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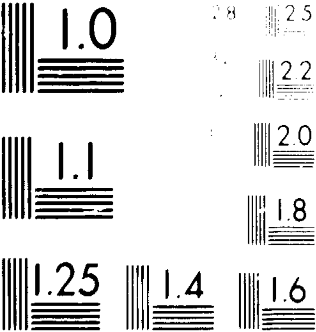
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Assistance to the Egyptian Iron and Steel Company

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TERMINAL REPORT

SECONDMENT TO THE EGYPTIAN IRON AND STEEL COMPANY,
BLAST FURNACE SECTION

21 November 1981 - 21 February 1982

Arab Republic of Egypt

by

A. Embleton, UNIDO Expert

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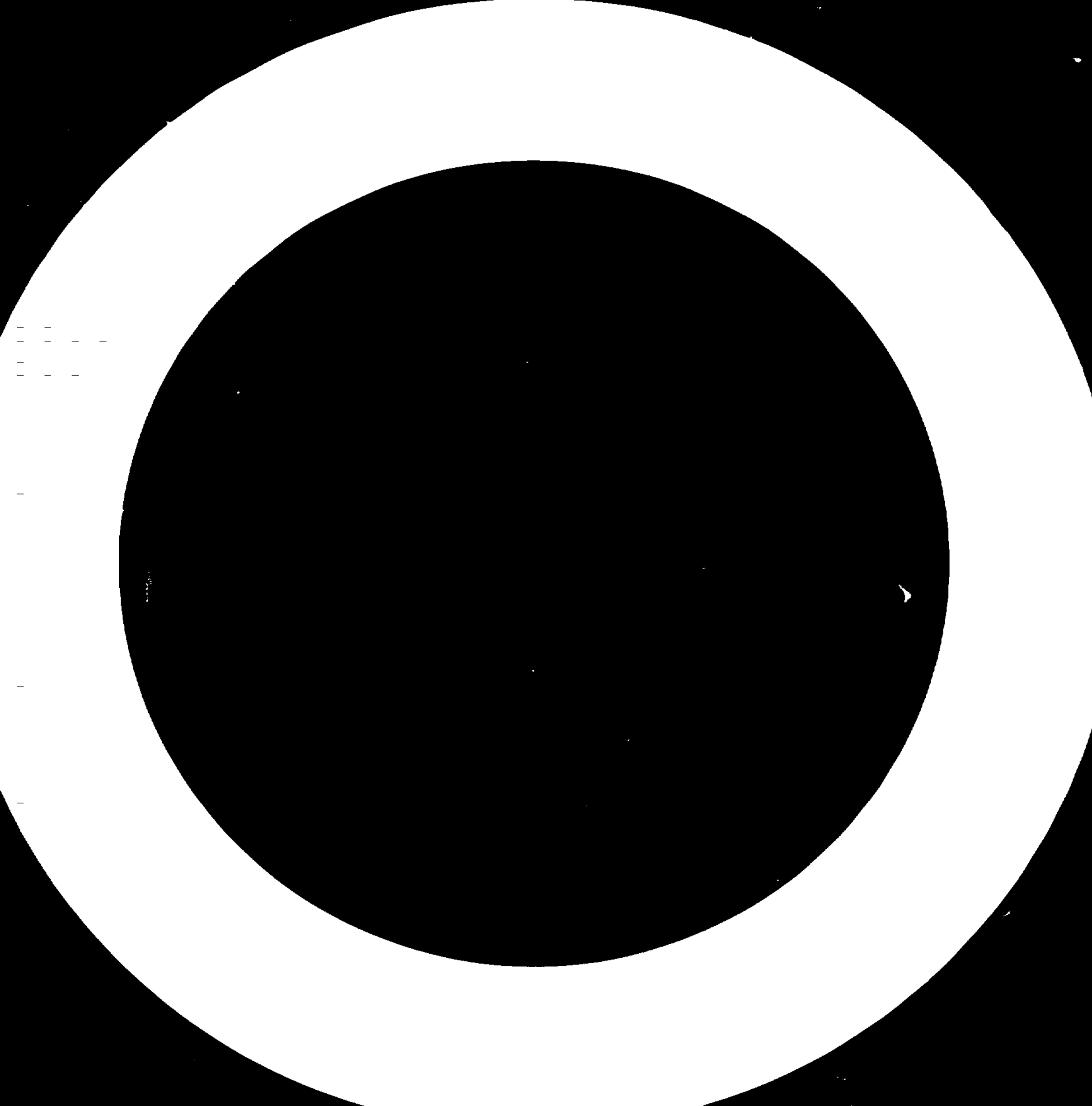


BLAST FURNACE OPERATIONS AT THE EGYPTIAN IRON AND STEEL COMPANY

INTRODUCTION

The primary objective of this U.N.I.D.O. secondment to the Hadisolb blast furnace plant was to ensure a successful re-commissioning of the No. 3 blast furnace. At the time of notification of the secondment, the 'blowing in' date was imminent.

After commissioning was completed and the furnace operating 'normally' a study was made of existing blast furnace practice to identify problem areas, mal-practices, etc., with the objective of increasing iron production and improving economy, yet still maintaining iron quality, and during this period there was much discussion with the blast furnace management.

According to the Operations Improvement Study previously requested by the Egyptian Iron and Steel Company, to cover the next six years' operations, the demand for iron will increase considerably in a two stage programme, as follows:-

	Stage 1	Stage 2
Date	1983	1988
Steelworks requirement, t.p.y.	1,200,000	1,600,000
Pig iron sales, t.p.y.	100,000	100,000
Total iron demand, t.p.y.	1,300,000	1,700,000

This report intentionally indentifies problem areas that affect the blast furnace operations at Hadisolb, and where possible, suggests remedial action necessary, to ensure that these tonnages can be produced.

Special mention is made of the re-commissioning of No. 3 blast furnace in December, 1981, (see appendix no. 3), and a suggested future furnace re-line programme covering the next five years, with maximum available tonnage on a daily basis has been developed (see appendix no. 7), along with sinter demand. It was recommended to management that sinter plant and steelworks major repair programme should coincide with this programme where possible, bearing in mind that there is some flexibility regarding furnace blowing out dates.

Also included are graphs of daily iron production at No. 3 and 4 furnaces (see appendix no. 1), and daily dry coke consumption (see appendix no. 2), as from October 1981 up to, and including, March 1982.

Samples of sinter and coke were sent to the U.K. for full appraisal, mineralogical analysis, etc., with a view to further understanding some of the problems associated with the blast furnace operation.

There is an urgent need to institute safety standards, develop training methods, and improve plant housekeeping, and particularly so as production increases towards maximum. Comments, reference these items are towards the end of this report.

There appears to be a scarcity of technical information available to plant middle management levels, and in answer to several requests, technical papers on many subjects related to blast furnaces and blast furnace operations were obtained from the U.K. and distributed accordingly. These papers included such subjects as burden distribution, control of alkalies, coke quality, hot blast stove design, control of flame temperature at the tuyeres, slag chemistry, control of slag quality, furnace refractories, etc and etc.

During the early days of the secondment it soon became apparent that the high alkalie, chloride and zinc contents in the Bahariya ore were causing serious problems both in sinter and blast furnace operations, and a visit to the mine was planned along with the blast furnace menagement.

The objective of this visit was to try and obtain a better understanding of the problems associated with the iron ore quality control.

This report commences with the visit to the Bahariya mine.

THE BAHARIYA ORE MINE

The blast furnace burdens consist of 100% sintered ore from the Bahariya mine which lies some 350 kilometres to the south west of the Hadisolb works, and following is a brief summary of the visit.

The mine is open cast, and consists of three main bodies of which the El Gedida deposit is the first to be exploited. It is believed that this El Gedida deposit is the best of the three main ore bodies, as far as grade is concerned, and has estimated reserves of some 126 million tons. From the commencement of mining operations in 1973 to the end of 1981, approximately twelve million tons of ore have been recovered.

This El Gedida deposit covers some nine square kilometres, occuring in the form of an anticline, with a little over burden at the centre, and some 25 metres at the extremes.

At the time of the visit the ore body thickness appeared to be about 14 metres, but it was reported that so far the maximum thickness had reached approximately 26 metres.

The ore body is highly variable throughout, with Fe content anything between 30% and 60%, with variable manganese content, reaching in places as high as 15% MnO. Intermixed with the ore body is a fluctuating contamination of Barite, Alkalies, Chlorides, the concentration depending mainly on the porosity of the iron ore layer.

The original core drilling programme on which the exploitation of the mine was first planned, was carried out on a 200 metre grid . During the early stages of the mining operation it became apparent that the ore body was extremely variable and the area planned for the first ten years of mining operations was then drilled to a 50 metre grid pattern.

