishing				
Materials cost - 94% yield to finished bar	228.0	258.2	399.4	400.3
Less credit for scrap (4% by weight)	1.5	2.4	7.4	7.4
Net cost of materials	226.5	255.8	392.0	392.9
Cost above materials Finishing, testing and inspection	34.2	34.2	34.2	34.2
Production cost of finished, tested, and inspected bars	260.7	290.0	426.2	427.1
Extra for heat-treatment	17.6	17.6	17.6	17.6
Production cost of heat-treated, finished, tested and inspected bars	278.3	307.6	443.8	444.7
Say - Unheat-treated bars	261	290	426	427
Heat-treated bars	279	308	444	445

appendix 33-16

PRODUCTION COST ESTIMATE OF FINISHED BARS - SPRING STEEL & FREE CUTTING STEEL (STAGE I)

(For En-44, En-45, En-47 and En-1A Steels)

		Cost per ton product ($/ton)			
		High carbon spring steel (En-44)	Silico-manganese spring steel (En-45)	Chrome-vanadium spring steel (En-47)	Free cutting steel (En-1A)
Steelmelt shop					
Materials cost	..	59.2	63.9	78.6	57.7
Cost above materials	..	46.4	46.4	46.4	46.4
Total cost of ingot	..	105.6	110.3	125.0	104.1
Blooming mill					
Billet rolling - 94% yield to billets	..				
Ingot cost	..	125.7	131.3	148.8	123.9
Less credit for scrap (12% by weight)	..	5.0	5.0	5.3	5.0
Net cost of materials	..	120.7	126.3	143.5	118.9
Cost above materials	..	17.6	17.6	17.6	17.6
Total cost of cogged billets	..	138.3	143.9	161.1	136.5
Billet conditioning (Yield 94%)					
Cost of materials	..	147.1	153.0	171.4	145.2
Cost above materials (no scrap recovery)	..	23.9	23.9	23.9	23.9
Production cost of conditioned billets		171.0	176.9	195.3	169.1
Bar rolling (91% yield to bar)					
Billet cost	..	187.9	194.4	[illegible]	[illegible]

Total cost of cogged billets	..	138.3	143.9	161.1	136.5
Billet conditioning (Yield 94%)					
Cost of materials	..	147.1	153.0	171.4	145.2
Cost above materials (no scrap recovery)	..	23.9	23.9	23.9	23.9
Production cost of conditioned billets		171.0	176.9	195.3	169.1
Bar rolling (91% yield to bar)					
Billet cost	..	187.9	194.4	214.6	185.8
Less credit for scrap (6% by weight)		2.3	2.3	2.4	2.3
Net cost of materials	..	185.6	192.1	212.2	183.5
Cost above materials	..	30.7	30.7	30.7	30.7
Production cost of bar	.	216.3	222.8	242.9	214.2
Heat-treatment and finishing Material cost - 94% yield to finished bar	..	230.1	237.0	258.4	227.9
Less credit for scrap (4% by weight)		1.5	1.5	1.6	1.5
Net cost of materials	..	228.6	235.5	256.8	226.4
Cost above materials Finishing, testing & inspection		34.2	34.2	34.2	34.2
Production cost of finished, tested and inspected bars	..	262.8	269.7	291.0	260.6
	Say:	263	270	291	261

Appendix 33-17

MATERIAL COST PER TON OF INGOT TOOL

Basis: One 6-ton arc furnace
8 000 tons of ingots per yea
5 000 tons of finished produc
Average yield - 90% from meta

Material	Price/ton material $	High speed steel Qty/t ingot kg	High speed steel Cost/t ingot $	Hot die ste Qty/t ingot kg	Cos in $
Metallics					
Plant return scrap a/ (HSS)	1 400/ton	260	364.00		
" " " (Hot die steel)	750/ton			250	137
" " " (Cold work die steel)	90/ton				
" " " (Low alloy tool steel)	140/ton				
" " " (Die block steel)	100/ton				
" " " (Carbon tool steel)	40/ton				
Purchased steel scrap - imported	50/ton	520	26.00	655	32
High carbon FeCr (65% Cr)	370/ton	60	22.20	50	18.
Low carbon FeCr (67% Cr, 0.1% C)	0.67/kg Cr cont	4	1.80	1	(
Fe-W (70% W)	8.10/kg W cont	211	1 196.40	112	635.
Fe-V (50% V)	6.67/kg V cont	21.5	71.60	7.5	25.
FeMo (70% Mo)	6.0/kg Mo cont	-	-	-	
Nickel pellets (99.8% Ni)	4.0/kg	-	-	-	
Standard FeMn (75% Mn)	215/ton	5	1.08	6	1.
Ferro-silicon (75% Si)	240/ton	4.5	1.08	4.5	1.
Aluminium shots	0.80/kg	0.5	0.40	0.5	0.
Iron ore (60% Fe)	15.0/ton	40	0.60	40	0.
Sub-total			1 675.16		902.
Fluxes					
Limestone	5.4/ton	40	0.22	40	0.
Burnt lime	13.5/ton	60	0.71	60	0.
Fluorspar	120/ton	10	1.20	10	1.
Silica sand	10/ton	5	0.05	5	0.
Petroleum coke	100/ton	20	2.00	10	1.
Others	-	-	1.50	-	1.
Sub-total			5.78		4.
Total material cost			1 680.94		906.
		Say	1 681		907

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a/ Price for imported steel scrap delivered at plant site is taken at $ 50 per ton; and for the pl steel scrap, from the plant, is estimated based on the price of the recoverable alloys from th

SECTION 1

Appendix 33-17

ER TON OF INGOT TOOL STEEL (STAGE II)

n arc furnace
ns of ingots per year
ns of finished products
yield - 90% from metallics to ingots

steel	Hot die steel		Cost work die steel		Low alloy tool steel		Die block steel		Carbon tool steel	
ost/t ngot ฿	Qty/t ingot kg	Cost/t ingot ฿	Qty/t ingot kg	Cost/t ingot ฿	Qty/t ingot kg	Cost/t ingot ฿	Qty/t ingot kg	Cost/t ingot ฿	Qty/t ingot kg	Cost/t ingot ฿
64.00										
	250	187.50								
			250	22.50						
					250	35.00				
							250	25.00		
									220	8.80
26.00	655	32.75	630	31.50	778	38.90	800	40.00	855	42.75
22.20	50	18.50	188	69.50	22	8.14	10.5	3.88	-	-
1.80	1	0.45	-	-	-	-	-	-	-	-
96.40	112	635.00	-	-	21.5	121.90	-	-	-	-
71.60	7.5	25.00	7.5	25.0	3.7	12.70	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	12	48.00	-	-
1.08	6	1.29	6	1.29	6	1.29	6	1.29	6	1.29
1.08	4.5	1.08	4.5	1.08	4.5	1.08	4.5	1.08	4.5	1.08
0.40	0.5	0.40	0.5	0.50	0.5	0.40	0.5	0.40	0.5	0.40
0.60	40	0.60	40	0.60	40	0.60	40	0.60	40	0.60
75.16		902.57		151.87		220.01		120.25		54.92
0.22	40	0.22	40	0.22	40	0.22	40	0.22	40	0.22
0.71	60	0.81	60	0.81	60	0.81	60	0.81	60	0.81
1.20	10	1.20	10	1.20	10	1.20	10	1.20	10	1.20
0.05	5	0.06	5	0.05	5	0.05	5	0.05	5	0.05
2.00	10	1.00	40	4.00	15	1.50	15	1.50	25	2.50
1.50	-	1.00	-	1.00	-	1.00	-	1.00	-	1.00
5.78		4.28		7.28		4.78		4.78		5.28
80.94		906.85		159.15		224.79		125.03		60.20
81		907		159		225		125		60

r ton; and for the plant return scrap without alloys at ฿ 35 per ton; and the price of alloy
erable alloys from the scrap and the price of the mild steel scrap at ฿ 35 per ton.

Appendix 33-18

PRODUCTION COST ESTIMATE OF TOOL & DIE STEELS (STAGE II)

	Cost of rolled or forged products in $/ton					
	High speed steel AISI-T1	Hot die steel AISI-H21	Cold work die steel AISI-D3	Low alloy tool steel AISI-S1	Die blocks steel Ni 1.45,Cr .65	Carbon tool steel AISI-W1
Steelmelt shop						
Cost of materials ..	1 681	907	159	225	125	60
Cost above materials ..	102	77	102	51	77	51
Total cost of ingot per ton ..	1 783	984	261	276	202	111
Cogging						
(Per cent yield) ..	(80)	(80)	(80)	(82)	(80)	(82)
Cost of materials ..	2 229	1 230	326	336	252	135
Less credit for scrap 15% by weight a/	262	141	17	24	19	7
Net cost of materials ..	1 967	1 089	309	312	233	128
Cost above materials ..	66	50	66	33	50	33
Total cost of cogged billets/semis	2 033	1 139	375	345	283	161
Conditioning						
(Per cent yield) ..	(91)	(91)	(91)	(92)	(91)	(92)
Cost of materials ..	2 234	1 251	412	379	311	177
Less credit for scrap 2% by weight a/	31	16	2	2	2	-
Net cost of materials ..	2 203	1 235	410	377	309	177
Cost above materials ..	52	39	52	26	39	26
Total cost of conditioned billets/semis	2 255	1 274	462	403	348	203
Rolling or forging						
(Per cent yield) ..	(89)	(89)	(89)	(91)	(89)	(91)
Cost of materials ..	2 534	1 431	519	443	391	223

Net cost of materials ..	2 203	1 235	410	377		309	177	
Cost above materials ..	52	39	52	26		39	26	
Total cost of conditioned billets/semis	2 255	1 274	462	403		348	203	
Rolling or forging (Per cent yield) ..	(89)	(89)	(89)	(91)		(89)	(91)	
Cost of materials ..	2 534	1 431	519	443		391	223	
Less credit for scrap 7% by weight a/	110	59	7	9		8	3	
Net cost of materials ..	2 424	1 372	512	434		383	220	
Cost above materials ..	96	72	96	30b/	48c/	72	30b/	48c/
Total cost (rolled or forged products)	2 520	1 444	608	464	482	455	250	268
Heat-treatment finishing and inspection (Per cent yield) ..	(93)	(93)	(93)	(94)	(94)	(93)	(94)	(94)
Cost of materials ..	2 709	1 552	653	493	513	489	266	285
Less credit for scrap 5% by weight a/	75	40	5	6	6	5	2	2
Net cost of materials ..	2 634	1 512	648	487	507	484	264	283
Cost above materials ..	110	80	110	55	55	80	55	55
Total production cost $/ton product	2 744	1 592	758	542	562	564	319	338

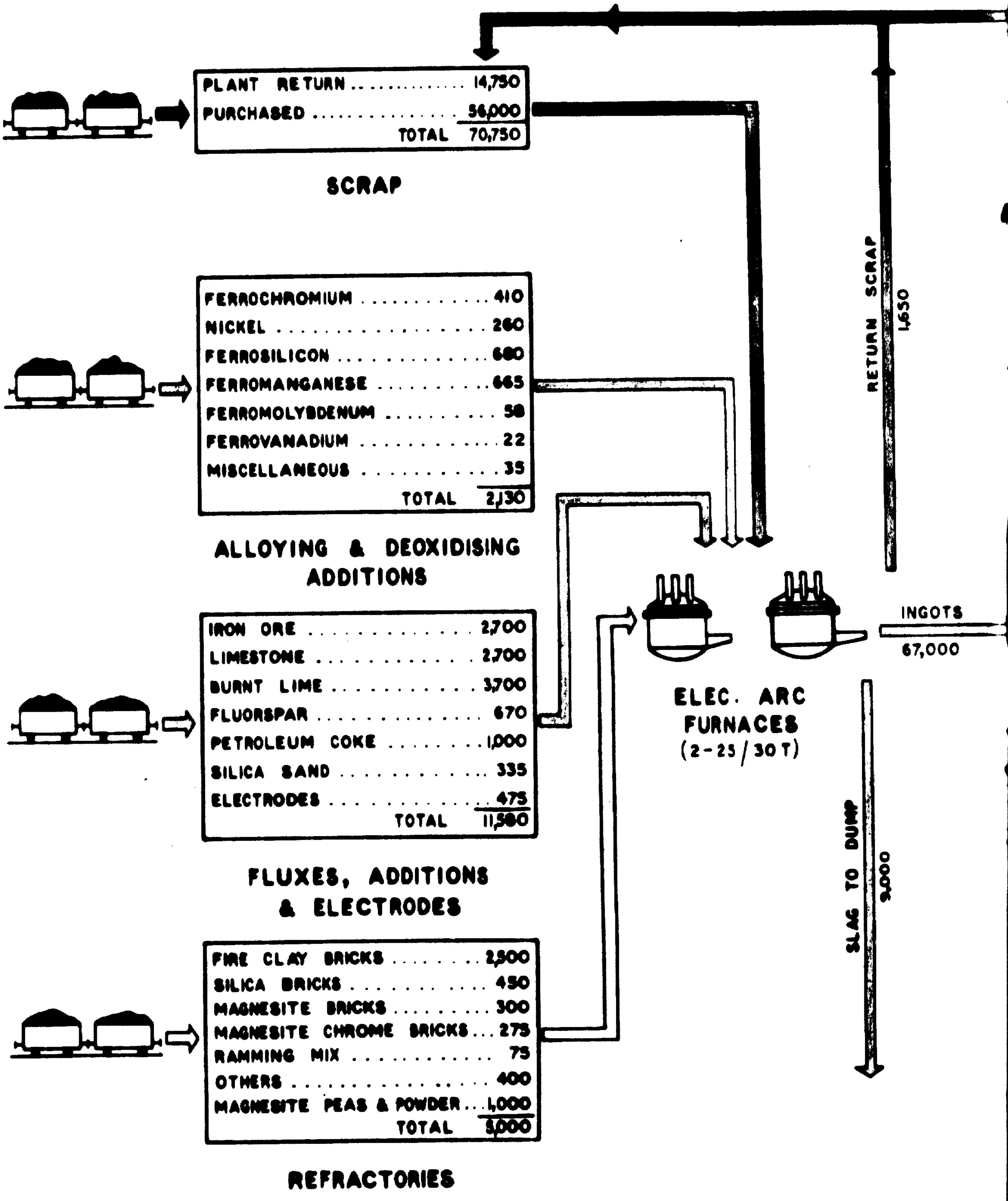
a/ Scrap recovery for higher yield material is assumed to be 1% less
b/ Rolled products from the bar mills of stage I
c/ Forged or handmill rolled products

	TABRIZ	ARAK
Wages - Unskilled	$ 1.6/day	$ 1.6/day
Semi-skilled	$ 2.4/day	-
Skilled	$ 2.7 to 4.7/day	$ 4 to 8/day
Fresh engineers	$ 400/month	$ 350/month
Experienced engineers (7 to 8 years)	$ 670/month	$ 600/month
F. <u>Construction material</u> (Source of supply and cost)		
Steel	$ 0.33/kg (as erected $ 0.47/kg)	$ 0.24/kg ($ 0.37 as erecto
Cement	$ 24/ton ($ 28/ton from USSR & $ 34/ton from Teheran)	$ 26/ton
Bricks	$ 24/1 000 - Teheran bricks $ 16/1 000 - Local bricks	$ 12/1 000 bricks
Sand	$ 2/cu m	$ 1.3/cu m
Gravel (aggregate)	$ 1.9/cu m	$ 2.1/cu m crushed
Shuttering wood	-	$ 100/cu m from USSR
G. <u>Transport facilities</u>	Well connected by road and rail to Teheran and other cities; and Zulfa port in north on Iran-Russia border. Also airport at Tabris for connections to Teheran and other cities	Well connected by rail and road to Teheran, Isfahan, Ahwaz etc. No airport at Arak.
H. <u>Other facilities</u>	Tabriz is the third biggest city in Iran, with a population of about 400 000. It is an industrial city with textile mills, match factories, leather works, the machine building plant, tractor plant, diesel engine plants of Dorman, Leyland etc. Hence availability of labour & general facilities should not be much of a problem.	Arak is known for grain & fruits. The present popul tion is about 72 000. Hen availability of skilled la and other facilities will a problem.

SECTION 1

a/ Data on temperature, rainfall, humidity etc, relate to the year 1964.

DRAWINGS - VOLUME V



SCRAP

PLANT RETURN	14,750
PURCHASED	56,000
TOTAL	70,750

ALLOYING & DEOXIDISING ADDITIONS

FERROCHROMIUM	410
NICKEL	260
FERROSILICON	680
FERROMANGANESE	665
FERROMOLYBDENUM	58
FERROVANADIUM	22
MISCELLANEOUS	35
TOTAL	2,130

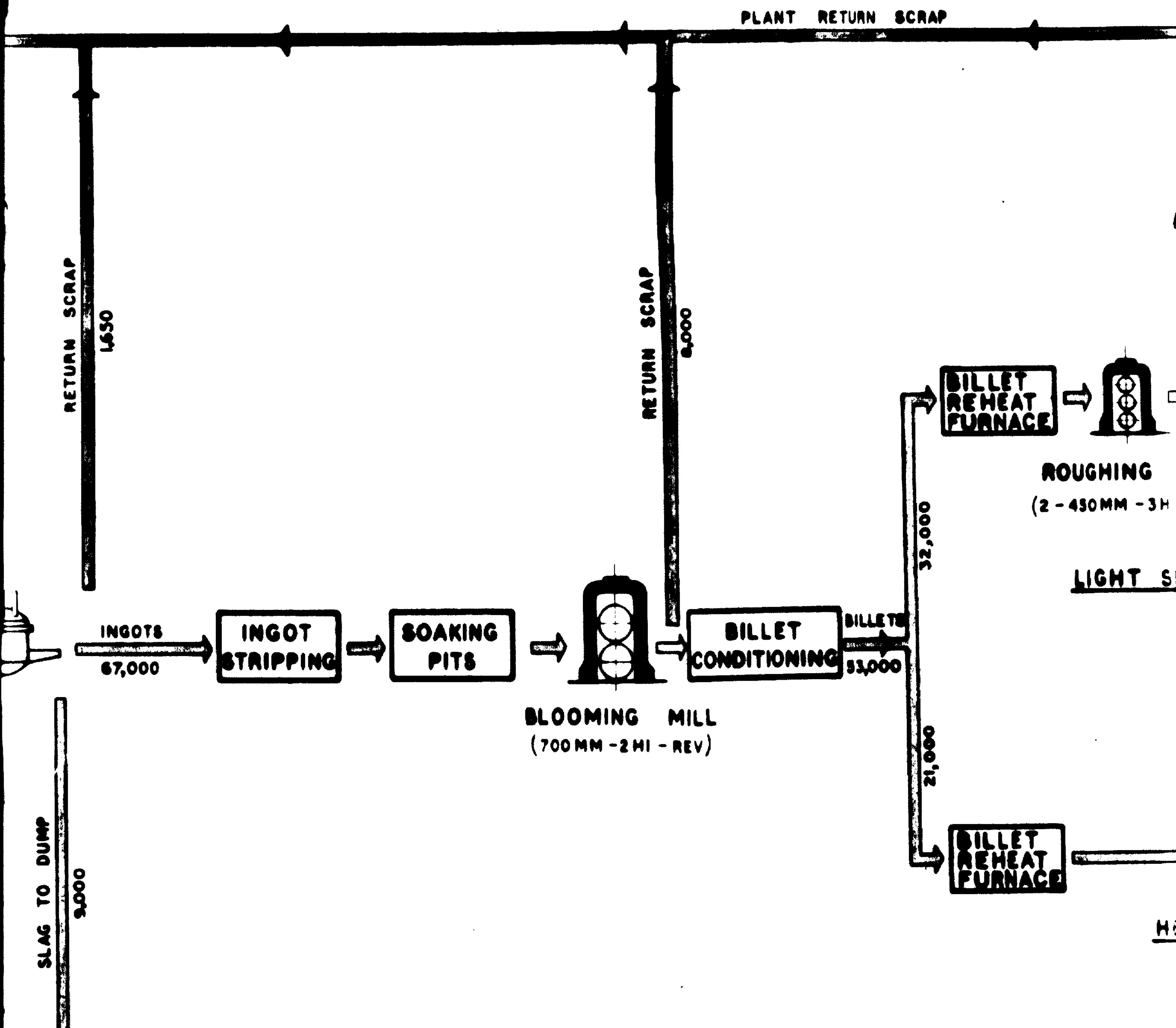
FLUXES, ADDITIONS & ELECTRODES

IRON ORE	2,700
LIMESTONE	2,700
BURNT LIME	3,700
FLUORSPAR	670
PETROLEUM COKE	1,000
SILICA SAND	335
ELECTRODES	475
TOTAL	11,580

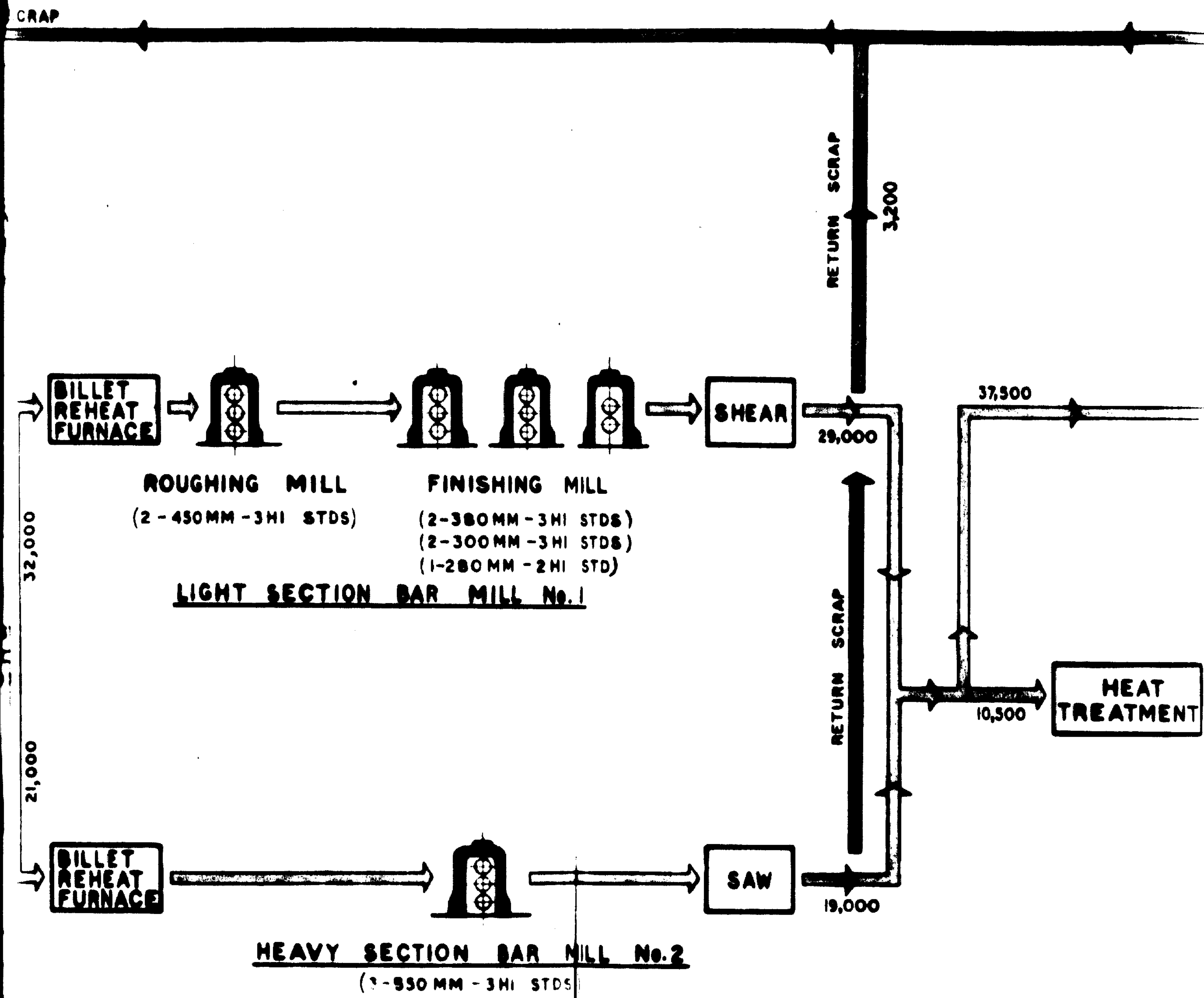
REFRACTORIES

FIRE CLAY BRICKS	2,500
SILICA BRICKS	450
MAGNESITE BRICKS	300
MAGNESITE CHROME BRICKS	275
RAMMING MIX	75
OTHERS	400
MAGNESITE PEAS & POWDER	1,000
TOTAL	5,000

SECTION 1


PLANT RETURN SCRAP
RETURN SCRAP
1,650
RETURN SCRAP
8,000
INGOTS
67,000
INGOT STRIPPING
SOAKING PITS
BLOOMING MILL
(700 MM - 2 HI - REV)
BILLET CONDITIONING
BILLETS
53,000
32,000
21,000
BILLET REHEAT FURNACE
BILLET REHEAT FURNACE
ROUGHING
(2 - 450MM - 3H
LIGHT S
H
SLAG TO DUMP
9,000

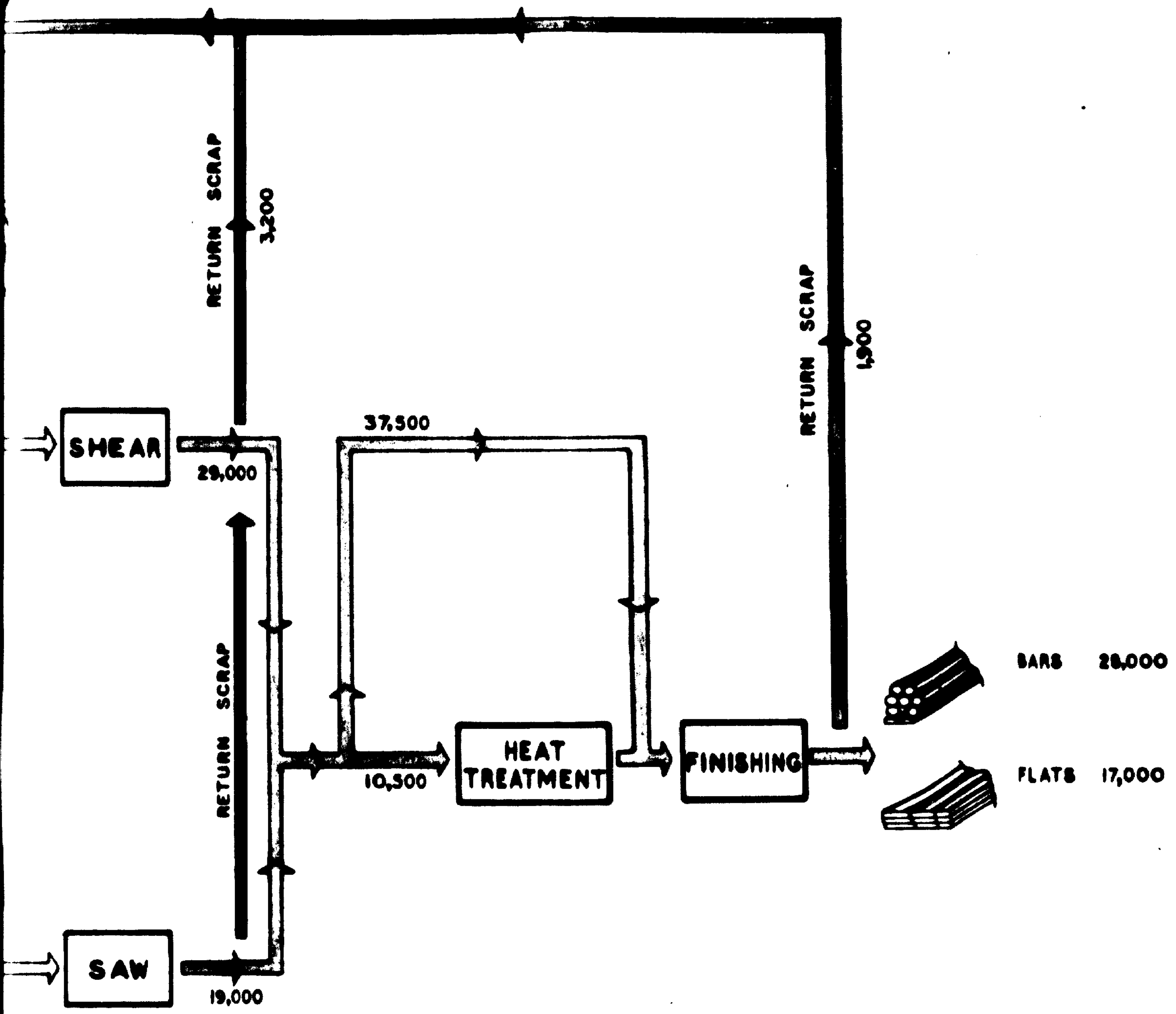
SECTION 2



SECTION 3

NOTE:

QUANTITIES ARE IN TONS / YEAR.



.2

SECTION 4

/ YEAR.