The mining plan for 1981 - 1982 consists of eleven areas for which the predicted average analysis and planned tonnage are given:

PRODUCTION PROGRAMME JULY 1981 - JUNE 1982

	Area	Estimated Ore Tonnage	% Fe	SiO_2	Cl.	MnO	Estimated overburden Tonnage
	I	77,000	50.69	13.41	0.17	1.01	1,212,000
East	II	153,000	51.59	8.87	0.55	2.65	108,000
Side	III	106,700	52.73	9.94	0.72	1.69	
	X	398,700	47.38	14.74	0.08	2.76	-
	IV	244,800	55.23	5.43	1.25	0.93	
	V	306,600	59.16	3.42	0.77	1.02	51,000
South and	VI	320,900	58.42	4.69	0.88	1.12	
West	$VIII_1$	157,600	55.05	4.87	1.28	2.24	19,000
Side	$VIII_2$	447,700	57.54	4.15	0.59	1.21	
	IX_1	255,700	53.74	5.48	0.80	1.86	198,000
	IX_2	295,900	48.76	7.49	0.53	4.02	
TOTAL		2,765,000	54.01	7.04	0.67	1.89	1,588,000

The aim of the management is to obtain the average analysis specification of Fe, SiO_2, Cl and MnO for each 90,000 tons of ore, this being the capacity of each of the two pairs of blending piles. The production rate is 1,200 to 1,300 tons per hour over a ten hour day, giving a cycle time of 7 to 8 days per pile of ore.

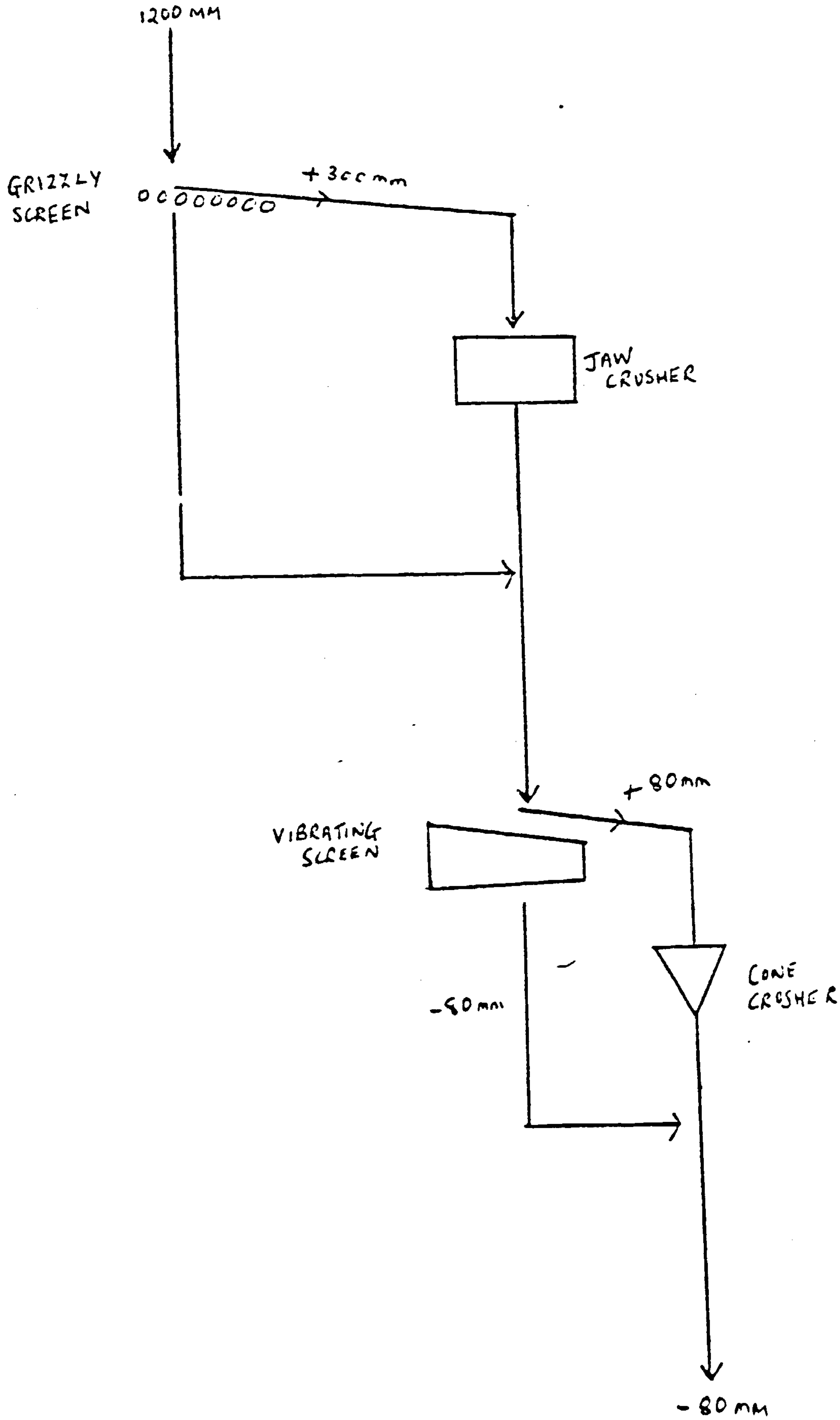
Analysis control is based on the 50 metre grid core analysis updated by analysis of samples taken from the charge bore holes at the mine face.

Control of ore grade is very difficult in view of the variability of the ore and the mine management were contemplating trying to improve the situation using larger blending piles and more sophisticated blending equipment.

Excavation is by electrically powered shovels of 4.6 m^3 capacity, i.e. 8/9 tons of material. The power supply is via the grid system from the Aswan High Dam.

The dump trucks used are a mixture of Russian and American designs, varying in size from 27 to 75 tons capacity.

Maintenance is carried out on the day shift with mining operations taking place on two shifts, between 1700 hrs and 700 hrs, FLOW SHEET ore crushing, screening and blending at the Bahariya Mine.



The crushed ore is discharged to one of two pairs of blending piles via wing trippers.

Reclaiming from the beds is via mobile electric shovel, as used at the mine face, into rail wagons for transfer to the stock piles at Hadisolb works.

The mine is capable of loading three trains each of fifty five cars per day. The capacity of each car being 65/70 tons.

There are problems with the rail transport of ore to Hadisolb works and some improvement in the present system of operation is necessary if the forecasted increase in iron tonnage is to be met.

Strong desert winds, especially in the months of March, April, May and June cause heavy drifting of sand across the rail tracks and increased ore demand will necessitate more sophisticated methods of sand removal, increased loco power and truck availability. There is a need to increase ore stocking capacity at the Hadisolb works and a study of this is included in the rehabilitation programme.

By steel industry standards, Bahariya ore is a very marginal ore. It is high in phosphorous, gangue constituents, sulphur and ignition loss. Its most undesirable characteristics, however, are its' high alkalie and chloride content, which are seriously affecting both sintering and blast furnace processes.

TYPICAL ANALYSIS OF THE BLENDED BAHARIYA ORE (Average 178 samples)

Fe	52.91	Mn	1.40	K_2O	0.127
SiO_2	7.62	S	0.47	BaO	2.19
CaO	0.49	P_2O_5	0.50	I. loss	7.59
MgO	0.50	Cl	0.69		
Al_2O_3	1.86	Na_2O	0.502		

The overall cost of problems in sinter plants and blast furnaces caused by and associated with the alkalie and chloride content of the ore substantiate the need for a washing process prior to sintering. Some pilot plant trials have already been carried out and it is suggested that planning for trials on a larger scale should commence without delay. There has been much discussion with plant management reference this matter.

Raw Material Handling at Hadisolb

The ore wagons from Bahariya are tipped by wagon tippler into ground bunkers and the ore is transferred to one of three stockpiles each with a capacity of 45,000 tons. Reclaim is by vertical sectioning. The Rehabilitation Programme allows for a second wagon tippler to be installed with increased handling speed, as well as increased ore stocking and reclaiming facilities. It is recommended that stocking capacity is increased to around 250,000 tons in order to satisfactorily meet Stage II iron demands.

A fourth stockpile of similar size handles incoming limestone from the harbour.

All four piles are served by a single stacker and one revolving bucket reclaimer. The ore and limestone are transported from the stockpiles to the crusher building via conveyors.

At the ore preparation plant the ore is reduced by three cone crushers to - 8mm, with approximately 50% of the as received R.O.M. ore being screened off at 8 mm prior to the crushers.
The limestone is crushed to - 3mm in hammer mills.

From the crushers the ore is blended in drum mixers whose main purpose is to permit the addition of water to the ore, to begin the process of micro pelletisation of the crushed ore fines. The addition of water at the drum mixers is very unreliable, and at times non-existent. From the drum mixers the ore is conveyed to the blending house for storage and later reclaiming. The capacity of the blending house is 30,000 tons in two piles, each of 15,000 tons. One automatic reclaimer services both blending piles. This step in the process provides additional blending and uniformity prior to delivery to the feed bins.

The feed bins also contain limestone crushed to - 3mm, and coke crushed to -5mm. Both these additions are suspect from the sizing point of view. The limestone appears to contain a high percentage of very fine powder and the crushed coke contained some oversize as well as too fine elements, both affecting the sinter physical quality.

From the feed bins these materials are fed at controlled rates onto a collecting belt and delivered to the primary mixing drum, where again, the addition of the correct amount of water was suspect.

At the sinter plant there is a final mixing drum where the water was again added, prior to the mix being fed onto the strand. Here there were problems with the automatic valve controlling the addition of the water, and it was being added according to the judgement of the operators, which is detrimental to good practice.

Discussion took place with the operators, reference the problem of water additions to the crushed ore and sinter mix, and plans to remedy the situation were developed in principle.

The burden of all blast furnaces is 100% sinter made from 100% Bahariya ore. Because of the difficulties experienced in blast furnace operation due to poor physical quality of sinter, i.e. high hot blast pressure, erratic stockline movement, slow driving rates and low iron production, scaffold formations in middle and lower stacks, etc. due to alkalie sublimation, many visits were made to the sinter plants to observe operations and discuss problems with management etc., especially the problems that affected blast furnace operation, and the following comments outline the prevailing situation and remedial action necessary.

There are two sinter plants at the Hadisolb works, No. 1, with two strands, and No. 2 with four strands, and the following is the main design data.

Item	No. 1 Plant	No. 2 Plant
Design	Russian	Russian
Commissioning date	1961	1974
No. of strands	2	4
Width inside pallets (m)	2.0	2.5
Length over wind boxes (m)	25	30
Grate area (each line) (m^2)	50	75
Total grate area (all lines) (m^2)	100	300
Rated capacity (1,000 t.p.y.)	750	2,400
Sinter cooling method	Rotary	Straight strand line
Capacity of Exhausting System (m^3/min)		6,500
Air Suction (design mm H_2O)		1,200
Air Suction (actual mm H_2O)		800
Strand speed (design m/min)		3.5
Strand speed (actual m/min)		2.5

The normal pattern of sinter distribution to the blast furnaces is mentioned in the section of the report dealing with blast furnace operation.

The sintering process has numerous problems that are affecting production and the physical quality of the sinter as charged to the blast furnaces, and the more important of these problems are listed below:

(1) The high levels of chloride and sulphur in the Bahariya ore causes serious corrosion problems in many areas throughout the process, increasing greatly the amount of maintenance required and thereby the amount of strand downtime.
There is a need for more thorough and detailed system of planned maintenance.

(2) As previously mentioned, the size analysis of the materials used in the sinter mix need to be reviewed, and necessary action taken. Redesign of crushing and screening facilities for ore, coke breeze, limestone, and screening of the returned sinter fines to control upper size limit should be carried out without delay, as these affect sinter quality irrespective of any action taken during the sinter processing.

(3) The problems associated with the water addition in drum mixers, etc. to promote micro pelletisation should be revised and re-instituted as soon as possible.

(4) The use of the hearth layer on the sinter strand has been discontinued and this causes uneven gaps to develop between the grate bars for the following reasons:
(a) warping due to excessive heating
(b) sublimation of alkalies sealing up large areas between the bars
(c) the design of the grate bar (round) is not condusive to efficiency and should, at least, be manufactured from heat resisting steel instead of mild steel

The resulting influence on the sinter bed gives areas of bed collapse where the gap between the bars is too large, and the areas of poor and non sintering, where the gaps between the bars are made up with alkalie. The use of the hearth layer has been discontinued in an endeavour to remove as much alkalie from the sinter as possible during processing. It is agreed that if ore washing is introduced on a regular basis the installation of the hearth layer will be resumed along with a more efficient design of the grate bar.

(5) Wind box sealing arrangements are not good, and excess leakage at the pallets necessitates reduction in strand speed with resulting loss of output. A new design of spring bonded seal has been installed at the recent major repair of No. 4 strand, replacing the original design, using water dooled flexible tubing. This new design is only partly effective. Study should be made of recent developments in wind box sealing, and one of the more effective systems adopted.

(6) The present method used to level the material on the sinter bed is unsatisfactory as it has a tendency to compact the bed, as well as level it. This method should be discarded altogether if a more effective system cannot be developed.

(7) The whole philosophy of sinter screening both at sinter plants and blast furnaces needs to be thoroughly reviewed. Effective screening to prodnce a clean + 5mm sinter charged to the blast furnaces is the objective to be achieved, and willhave the following beneficial effects as against the present system

(a) increased production of blast furnace sinter of acceptable size (the present screens are set at 8 mm)
(b) more effective production control yielding improved sinter quality at the blast furnaces (-8mm sinter returned fines are too large in size for good quality sinter manufacture)
(c) increased iron production and improvement in furnace economy
(d) reduction in fluedust make, and atmospheric pollution.

(8) The problems associated with the handling of hot returned fines should be thoroughly reviewed.

(9) From the appearance of the final sinter received at the blast furnaces there is a lack of control during ignition, e.g.

(a) The final sinter from no. 1 plant contained a high proportion of unsintered ore
(b) from no. 2 plant the sinter not only contains unsintered ore but also large quantities of heavily slagged sinter. It seems that sintering ignition conditions are too severe, causing heavy slagging at the surface of the bed, resulting in loss of bed permeability.

(10) Plant housekeeping and safety standards are not acceptable when compared with European and American standards. Much of the air suction system for dust removal is out of order, resulting in excessive atmospheric pollution which must have a demoralising effect on all personnel.
The poor state of plant housekeeping, lack of minor electrical and mechanical maintenance, and safety standards generally, should be given immediate priority.

(11) Instrumentation for recording and control seems to be in need of some rehabilitation. At the present time much of the system seems to be out of operation. A full scale review of all instrumentation should be carried out, replacing where necessary with more up to date control equipment.

There is planning for a fifth sinter strand at No. 2 sinter plant and it was intimated that erection by a Russian construction company would commence within the next two years.

BLAST FURNACE PLANT AND PROCESS

There are four blast furnaces at the Hadisolb Plant (see appendix no. 6). Nos. 1 and 2 furnaces have similar dimensions, and were installed as part of the original Demag Plant built in 1955 - 1958. Nos. 3 and 4 furnaces also have identical design, and have been installed as part of the major expansion of the plant. These two furnaces were erected by the U.S.S.R. firm of V/O Tyazhpromexport, to their own designs in 1974.

A fifth furnace is envisaged in the future to meet steelwork and cold pig iron demand, and it has been suggested because of results obtained from nos. 3 and 4 furnaces, and also to alleviate the heavy engineering spares position, that the fifth furnace design should be identical with nos. 3 and 4, and built as an extension to this plant area.

With increase in hot blast temperature to 1100/1150°C at nos. 3 and 4 furnaces, there is inadequate stove capacity for continuous operation at full furnace blowing rates, and it is suggested that the building of a fifth stove at nos. 3 and 4 furnaces should be evaluated without delay and should also be included in the plans for the fifth furnace.

Stock House practices, charging sequences, stockline level control are average at Nos. 1 and 2 furnaces. Sinter screening should be made available at these furnaces and some improvement in the general standard and availability of instrumentation is required to improve efficiency.

At nos. 3 and 4 furnaces these operations are under good control, but improved maintenance and modernisation of instrumentation could be advantageous.

A gas probe used to monitor CO_2 distribution across the furnace stocklines at Nos. 3 and 4 furnaces, and charging sequences, along with distri[illegible]on cycles can be varied accordingly. The whole charging system at [illegible] [illegible]nd 4 furnaces is a very versatile design, and enables good control [illegible] operation.

In wall thermocouples and continuous top gas analysis are available to assist in determining charging practice.

MAIN DESIGN DATA

ITEM	Unit	Nos. 1 & 2 Furnaces	Nos. 3 & 4 Furnaces
Design		Demag - German	Tyazhpromexport - Russian
Commencement of operation	year	1958	1974
Hearth diameter	m	5.1	7.2
Hearth area	m^2	20.5	40.7
Furnace inner volume	m^3	575	1,033
Working volume	m^3	463	890
Iron notches	number	1	1
Slag notches	number	1	2
Tuyeres	number	10	14
Stoves	number	3	3
Heating area of stoves - each	m^2	12,500	23,160
Hot blast temperature, maximum	°C	800	1,100
Maximum attainable wind volume	nm^3/min	1,500	2,200
Top pressure	kg/cm^2	0.025	1.00

STOCK HOUSE SCREENS (present system)

coke	mm	25	45
sinter	mm	none	8

RATED CAPACITY

Each furnace	T.P.Y.	1,000	223	670
Plant capacity	T.P.Y.	1,000	1,786	

SERVICES TO BLAST FURNACE PLANTS

(1) Molten Iron Disposal

Molten iron is transferred to the steel plant mixer or pig casting machine by 100 ton capacity hot metal ladles. Initially these ladles were of semi closed top design, but have recently been fitted with fully open tops to assist in speed of ladle skulling and relining. This appears to have been a correct decision. There are 36 hot metal ladles available for service and from observation at the blast furnaces are well maintained and kept in good condition, ref: top skulls.

(2) Pig Casting Machine

The pig casting machine is situated between the blast furnaces and the steel works mixer.
There are two double strand pig casting machines, housed in one building, with a total rated capacity of 1,600 tons per day. The lime solution preparation plant, pig cooling system, and stocking areas seem adequate. From observation it would appear that the capacity of the machines could be considerably increased with speeding up of ladle movement facilities, etc., at the machine, improved running repair facilities, spout replacement, etc.