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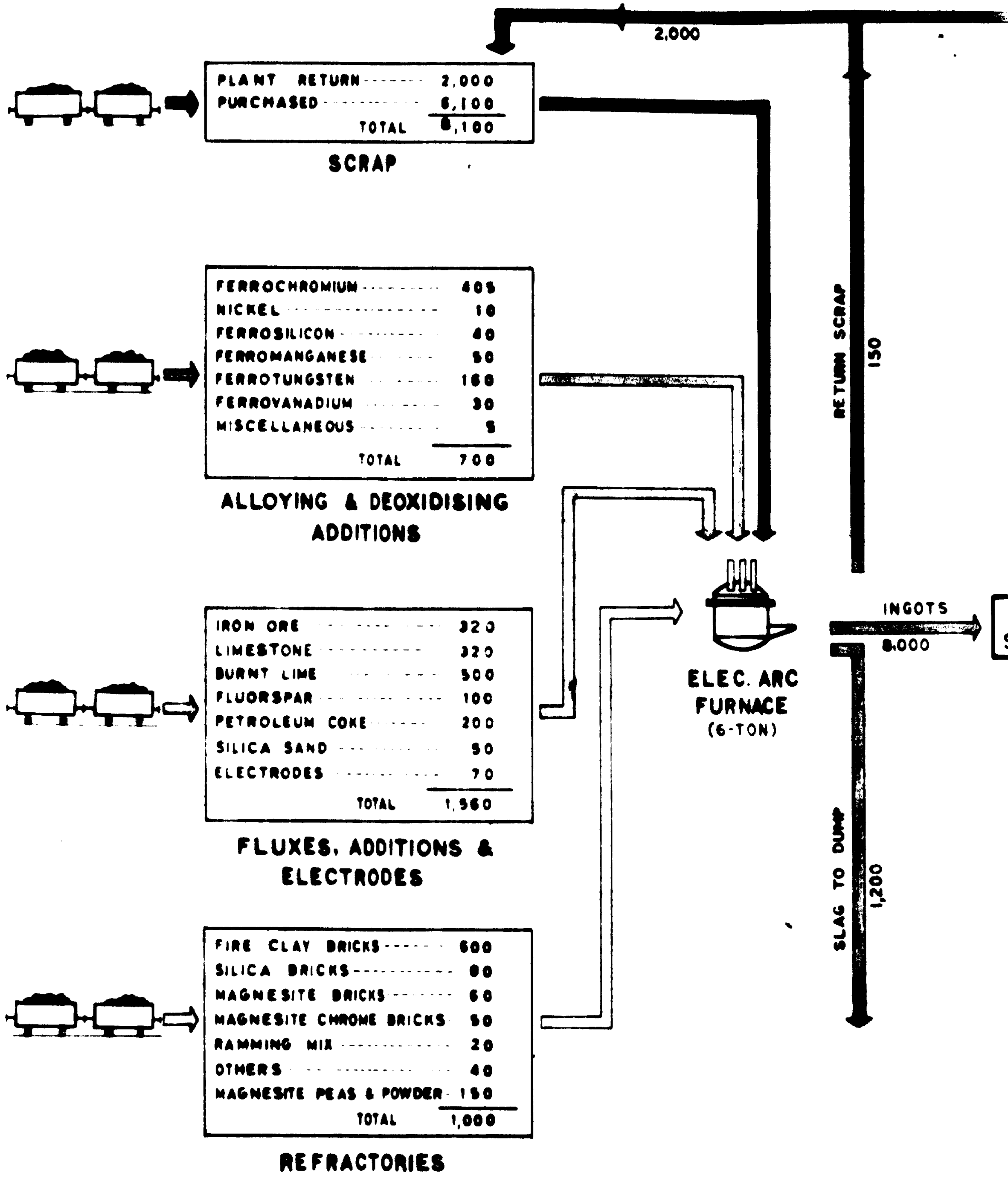
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT — FLOW SHEET - STAGE I

DRAWN		3.11.69	No. 5131 - V - 1
APPROVED	KSV	7.11.69	



PLANT RETURN	2,000
PURCHASED	6,100
TOTAL	8,100

SCRAP

FERROCHROMIUM	405
NICKEL	10
FERROSILICON	40
FERROMANGANESE	50
FERROTUNGSTEN	160
FERROVANADIUM	30
MISCELLANEOUS	5
TOTAL	700

ALLOYING & DEOXIDISING ADDITIONS

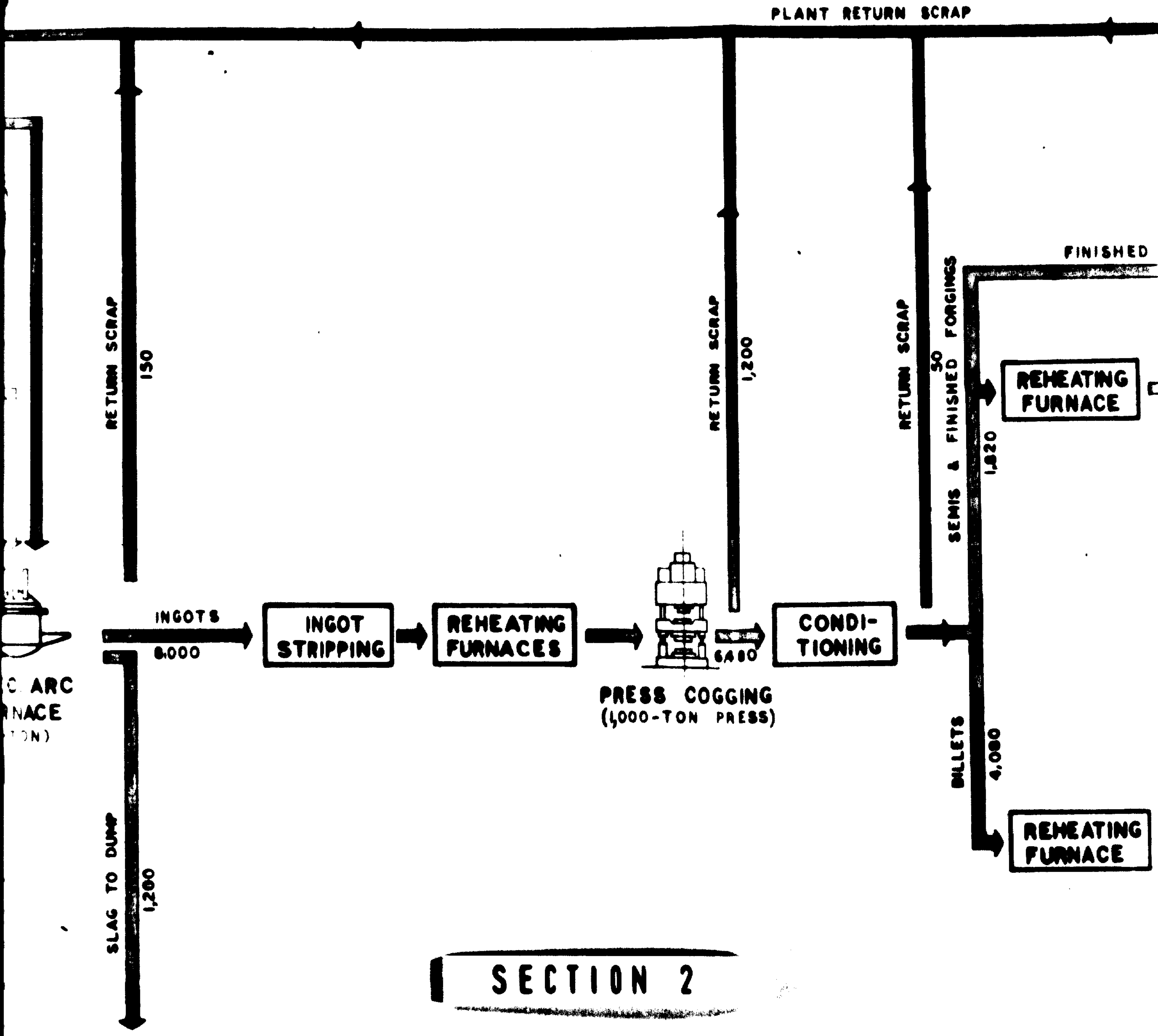
IRON ORE	320
LIMESTONE	320
BURNT LIME	500
FLUORSPAR	100
PETROLEUM COKE	200
SILICA SAND	50
ELECTRODES	70
TOTAL	1,560

FLUXES, ADDITIONS & ELECTRODES

FIRE CLAY BRICKS	600
SILICA BRICKS	80
MAGNESITE BRICKS	60
MAGNESITE CHROME BRICKS	50
RAMMING MIX	20
OTHERS	40
MAGNESITE PEAS & POWDER	150
TOTAL	1,000

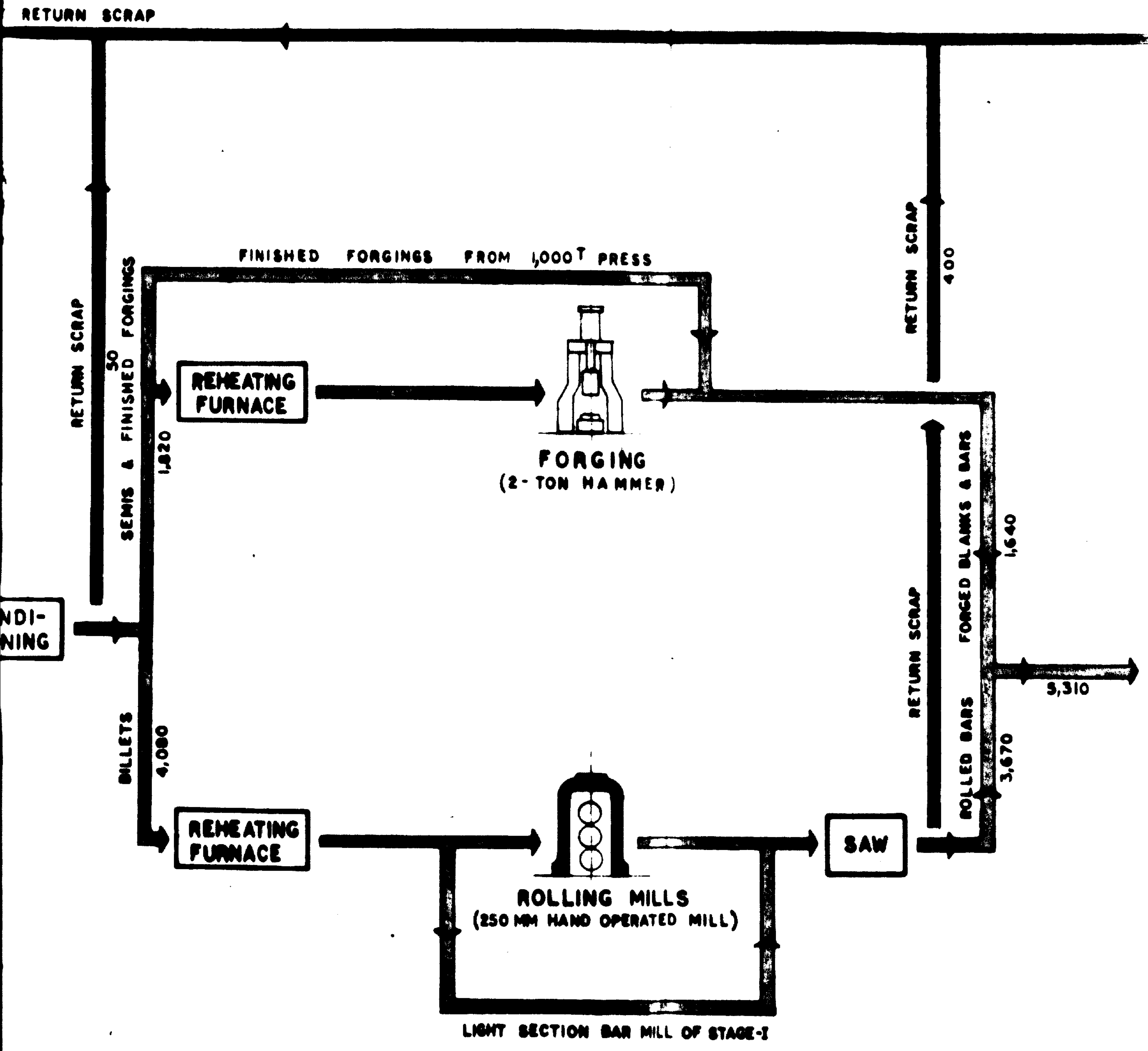
REFRACTORIES

SECTION 1

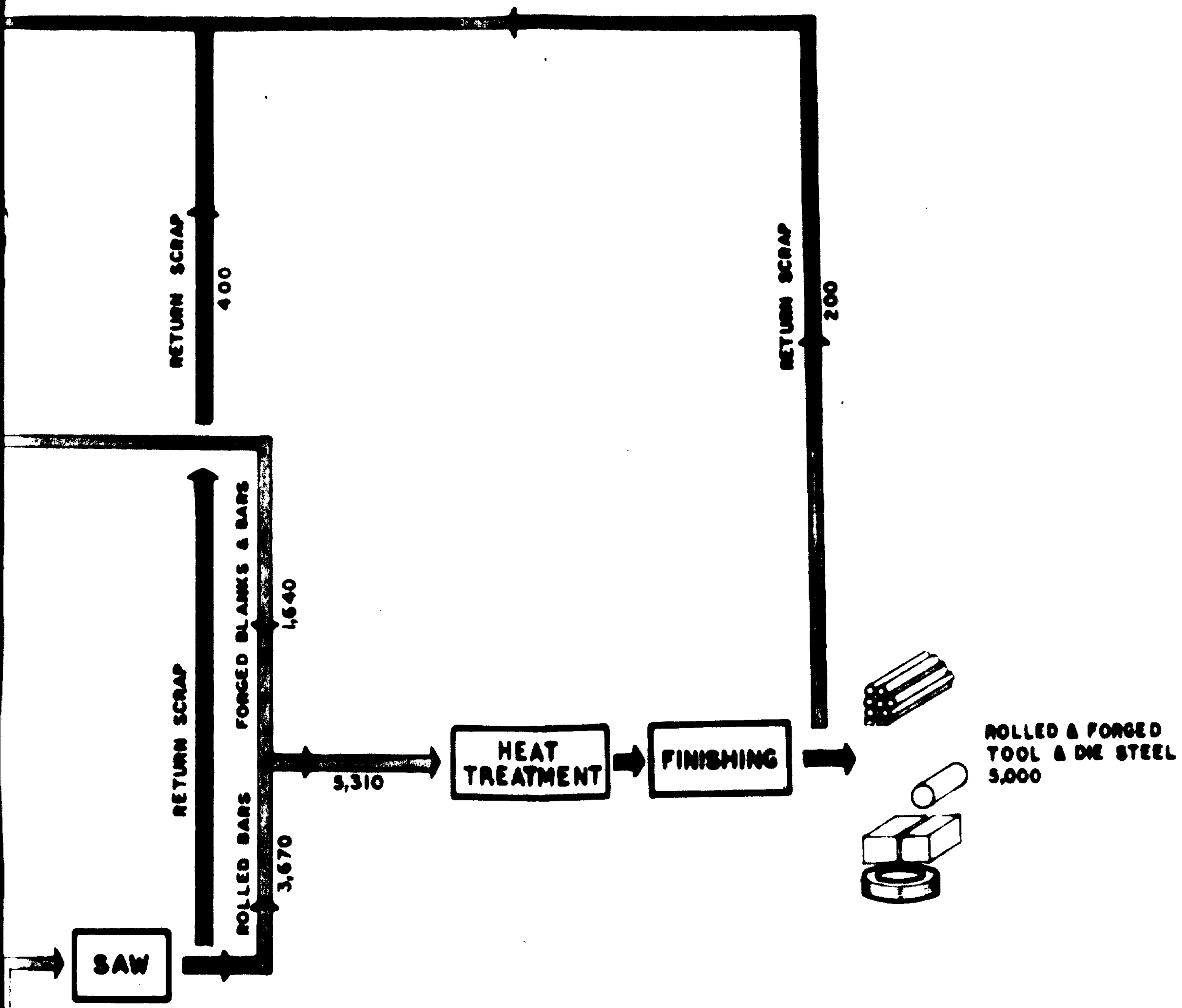


SECTION 2

NOTE: QUANTITIES ARE IN TONS/YEAR.


RETURN SCRAP
RETURN SCRAP
50
SEMIS & FINISHED FORGINGS
1,820
FINISHED FORGINGS FROM 1,000T PRESS
REHEATING FURNACE
FORGING
(2-TON HAMMER)
RETURN SCRAP
400
NDI-
NING
BILLETS
4,080
REHEATING FURNACE
ROLLING MILLS
(250 MM HAND OPERATED MILL)
SAW
RETURN SCRAP
FORGED BLANKS & BARS
1,640
ROLLED BARS
3,670
5,310
LIGHT SECTION BAR MILL OF STAGE-I

SECTION 3



SECTION 4

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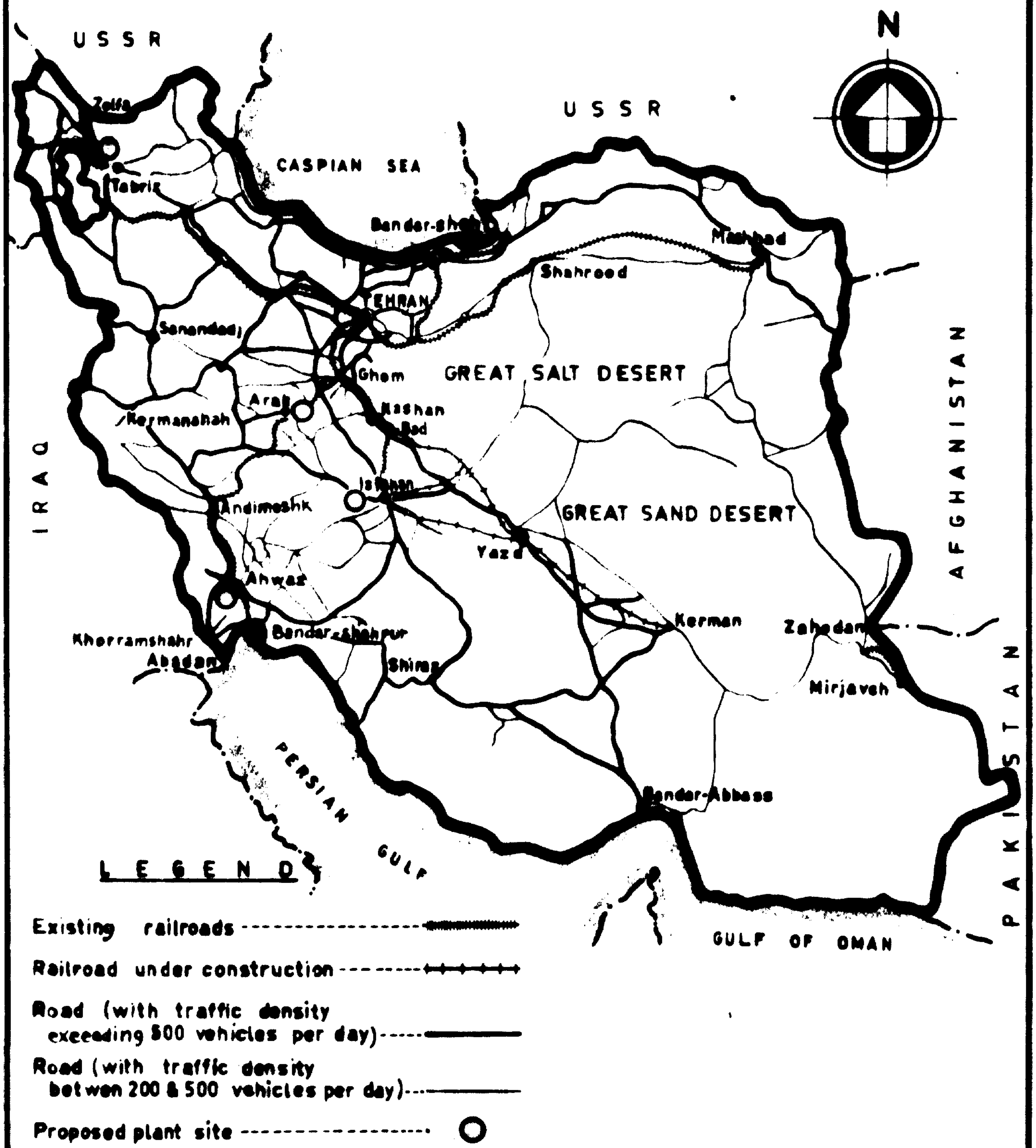
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—FLOW SHEET-STAGE II

DRAWN		9.12.69	No. 5131-V-2
APPROVED		15.12.69	



M. N. DASTUR & Co. PRIVATE LTD.
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FOR:
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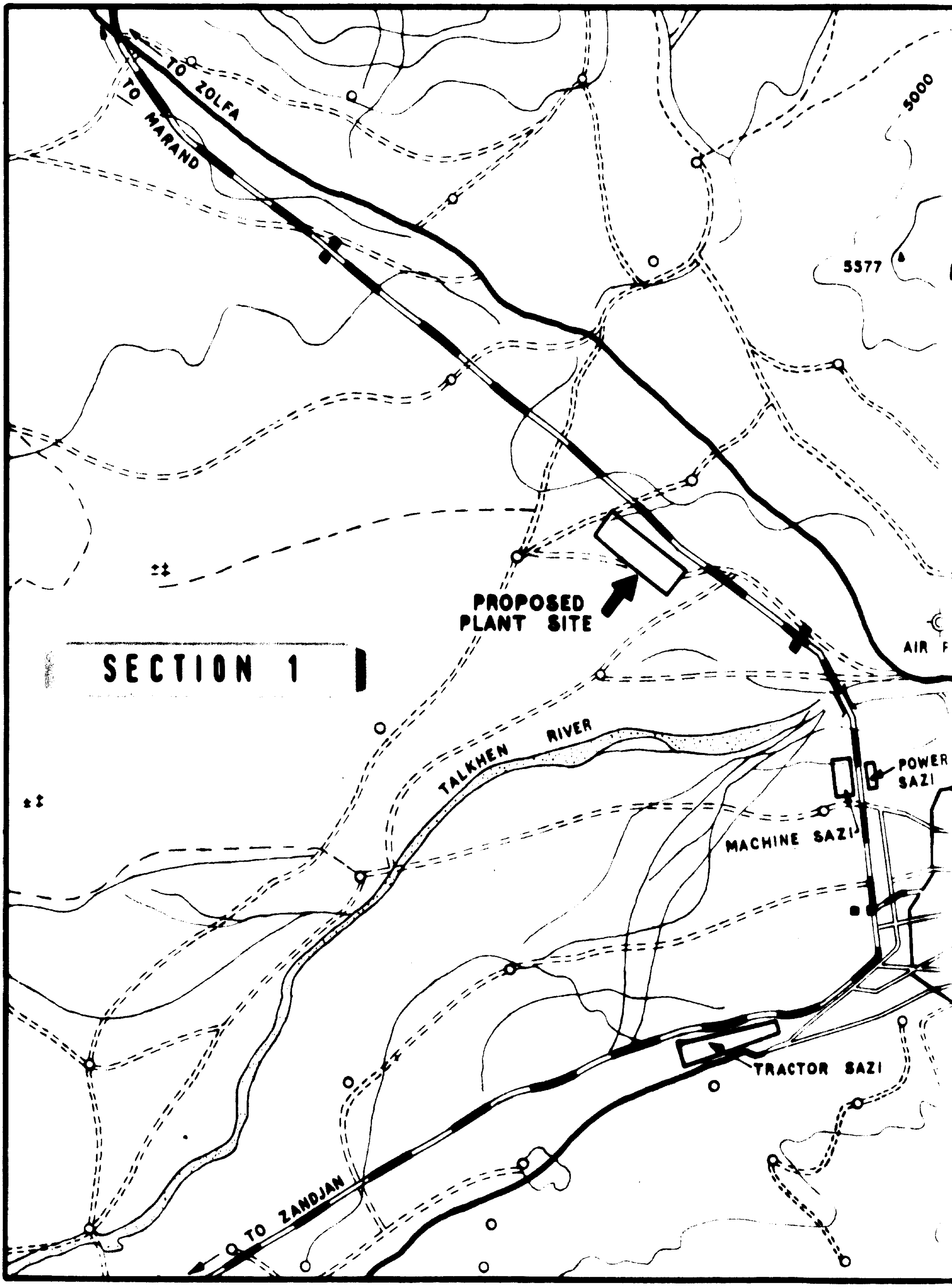
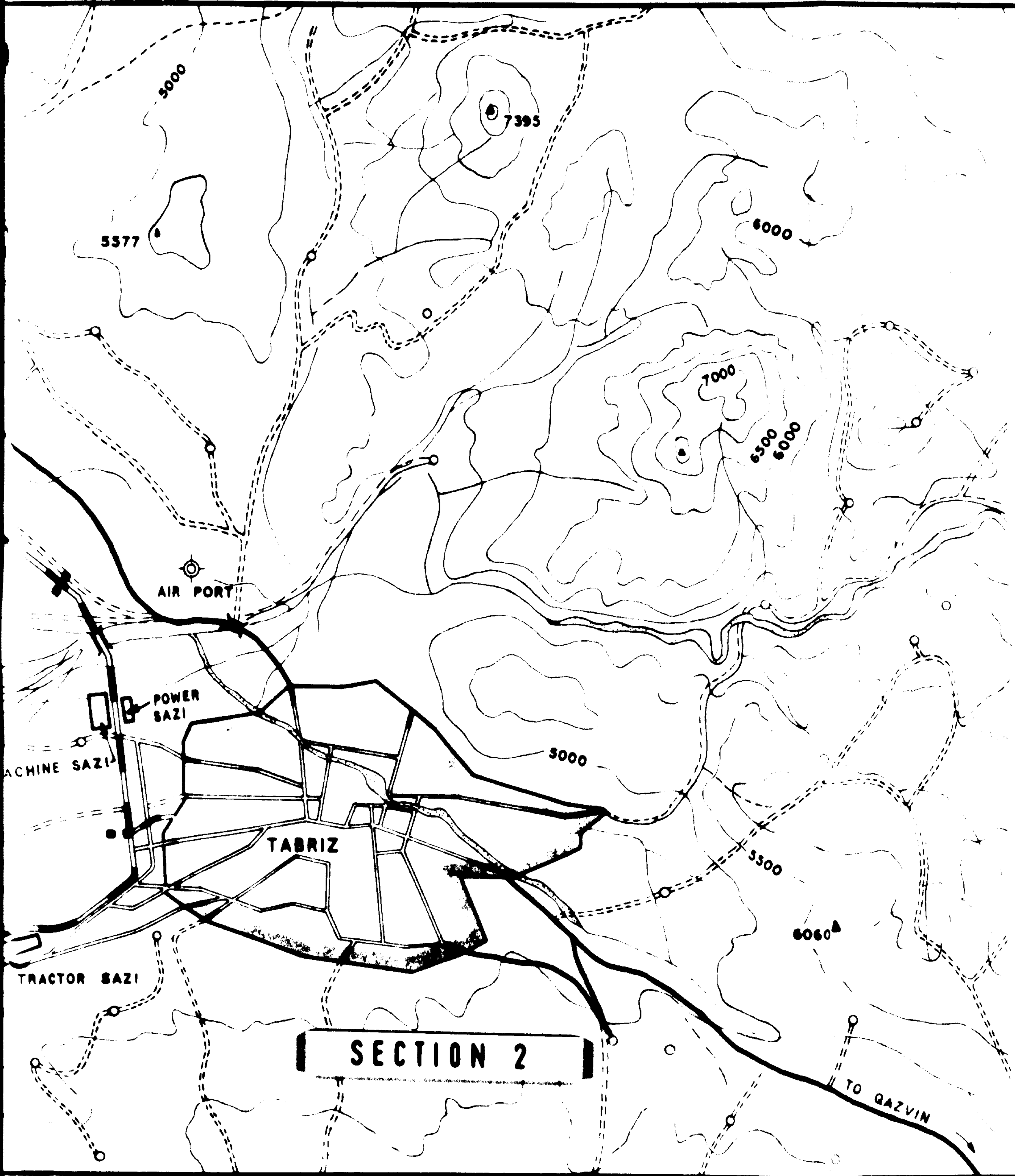
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEEL PLANT — MAP SHOWING
LOCATION OF VARIOUS PLANT SITES

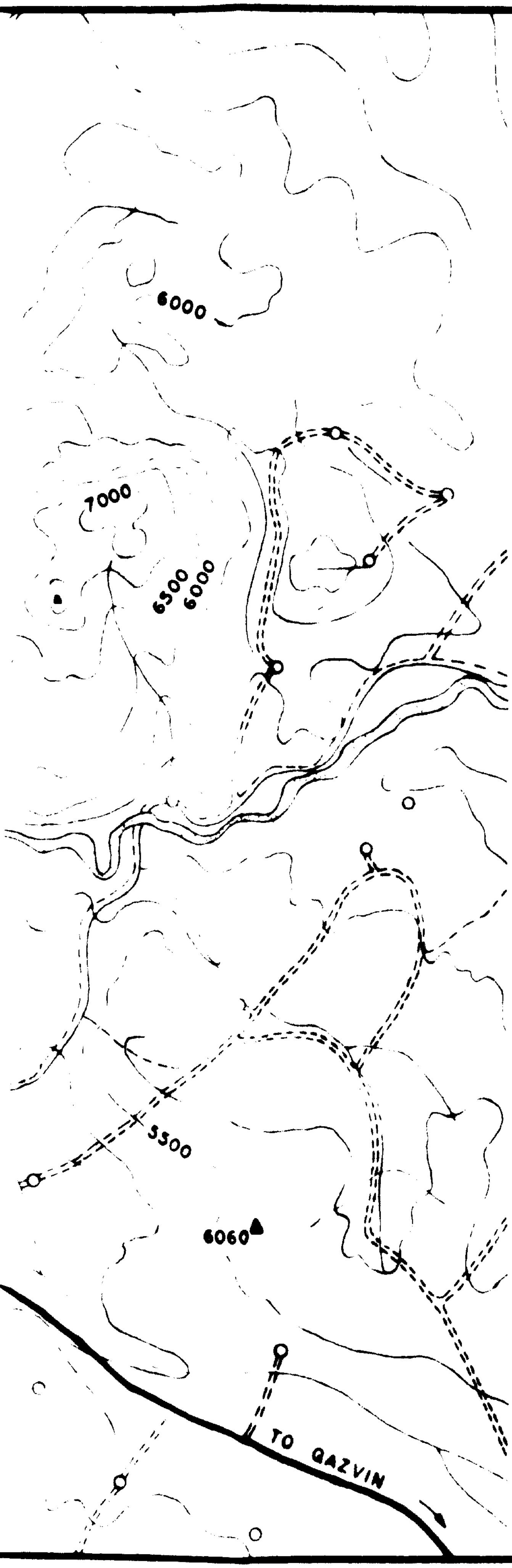
DRAWN		5.11.69.	No. 5131-V-3
APPROVED		11.11 69	

ARAK	ISFAHAN	AHWAZ
.6/day	$ 2.0/day	$ 2.0/day
to 8/day	$ 4 to 6/day	$ 2.7 to 4.8/day
/month	$ 350/month	$ 400/month
/month	$ 600/month	$ 670/month
.24/kg ($ 0.37 as erected)	$ 0.35/kg	$ 0.22/kg
/ton	$ 20/ton at site $ 18.5/ton at factory	$ 21/ton at Dorud plus transport cost
/1 000 bricks	Good quality bricks not available. These have to be purchased from Teheran	$ 26.5/1 000 bricks from Teheran $ 14.5/1 000 bricks local
./cu m	$ 1.6 to 2.3/cu m	$ 4.0/cu m washed ($ 2.6/cu m unwashed)
.1/cu m crushed	$ 1.6/cu m	$ 2.6 to 3.3/cu m
/cu m from USSR	$ 98.5/cu m from USSR	-
connected by rail and to Teheran, Isfahan, etc. No airport at .	Well connected by rail and road to all major towns such as Teheran, Ahwaz, Arak, Qom etc. Also airport at Isfahan for connections to Teheran and other cities	Very close to highway and railway connecting Khorramshahr & Abadan to Ahwaz and all cities north of Ahwaz. Ahwaz is also connected to Bandar Shahpur by road and railway. There is airport at Ahwaz for connection to Teheran and other major cities.
is known for grain & s. The present population is about 72 000. Hence ability of skilled labour other facilities will be oblem.	Isfahan is known as Manchester of Iran, with a large number of textile mills, hand operated looms & large carpet weaving establishment. With the setting up of Isfahan Steel Plant, several ancillary industries are expected to be set up. Isfahan has a population of about 425 000. Hence there should be no problem in regard to availability of labour. Proposed plant could share some of the facilities of the steel plant such as power, water, oxygen, maintenance shop facilities etc which would be readily available.	Ahwaz is an important railway junction of Khorramshahr-Teheran route. Ahwaz is the capital of Khuzistan which is potentially the richest area of Iran. Abadan, about 120 km away from Ahwaz has one of the world's biggest oil refineries. The present population of Ahwaz is about 200 000. With about 400 000 in Abadan, this area is expected to become the second biggest industrial centre in Iran next to Teheran. River Karun is navigable from Ahwaz to Khorramshahr and thus serves as an important alternative source of economical transport

SECTION 2


TO ZOLFA
TO MARAND
5000
5577
PROPOSED PLANT SITE
SECTION 1
AIR F
TALKHEN RIVER
POWER SAZI
MACHINE SAZI
TRACTOR SAZI
TO ZANDJAN


5000
7395
5577
6000
7000
6500
6000
AIR PORT
POWER SAZI
ACHINE SAZI
TABRIZ
5000
5500
6060
TRACTOR SAZI
SECTION 2
TO QAZVIN



N

LEGEND

MAIN ROADS	━━━
MAIN ROAD (WITHOUT ASPHALT)	═ ═ ═
ANIMAL ROAD	= = = = = =
RAILWAY TRACK	▬ ▬ ▬
RIVERS / NALLAS	≈
PLANT SITE	▭