(3) Hot Metal Skulling and Repair Shop

Adjacent to the pig casting machine building is the Hot Metal Ladle Skulling and Repair Shop. It is in need of some reorganisation and enlarging of facilities available, in order to cope with the increased number of ladles that will be in service to meet the increased tonnages and increased number of casts per day per furnace. Even so, the ladles are maintained in very good order.
Normal ladle life is around 200 casts, and reline time around 6/7 days. The taphole gun mix is also manufactured in the shop, using a double roller mill. The coke breeze is delivered after grinding, from the sinter plant. Periodic oversize caused mix problems, which reflected in taphole length control.

(4) Slag Disposal and Processing

At present all slag is granulated and reclaimed mainlyfor local cement manufacture. A second granulation plant is under construction and between them these two plants will easily handle all slag manufactured with all furnaces on full production, making some 5,100 tons of iron per day, i.e. approximately 2,000/2,500 tons slag per day.
A slag pumice plant is now more or less complete and under test running. It has an estimated capacity of approximately 1,000 tons per day. A slag wool plant is under contruction with a capacity estimated at 250 tons per day.
A slag pelletising pilot plant has been set up to make the bulk aggregate material for the manufacture of lightweight blocks for insulation purposes, and to date the results look very promising.
There are some 50 slag ladles available to service the blast furnace plants, with a lime spraying plant for coating the inside of the ladles, situated between the granulation plant and the blast furnacee.

(5) Furnace Blowers

Nos. 1 and 2 furnaces are serviced with electrically driven blowers, with one spare blower available. The blowers are adequate for the furnaces. These blowers are a works safeguard in case of general steam failure at the works.
Nos. 3 and 4 furnaces are serviced with steam turbine driven blowers, with one spare blower available. Both turbines and blowers are of rugged design and capable of meeting the maximum needs of the furnace.

(6) Gas Washing Plant and Gas Storage

At nos. 1 and 2 furnaces the gas washing system comprises one primary and two secondary dust catches at each furnace with primary scrubbers, disintegrators and final driers common to both furnaces. There is also a Klonne type blast furnace gas holder beside the gas cleaning plant with a capacity of some 80,000 m^3.
At nos. 3 and 4 furnaces each furnace is equipped with primary dust catcher, with the isolation valve at the dust catcher inlet, primary scrubber, two venturi scrubbers, two electrostatic precipitators and final driers. The gas systems connect with the gas holder at nos. 1 and 2 furnaces. Because of the sublimation of alkalies and zinc from the crude furnace gas, there are constant problems with build up in the crude gas mains (see appendix no. 12). To maintain control complete cleaning of the crude gas main at each furnace must take place every six months as and until the washing of the ore is instituted. Observation showed 85/90% build up in certain areas of the crude mains.

PRESENT AVAILABILITY AND GENERAL CONDITIONS PREVAILING AT THE BLAST FURNACE

No. 1 Furnace - was blown out empty on February 7th, 1982 due to non-availability of sinter and suspected extensive scaffold formation within the furnace stack. Examination after blowing out showed a complete ring scaffold in the lower stack and covering approximately 50% of the cross-sectional area. Care was taken in quenching down the furnace in order to protect the carbon brickwork in the bosh.

The scaffold formation has now been removed and after very minimum repairs the stack refractories, taphole area, water systems, gas main cleaning, etc., the furnace is expected to be recommissioned early in May, for a further extra campaign life of approximately one year, after which a full reconstruction programme will be put into practice. (see appendix no. 7).

It is anticipated that during this next year of extra campaign life, the furnace will manufacture high silicon iron, i.e. 1.5 - 2.5%. for use in local foundries. Anticipated tonnage will be 350 - 400 tons per day.

No. 2 Furnace - was blown out on June 19th, 1979, for a complete rebuild from foundation level. Hearth and tuyere belt shell plates are now erected and work is starting on the erection of the stack shell plates.

The expected date of re-commissioning is January, 1983, (see appendix no. 7)

No. 3 Furnace - was re-commissioned on December 9th, 1981, with the old hearth from the previous campaign left in, and renewed tuyeres belt, bosh and stack refractories. The furnace has operated on reduced blowing rate until mid March, 1982, because only two stoves were available for blowing. With the commissioning of the third stove, blowing rates were steadily increased and obvious signs of stack build up started to show despite the use of high top pressure and charging sequence changing, etc., at regular intervals. The affects have shown in: hearth temperature reductions, (see appendix no. 13), high blowing pressures, irregular burden movements, etc. To some extent this situation was expected and anticipated, as shortage of sinter caused long periods of furnace down time, (see appendix no. 1 and 2), and poor physical quality of sinter coupled with incorrect screening practice has led to furnace interior build up and patterning.

No. 4 Furnace - was recommissioned April 19th, 1979, after complete reline. The furnace has operated well, but the effects of poor sinter quality, downtime, etc., are taking their normal course of reactions on furnace driving rates, etc. Despite this, the month of March was an all time record production for this furnace.

The month of February, 1982, produced an all time record for iron production at Hadisolb works, and the month of March exceeded iron production record for February. 98% of all iron produced was within steelworks specifications.

GENERAL COMMENTS RE: BLAST FURNACES

(1) The whole of the Demag plant is in a generally neglected state, and in need of a thorough over-haul and clean up. The practice of dropping dry flue dust from elevated mains to ground level should be discontinued to try and improve the general state of untidyness and atmospheric pollution. The use of canvass shutes and skips at ground level has been suggested.

Five of the six Cowper stoves have been recently relined at the Demag plant, but hot blast mains, valves, etc., need attention. There is excessive blast, gas, water and steam leakage around the plant. The furnace burdens, scale cars, charging systems, etc., need overhauling and cleaning up.

(2) The Russian plant (nos. 3 and 4 furnaces) is robustly built and generally in good condition, but mechanical, electrical, instrument maintenance, particularly in small items, need a thorough examination and planned repair system. Blast, water and steam leakage areexcessive and general design in many cases needs reviewing. There is considerable gas leakage passing the large bell at both furnaces despite the addition of extra counter balance weights. A full scale investigation is taking place, re: design, type of material used, etc., to try and overcome this excessive wearing of the large bell seating, as the problem appears to be something inherent from initial design. H.T.P. at No. 4 furnace has been reduced accordingly.
Back draughting chimneys are in the process of erection at both furnaces to stop the damaging effect of alkalies on the stove brickwork when backdraughting.

Housekeeping is poor by European standards, but the nos. 3 and 4 blast furnace plant compares well with the rest of Hadisolb works. Work is in process to try and improve the housekeeping situation at both blast furnace plants.

FURNACE CHARGING MATERIALS

Coke

The coke from the Al Nasr Works is made from coal imported from Russia and America, and is fed to the blast furnace bunkers or stock yard by belt conveyor. At present there are some 160,000 tons in stock.

The Al Nasr Coke Works is operated by an independent company known as the "Al Nasr Company for Coke and Chemicals", and includes coal handling and preparation, three coke batteries, coke quenching, screening, handling and storage, gas processing and fertiliser plant.

The coal is unloaded from ocean going vessels at the port of Alexandria and transhipped to Hadisolb by 450 ton capacity barges, or by rail road. Some 70% is transhipped by barge to Hadisolb docks.

The coal stockyard capacity at Hadisolb Docks is around 250,000 tons, and is serviced by the gantry cranes which off-load the barges. The coal is fed to the coking plant by means of a 3,500 m. long overhead conveyor, which is loaded by gantry cranes direct, or from stock.

Nos. 1 and 2 coke batteries each have 50 ovens, yielding 11 tons of cokeper charge, and no. 3 battery has 65 ovens, yielding 13.7 tons of coke per charge.

Chemically, the coke is very average with high ash and sulphur contents, and a $Na_2O + K_2O$ content of 0.20, which is high for coke, and aggravate the alkalie problem caused by the Bahariya ore. The coke fines for sinter making are the crushed screenings from the furnace coke.

The coke has very good physical qualities and behaves exceedingly well in the furnace, maintaining its' shape, within reason, down to tuyere level, and thereby maintaining a high level of burden porosity at all times. This is a very important factor re: Hadisolb blast furnace practice, as the sinter which makesup 100% of the burden is often very friable in quality, and would otherwise cause serious furnace driving problems, especially with the inefficient sinter screening system. (See note ref. this on 'Sinter Quality') Some lack of coke reactivity is suspected but under present conditions the maintaining of a good level of bosh and stack permeability is of vital importance.

Coke Analysis	Range
Moisture	3.5 - 5.5
Sulphur	0.90 - 1.08
Volatile matter	1.20 - 1.23
Fixed Carbon	88.0 - 89.0
Ash	10.0 - 11.00
$Na_2O + K_2O$	0.18 - 0.20
+40 Micum	79 - 85
-10 Micum	5 - 9
ASTM	around 55

With this quality of coke, coupled with the use of high top pressure, the furnaces have a remarkable recovery potential from the upset hearth and bosh conditions.

The coke is fed into two bunkers at each furnace and screened over vibratory 40 mm bar screens, into weigh hoppers directly above the skip. The fines from these screens are fed direct to the sinter plant or to the stock pile.

SINTER

Sinter from both sinter plants is transferred to the blast furnaces by belt conveyor.

From No. 1 sinter plant, the sinter belt delivers to a highline overhead bunker, serviced by a highline transfer car, which delivers to the furnace bunkers. Sinter from no. 1 sinter plant can also be waggoned from the high line overhead bunker and delivered to No. 3 and No. 4 furnace via conveyor belt from the ground bunker system.

From No. 2 sinter plant the sinter belt delivers direct to the stockhouses of No. 3 and No. 4 furnaces. Excess sinter can be put out to wagons from no. 3 stockhouse.

The system works well, and there are discussions taking place for direct feeding by belt from no. 1 sinter plant to no. 3 and no. 4 furnaces.

SINTER QUALITY - chemical

The sinter is made from 100% blended Bahariya ore and makes up 100% of the blast furnace burden for all furnaces.

Average Analysis	Range
Fe	53.5 - 56.00
FeO	11.10 - 15.00
MgO	0.50 - 0.60
SiO_2	6.9 - 7.70
CaO	7.10 - 8.20
P_2O_5	0.49 - 0.51
Mn	1.38 - 1.80
S	0.12 - 0.16
N ace	.30
$Na_2O + K_2O$	.45
CaO/SiO_2	1.0 - 1.1

The chemical quality of the sinter is dictated by the following:-

(1) the use of 100% Bahariya ore
(2) the blast furnace slag quality required for cement making
(3) iron quality required for steelworks operation
(4) the maintaining of a suitable hearth temperature (partially controlled by slag melting point)

The alkaline, chloride, zinc content of the sinter causes serious problems in blast furnace operation:-

(1) Formation of Furnace stack inwall scaffolds through the process of sublimation. Periodic removal by washing down with acid slag, flouride, etc. is essential, thereby temporarily upsetting the furnace working balance.
(2) Serious attack on the furnace inwall refractories.
(3) High coke consumption.
(4) Periodic upset of furnace driving rate with high blast pressures loss of production etc.
(5) Make up in dust catchers and crude gas mains.
(6) Atmospheric pollution levels are consistently high.

SINTER QUALITY - Physical

The physical quality of the sinter is not good. It is very friably and breakdown between leaving the sinter plant and arrival at the blast furnace skip is much too great.

The screening systems at both sinter plant and blast furnaces are inefficient and need completely re-vamping to ensure a clean + 5mm sinter charged to the furnaces at all times. The present system of screening is out of balance and the following problems develop:-

(1) The screens at sinter plants and blast furnaces operate blind, and so it is impossible to observe the percentage of make up of the screen mats.
(2) The area of the screen and type of screen used do not allow efficient screening, resulting in a large proportion of - 3 mm sinter being charged to the furnace

(3) Screening at 8 mm to try and obtain cleaner sinter (present practice) allows a percentage of 6 - 8 mm sinter into the returned fines. This is detrimental to future sinter manufacture and also reduces the tonnage of acceptable sinter produced.

The whole sinter screening system is now under review for improvement, in the near future. There has been much discussion reference this.

SINTER STOCKING

There are no adequate sinter stocking arrangements and the furnace bunkers hold about 7 - 8 hours supply if they are full, and so the balancing of sinter make with sinter demand often becomes impossible, with ensuing plant shutdowns.

It is imperative that a sinter stock of some 70/80,000 tons is developed within easy access of the furnace bunkers to act as buffer supply.

This development is now under consideration. Recently a temporary small sinter buffer stock was developed from sheer necessity from the feed out point in no. 3 furnace stock house, and reclaiming where necessary via the ground bunker system. However, handling facilities were not good and produce excessive breakdown of the sinter which reflects in the furnace performance.

FLUXES

Furnace basicity is balanced as far as possible by adding 100% of flux required to the sinter mix - the flux is limestone as against the use of dolomite, to keep MgO levels in the slag to a minimum to benefit cement manufacture. Where furnace basicity tends to get out of balance a minimal corrective addition of limestone is added to the furnace charge. The size of this limestone should be within range - 30mm + 5 mm (as charged direct to the furnace)

OTHER ALTERNATIVES FOR FURNACE BURDEN IMPROVEMENT

The run of mine ore as currently supplied from Bahariya is not suitable for direct charging into the blast furnace because of its' large size range and extremely variable physical quality and chemical analysis.
Alkalie and chloride contents are variable but consistently high and MnO ranges from 1 - 4%.

As previously commented, the washing of Bahariya ore is urgently required to help the operators of both sinter and blast furnace plants, and pilot plant investigations coupled with a total cost return on capital outlay should have high priority.

The advantages gained from using imported iron ore of suitable quality should be considered:

(1) As fines to blend with present sinter mix to reduce manganese, sulphur, alumina and alkalie levels.

(2) As rubble ore, crushed to - 40 mm and screened at + 8 mm to supplement the sinter supply, and help reduce manganese and sulphur content in hot metal and alumina in the the slag.
The quantity of rubble ore charged to the blast furnace should not exceed 20% of the furnace total burden otherwise furnace economy will be affected.
Note - it has been suggested that Conakry ore, being relatively local could be a source of supply. Past experience has proved that this ore is very difficult to smelt because if its' high alumina and chromium content.

(3) Pellets of suitable quality could be an advantage economically but care must be taken to test their reaction to alkalies at high temperature before purchase is made.
The physical stability of pellets within the furnace stack must be considered, bearing in mind the non-reactivity of the coke and the ensuing increase of voidage within the furnace.

BLAST FURNACE OPERATIONS

The figures quoted below are -o. no. 4 furnace and are typical of operation during the periods of maximum blowing rates.

Iron analysis	98% within steelworks specification 1.20 Si .065 max.	
Iron production	see appendix no 1	achieved production of 2 tons per m^3 effective furnace volume
Coke rate	see appendix no 2	
Natural gas rate	5,000 m^3/hr. (64 - 68 m^3 per ton iron)	
Ore/Coke ratio	3.1 - 3.3	
Added flux/ton iron	30 - 40 kgs.	
Sinter/ton iron	1730 - 1780 kgs.	
Blowing rate, max	2,100 - 2,150 m^3/min	
Down time	2 - 30 hours per week	excessive
Reduced blast	6 - 19 hours per week	
Blast temperature	1150°C	
Hot blast pressure	2.00 - 2.45 Kgm/Cm^2	
High Top Pressure	1.00 Kgm/Cm^2	
Slag volume/ton iron	411 - 448 Kgms.	

SLAG ANALYSIS	Range
CaO/SiO_2	0.98 - 1.10
$CaO + MgO/SiO_2 + Al_2O_3$	0.78 - 0.84
SiO_2	32.30 - 36.10
CaO	32.10 - 36.10
MgO	3.20 - 4.50
Al_2O_3	12.50 - 13.90
Mn	.96 - 1.95
S	1.30 - 1.88

CAST HOUSE PRACTICE

All furnaces have individual cast houses.

At nos. 1 and 2 furnaces the existing cast house layout is satisfactory for handling the expected maximum daily iron tonnage of 600 tons per furnace, but operation would be improved with the introduction of a suitable taphole drill and especially at times of high production. The furnaces have one taphole and one slag notch.

The installation of suitable taphole drills would:-

(a) help to maintain taphole length and strength
(b) control iron and slag flow from taphole
(c) increase the safety factor for men working on the cast house floor
(d) reduce the workload and enable more casts per day to be made in times of high production
(e) reduce cast house costs

Equipment for measuring hot metal and slag temperature should be installed as a guide to hearth temperature and condition.

Nos. 3 and 4 furnaces have one taphole and two slag notches at different levels (see appendix no. 11). The general layout of the cast houses is satisfactory and comfortably handles tonnages in excess of 2,000 tons per day, per furnace.

Taphole condition is generally good, with average length of 1½m. The type of clay used for stopping is anhydrous tar bonded mix using - 5 mm coke breeze from the sinter plant roll crushers. The clay stopping is manufactured in the ladle repair shop. Coke breeze size exceeds 5 mm at times.

The Russian designed and manufactured taphole guns are massively built and very reliable. They hold $\frac{1}{2}m^3$ of taphole mix with a ram pressure ensuring operation under all conditions.

The taphole drills are likewise massively constructed and capable of drilling through to the molten iron under most taphole conditions.

Casting trough practice is good and slag skimming very efficient. Relining of the trough is done away from the furnaces, with the entire trough being changed approximately every 10 days. The cast house crane has good accessibility to the taphole area and has a lifting capacity capable of removing the entire trough with the aid of a lifting frame. With the present trough practice, draining of iron and slag is done after every cast.

Iron runners are short and easily maintained with the existing sand quality. The metal ladles are set on two adjacent railway tracks and a radial arm swinging spout is used for filling. The ladles on the inner road are shunted by means of an electrically operated pusher.

The method is very efficient, reliable and labour saving, and will easily handle the tonnage when the furnaces are on maximum output.

Notch and casting slag are handled with the same design of equipment as used for the iron and again the system is very efficient.

To date, the practice entails the draining of the iron casting trough after each cast, even when casting eleven times in 24 hours. Discussion has taken place ref: non-draining of the trough after each cast, in order tosave time and labour, which is very necessary when the furnaces are onfull production. The non draining of the trough will also enable more casts per day to be made, with less, or non use of the slag notches.