SECTION 3

1 0 1 2 3 4 5

SCALE : KILOMETRES

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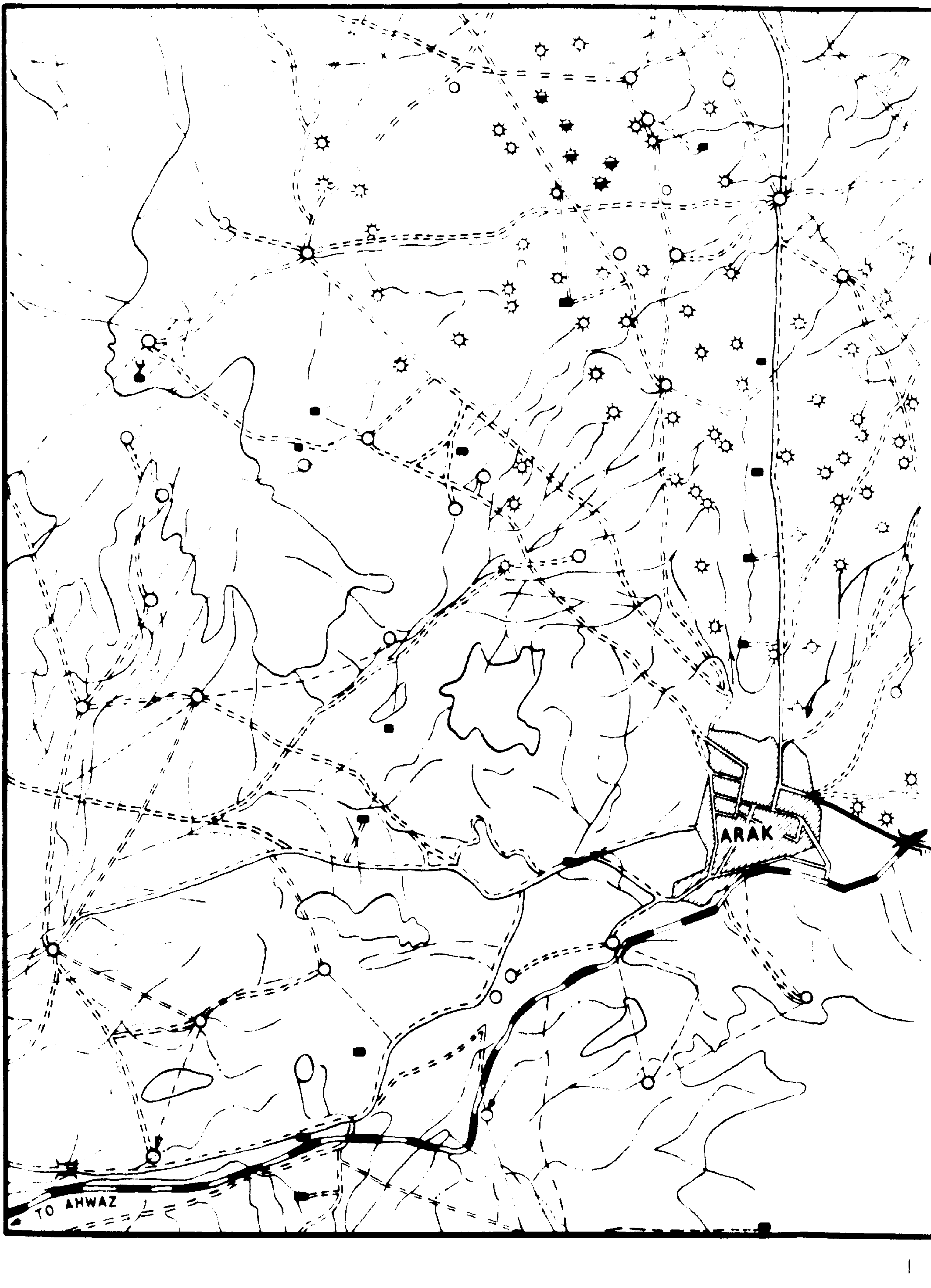
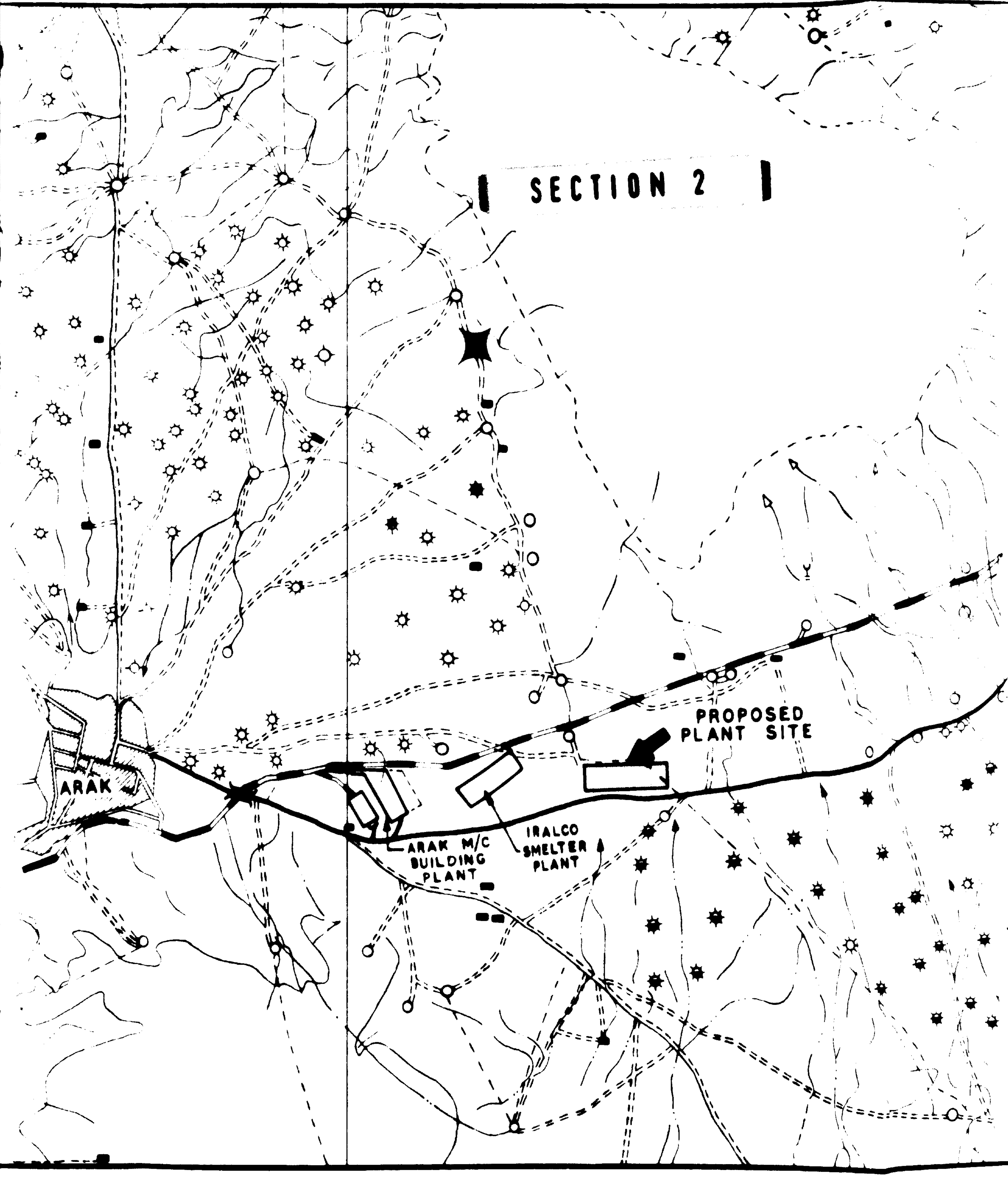
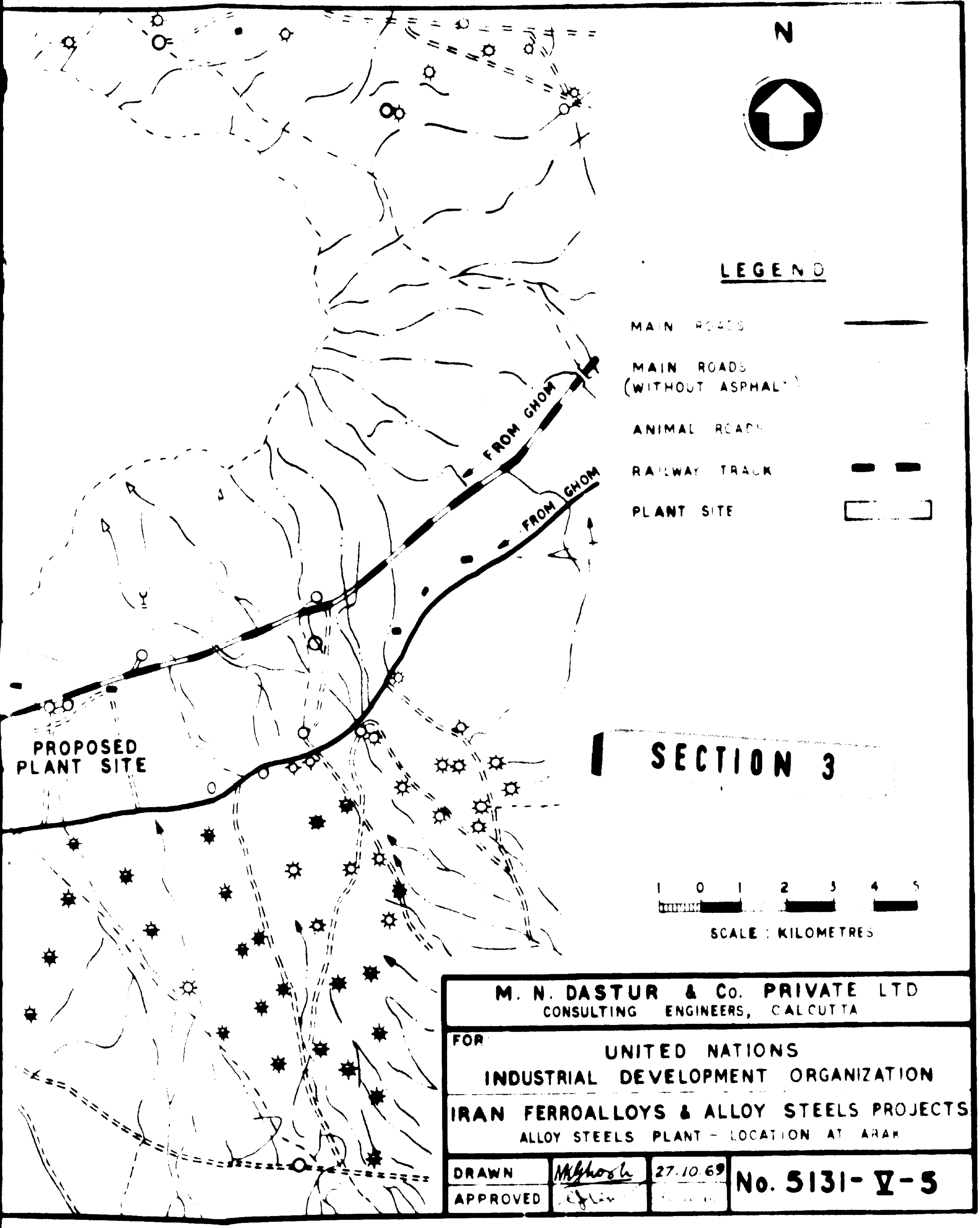
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—LOCATION AT TABRIZ

DRAWN	M Ghosh	24.11.69	No. 5131 - V - 4
APPROVED		28 11 69	

SECTION 1




SECTION 2
PROPOSED PLANT SITE
ARAK
ARAK M/C BUILDING PLANT
IRALCO SMELTER PLANT



SECTION 3

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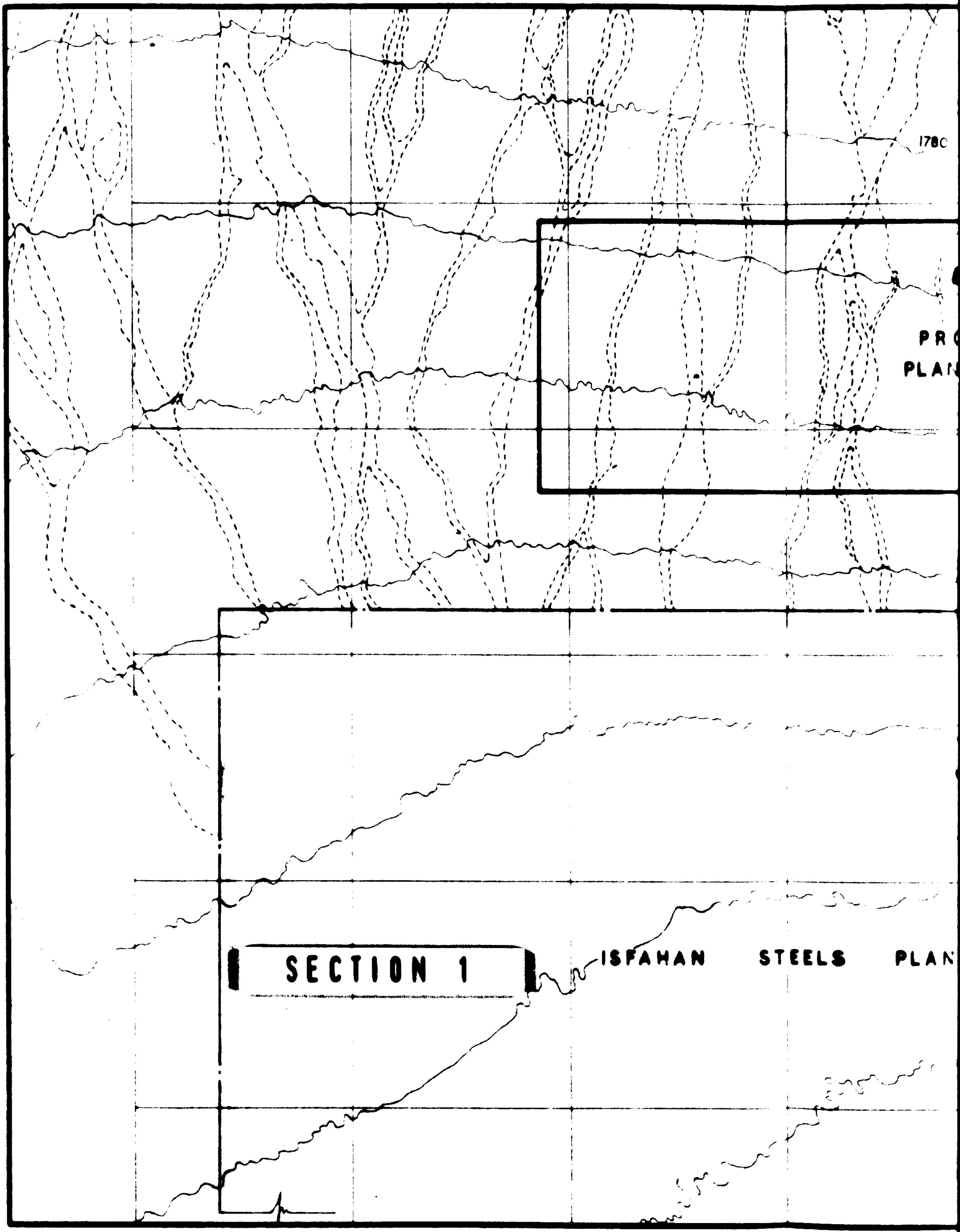
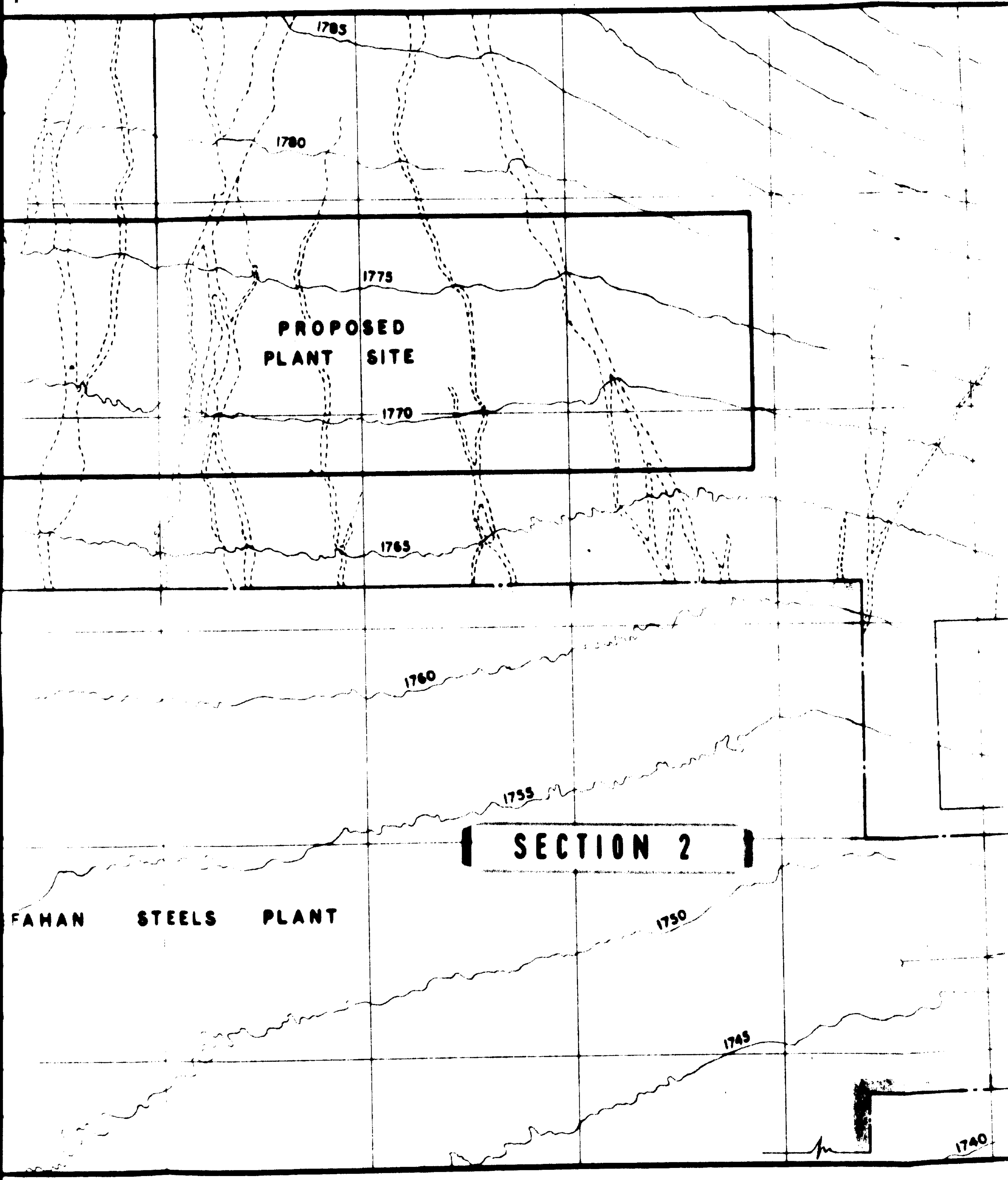
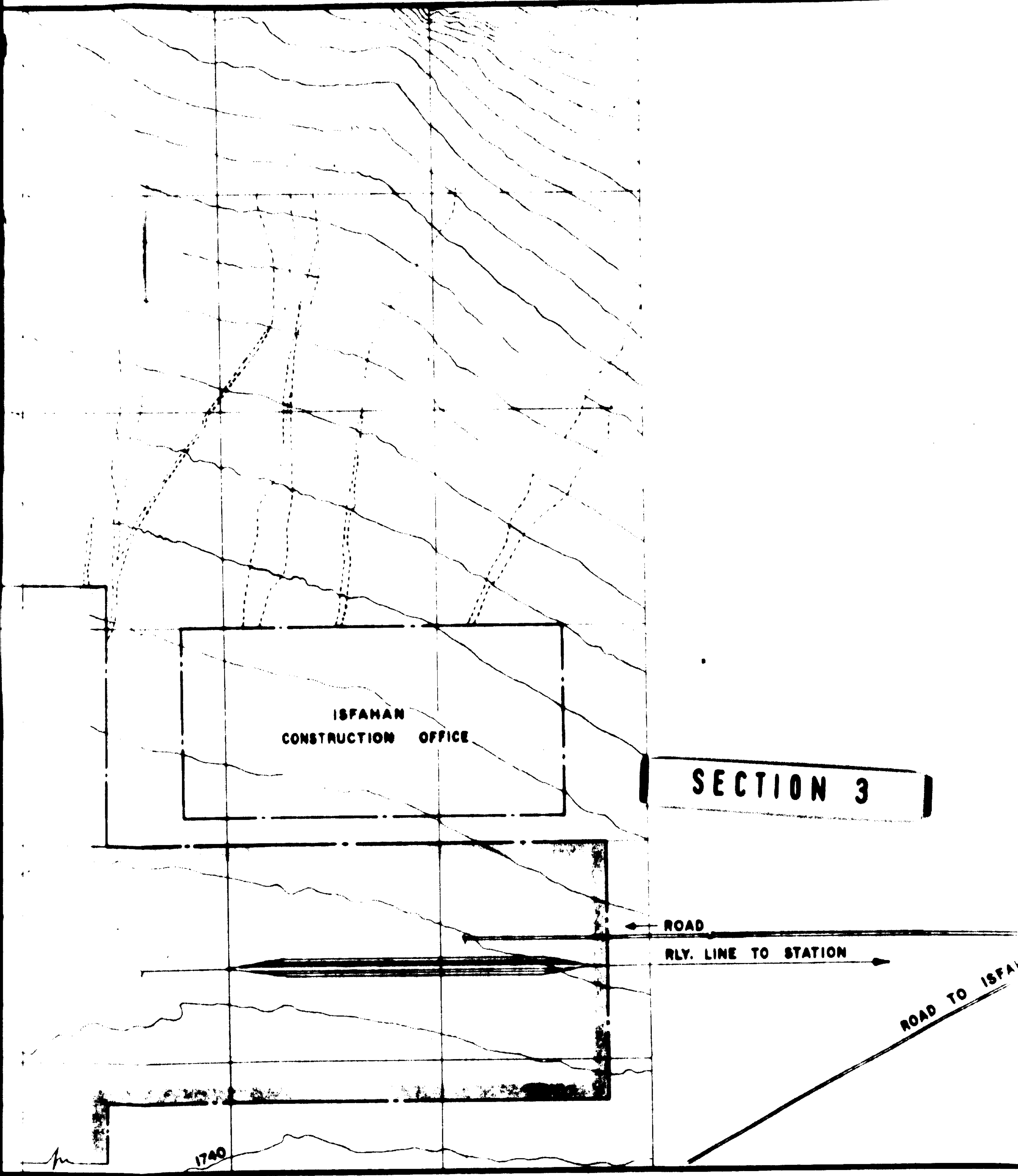
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT - LOCATION AT ARAK

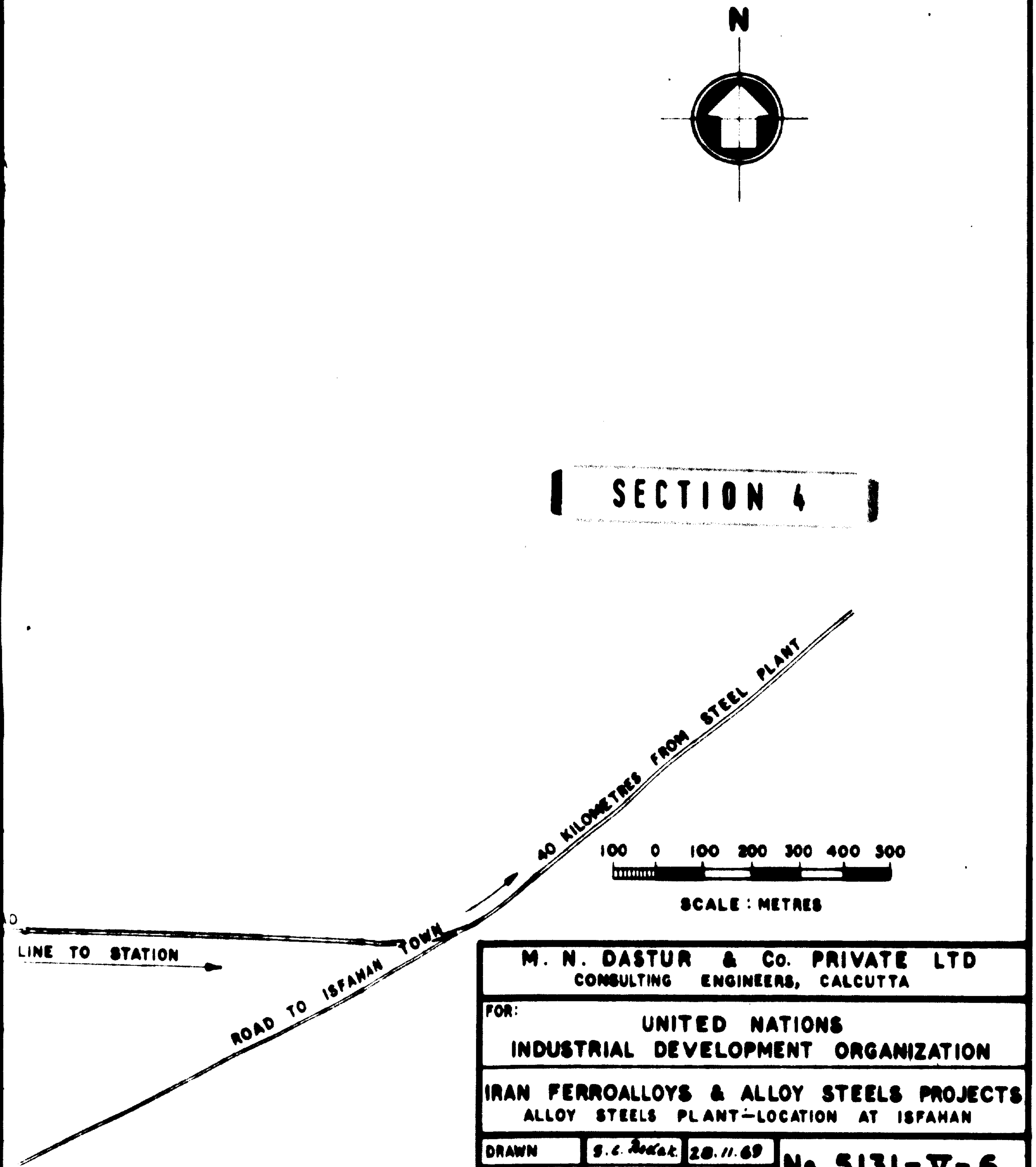
DRAWN	MKGhosh	27.10.69	No. 5131-V-5
APPROVED			


1780
PR
PLAN
SECTION 1
ISFAHAN STEELS PLAN


1785
1780
1775
PROPOSED
PLANT SITE
1770
1765
1760
1755
SECTION 2
FAHAN STEELS PLANT
1750
1745
1740


ISFAHAN
CONSTRUCTION OFFICE
SECTION 3
ROAD
RLY. LINE TO STATION
ROAD TO ISFA
1740

SECTION 4



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IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—LOCATION AT ISFAHAN

DRAWN	S.C. Kodak.	28.11.69
APPROVED		4.12.69

No. 5131-V-6

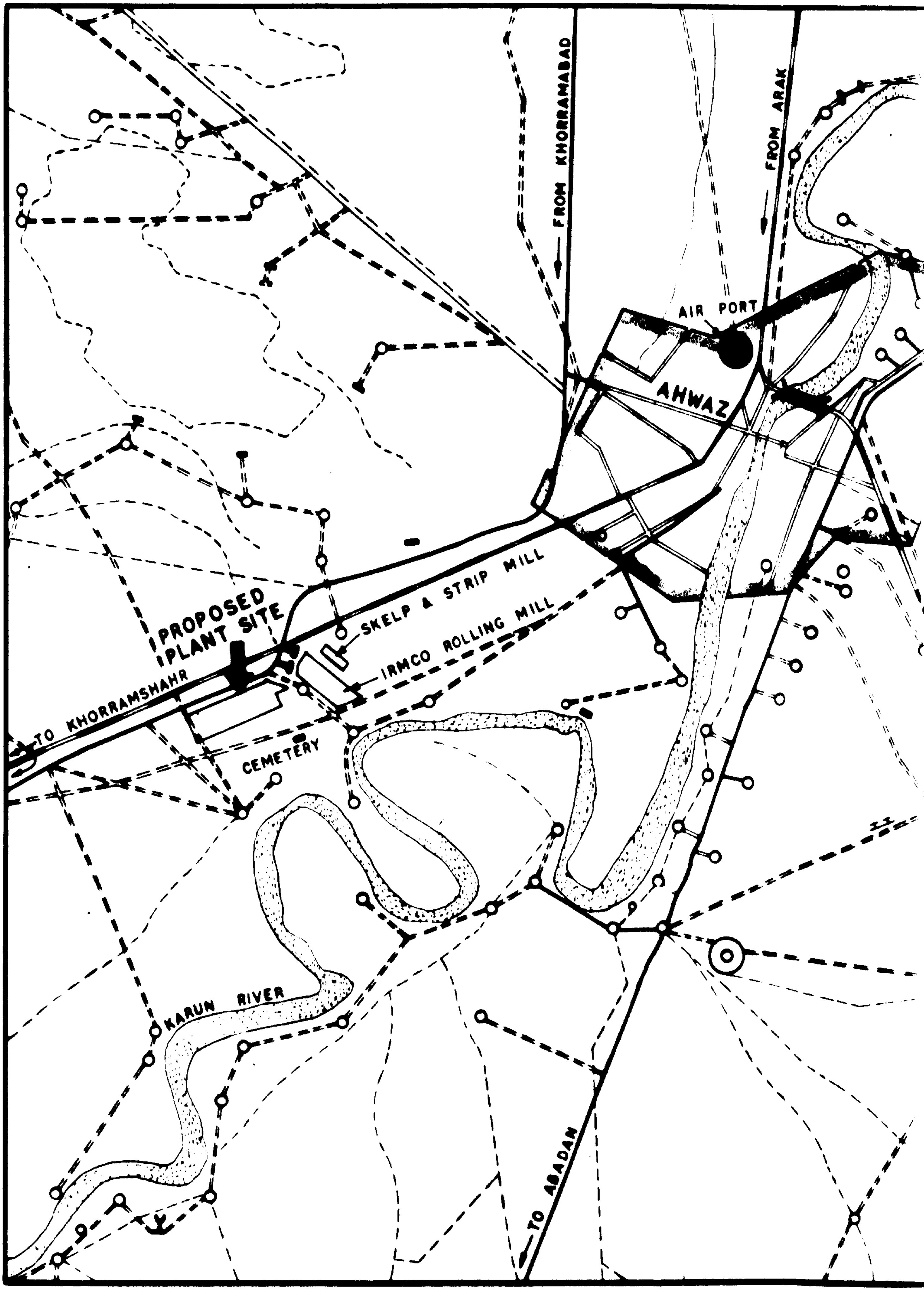
Appendix -

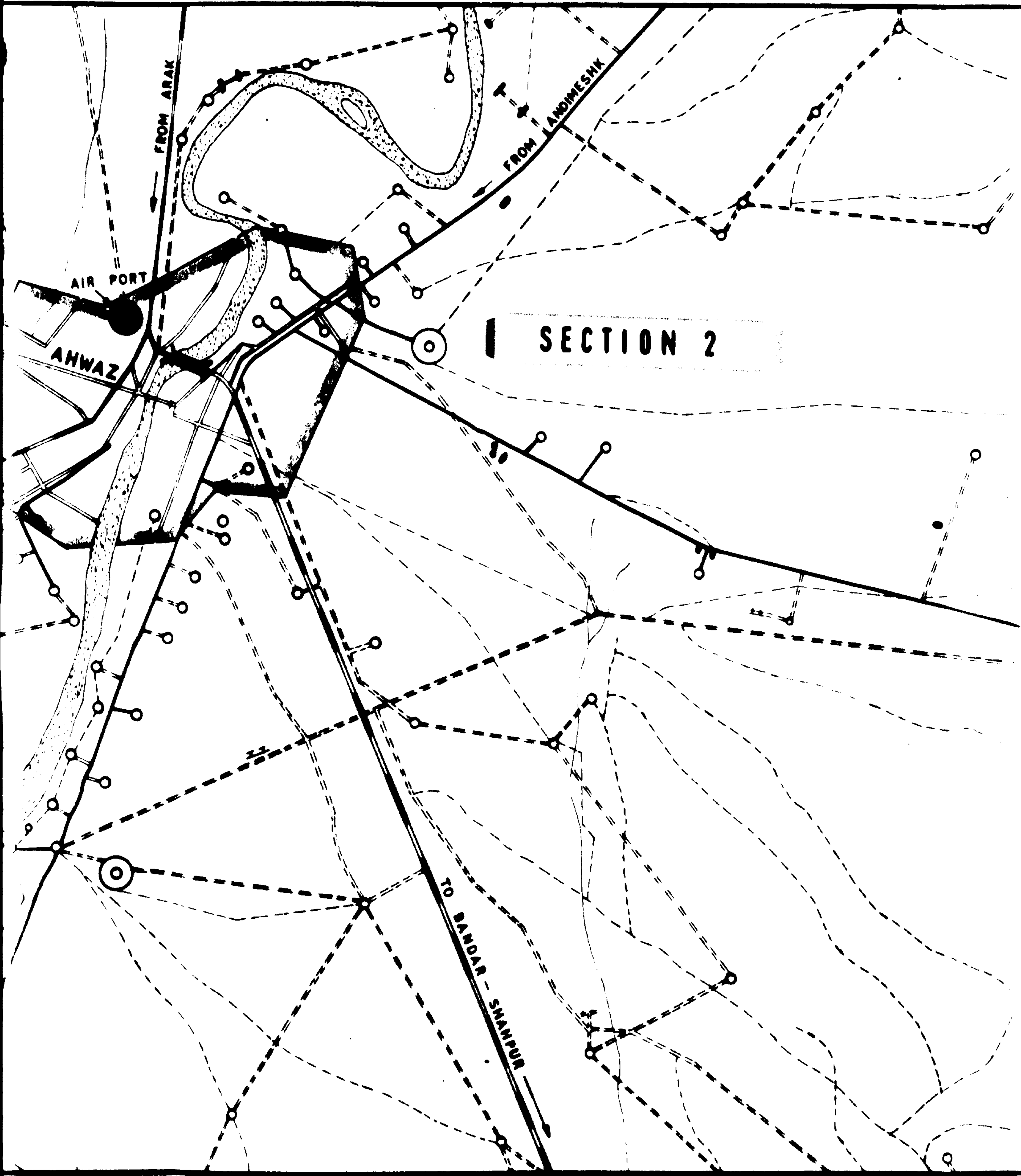
FACTORS AFFECTING CAPITAL INVESTMENT AT V

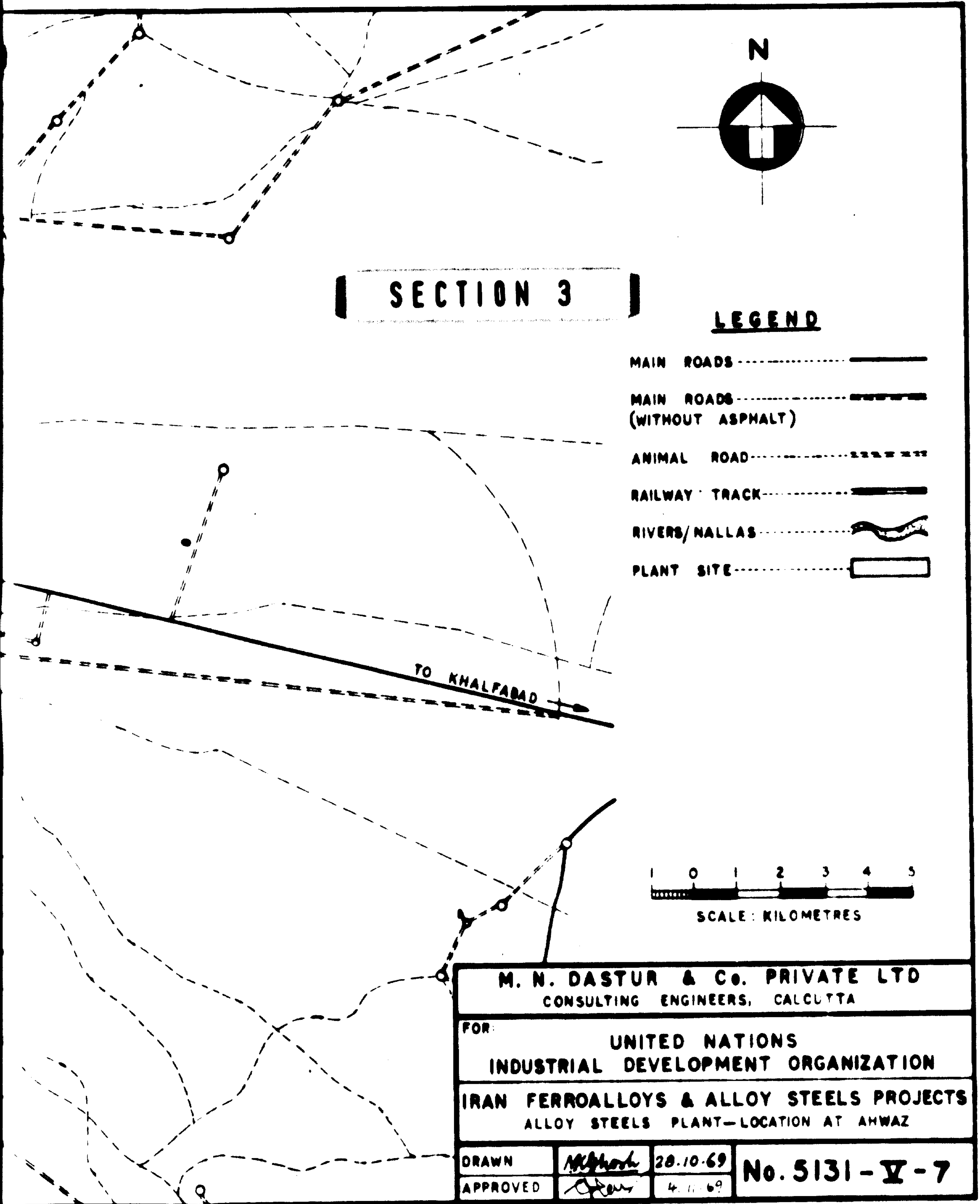
		TABRIZ	ARAK
1.	Land ..	$ 0.9 to 1.2 per sq m	$ 0.50 per sq m
2.	Site preparation ..	Nominal	Slightly higher than tho other sites
3.	Construction cost ..	High compared to other locations	In-between cost for Tabr Ahwas
4.	Water supply ..	High cost due to number of wells to be dug	High cost due to number wells to be dug
5.	Power supply ..	At all sites power will be purchased at either 33 kV or 20	
6.	Railway siding ..	Lowest; about 1 km of siding	Highest; about 4 km of s
7.	Approach road ..	High; about 3 to 4 km of road with over bridge or level crossing	Low; about 1/2 km road existing Arak-Qom road
8.	Rail transport cost for imported equipment and material from Khorramshahr	Distance about 1 640 km. Freight about $ 20/ton.	Distance about 620 km. Freight about $ 10/ton
9.	Township ..	Tabriz about 10 km from the plant, hence no township	Arak about 10 km from t but due to limited av of skilled labour and enced engineers, towns be necessary