Trials using this practice of non-drainage will commence very soon. It will prove to be very beneficial as production increases, with reduction in furnace down time, due to less slag notch failure. The incidence of slag notch failure at Nos. 3 and 4 furnaces is much too high under present conditions of operation.

The design of the slag notch tuyere requires further study. It is very obvious from the pattern of failure that the cooling water is not circulating correctly within the tuyere and steam is forming at the inner base when slag is being flushed. Redesign of the internal pipework or higher circulating water pressure within the slag tuyere will remedy the situation and save considerable furnace down time.

BLOWING TUYERES

Nos. 3 and 4 furnaces are undertuyered, i.e. there is too much circumferential distance between the centre line of each blowing tuyere, and there is a tendency for build up of cold slag at the tuyere nose when the slag is viscous. Together these two factors upset the initial distribution of blast to the furnace which in turn upsets the balance of blast/natural gas injection at each tuyere.

The use of dipping tuyeres will help remedy the situation and introduction was made to a suitable manufacturer of quality tuyeres and drawings etc. have been submitted. Hadisolb also requested computer calculations for the positioning of the natural gas injection pipe within the tuyere to obtain maximum flow relative to furnace economy, as and when oxygen enrichment of the blast is available. Improvement in instrumentation to balance blast and natural gas injection under all conditions of blast flow is required.

The Russian designed oxygen plant is now being completed and it is estimated that the oxygen for enrichment will be available in mid 1983.

INDUSTRIAL SAFETY

There is a completely negative attitude towards safety and safe working practices at Hadisolb Works, and the high accident frequency rates quoted endorse this statement. It is agreed that accident frequency rates per million man hours worked can be, to some extent, influenced by company attitude towards the injured person, etc. but frequency rates of less than five lost time accidents per millions man hours worked are quite common place in European and American steelworks as against the quoted figures of 50 to 70 at Hadisolb.

From observations made, there are many unsafe practices in thehandling of electricity, works traffic, entry into enclosed space, working at heights, use of lifting equipment, lack of guards on moving machinery, etc and etc., and the development of safe working procedures and training of all personnel, including management, in their respective responsibilities and attitudes to safety is of prime importance. It would appear in many instances that employees were totally oblivious to the risks that were being taken.

On no occasion was protective clothing of any type seen to be worn, including safety goggles and safety shoes, even when exposed to the risks of flame and molten metal, and it was a relatively common sight to see a man working on the cast house floor in open sandals, etc. Helmets were worn by certain members of management only, despite the fact that most of the structures are 20/30 metres and more in height, amd it was a common sight to see visitors to the plant, including busloads of male and female students, walking around the plant and watching furnaces, casting, etc., without a single item of personal protection of any kind. There was much discussion reference this with the management.
At the blast furnaces there were no gas masks, or resuscitation equipment for immediate use. Gas masks, etc. were available from the safety department but they were much too far away, and the vital minutes were lost when gassing accidents occurred. From observation of prevailing conditions it seemed that the safety department was non-effective in trying to remedy the situation.

There is urgent need for an experienced operator well versed in iron and steel works safety procedures and the potential of the hazards involved, to show to the Egyptian management the methods that can be used to increase employee awareness of the potential danger and also the Company responsibility towards it's employees.

In the United Kingdom the Factories Inspectorate would immediately close down any establishment where the conditions existed similar to those within Hadisolb works.

During the 'blowin' of no. 3 furnace, as previously mentioned, a number of workers suffered effects of blast furnace gas, because they disobeyed orders of the operations manager. This happened on two occasions within a period of one hour.

It was appreciated that these employees were attending to urgent jobs, but they seemed oblivious to the danger that they were in, and that gas is no respector of persons. Also their managers did not seem to appreciate their responsibility in allowing men to work in such conditions without adequate protection. After the accidents occurred it was obvious that there was no organised rescue procedure and/or facilities to treat the casualties, etc.

During the next few weeks a full procedure was developed for entry/rescue from gaseous conditions with necessary equipment, training required, etc., including procedure for entry into enclosed space, (see appendix nos. 8 and 9). This is now in the possession of the Hadisolb management, and much discussion has taken place, ref. the subject, and its implications towards improved efficiency.

PLANT HOUSEKEEPING

The general standard of plant housekeeping was not good and much discussion took place ref. the subject, pointing out that a good standard of housekeeping is tangible evidence of an efficiently run plant, etc., along with the effect on employee attitude towards the company etc.

There was ample evidence everywhere of accumulated spillage, piles of waste materials mixed up with valuable spares etc.

There was a tendency towards excessive waste of resource, including leakage of compressed air, steam, water, oil, etc., in many areas, with no attempt to remedy the same, or retrieve spare parts.

There was urgent need for the development of an efficient works cleaning up system, with an area allocated for the formation of a spoil tip. All material for the tip to pass through a reclamation system for separating all metallics, etc.

The work of cleaning up the blast furnaces plant had commenced and some headway made.

TRAINING

There appears to be no on going system of formal training for operatives, foremen, or middle management at Hadisolb works.

It seems that senior management get the opportunity to attend seminars and training courses etc., and have some access to technical literature, but below this level there appears to be little opportunity.

There were frequent requests from middle management and foremangrades for technical literature, information, etc., amd where possible, these requests were met with information sent out from the U.K., if not readily to hand.

There is an urgent need for a formal training system to be set up for all employees if the existing potential is to be fully realised.

Some discussion with management took place reference this subject.

CONCLUSIONS AND SUMMARY

As shown in appendix no. 7, the furnaces on full production with allowance for 5% maintenance downtime, can meet the no. 2 stage iron demand, except during reline periods and/or major breakdowns, mishap, etc., therefore to cover for all eventualities, the fifth furnace is required to ensure that maximum demand can be met at all times.

However, certain other areas require further study and development if maximum iron making potential is to be realised, as follows:

(a) the alkalie, chloride content of the Bahariya ore must be reduced to satisfactory operational levels, and the present quality of coke maintained

(b) furnace sinter quality and supply problems must be solved without delay with the provision of adequate buffer stocks

(c) instrumentation and control must be reviewed and modernised accordingly and a data logging system installed

(d) oxygen enrichment of the blast should be made available as soon as possible with correspondingly balanced natural gas injection at the tuyeres (each tuyere)

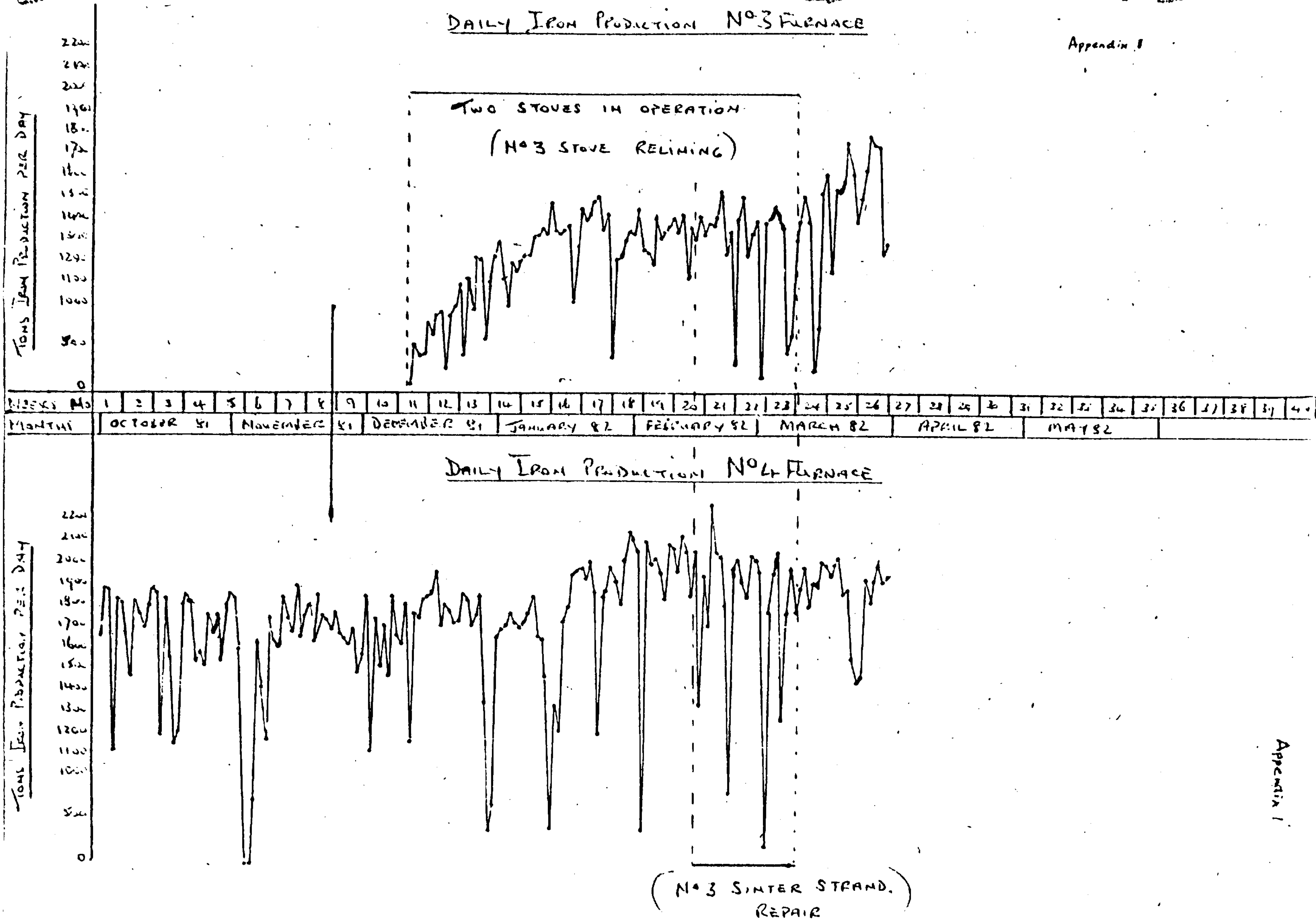
(e) extra Cowper stove capacity is required at nos. 3 and 4 furnaces and must be included in the plan for no. 5 furnace

(f) safety standards, safety training, operator training, plant house-keeping standards must be thoroughly re-organised, and brought up to acceptable levels

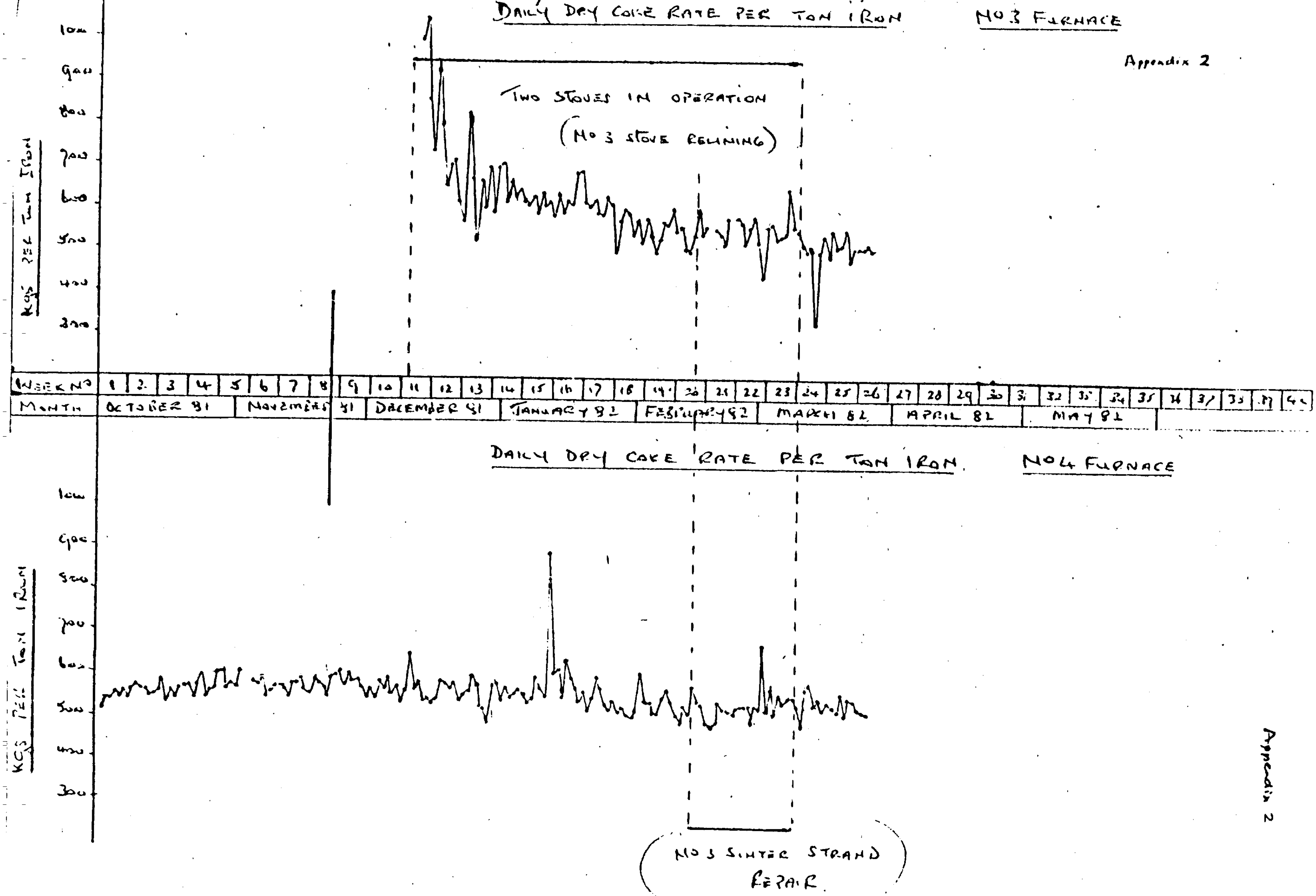
(g) specialised management training should be available, preferably in other countries, for all levels of senior and middle management.

A study of appendices no. 1 and no. 2 showing recently achieved iron production and coke rates, gives some idea of the potential that is available, and will be realised if action is taken on these points, all of which have been well discussed with the Ironworks management.

Appendix 1


DAILY IRON PRODUCTION No3 FURNACE
TWO STOVES IN OPERATION
(No3 STOVE RELINING)
TONS IRON PRODUCTION PER DAY
WEEKS No
MONTHS
OCTOBER 81
NOVEMBER 81
DECEMBER 81
JANUARY 82
FEBRUARY 82
MARCH 82
APRIL 82
MAY 82
DAILY IRON PRODUCTION No4 FURNACE
TONS IRON PRODUCTION PER DAY
(No3 SINTER STRAND. REPAIR)

Appendix 2



DAILY DRY COKE RATE PER TON IRON
No 3 FURNACE
TWO STOVES IN OPERATION
(No 3 STOVE RELINING)
KGS PER TON IRON
1000
900
800
700
600
500
400
300
WEEK No
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
MONTH
OCTOBER 81
NOVEMBER 81
DECEMBER 81
JANUARY 82
FEBRUARY 82
MARCH 82
APRIL 82
MAY 82
DAILY DRY COKE RATE PER TON IRON.
No 4 FURNACE
No 3 SINTER STRAND REPAIR

APPENDIX NO. 3 (1)

THE RE-COMMISSIONING OF NO. 3 BLAST FURNACE - DECEMBER, 1981

One of the main objectives of the U.N.I.D.O. contract was to ensure the successful blow in of no. 3 blast furnace after a partial reline. The lighting up of the furnace was planned for Wednesday, 25th November, 1981.

After arrival at the works on Sunday, 22nd November, 1981, it was very soon obvious that this deadline could not be met, despite the fact that arrangements were made for the Minister of Industry to perform the lighting up ceremony.

This deadline could not be met for the following reasons:

(1) The air pressure test on the furnace showed much leakage around the bosh and stack cooler housings.
(2) Maintenance repairs were still in progress on materials handling and charging systems and it was estimated that this work could not be satisfactorily completed by the pre-arranged lighting up date of November 25th.
(3) The old hearth bottom left in from the previous campaign was not sufficiently cleared especially in the region of the taphole.
(4) There was a large amount of equipment, ballast, steel scrap, etc., around the entire site, left from the furnace repair, and accessibility was poor. Good accessibility to all areas and sections of the furnace structures are essential before blowing in commences, so that any arising emergencies can be more easily attended to.
(5) A careful drying out procedure was recommended, despite the urgency, for a minimum of four days, reaching a stack brickwork inwall temperature of at least 350°C as a precaution against initial spallingof the refractures during the blowing in operation. The object of this exercise was the prolonging of refractory life during the future campaign. The drying out was to be done with hot blast.

Welding up of the furnace shell plates, cooler boxes, etc., contimued for the following six days and the next pressure test on the furnace showed only minimal leakage. Cutting out of the hearth bottom continued.

Drying out commenced immediately, and continued for a further four days, care being taken to carefully control the rate of temperature increase and reaching 350°C on the third day. After cooling, a further air test was put on the furnace, and the amount of leakage was still unsatisfactory. It was agreed that more work should be done, to completely seal all leakage, and this was completed by 6th December, 1981, and a final air test up to ½ ATM pressure gave satisfactory results.

A 15 cm diameter tube was built into the taphole and wooding of the furnace hearth to slightly above tuyere level commenced and was completed by 4 a.m. Monday, 7th December, 1981.

Charging the furnace to normal stockline was completed during Tuesday, 8th December, despite several arising problems.

It was agreed that the initial coke charge should be increased by 50% and the number of charges of no. 1 blowing in burden be increased from 10 to 20 for the following reasons.

(1) A fault was discovered on the coke weighing system, and the amount of coke already charged was an unknown quantity.

(2) The levels of residual iron and slag materials left in the hearth bottom, from the previous campaign, was considered to be too high, relative to the taphole level. Also a lot of burden material, obviously left in the charging system from the previous campaign had found it's way into the furnace when the system was tested, and this must have occurred after the furnace hearth had been finally cleaned out.

The furnace was filled to normal stockline after the ninth round of no. 2 blowing in burden had been charged.