SECTION 1

SECTION 1


FROM KHORRAMABAD
FROM ARAK
AIR PORT
AHWAZ
PROPOSED PLANT SITE
SKELP & STRIP MILL
IRMCO ROLLING MILL
TO KHORRAMSHAHR
CEMETERY
KARUN RIVER
TO ABADAN


FROM ARAK
FROM ANDIMESHK
AIR PORT
AHWAZ
SECTION 2
TO BANDAR-SHAHPUR



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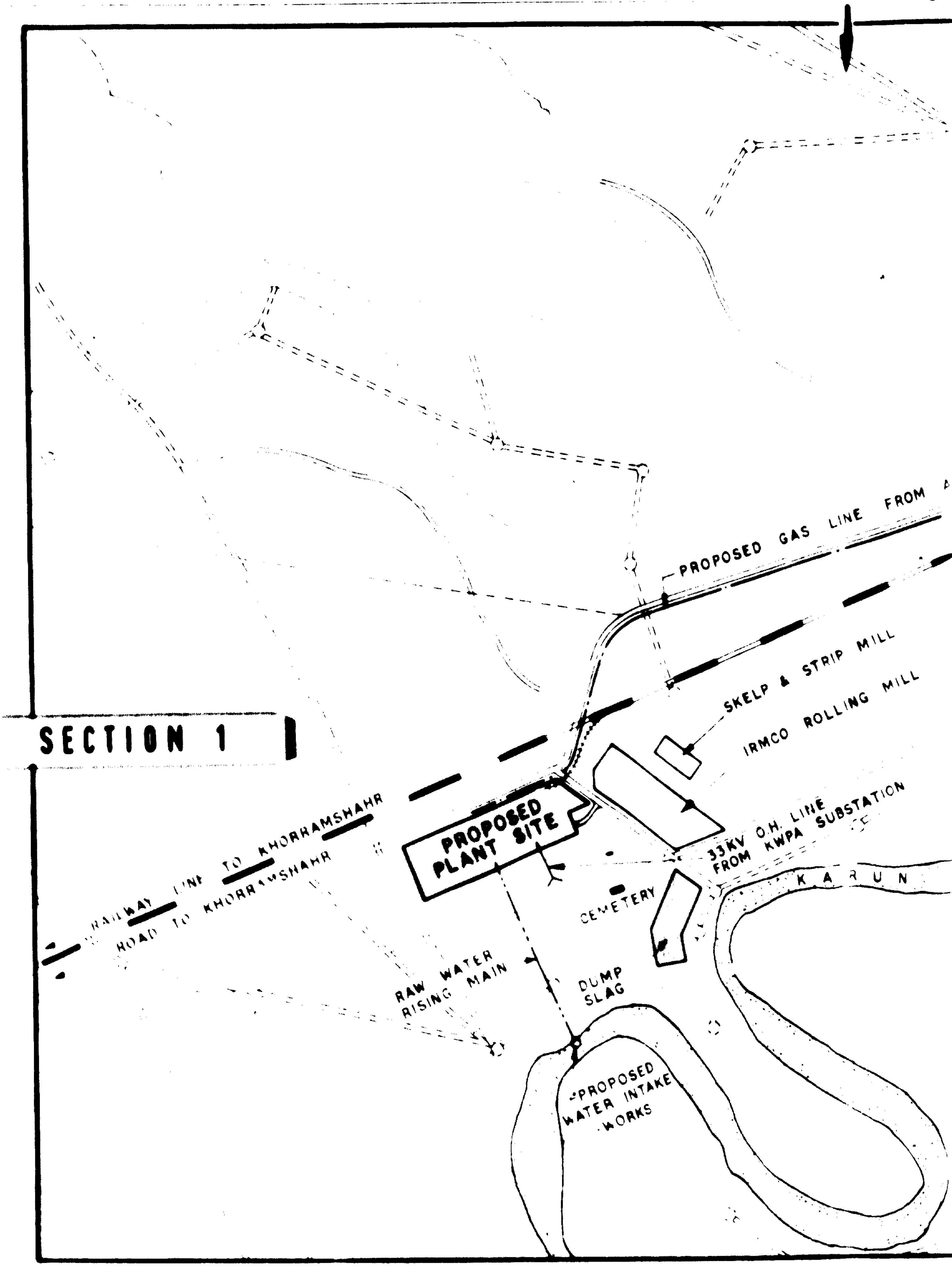
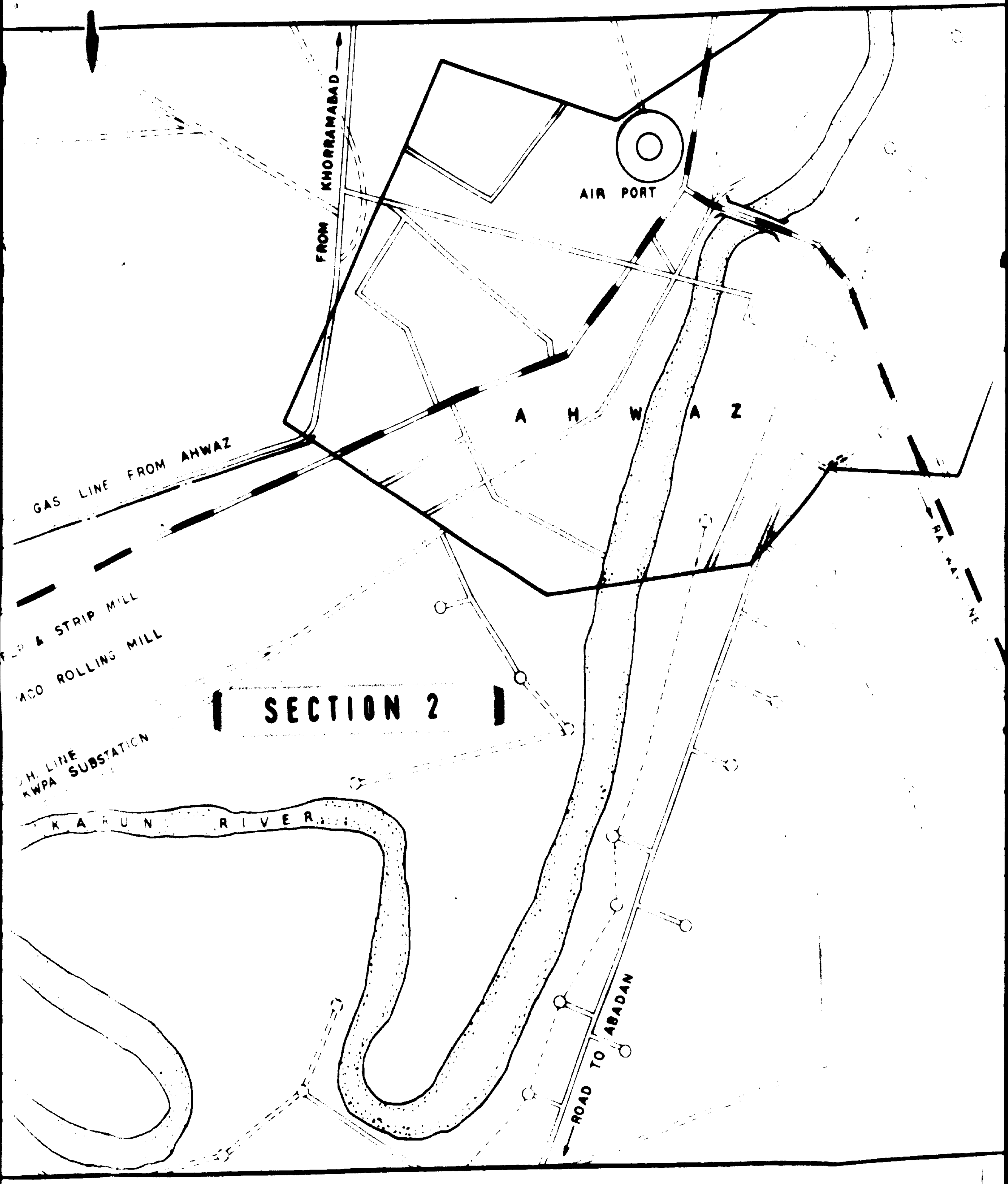
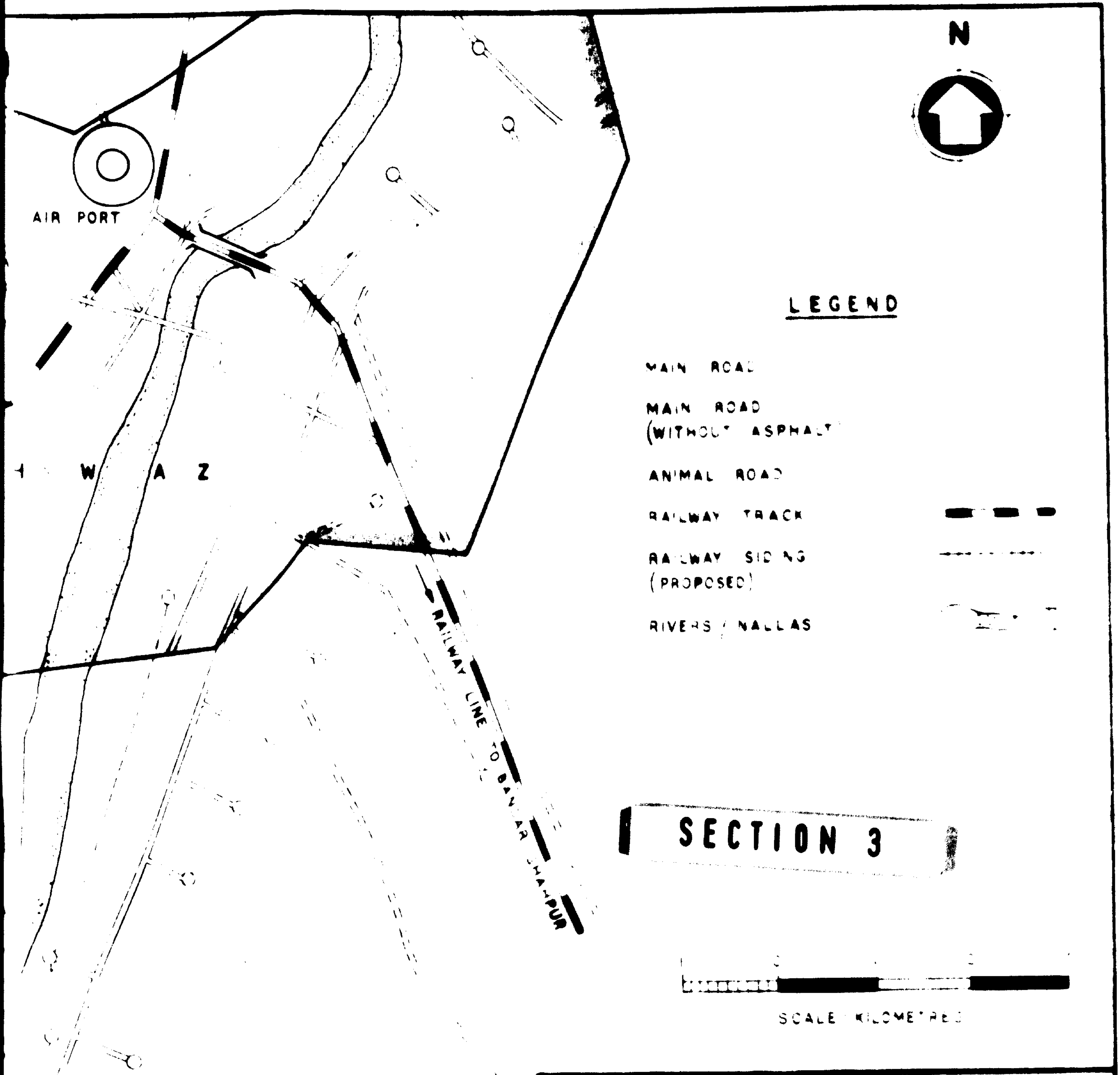
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—LOCATION AT AHWAZ

DRAWN		28.10.69
APPROVED		4.11.69

No. 5131 - V - 7


SECTION 1
PROPOSED GAS LINE FROM A
SKELP & STRIP MILL
IRMCO ROLLING MILL
RAILWAY LINE TO KHORRAMSHAHR
ROAD TO KHORRAMSHAHR
PROPOSED PLANT SITE
33KV O.H. LINE FROM KWPA SUBSTATION
KARUN
CEMETERY
RAW WATER RISING MAIN
DUMP SLAG
PROPOSED WATER INTAKE WORKS


FROM KHORRAMABAD
AIR PORT
A H W A Z
GAS LINE FROM AHWAZ
LP & STRIP MILL
MCO ROLLING MILL
SECTION 2
H. LINE
KWPA SUBSTATION
KARUN RIVER
ROAD TO ABADAN
RAILWAY LINE



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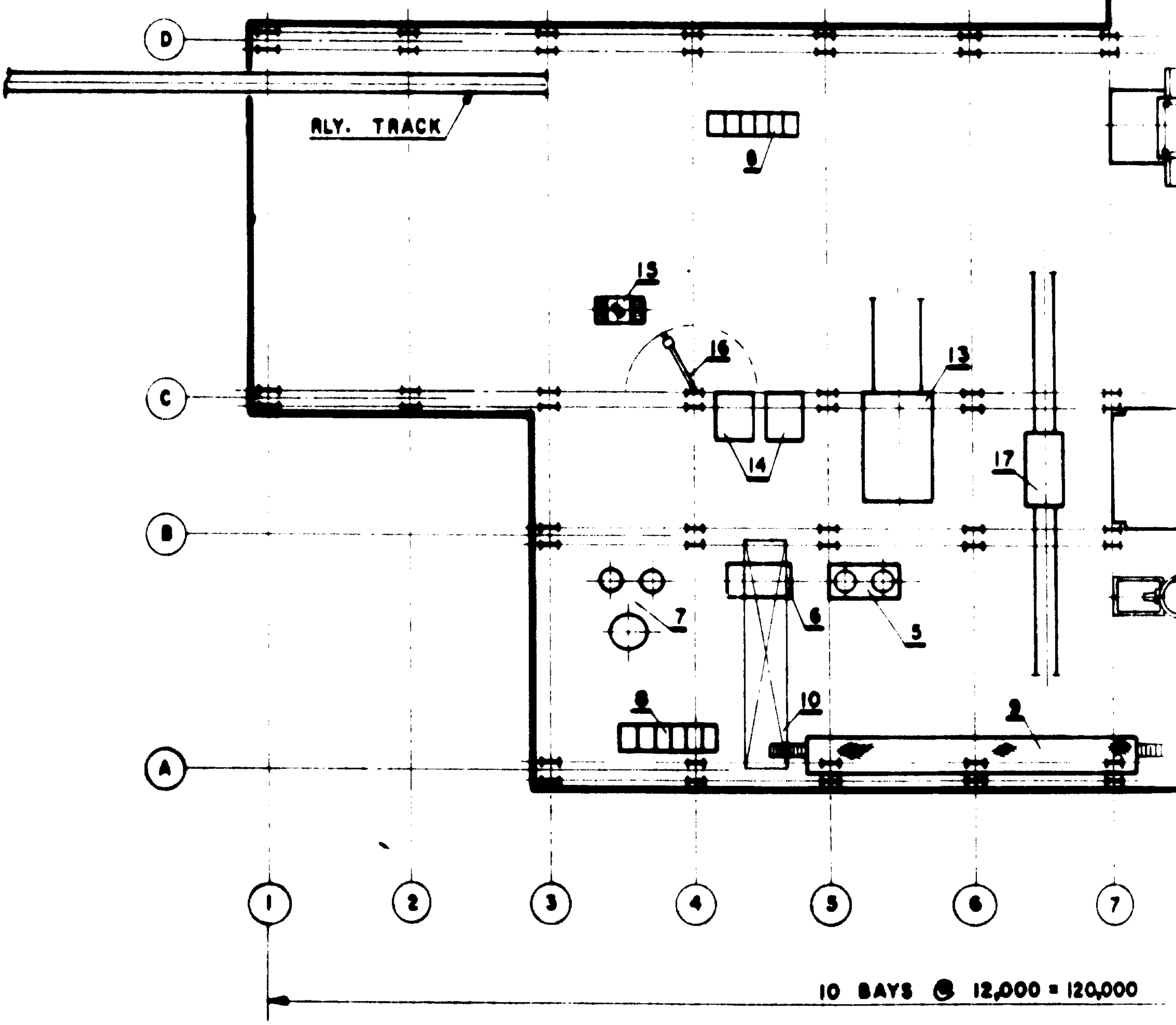
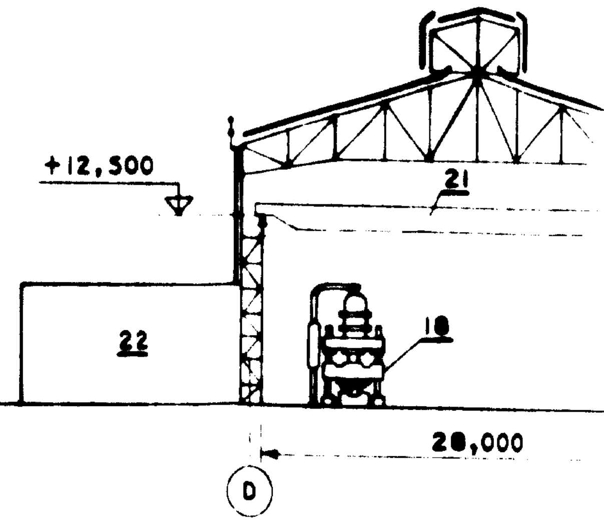
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT - AHWAZ SITE PLAN

DRAWN 29.11.69
APPROVED

No. 5131-V-8


D
C
B
A
RLY. TRACK
9
15
16
13
14
17
7
6
5
10
8
2
1
2
3
4
5
6
7
10 BAYS @ 12,000 = 120,000

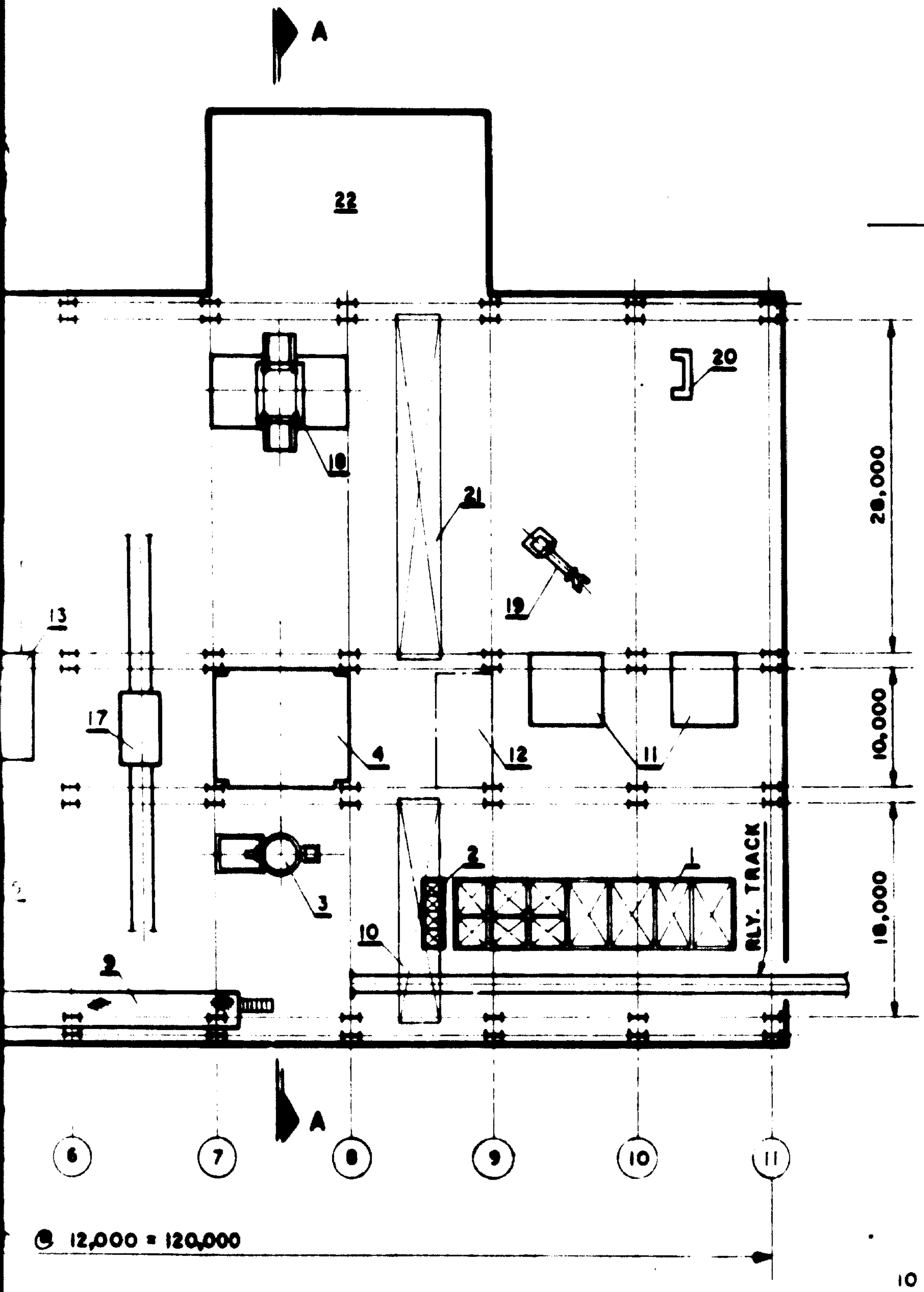
SECTION 1



SE

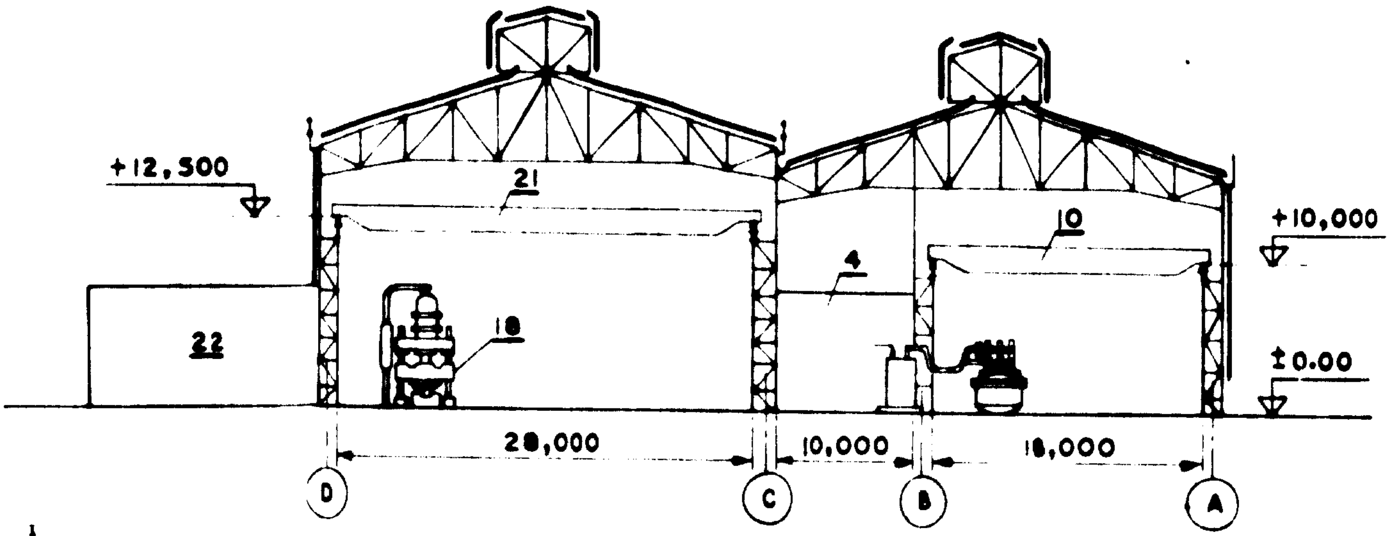
L

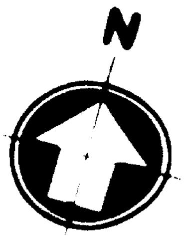
1. SCRAP BINS
2. ADDITIONS BINS
3. 6-TON ELEC. ARC FURNAC
4. TRANSFORMER ROOM
5. LADLE PREHEATING STN.
6. STOPPER ROD OVEN
7. LADLE & ROOF RELINING
8. COOLING BOXES
9. TEEMING PLATFORM
10. 10/5-TON E.O.T CRANE
11. REHEATING FCES. FOR PR



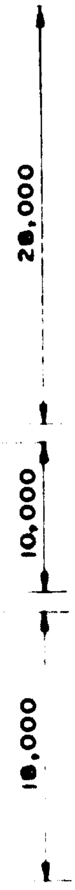
SECTION 2

SCALE : METRES





SECTION A-A



L E G E N D

1. SCRAP BINS
2. ADDITIONS BINS
3. 6-TON ELEC. ARC FURNACE
4. TRANSFORMER ROOM
5. LADLE PREHEATING STN.
6. STOPPER ROD OVEN
7. LADLE & ROOF RELINING
8. COOLING BOXES
9. TEEMING PLATFORM
10. 10/5-TON E.O.T CRANE
11. REHEATING FCES. FOR PRESS
12. FERROALLOY & ELECTRODE STORAGE
13. PREHEATING & ANNEALING FURNACE
14. REHEATING FURNACES FOR HAMMER
15. 2-TON HAMMER
16. JIB CRANE
17. TRANSFER TROLLEY
18. 1000-TON PRESS
19. FURNACE CHARGER
20. STAND FOR CHAIN TURNING GEAR
21. 30/10-TON E.O.T CRANE
22. HYDRAULIC STATION

SECTION 3

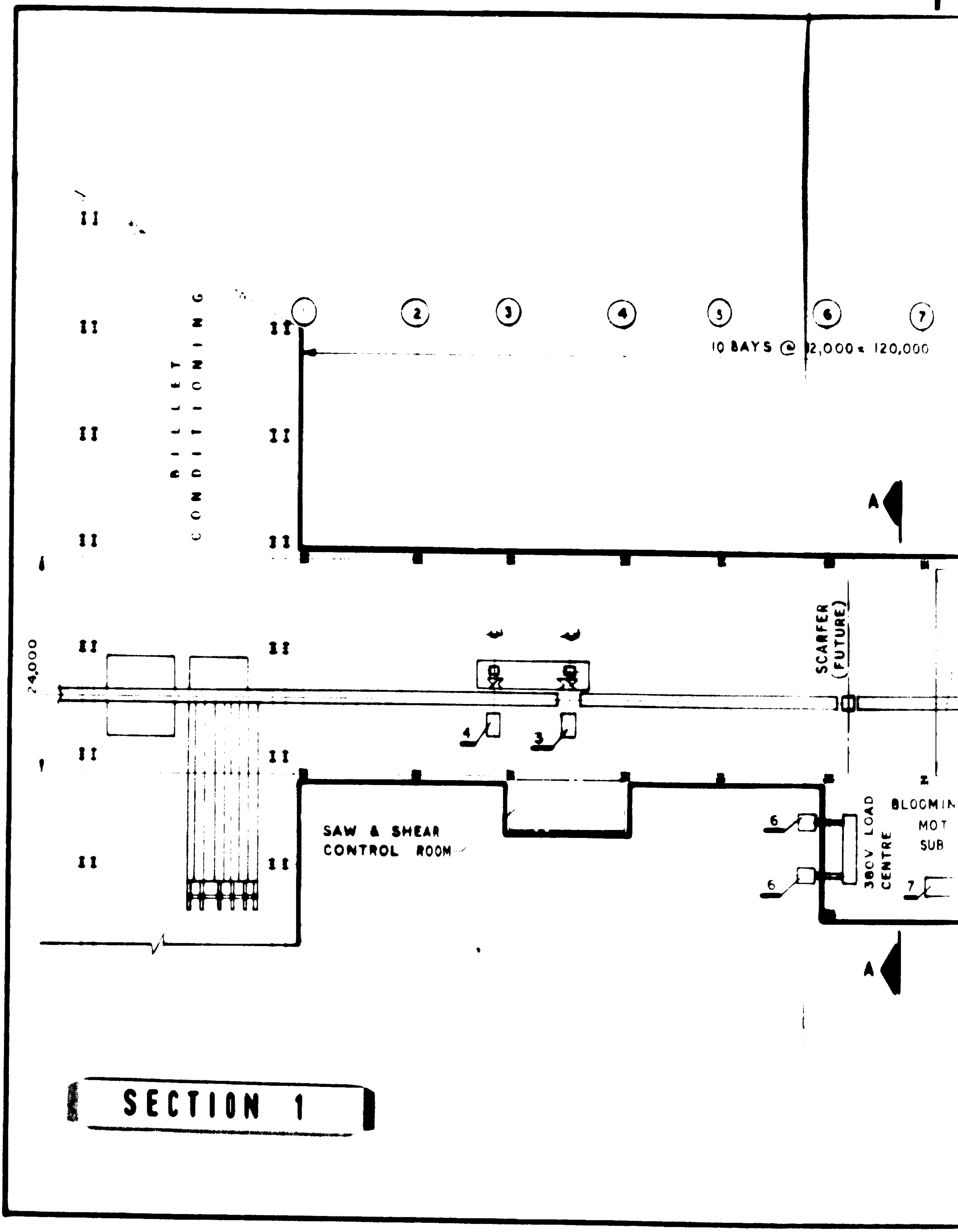
SCALE: METRES

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEEL PLANT — STEELMELT/ FORGE SHOP LAYOUT (STAGE II)

DRAWN	S. C. Bodur	5.11.69	No. 5131-V-11
APPROVED		11.11.69	


BILLET CONDITIONING
1
2
3
4
5
6
7
10 BAYS @ 12,000 = 120,000
A
24,000
SCARFER (FUTURE)
4
3
SAW & SHEAR CONTROL ROOM
6
6
380V LOAD CENTRE
BLOOMIN
MOT
SUB
7
A

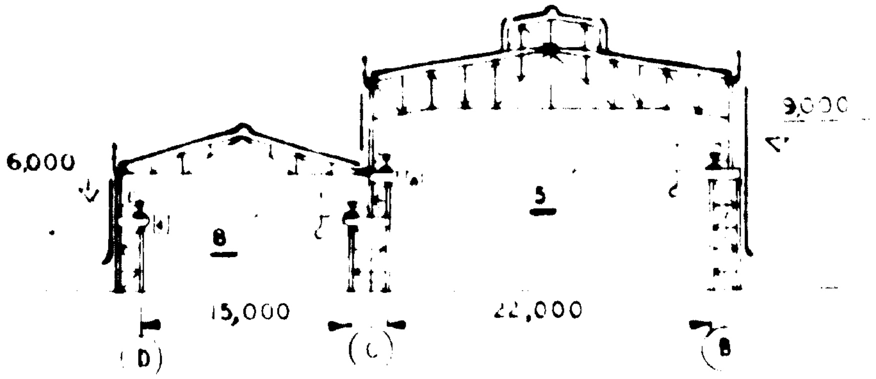
SECTION 1

Appendix - 26-2

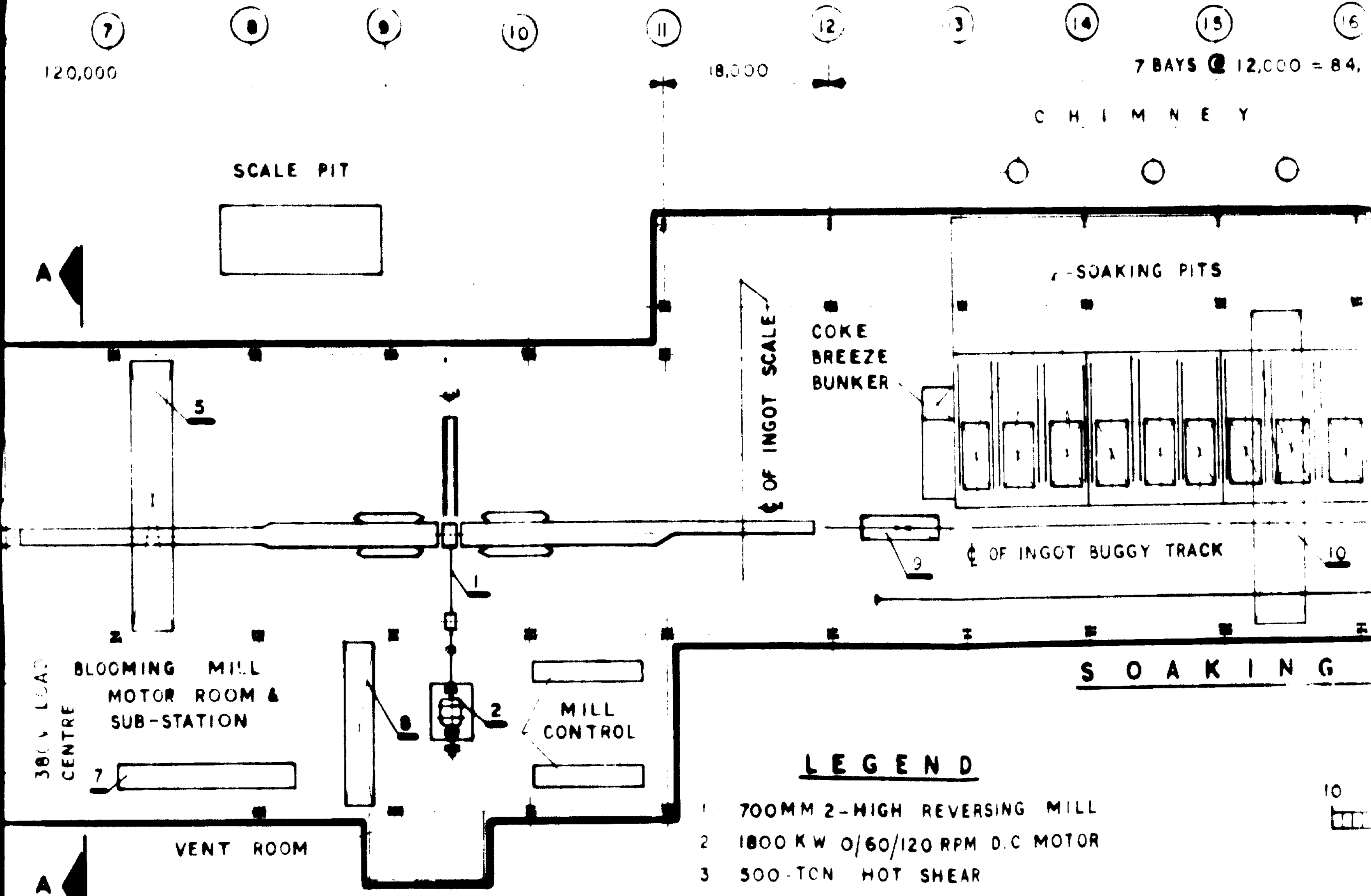
INVESTMENT AT VARIOUS SITES UNDER CONSIDERATION

ARAK	ISFAHAN	AHWAZ
r sq m	-	$ 0.50 per sq m
higher than those at ites	Nominal	Nominal
n cost for Tabris and	In-between cost for Tabris and Ahwas	Low compared to other locations
due to number of o be dug	Higher compared to Ahwas due to longer pipeline	Low compared to other locations
r 33 kV or 20 kV and there	would not be appreciable difference	in plant power distribution cost
about 4 km of siding	Midway; about 2.5 km of siding	Midway; about 2 km of siding
t 1/2 km road from the Arak-Qom road	High; about 3 km of road from the existing Isfahan-Shaherkow road	Low; about 1/2 km from the existing Ahwas-Khorramshahr road
about 620 km. out $ 10/ton	Distance about 1 240 km (by rail). Freight about $ 20/ton.	Distance about 120 km. Freight $ 2.0/ton.
10 km from the plant, to limited availability led labour and experi- gineers, township will ssary	Isfahan about 40 km from the plant; hence a township will be necessary	Ahwas about 10 km from the plant. With availability of adequate skilled labour, no township is necessary

SECTION 2



SECTION A-A



BLOOMING MILL

SECTION 2

LEGEND

1	700MM 2-HIGH REVERSING MILL
2	1800 KW 0/60/120 RPM D.C MOTOR
3	500-TON HOT SHEAR
4	HOT SAW
5.	40-TON E.O.T CRANE
6	TRANSFORMER
7.	6KV SWITCHING STATION
8	15-TON E.O.T CRANE
9.	INGOT BUGGY
10.	3/20-TON E.O.T SOAKER CRANE
11	COOLING PITS
12	FURNACE

M. N

FOR

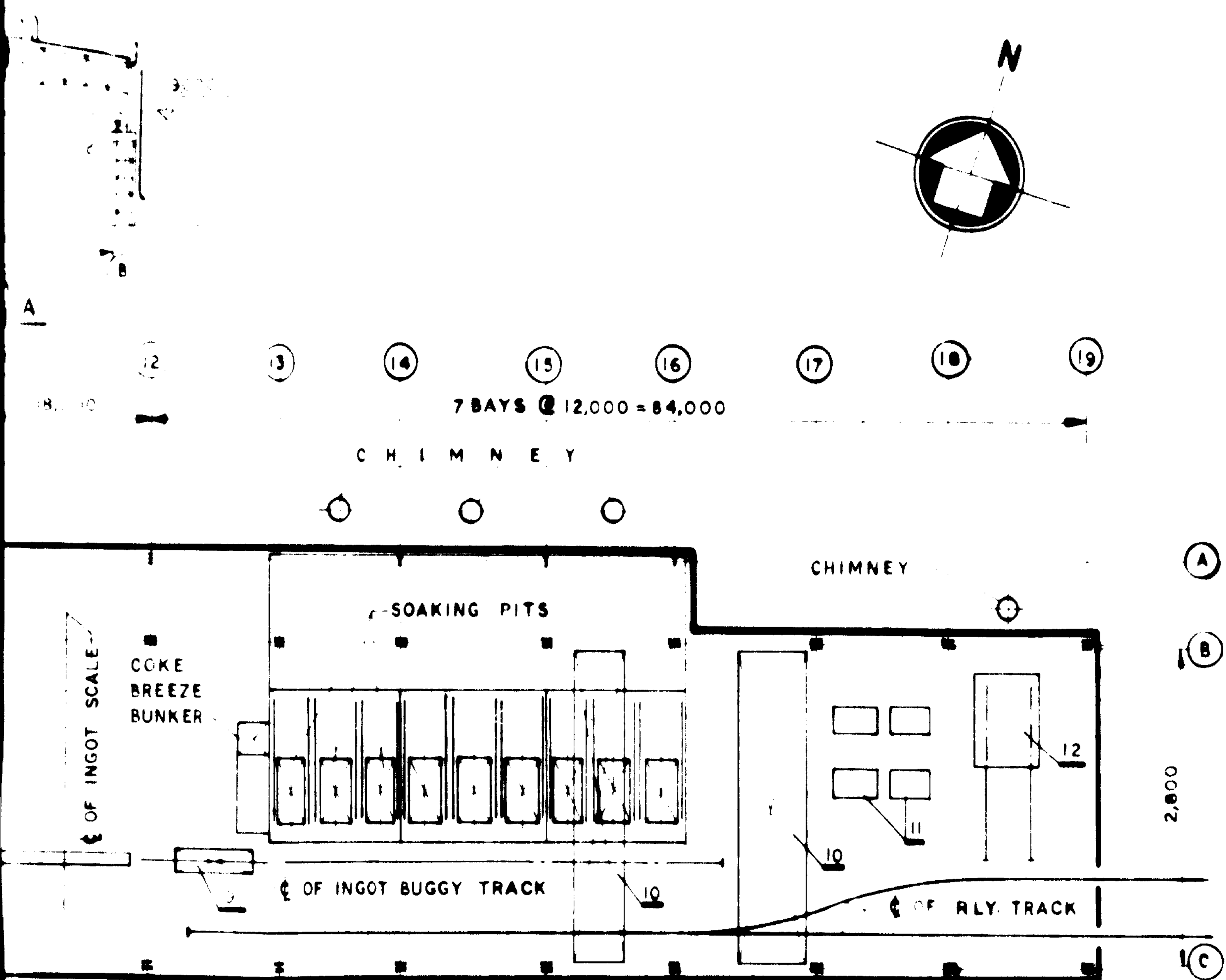
INDUS

IRAN FE

ALLOY S

DRAWN

APPROVE



SOAKING PITS

SECTION 3

10 0 10 20 30

SCALE : METRES

LEGEND

- 700MM 2-HIGH REVERSING MILL
- 1800 KW 0/60/120 RPM D.C. MOTOR
- 500 TON HOT SHEAR
- HOT SAW
- 40-TON E.O.T CRANE
- TRANSFORMER
- 6 KV SWITCHING STATION
- 15-TON E.O.T CRANE
- INGOT BUGGY
- 3/20-TON E.O.T SOAKER CRANE
- COOLING PITS
- FURNACE

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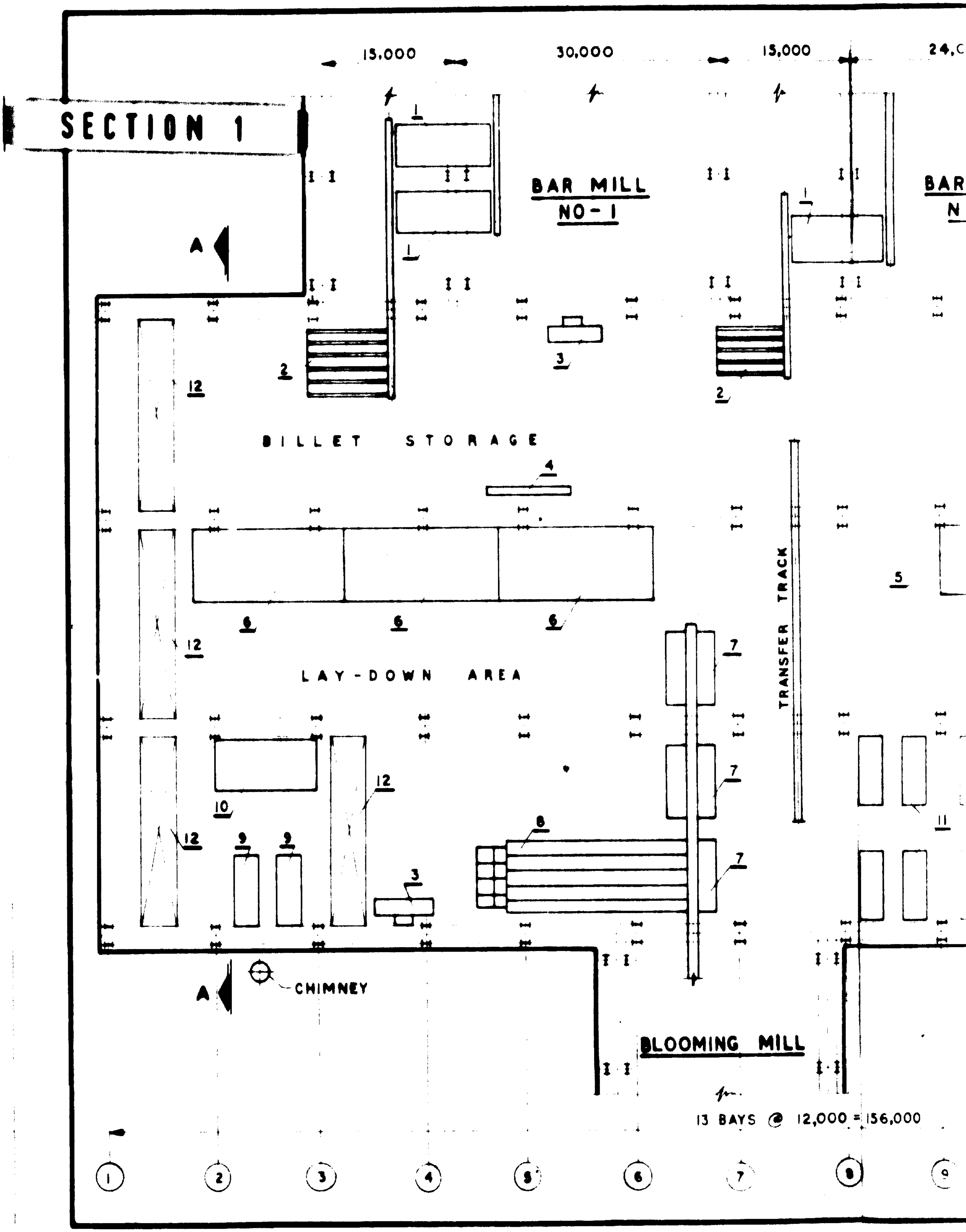
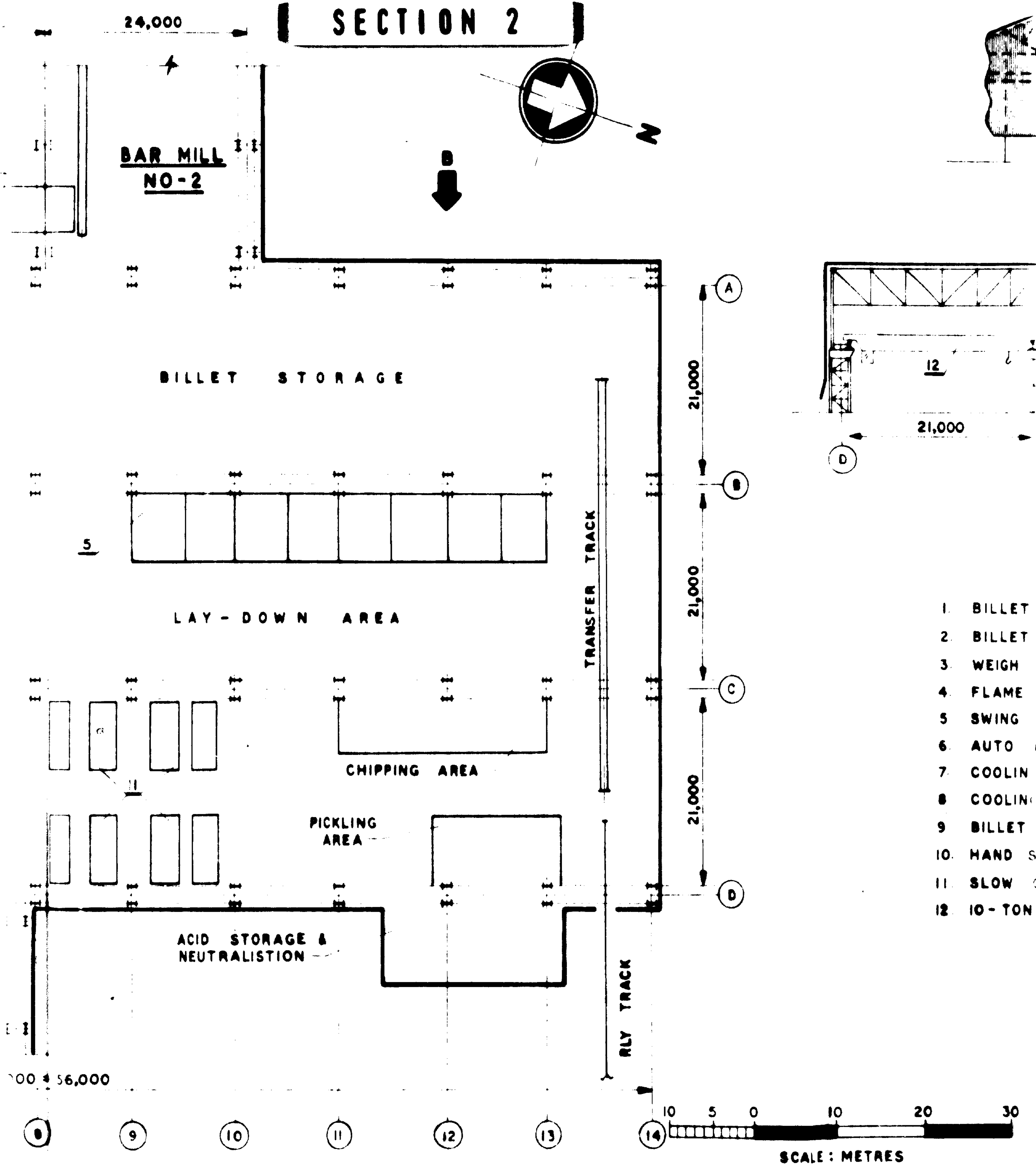
FOR.
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

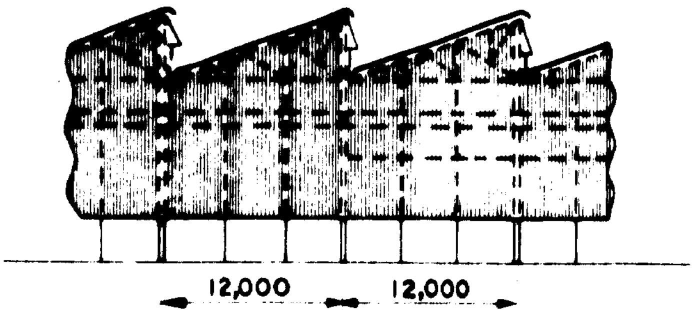
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT-SOAKING PITS & BLOOMING MILL
LAYOUT

DRAWN	S. Gupta	29 9 69	No. 5131-V-12
APPROVED			

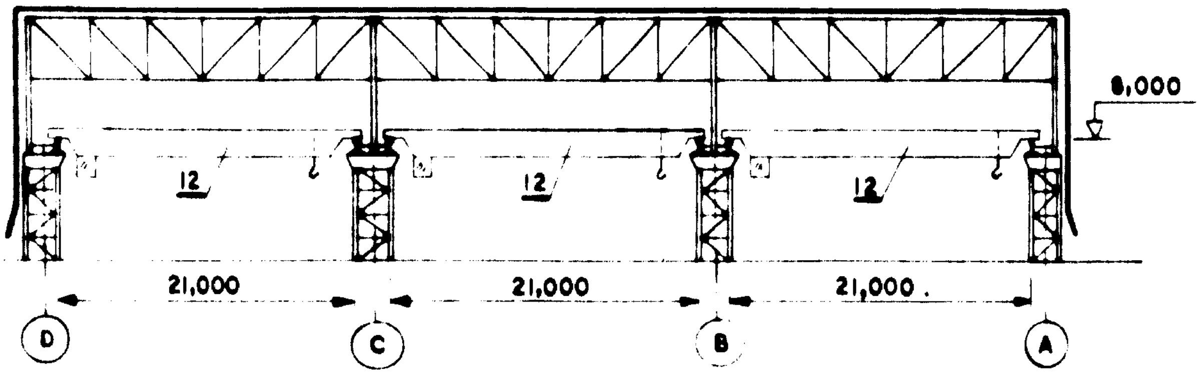

SECTION 1
15,000
30,000
15,000
24,C
BAR MILL
NO-1
BAR
N
A
A
1
1
1
2
2
3
3
4
5
6
6
6
7
7
7
8
9
9
10
11
12
12
12
12
BILLET STORAGE
LAY-DOWN AREA
TRANSFER TRACK
CHIMNEY
BLOOMING MILL
13 BAYS @ 12,000 = 156,000
1
2
3
4
5
6
7
8
9

SECTION 2

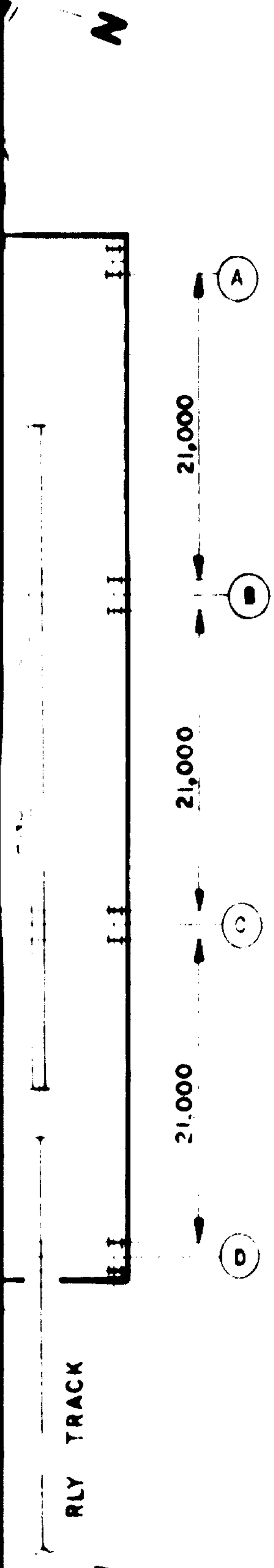

24,000
N
BAR MILL NO-2
B
BILLET STORAGE
5
LAY-DOWN AREA
TRANSFER TRACK
11
CHIPPING AREA
PICKLING AREA
ACID STORAGE & NEUTRALISTION
RLY TRACK
21,000
21,000
21,000
A
B
C
D
00 ‡ 56,000
8
9
10
11
12
13
14
10 5 0 10 20 30
SCALE : METRES
12
21,000
D
1. BILLET
2. BILLET
3. WEIGH
4. FLAME
5. SWING
6. AUTO
7. COOLIN
8. COOLIN
9. BILLET
10. HAND
11. SLOW
12. 10 - TON



ELEVATION ON - B



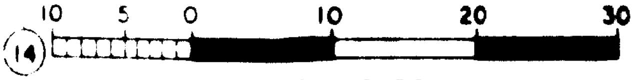
SECTION ON A-A



LEGEND

1. BILLET REHEATING FURNACES
2. BILLET DEPILER
3. WEIGH SCALE
4. FLAME CUTTING MACHINE
5. SWING GRINDERS
6. AUTO BILLET GRINDERS
7. COOLING BOXES
8. COOLING BED
9. BILLET PREHEATING FURNACE
10. HAND SCARFING MACHINE
11. SLOW COOLING COVERS
12. 10 - TON E.O.T CRANES

SECTION 3



SCALE : METRES

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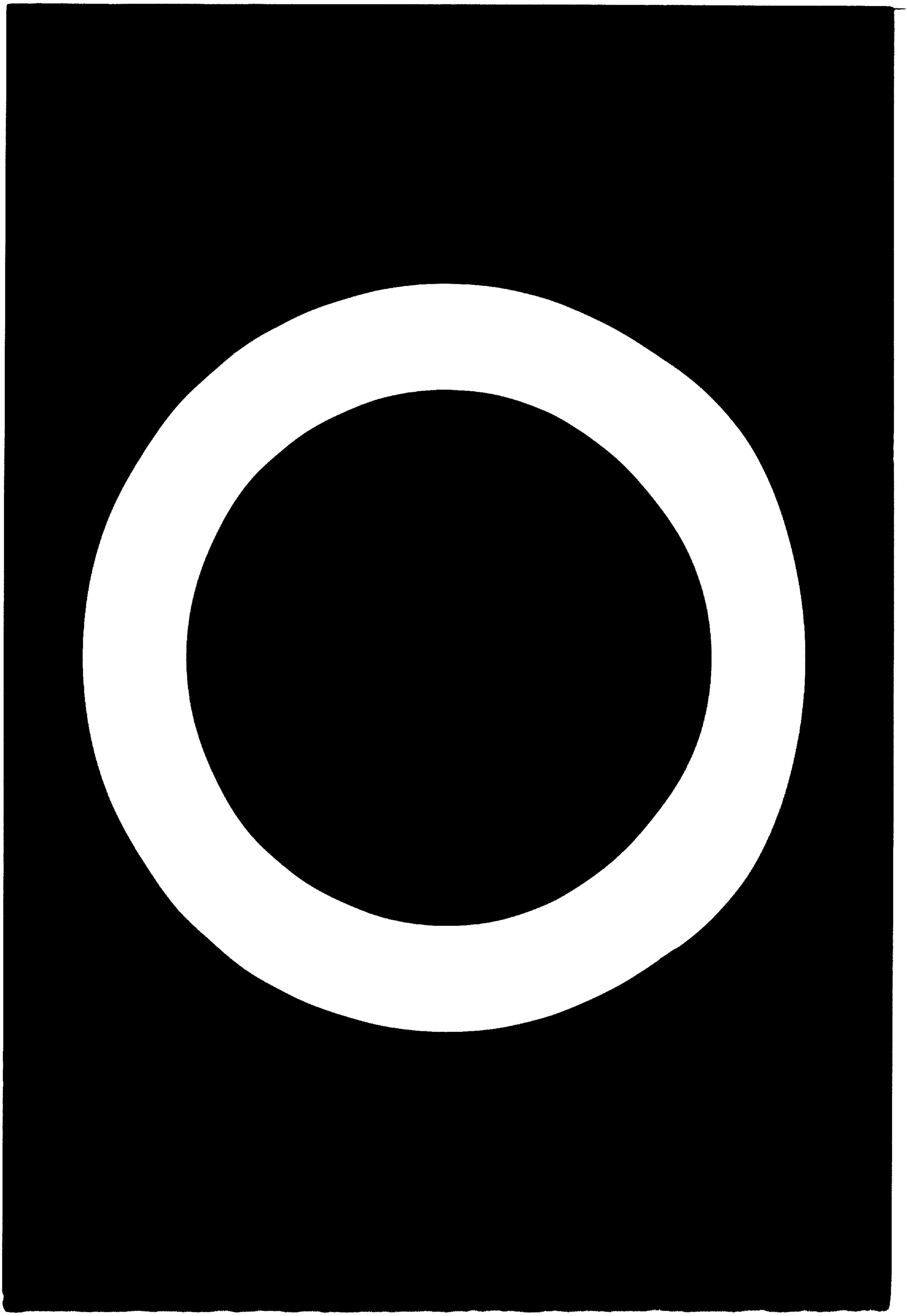
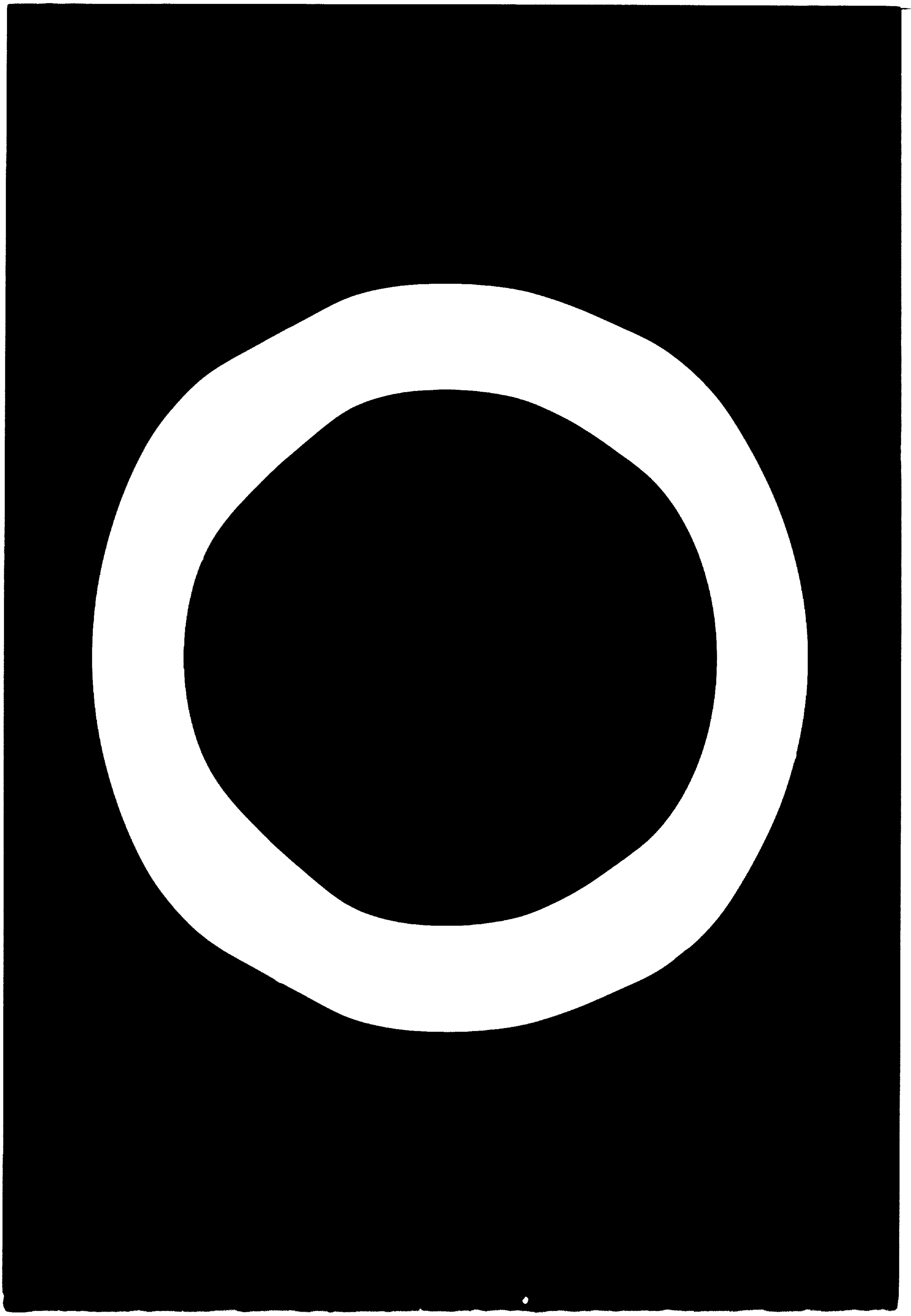
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—BILLET CONDITIONING & STORAGE LAYOUT

DRAWN		6.11.69	No. 5131-V-13
APPROVED		12.11.69	

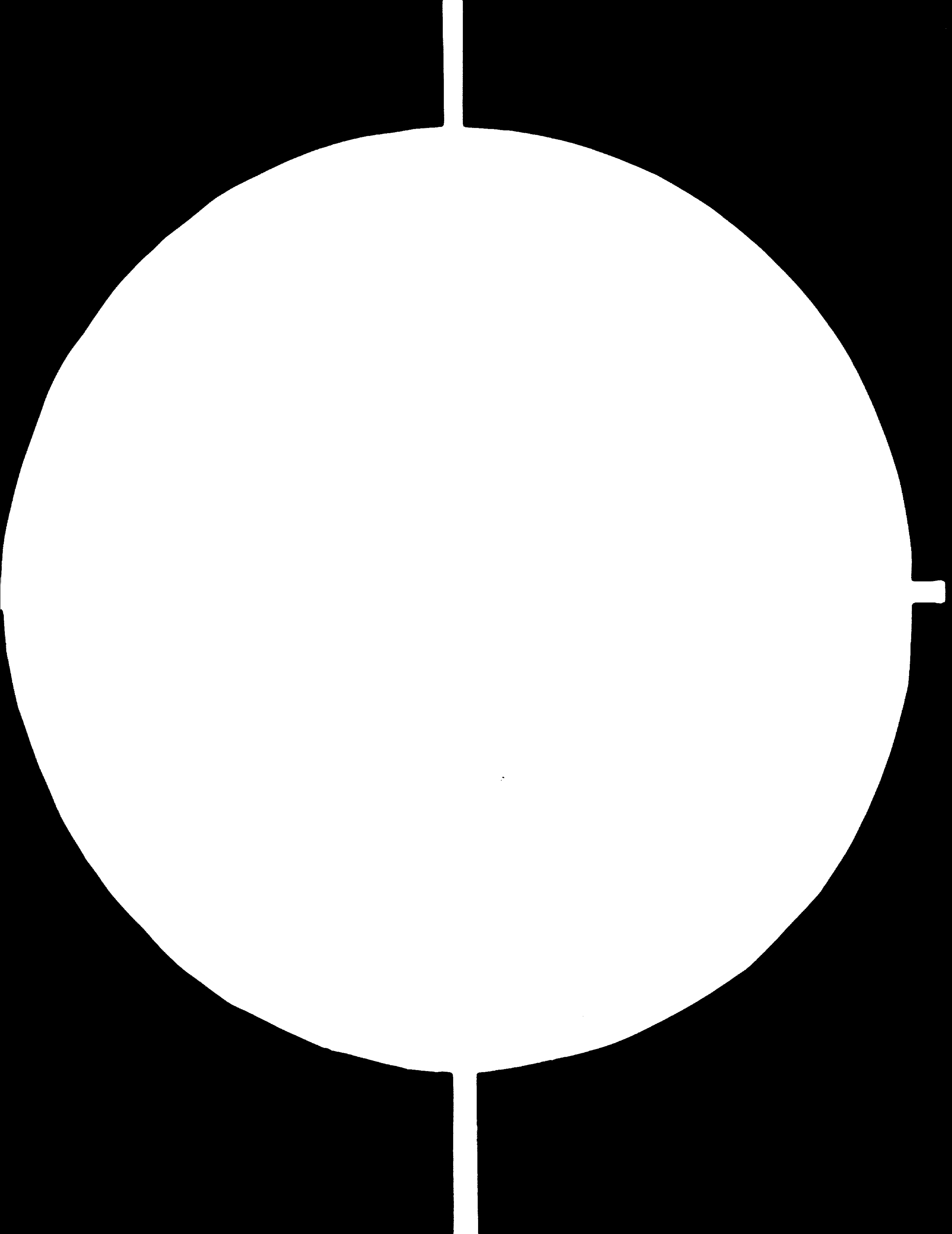




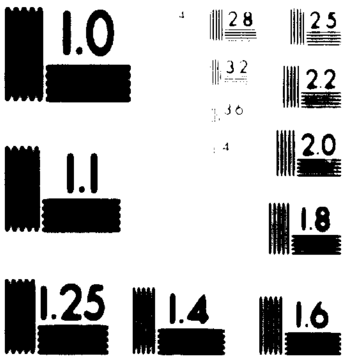
B-389

→

84.04.16
AD. 85.03
ILL 5.5



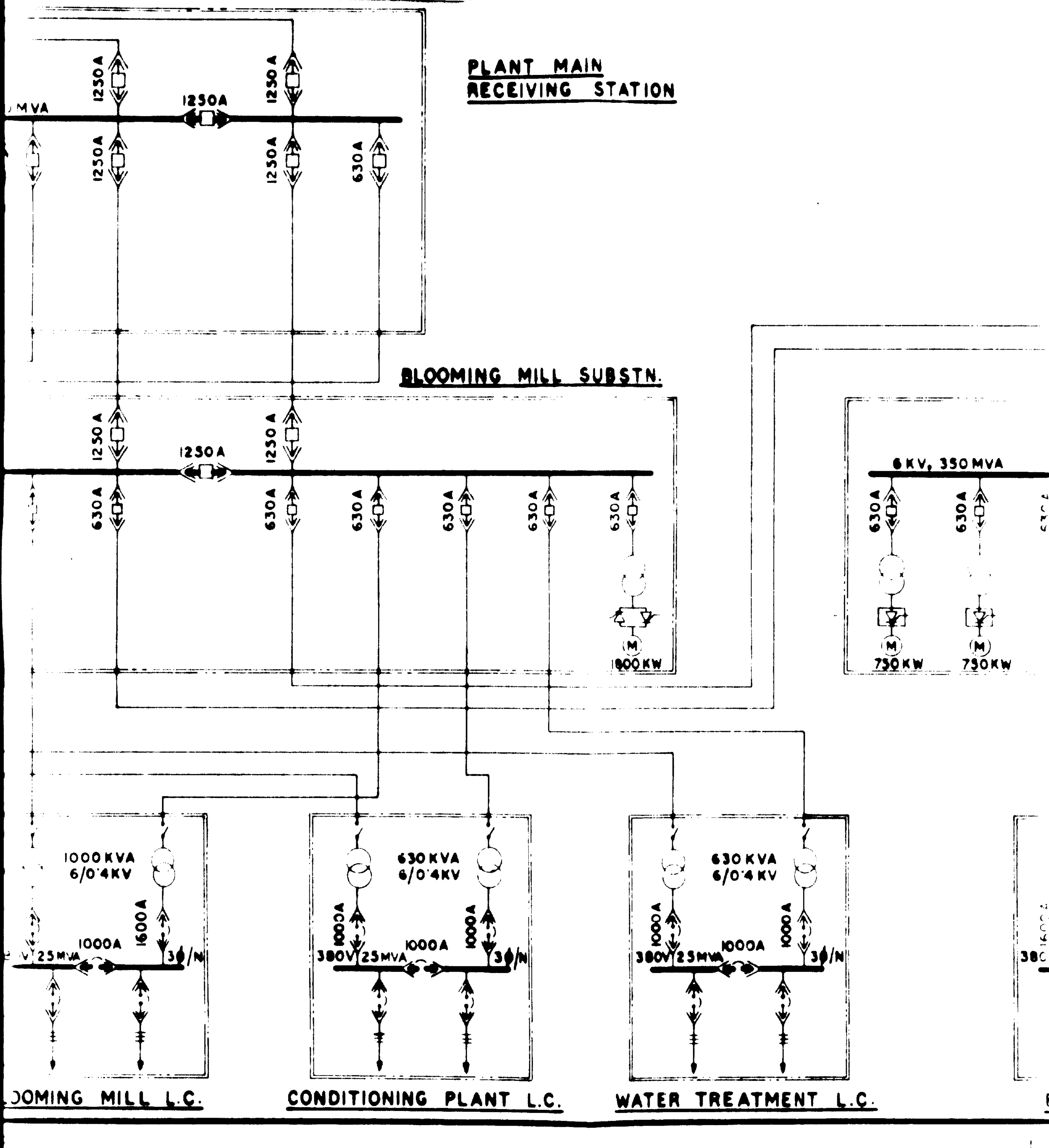
10 OF 10



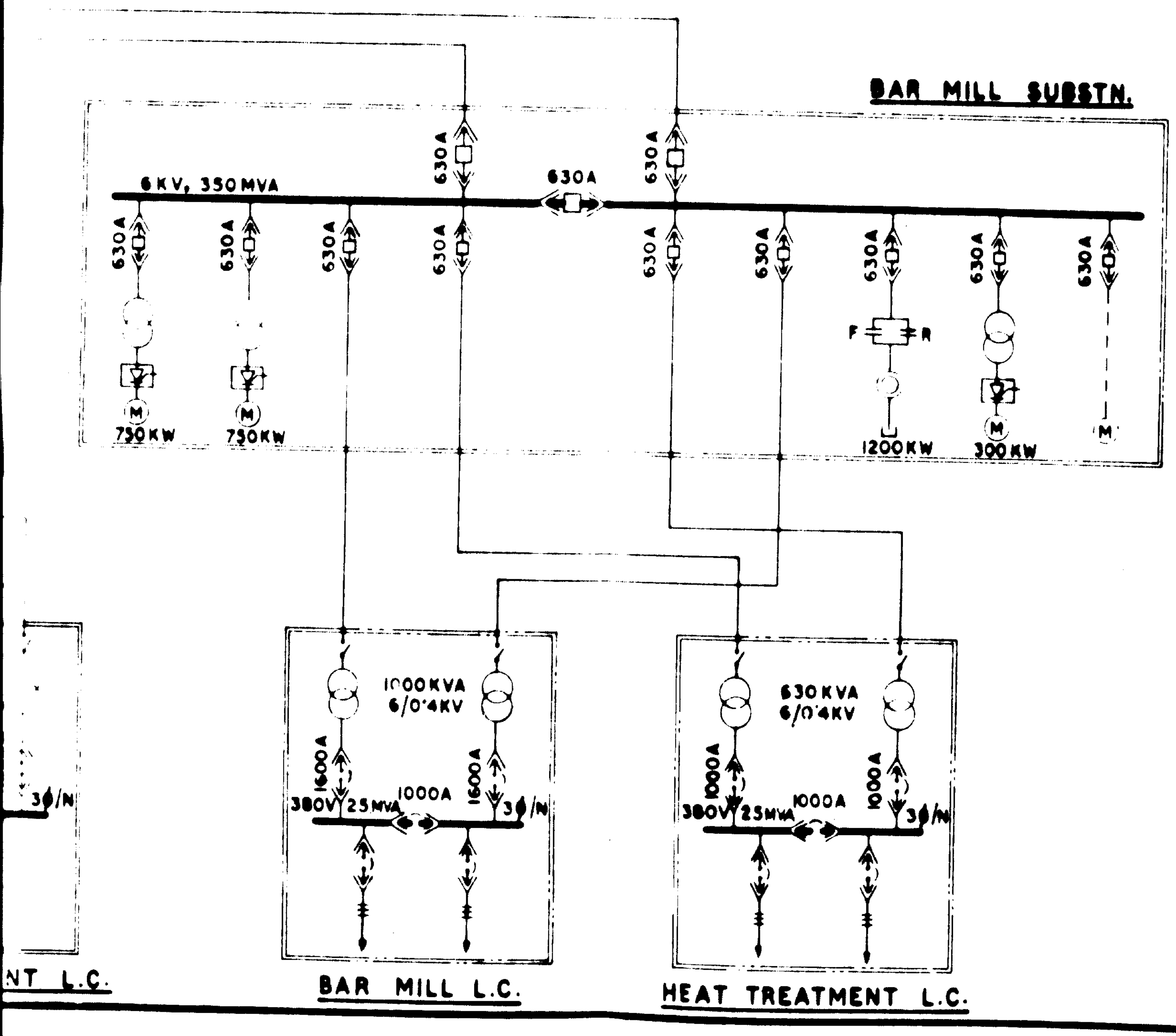
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
ANSI and ISO TEST CHART No. 2

24x
F

SECTION 2

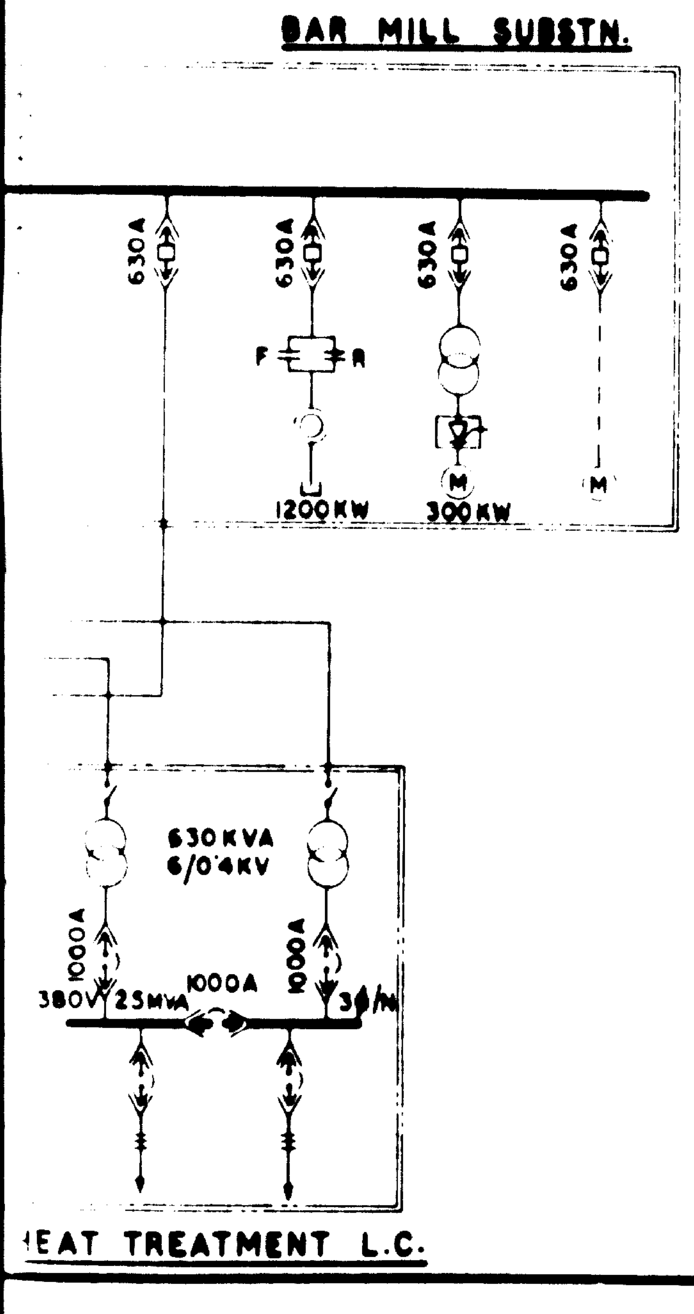

PLANT MAIN RECEIVING STATION
MVA
1250A
1250A
1250A
1250A
1250A
1250A
630A
BLOOMING MILL SUBSTN.
1250A
1250A
1250A
630A
630A
630A
630A
630A
630A
M
1800 KW
6 KV, 350 MVA
630A
630A
M
750KW
M
750KW
1000 KVA
6/0·4KV
1600A
25MVA
1000A
3Ø/N
ЭOMING MILL L.C.
630 KVA
6/0·4KV
1000A
1000A
380V
25MVA
1000A
3Ø/N
CONDITIONING PLANT L.C.
630 KVA
6/0·4 KV
1000A
1000A
380V
25MVA
1000A
3Ø/N
WATER TREATMENT L.C.
38C

SECTION 3



33K.
DRAW
L T.
ISOLA
FUSE
MOTO
POWE
REAC
SILIC
A.C
D.C
LIQUI
ARC
MULTIF
LOAD

M
FOR
IND
IRAN
ALLOY
DRAWN
APPROV



LEGEND

- 33KV ISOLATOR
- DRAWOUT TYPE H.T. CIRCUIT BREAKER
- L.T. AIR CIRCUIT BREAKER
- ISOLATING SWITCH
- FUSE
- MOTOR CONTACTOR STARTER
- POWER TRANSFORMER
- REACTOR
- SILICON CONTROLLED RECTIFIER
- A.C. SLIP RING MOTOR
- D.C. MOTOR
- LIQUID SLIP REGULATOR
- ARC FURNACE
- MULTIPLE FEEDERS
- LOAD CENTRE SUBSTATION .... L.C.

SECTION 4

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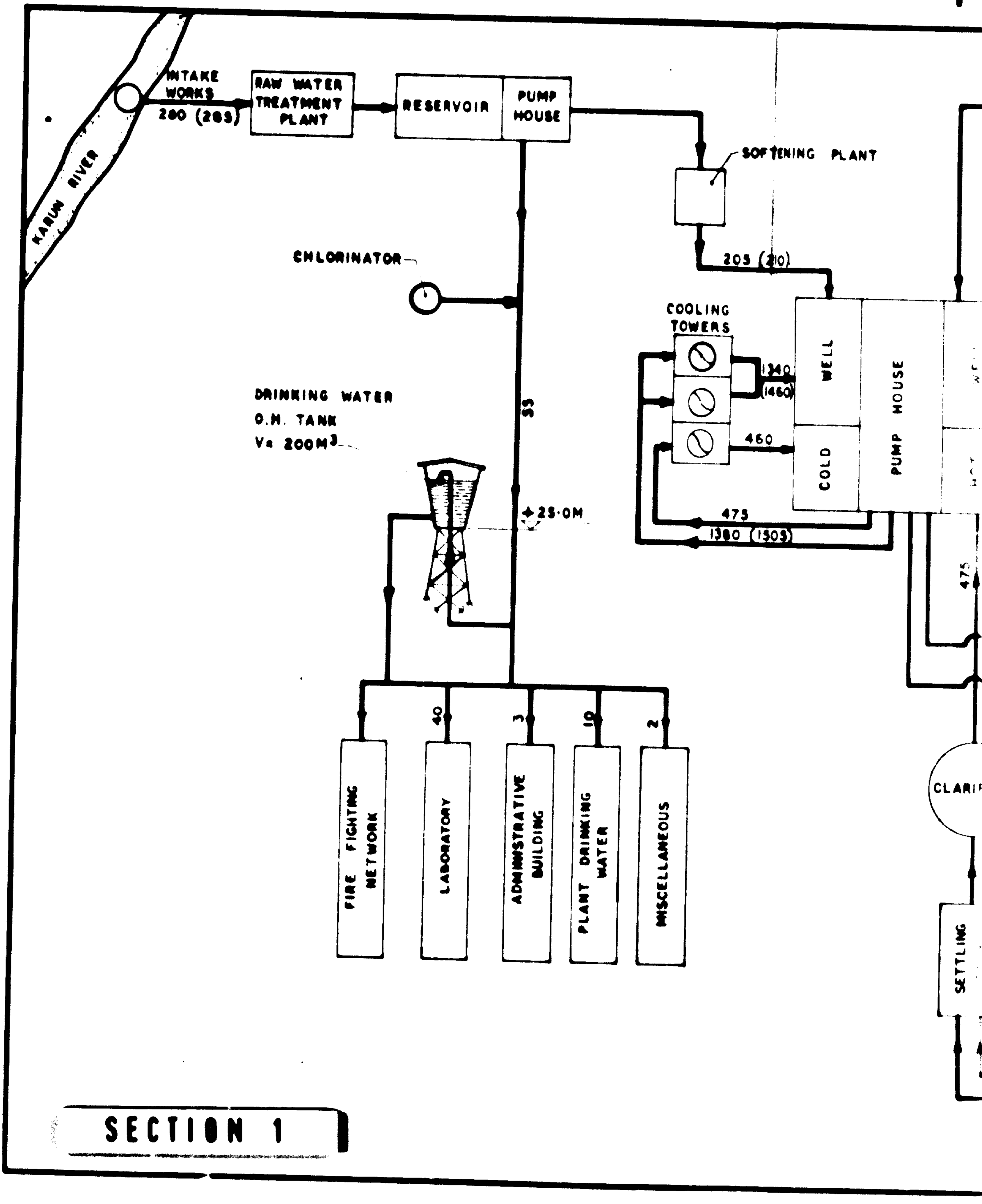
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

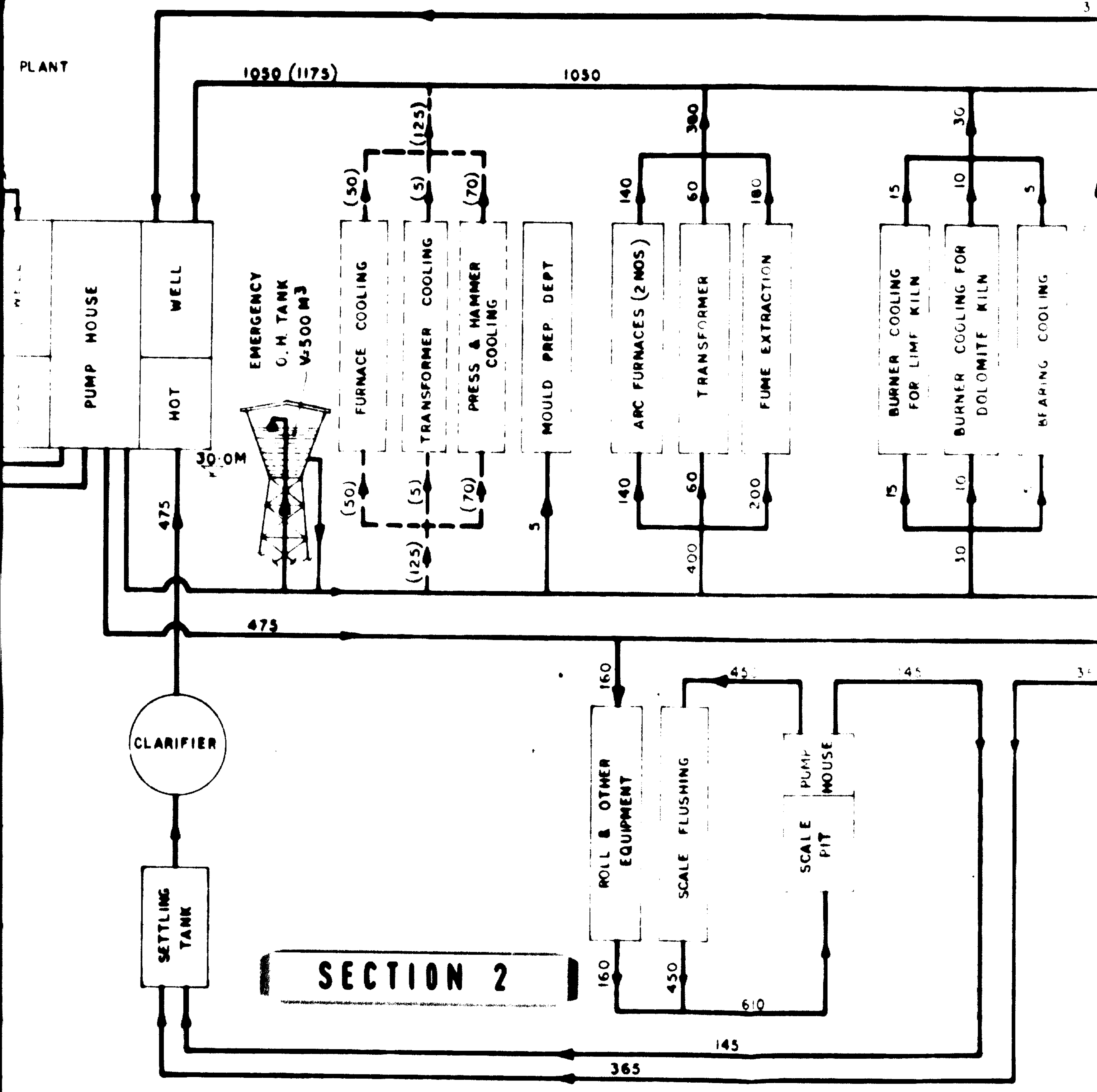
IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—POWER DISTRIBUTION STSTEM

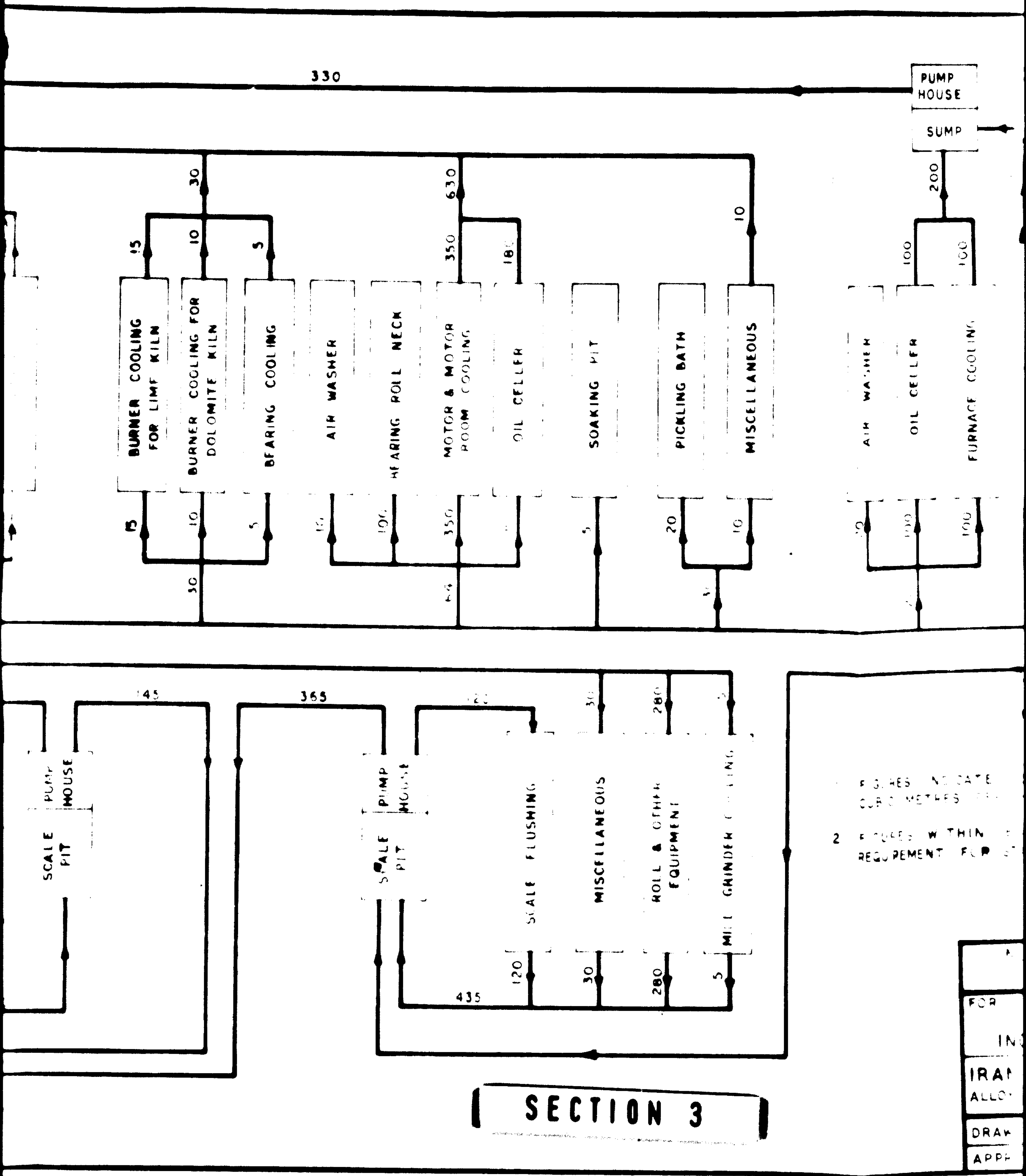
DRAWN		4.11.69
APPROVED		7.11.69

No. 5131-V-16

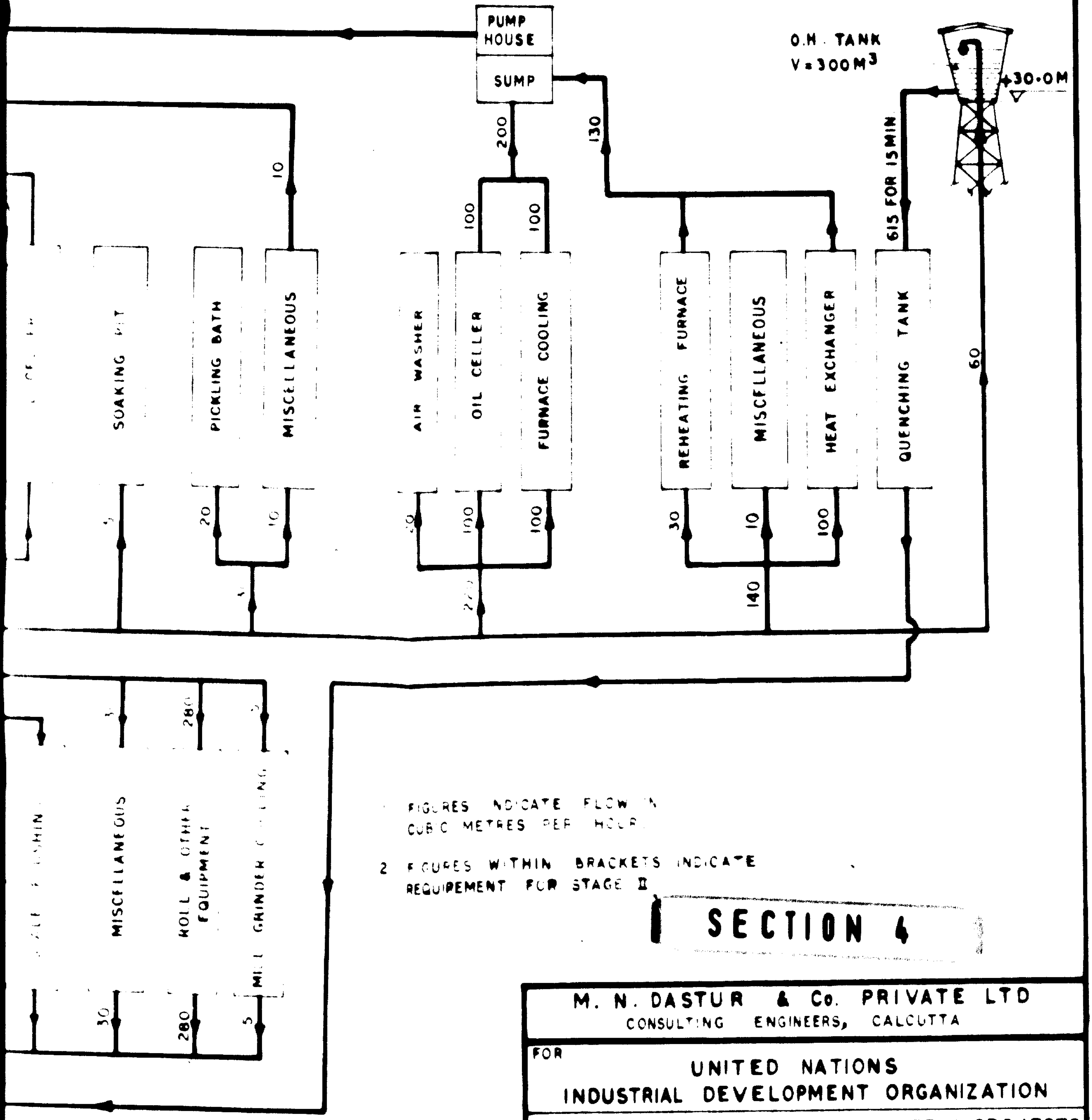

KARUN RIVER
INTAKE WORKS
280 (285)
RAW WATER TREATMENT PLANT
RESERVOIR
PUMP HOUSE
SOFTENING PLANT
205 (210)
CHLORINATOR
DRINKING WATER
O.H. TANK
V= 200M3
55
+ 25.0M
COOLING TOWERS
1340
(1460)
460
475
1380 (1505)
WELL
COLD
PUMP HOUSE
475
CLARI
SETTLING
40
3
10
2
FIRE FIGHTING NETWORK
LABORATORY
ADMINISTRATIVE BUILDING
PLANT DRINKING WATER
MISCELLANEOUS

SECTION 1


PLANT
1050 (1175)
1050
PUMP HOUSE
WELL
HOT
EMERGENCY
O. H. TANK
V=500 M3
30.0M
(125)
(50)
(5)
(70)
FURNACE COOLING
TRANSFORMER COOLING
PRESS & HAMMER COOLING
MOULD PREP. DEPT
5
300
140
60
180
ARC FURNACES (2 NOS)
TRANSFORMER
FUME EXTRACTION
140
60
200
400
30
15
10
5
BURNER COOLING FOR LIME KILN
BURNER COOLING FOR DOLOMITE KILN
BEARING COOLING
15
10
30
475
475
CLARIFIER
SETTLING TANK
160
ROLL & OTHER EQUIPMENT
SCALE FLUSHING
PUMP HOUSE
SCALE PIT
450
145
160
450
610
145
365
SECTION 2


330
PUMP HOUSE
SUMP
200
100
100
30
630
10
15
10
5
350
180
BURNER COOLING FOR LIME KILN
BURNER COOLING FOR DOLOMITE KILN
BEARING COOLING
AIR WASHER
BEARING ROLL NECK
MOTOR & MOTOR ROOM COOLING
OIL CELLER
SOAKING PIT
PICKLING BATH
MISCELLANEOUS
AIR WASHER
OIL CELLER
FURNACE COOLING
15
10
5
10
100
350
5
20
10
10
100
100
30
145
365
120
30
280
5
PUMP HOUSE
SCALE PIT
PUMP HOUSE
SCALE PIT
SCALE FLUSHING
MISCELLANEOUS
ROLL & OTHER EQUIPMENT
MILL GRINDER
120
30
280
5
435
FIGURES INDICATE
CUBIC METRES
2 FIGURES WITHIN
REQUIREMENT FOR
FOR
IRAN
ALLO
DRAW
APPR

SECTION 3



FIGURES INDICATE FLOW IN CUBIC METRES PER HOUR.

2 FIGURES WITHIN BRACKETS INDICATE REQUIREMENT FOR STAGE II

SECTION 4

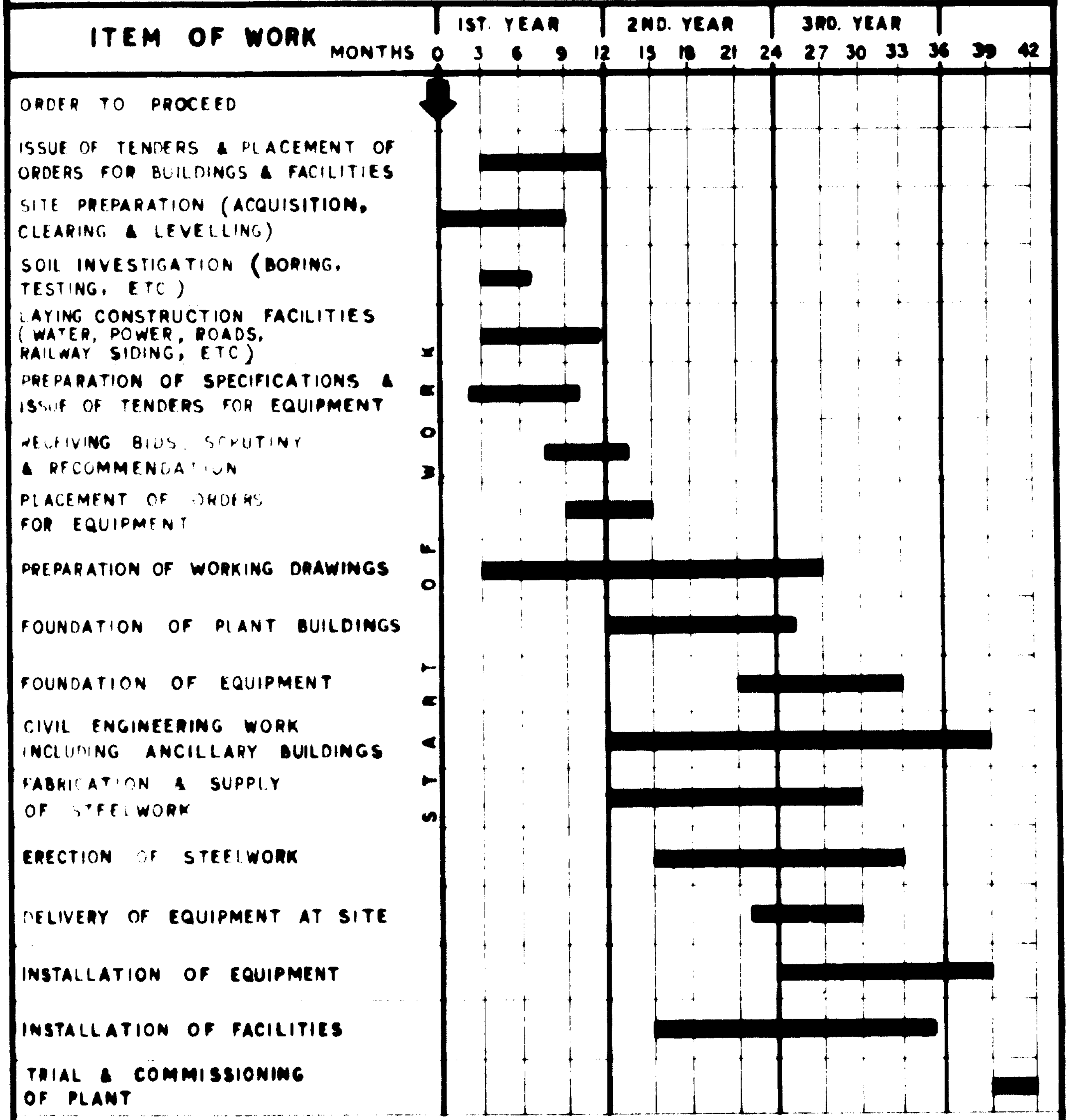
M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT-SCHEMATIC DIAGRAM OF WATER SYSTEM

DRAWN		30.10.69	No. 51[illegible]1-V-17
APPROVED		6 [illegible] 69	

CONSTRUCTION SCHEDULE



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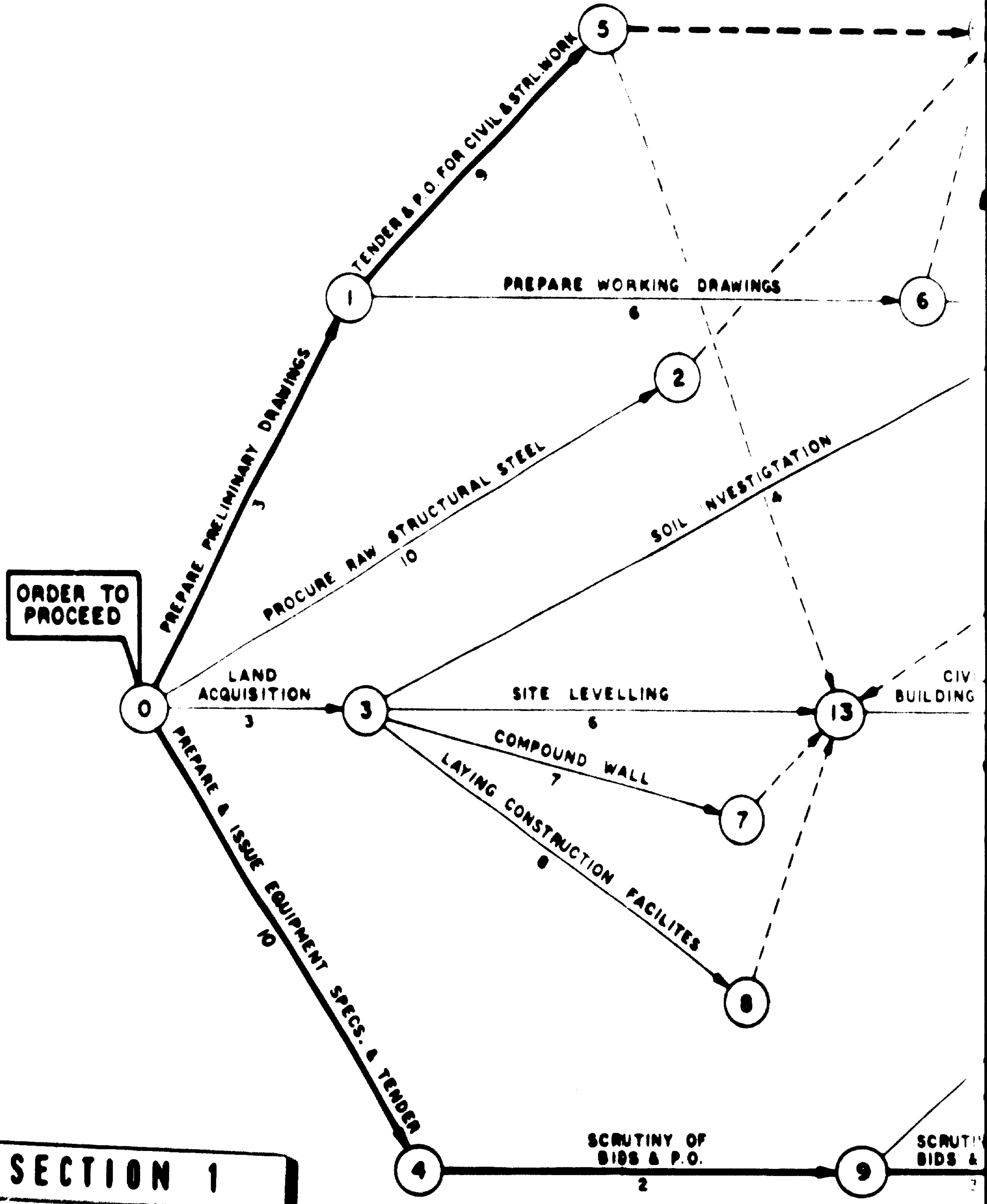
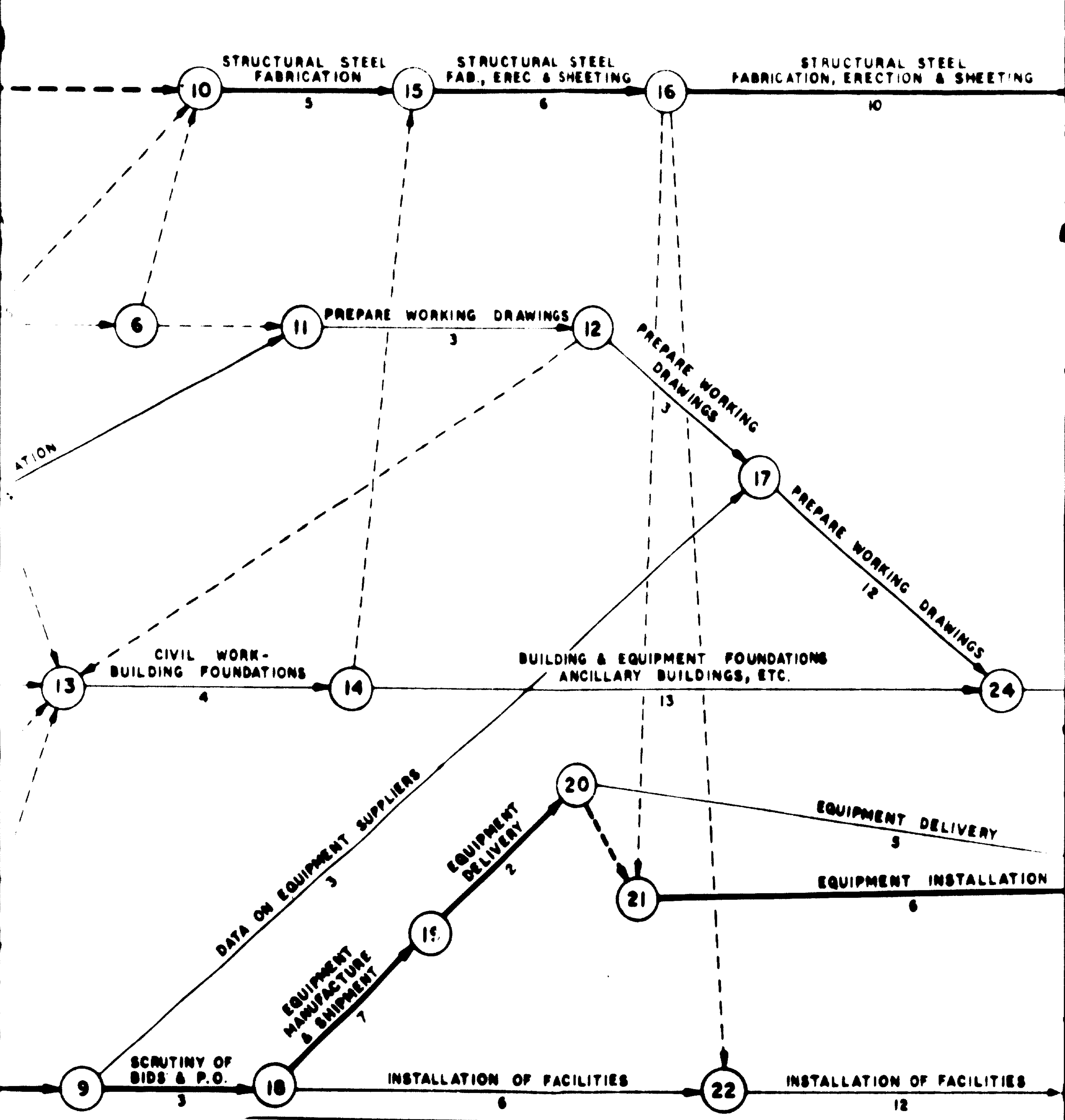
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—CONSTRUCTION SCHEDULE

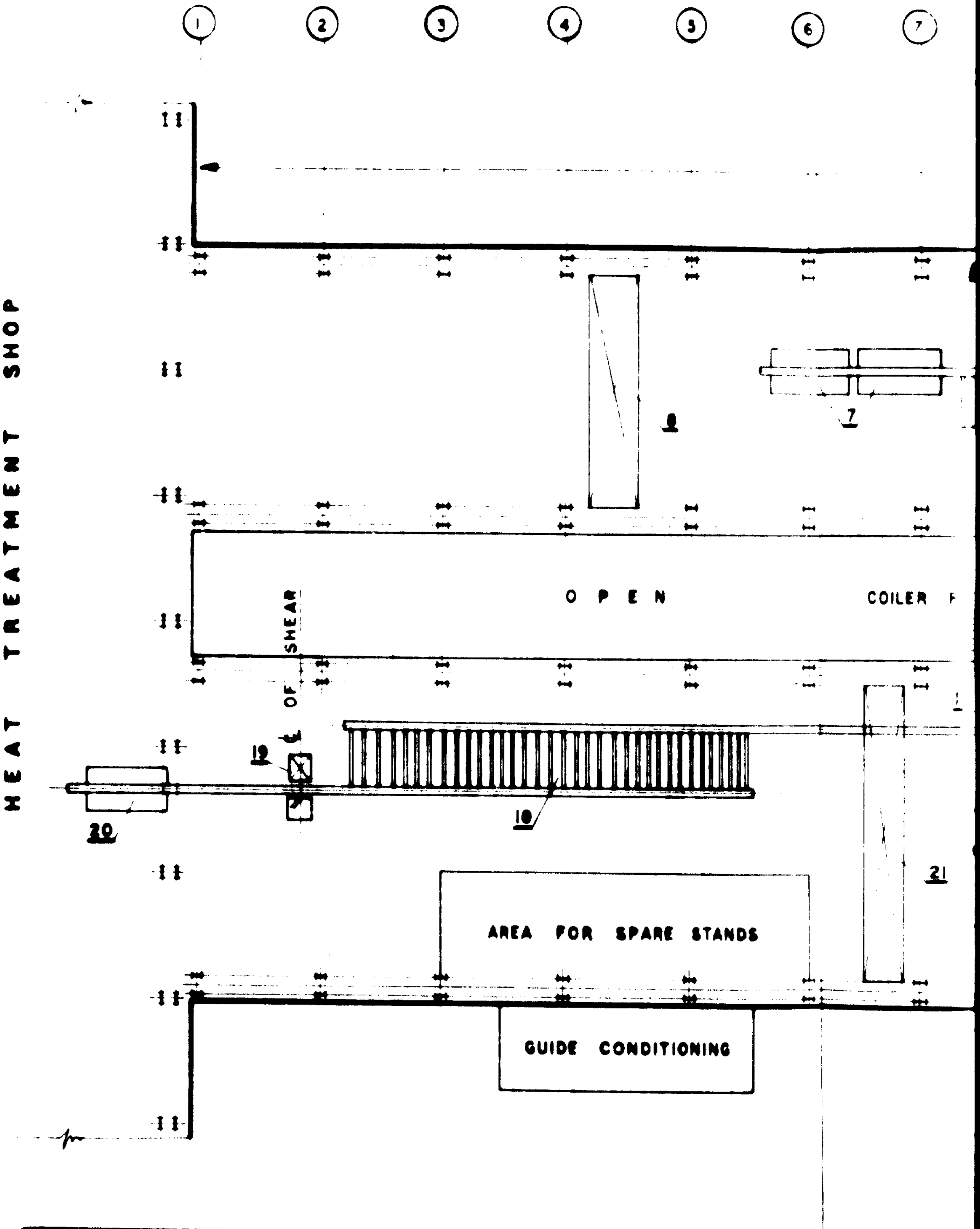
DRAWN	22.10.69	**No. 5131-V-18**
APPROVED	22.10.69	

SECTION 1

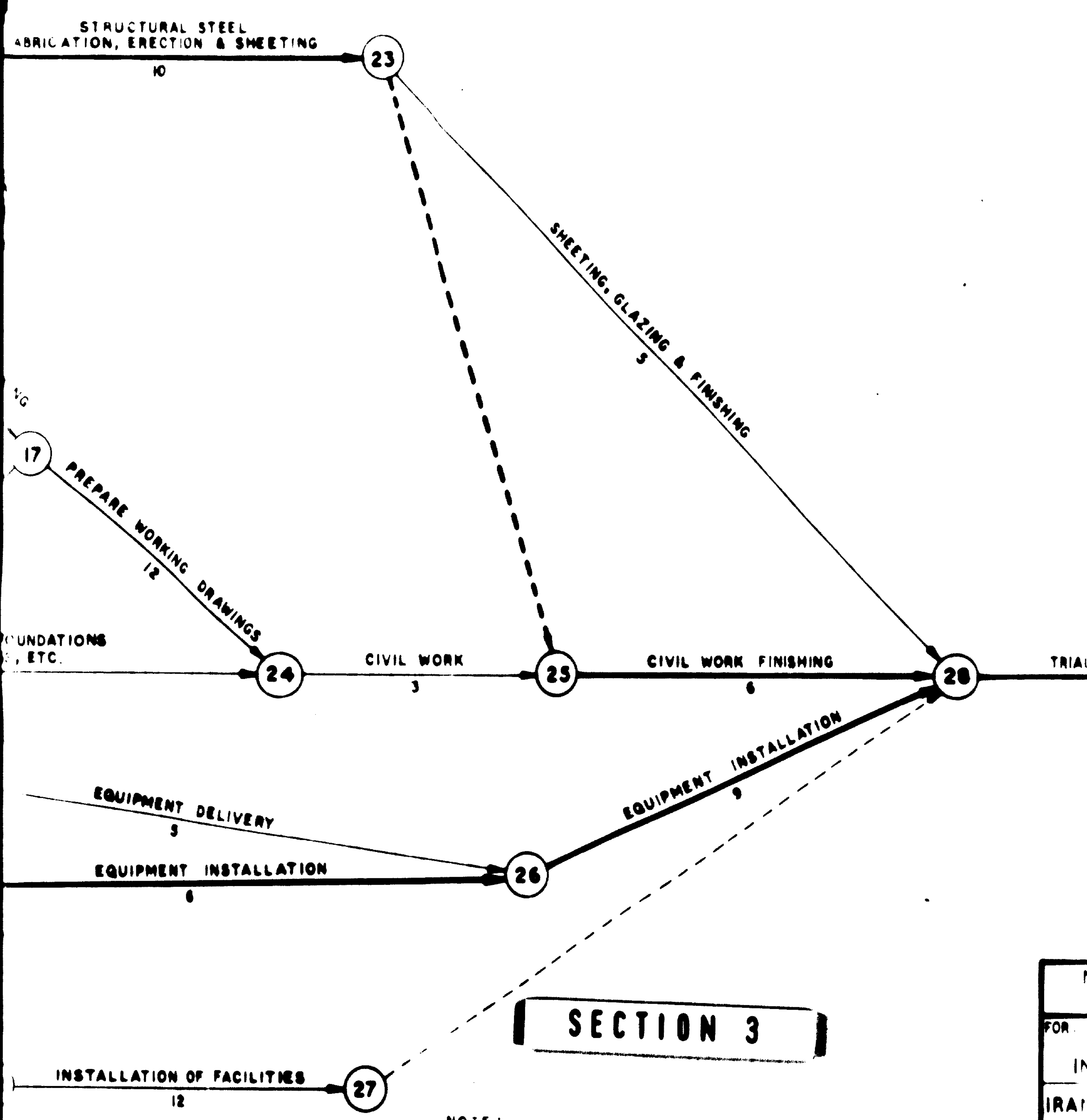

ORDER TO PROCEED
0
PREPARE PRELIMINARY DRAWINGS
3
1
TENDER & P.O. FOR CIVIL & STRL. WORK
9
5
PREPARE WORKING DRAWINGS
6
6
PROCURE RAW STRUCTURAL STEEL
10
2
SOIL INVESTIGATION
4
LAND ACQUISITION
3
3
SITE LEVELLING
6
13
COMPOUND WALL
7
7
LAYING CONSTRUCTION FACILITES
8
8
CIV
BUILDING
PREPARE & ISSUE EQUIPMENT SPECS. & TENDER
10
4
SCRUTINY OF BIDS & P.O.
2
9
SCRUTI
BIDS &


STRUCTURAL STEEL FABRICATION
5
STRUCTURAL STEEL FAB., EREC & SHEETING
6
STRUCTURAL STEEL FABRICATION, ERECTION & SHEETING
10
10
15
16
6
11
12
PREPARE WORKING DRAWINGS
3
PREPARE WORKING DRAWINGS
3
17
PREPARE WORKING DRAWINGS
12
ATION
13
CIVIL WORK-BUILDING FOUNDATIONS
4
14
BUILDING & EQUIPMENT FOUNDATIONS ANCILLARY BUILDINGS, ETC.
13
24
DATA ON EQUIPMENT SUPPLIERS
3
20
EQUIPMENT DELIVERY
5
EQUIPMENT DELIVERY
2
21
EQUIPMENT INSTALLATION
6
19
EQUIPMENT MANUFACTURE & SHIPMENT
7
9
SCRUTINY OF BIDS & P.O.
3
18
INSTALLATION OF FACILITIES
6
22
INSTALLATION OF FACILITIES
12

SECTION 2


1
2
3
4
5
6
7
HEAT TREATMENT SHOP
8
7
OPEN
COILER F
℄ OF SHEAR
19
20
10
21
AREA FOR SPARE STANDS
GUIDE CONDITIONING

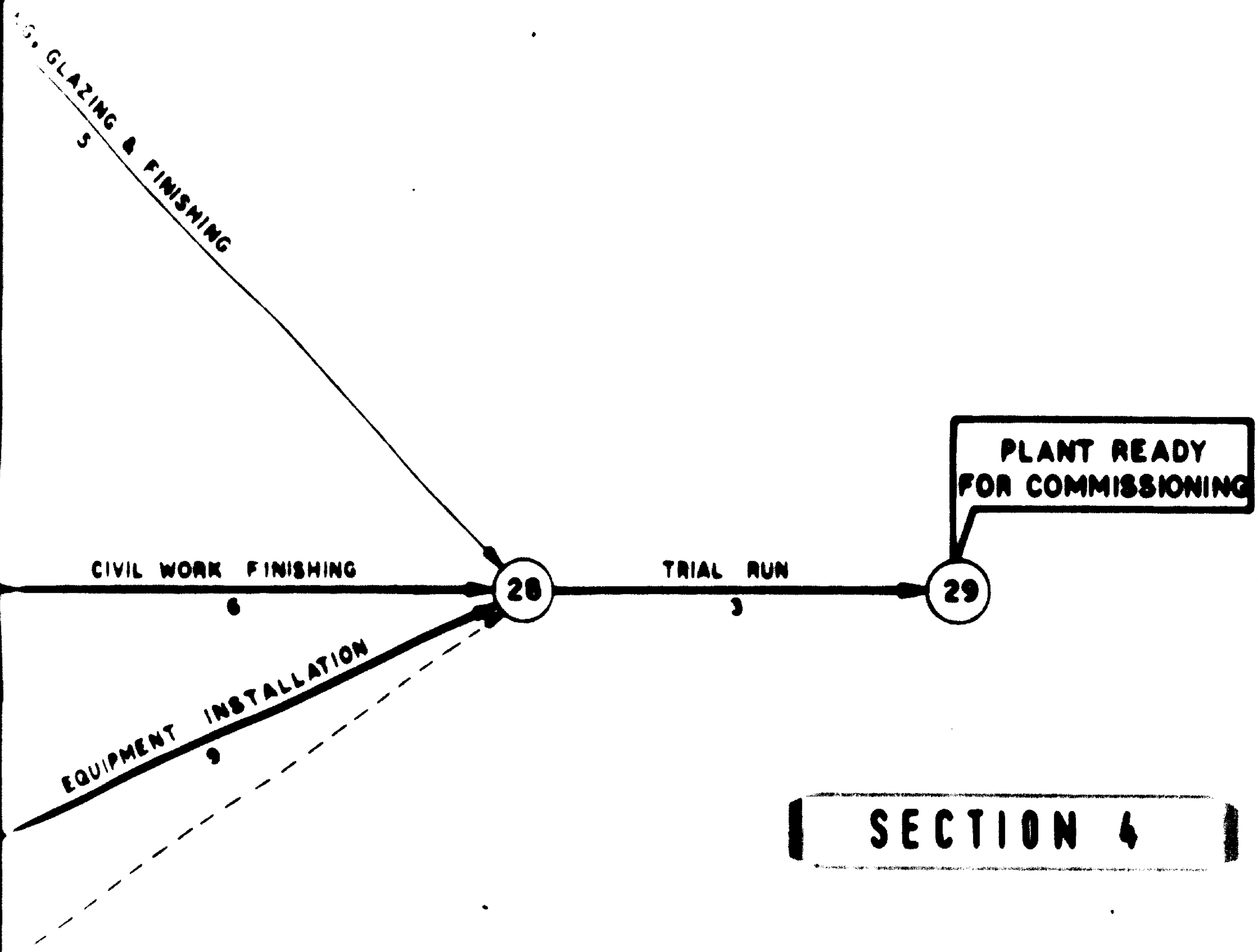
SECTION 1



NOTE:

ACTIVITY TIME DURATION IN MONTHS

CRITICAL PATH SHOWN THUS



SECTION 4

DURATION IN MONTHS
HOWN THUS

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—NETWORK FOR CONSTRUCTION

DRAWN		3.10.69	No. 5131-V-19
APPROVED		[illegible]	

SL No	ACTIVITY CODE	DURATION (MONTHS)	EARLIEST		LATEST		FLOAT		REMARK
			START	FINISH	START	FINISH	TOTAL	FREE	
1	0 - 1	3	0	3	0	3	0	0	CRITICAL
2	0 - 2	10	0	10	2	12	2	0	
3	0 - 3	3	0	3	2	5	2	0	
4	0 - 4	10	0	10	0	10	0	0	CRITICAL
5	1 - 5	9	3	12	3	12	0	0	CRITICAL
6	1 - 6	6	3	9	4	10	1	0	
7	2 - 10	0	10	10	12	12	2	2	
8	3 - 7	7	3	10	6	13	3	0	
9	3 - 8	8	3	11	5	13	2	0	
10	3 - 11	4	3	7	6	10	3	2	
11	3 - 13	6	3	9	7	13	4	3	
12	4 - 9	2	10	12	10	12	0	0	CRITICAL
13	5 - 10	0	12	12	12	12	0	0	CRITICAL
14	5 - 13	0	12	12	13	13	1	0	
15	6 - 10	0	9	9	12	12	3	3	
16	6 - 11	0	9	9	10	10	1	0	
17	7 - 13	0	10	10	13	13	3	2	
18	8 - 13	0	11	11	13	13	2	1	
19	9 - 17	3	12	15	15	18	3	0	
20	9 - 18	3	12	15	12	15	0	0	CRITICAL
21	10 - 15	5	12	17	12	17	0	0	CRITICAL
22	11 - 12	3	9	12	10	13	1	0	
23	12 - 13	0	12	12	13	15	1	0	

SECTION 1

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T	REMARK
FREE	
0	CRITICA
0	
0	
0	CRITICA
0	CRITICA
0	
2	
0	
0	
2	
3	
0	CRITICAL
0	CRITICAL
0	
3	
0	
2	
1	
0	
0	CRITICAL
0	CRITICAL
0	
0	

SL. No	ACTIVITY CODE	DURATION (MONTHS)	EARLIEST		LATEST		FLOAT		REMARKS
			START	FINISH	START	FINISH	TOTAL	FREE	
24	12-17	3	12	15	15	18	3	0	
25	13-14	4	12	16	13	17	1	0	
26	14-15	0	16	16	17	17	1	0	
27	14-24	13	16	29	17	30	1	0	
28	15-16	6	17	23	17	23	0	0	CRITICAL
29	16-21	0	23	23	24	24	1	1	
30	16-22	0	23	23	27	27	4	0	
31	16-23	10	23	33	23	33	0	0	CRITICAL
32	17-24	12	15	27	18	30	3	2	
33	18-19	7	15	22	15	22	0	0	CRITICAL
34	18-22	6	15	21	21	27	6	2	
35	19-20	2	22	24	22	24	0	0	CRITICAL
36	20-21	0	24	24	24	24	0	0	CRITICAL
37	20-26	5	24	29	25	30	1	1	CRITICAL
38	21-26	6	24	30	24	30	0	0	CRITICAL
39	22-27	12	23	35	27	39	4	0	
40	23-25	0	33	33	33	33	0	0	CRITICAL
41	23-28	5	33	38	34	39	1	1	
42	24-25	3	29	32	30	33	1	1	
43	25-28	6	33	39	33	39	0	0	CRITICAL
44	26-28	9	30	39	30	39	0	0	CRITICAL
45	27-28	0	35	35	39	39	4	4	
46	28-29	3	39	42	39	42	0	0	CRITICAL

SECTION 2

LATEST	FLOAT		REMARKS
FINISH	TOTAL	FREE	
18	3	0	
17	1	0	
17	1	0	
30	1	0	
23	0	0	CRITICAL
24	1	1	
27	4	0	
33	0	0	CRITICAL
30	3	2	
22	0	0	CRITICAL
27	6	2	
24	0	0	CRITICAL
24	0	0	CRITICAL
30	1	1	CRITICAL
30	0	0	CRITICAL
39	4	0	
33	0	0	CRITICAL
39	1	1	
33	1	1	
39	0	0	CRITICAL
39	0	0	CRITICAL
39	4	4	
42	0	0	CRITICAL

SECTION 3

NOTE:

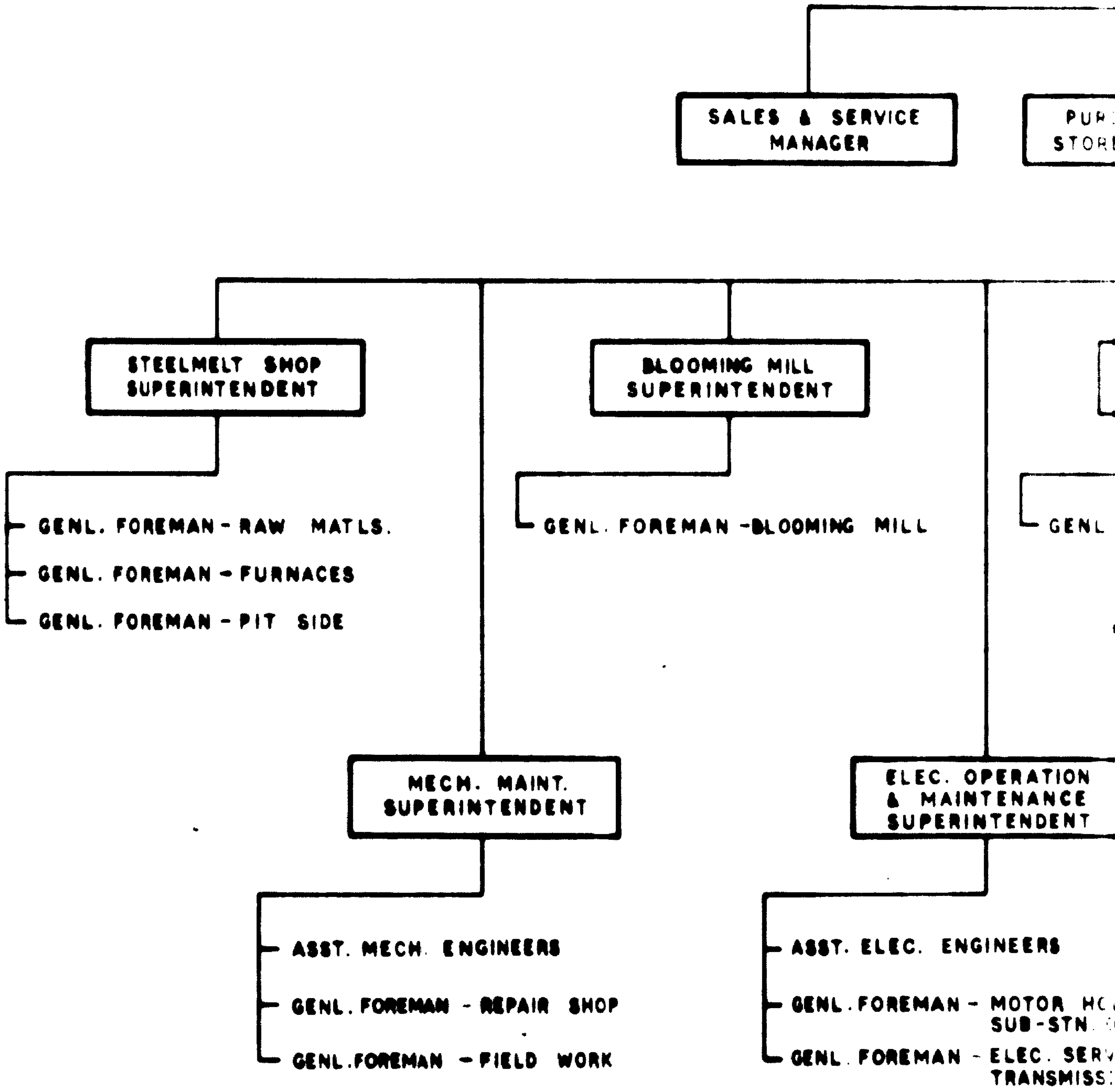
THIS TABLE REFERS TO NETWORK NO. 5131-V-19.

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

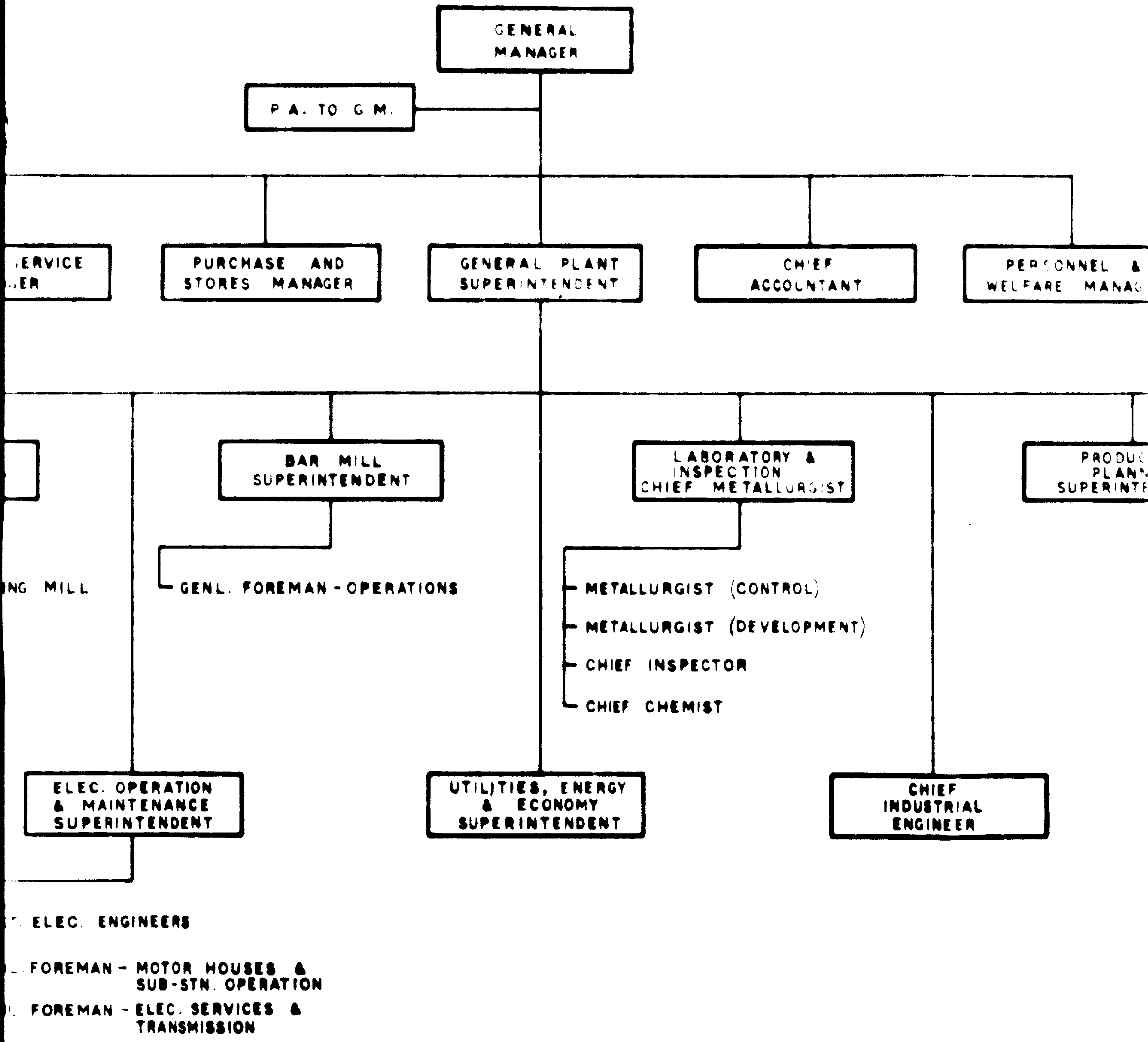
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—NETWORK TABLE

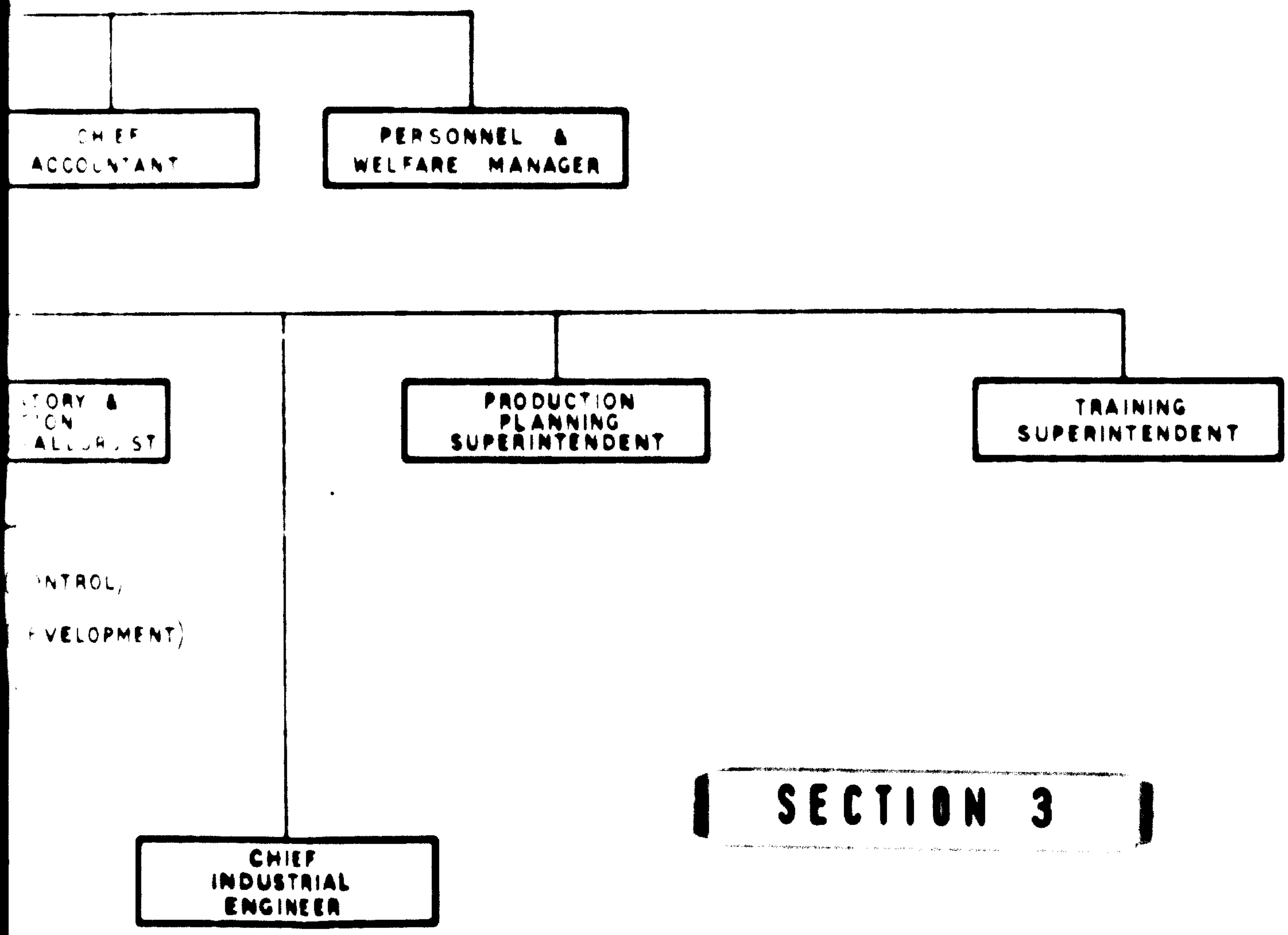
DRAWN		31.10.69	No. 5131-V-20
APPROVED		6.11.69	


SALES & SERVICE MANAGER
PUR
STOR
STEELMELT SHOP SUPERINTENDENT
BLOOMING MILL SUPERINTENDENT
GENL. FOREMAN - RAW MATLS.
GENL. FOREMAN - FURNACES
GENL. FOREMAN - PIT SIDE
GENL. FOREMAN - BLOOMING MILL
GENL
MECH. MAINT. SUPERINTENDENT
ELEC. OPERATION & MAINTENANCE SUPERINTENDENT
ASST. MECH. ENGINEERS
GENL. FOREMAN - REPAIR SHOP
GENL. FOREMAN - FIELD WORK
ASST. ELEC. ENGINEERS
GENL. FOREMAN - MOTOR HO
SUB-STN.
GENL. FOREMAN - ELEC. SERV
TRANSMISS

SECTION 1


GENERAL MANAGER
P.A. TO G.M.
ERVICE
ER
PURCHASE AND STORES MANAGER
GENERAL PLANT SUPERINTENDENT
CHIEF ACCOUNTANT
PERSONNEL & WELFARE MANAG
BAR MILL SUPERINTENDENT
GENL. FOREMAN - OPERATIONS
LABORATORY & INSPECTION CHIEF METALLURGIST
METALLURGIST (CONTROL)
METALLURGIST (DEVELOPMENT)
CHIEF INSPECTOR
CHIEF CHEMIST
PRODUC PLAN SUPERINTE
NG MILL
ELEC. OPERATION & MAINTENANCE SUPERINTENDENT
UTILITIES, ENERGY & ECONOMY SUPERINTENDENT
CHIEF INDUSTRIAL ENGINEER
ELEC. ENGINEERS
FOREMAN - MOTOR HOUSES & SUB-STN. OPERATION
FOREMAN - ELEC. SERVICES & TRANSMISSION

SECTION 2



SECTION 3

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT - POSSIBLE ORGANIZATION STRUCTURE

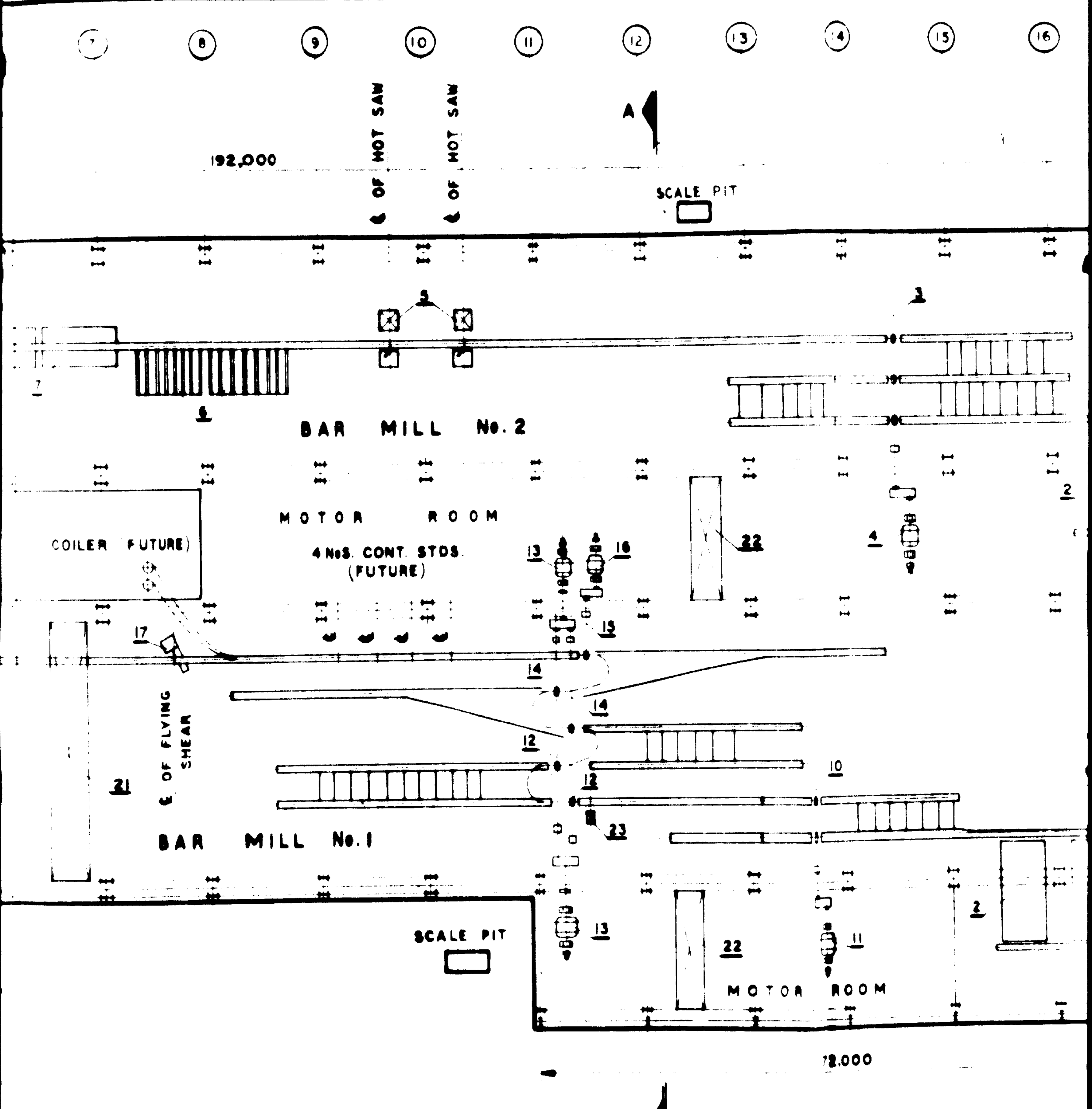
DRAWN	ROBIN ROY	22.10.69	No 5131-V-21
APPROVED		28.10.69	

B-389

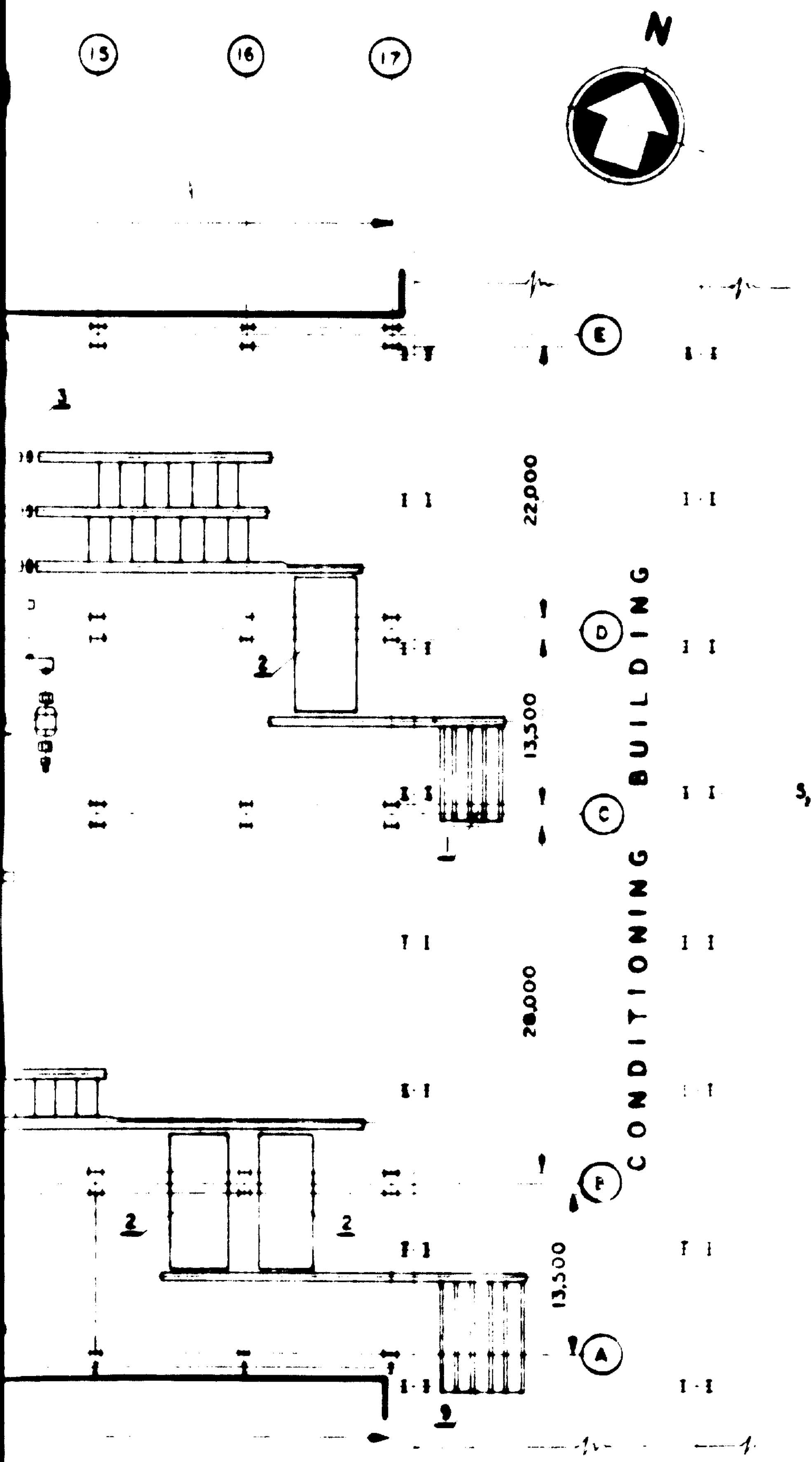
84.04.16

AD. 85.03

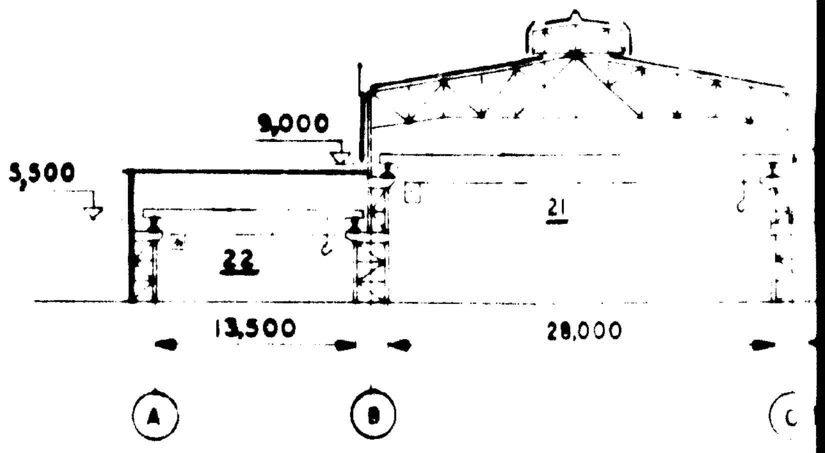
ILL 5.5


7
8
9
10
11
12
13
14
15
16
℄ OF HOT SAW
℄ OF HOT SAW
A
192,000
SCALE PIT
5
3
7
6
BAR MILL No. 2
2
MOTOR ROOM
COILER (FUTURE)
4 Nos. CONT. STDS.
(FUTURE)
13
16
22
4
17
15
14
14
℄ OF FLYING SHEAR
12
12
10
21
23
BAR MILL No. 1
2
SCALE PIT
13
22
11
MOTOR ROOM
72,000
A

SECTION 2



1. BILLET DEPILER
2. BILLET REHEATING FURNA
3. 550 MM 3-HIGH MILL S
4. 1500 KW AC MOTOR
5. HOT SAW
6. COOLING BED
7. COOLING BOXES
8. 25-TON EOT CRANE
9. BILLET DEPILER
10. 450 MM 3-HIGH MILL S
11. 1200 KW AC MOTOR
12. 380 MM 3-HIGH MILL STA



SECTION

SECTION 3

FOR

I

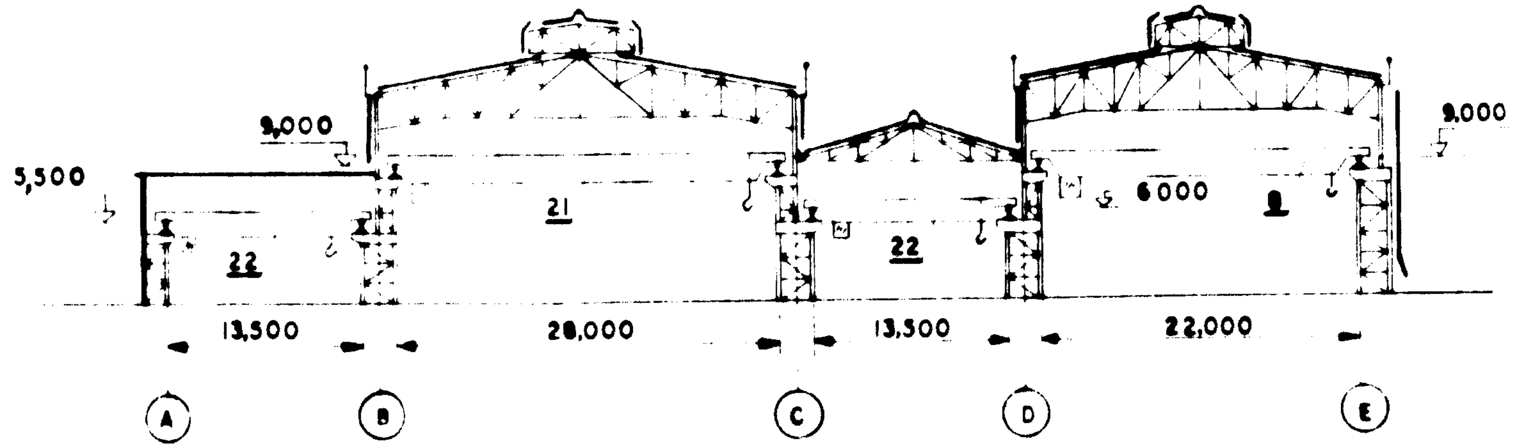
IRA

DRA

APP

LEGEND

1 BILLET DEPILER
2 BILLET REHEATING FURNACE
3 550 MM 3-HIGH MILL STANDS
4 1500 KW A.C. MOTOR
5 HOT SAW
6 COOLING BED
7 COOLING BOXES
8 25-TON E.O.T CRANE
9 BILLET DEPILER
10 450 MM 3-HIGH MILL STANDS
11 1200 KW A.C. MOTOR
12 380 MM 3-HIGH MILL STANDS
13 750 KW 300/750 RPM D.C. MOTOR
14 300 MM 3-HIGH MILL STANDS
15 260 MM 2-HIGH MILL STANDS
16 300 KW 300/750 RPM D.C. MOTOR
17 FLYING SHEAR
18 40 M LONG COOLING BED
19 COLD SHEAR
20 COLLECTING CRADLE
21 20-TON E.O.T CRANE
22 10-TON E.O.T CRANES
23 CROP SHEAR



SECTION ON A-A

SECTION 4

SCALE : METRES

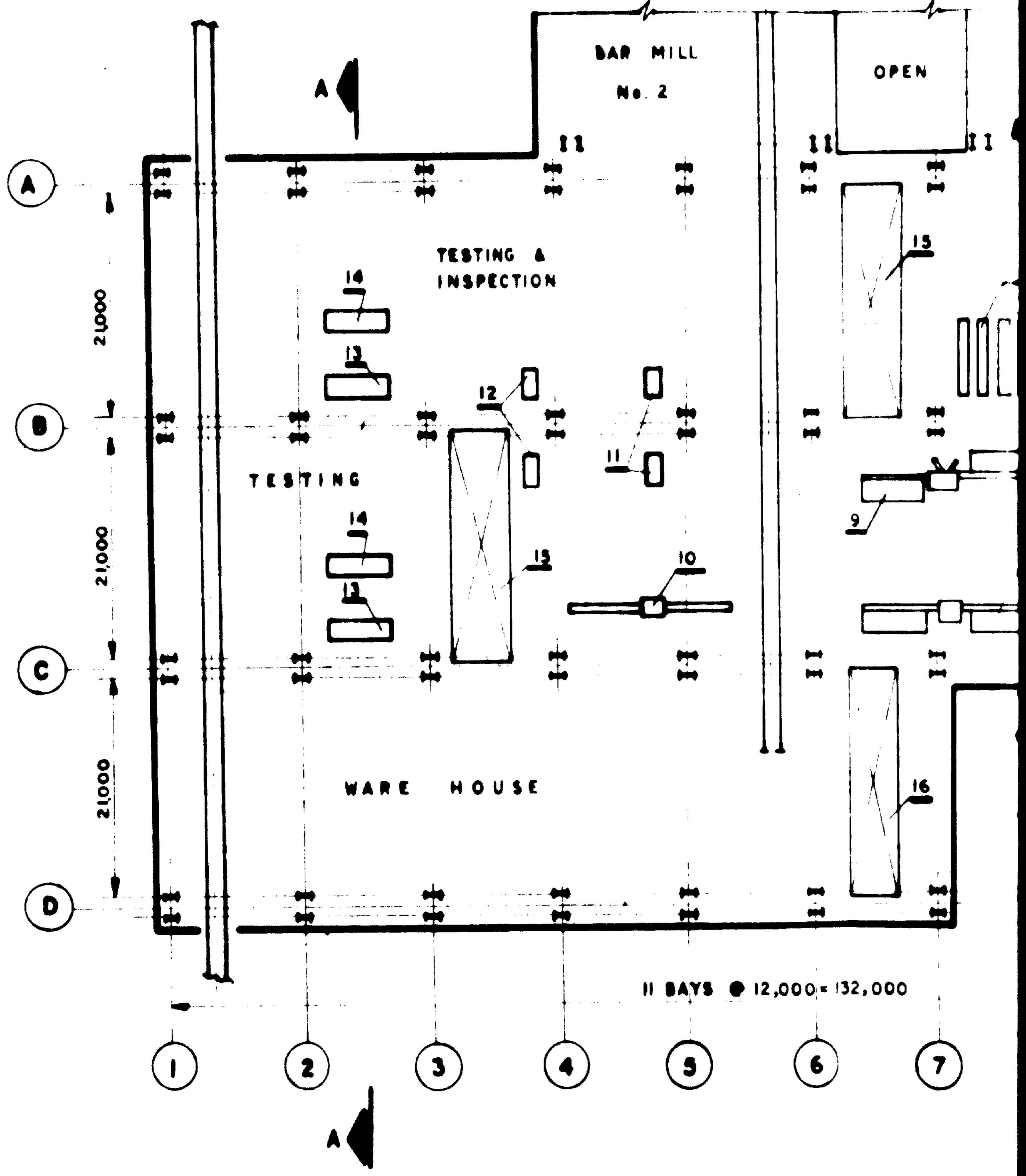
M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—BAR MILLS LAYOUT

DRAWN 3 11 69
APPROVED 7 11 69

No. 5131-V-14


BAR MILL
No. 2
OPEN
A
A
TESTING &
INSPECTION
TESTING
WARE HOUSE
A
B
C
D
21,000
21,000
21,000
14
13
14
13
12
11
10
15
15
16
9
11 BAYS @ 12,000 = 132,000
1
2
3
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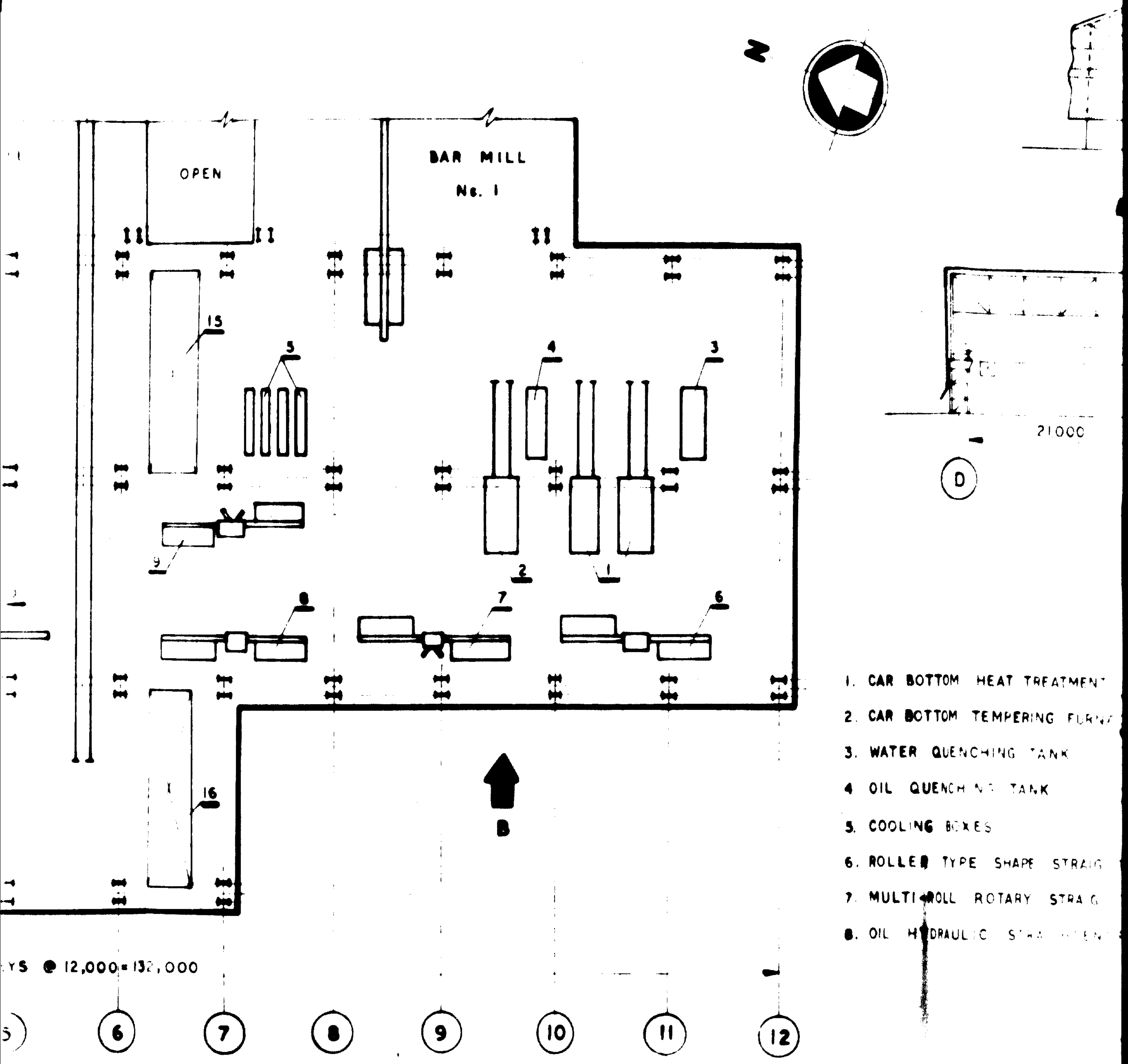
5
6
7

SECTION 1

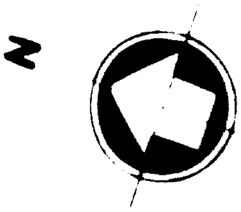


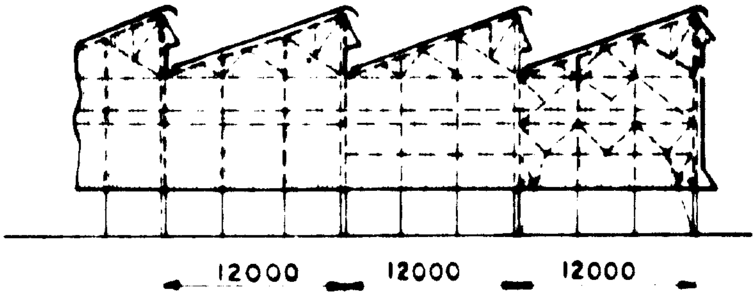
1. CAR BOTTOM HEAT TREATMEN
2. CAR BOTTOM TEMPERING FURN
3. WATER QUENCHING TANK
4. OIL QUENCHING TANK
5. COOLING BOXES
6. ROLLER TYPE SHAPE STRAIG
7. MULTI-ROLL ROTARY STRAIG
8. OIL HYDRAULIC STRAIGHTEN

SECTION 2

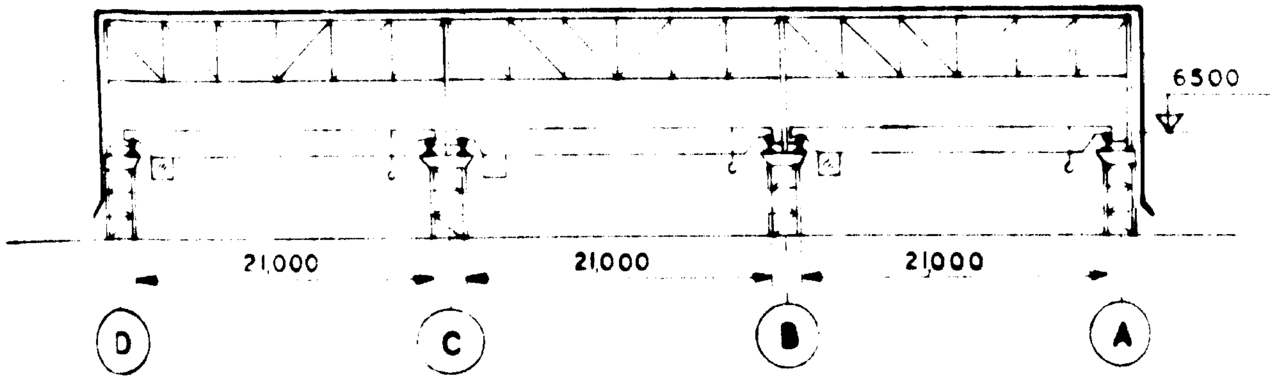
10 5 0 20

SCALE METRES





ELEVATION ON - B



SECTION A-A

LEGEND

1. CAR BOTTOM HEAT TREATMENT FURNACE
2. CAR BOTTOM TEMPERING FURNACE
3. WATER QUENCHING TANK
4. OIL QUENCHING TANK
5. COOLING BOXES
6. ROLLER TYPE SHAPE STRAIGHTENER
7. MULTI-ROLL ROTARY STRAIGHTENER
8. OIL HYDRAULIC STRAIGHTENER
9. MULTI-ROLL ROTARY STRAIGHTENER
10. CRANK OPERATED MECH. STRAIGHTENER
11. POWER HACKSAW
12. BAND SAW
13. MAGNAFLUX TESTER
14. ULTRASONIC TESTER
15. 10 - TON E.O.T CRANE
16. 5-TON E.O.T CRANE

SECTION 3

(12)

SCALE METRES

M. N. DASTUR & Co. PRIVATE LTD
CONSULTING ENGINEERS, CALCUTTA

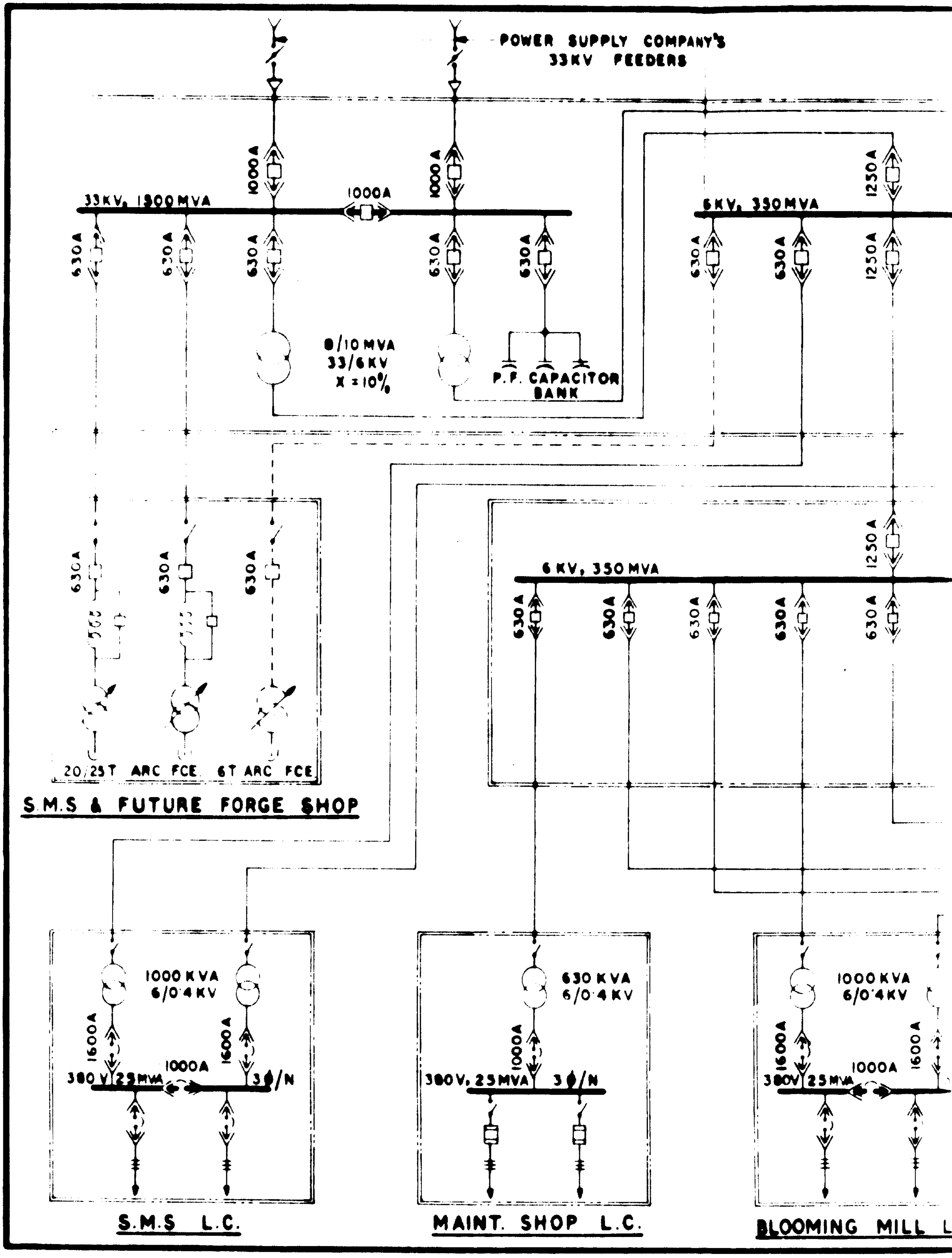
FOR
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

IRAN FERROALLOYS & ALLOY STEELS PROJECTS
ALLOY STEELS PLANT—HEAT TREATMENT, BAR FINISHING
& WAREHOUSE

DRAWN [illegible] 69
APPROVE

No. 5131-V-15

SECTION 1


POWER SUPPLY COMPANY'S 33KV FEEDERS
1000A
1000A
1000A
33KV, 1500MVA
630A
630A
630A
630A
630A
8/10 MVA
33/6KV
X = 10%
P.F. CAPACITOR BANK
1250A
6KV, 350MVA
630A
630A
1250A
630A
630A
630A
20/25T ARC FCE
6T ARC FCE
S.M.S & FUTURE FORGE SHOP
1250A
6 KV, 350 MVA
630A
630A
630A
630A
630A
1000 KVA
6/0·4 KV
1600A
1600A
1000A
380 V, 25 MVA
3∅/N
S.M.S L.C.
630 KVA
6/0·4 KV
1000A
380V, 25MVA
3∅/N
MAINT. SHOP L.C.
1000 KVA
6/0·4 KV
1600A
1600A
1000A
380V, 25MVA
BLOOMING MILL L