After a final check of all mechanical equipment, tuyeres, blowpipes, water cooling systems, etc., the furnace was lit at taphole and tuyeres using oxygen lances. The time of lighting was midnight, Tuesday, 8th December.

After a further two hours of free draughting, the 'swanneck' ports were closed and blast was admitted to the furnace. The tube set in the taphole was left open and ensuing gas was lit for safety reasons. It was very essential that the taphole area was thoroughly heated up on account of the high level of residual iron and other spillage left in the furnace from the previous campaign. This pipe was left open until molten slag started to blow from it, in the course of the day (Wednesday). The pipe eventually melted away but the blowing to atmosphere from the taphole continued as long as possible. As soon as the blowing slag became out of control, the taphole was lightly stopped, using the gun.

CHEMICAL COMPOSITION OF 'BLOW IN' BURDEN MATERIALS

Materials	Fe	SiO_2	Al_2O_3	CaO	MgO	Mn	S	P	I.L.	W
Sinter	53.39	8.18	1.54	9.53	0.67	1.55	.14	.218	.18	-
Dolomite	-	0.60	0.76	30.98	21.05	-	.04	.043	45.64	
Gran. Slag	0.55	33.16	11.04	39.59	3.38	1.53	1.41	-	-	13.
Coke Ash	13.71	44.34	24.45	3.88	2.54	-	1.78	.122	-	
Coke	Ash 10.79	S 0.96	H_2O 4.15	F.C. 87.82						

COMPOSITION OF 'BLOWING-IN' BURDEN

Burden No.	No. of Charges	Charging System	Charge Weight of Burden Mats. T.				Ore/ Coke Ratio	Coke		Slag/ Ton Iron	Burden CaO/ SiO_2	Iron per Charge T
			Coke	Gran. Slag	Dolc-Mite	Sinter		Total	Rate			
0	52	C.C.	5.6	0.00	0.00	0.00		291			0.086	
1	20	CCDS	5.6	2.0	0.80	0.00		112			1.130	
2	15	CCDS	5.6	4.0	0.90	0.00		84			1.180	
3	5	COOC	5.6	4.0	0.50	3.00	0.54	28	3.00	2.28	1.110	1.890
4	5	COOC	5.6	4.0	0.50	3.60	0.64	28	2.68	2.00	1.110	2.228
5	5	COOC	5.6	4.0	0.50	4.40	0.79	28	2.27	1.724	1.110	2.630
6	5	COOC	5.6	4.0	0.50	5.60	1.00	28	1.73	1.439	1.110	3.390
7	5	COOC	5.6	4.0	0.20	7.00	1.25	28	1.38	1.183	1.06	4.150
			627	200	40.5	118.0		627				

(3) APPENDIX NO.

CONT.....

WORKING BURDEN

8	15	COOC	5.6	–	–	9.0	1.61	84	1.05	0.88	5.30
9	19	COOC	5.6	–	–	9.2	1.64	106	1.03	0.88	5.42
10	22	COOC	5.6	–	–	9.5	1.70	123	1.00	0.89	5.59
11	30	COOC	5.6	–	–	10.6	1.89	168	0.89	0.91	6.23
12	38	COOC	5.6	–	–	12.3	2.20	212	0.77	0.91	7.21

APPENDIX NO 3 (4)

Appendix no. 3 (5)

The first slag was cast through the taphole duringThursday, 10th December, and as expected, was heavy and viscous because of the chilling effect of the old hearth bottom. Casting at the taphole was then carried out on a two hour programme and by Friday evening casting of iron and slag was under good control.

There was some difficulty in the first 24 hours of operation, in controlling the top gas temperature which was peaking at 600°C, but this could be expected because of the extra quantity of coke charged in the initial 'blowing in' burden, and was eventually brought under control as ore to coke ratio increased.

Both the slag notches were successfully brought into operation on Monday, 14th December, 1981.

Following are the initial iron and slag analysis. The silicon content of the iron for the first five casts was higher than normal and is the result of the extra coke charged during the initial fill of the furnace. It was expected, and the advantage was gained in the easy access of the tapping hole during the first few casts.

Date	Iron					Slag					
	C	Si	Mn	P	S	FeO	CaO	SiO_2	Al_2O_3	MgO	S
10.12.81						4.38	28.05	39.10	21.14	4.28	1.14
						3.61	36.52	31.70	18.64	5.57	2.15
						1.29	37.10	30.66	13.80	7.14	2.20
						1.55	37.52	30.84	14.40	7.26	2.52
						0.77	39.34	30.00	16.60	7.14	2.07
						0.52	38.68	30.92	16.20	7.14	2.36
						0.52	39.18	28.84	18.20	6.07	2.39
11.12.81	-	7.10	2.72	0.49	.030	0.52	41.17	30.20	17.20	5.64	2.06
	1.50	5.85	2.40	0.47	.026	0.52	41.83	30.00	17.83	6.18	2.01
	.50	6.30	2.34	0.48	.034	0.68	40.17	30.81	18.26	5.95	1.85
	3.10	4.55	1.92	0.43	.040	0.68	38.18	30.28	17.08	5.83	2.06
	.70	7.20	2.40	0.45	.030	0.77	39.84	30.84	16.98	4.52	1.76
	3.50	3.75	2.20	0.46	.026	-	-	-	-	-	-
	4.10	2.30	1.85	0.34	.038	0.52	39.01	28.36	20.00	5.81	1.96
	3.75	3.60	2.15	0.35	.020	0.65	36.19	27.60	18.06	4.76	2.40
	2.35	4.05	2.20	0.40	.022	0.77	39.18	27.36	20.42	6.78	2.60
	3.45	4.80	2.42	0.42	.025	-	-	-	-		-
12.12.81	3.60	4.33	2.30	0.37	.020	0.39	28.18	26.00	22.20	4.76	2.06
	2.90	3.30	2.18	0.40	.022	1.42	33.20	34.18	20.14	3.47	1.68
	4.00	2.80	2.05	0.38	.038	2.06	37.68	28.46	21.96	5.11	2.10
	3.90	2.10	1.90	0.42	.026	1.03	35.35	30.40	18.80	4.76	2.06
	4.10	2.80	1.85	0.39	.024	1.29	34.86	28.74	19.20	5.00	2.08
	4.10	2.50	2.18	0.42	.026	1.55	36.19	33.60	19.34	4.58	2.27

APPENDIX No3 (6)

Some of the analyses were open to suspect.

e.g. (1) Carbon in the iron

(2) The initial gas analyses are not reported as they continually showed high oxygen content and with all the coke (red hot) in the furnace this was impossible. They were later proved to be erroneous.

There were some fluctuations in silicon content after this date, but good control of iron quality was established by December 14th and the silicon content was maintained around 2% for approximately two weeks (foundry iron demand).

Slag quality was balanced within the next few days, as follows:

	Range		Range
FeO	0.80 - 1.20	MgO	3.50 - 4.50
CaO	35.00 - 37.00	Mn	1.10 - 2.00
SiO_2	32.00 - 35.00	S	1.00 - 1.40
Al_2O_3	13.00 - 14.00	CaO/SiO_2	1.05 - 1.10

Later the slag basicity was lowered successfully to a range of .90 - 1.00

For the next few weeks the progress of the furnace was carefully monitored. There were one of two teething troubles, with failure of mechanical equipment, skiphole spillage, initial casting trough maintenance caused by the high silicon iron etc., but the blowing rate, blast temperature, high top pressure, etc., were steadily increased until maximum blowing capacity allowable with only two Cowper stove availability was reached. The third Cowper stove, which was still under reline at the time of the blow in, was re-commissioned in mid-March.

As there was limited demand for iron of steelworks quality and a high demand for iron of 1.5 - 2.50 silicon content for foundry purposes, it was decided to maintain the silicon content within this range and transfer all iron to the casting machine. The plan worked well, and ensured that the furnace hearth bottom was well heated through.

The blow in was a success and the furnace was quickly under control.

The Minister for Industry visited the furnace on Wednesday, 16th December, 1981, and expressed his satisfaction.

SAFETY STANDARDS DURING THE INITIAL BLOW IN PERIOD

The standard of safety and safe working practice within the Hadisolb Works is far from acceptable when compared with the European and American standards, and much needs to be done to ensure adequate protection for the employee. There is a separate section in this report, reference this.

During the blowing in andblowing out operations at blast furnaces the potential hazard is very high and adherence to a strict, laid down, safety procedure is ofutmost importance if the work force are to be adequately protected during unexpected incidents, i.e. when this high level of potential hazard suddenly becomes real.

The absence of any laid down procedure in this respect of safety and protection was noted, for example:

For the first few hours after the blast is blown into a new furnace, the carbon monoxide content of the gas is extremely high. Also with everything around the furnace being new, the amount of gas leakage that will occur is somewhat of an unknown quantity.

Despite this, there were no gas masks available in case of emergency at the furnace. After request, two were obtained from elsewhere in the works to cover eventualities, but it was fairly evident that few, if any, of the workers around the furnace were familiar with their use.

There were no rescue or resuscitation services available and treatment of gassed employees did not commence as and until the ambulance arrived, again from elsewhere in the works.

Due to orders being ignored, on two separate occasions several workers suffered from the effects of inhaling carbon monoxide, within one hour of the blast being administered to the furnace.

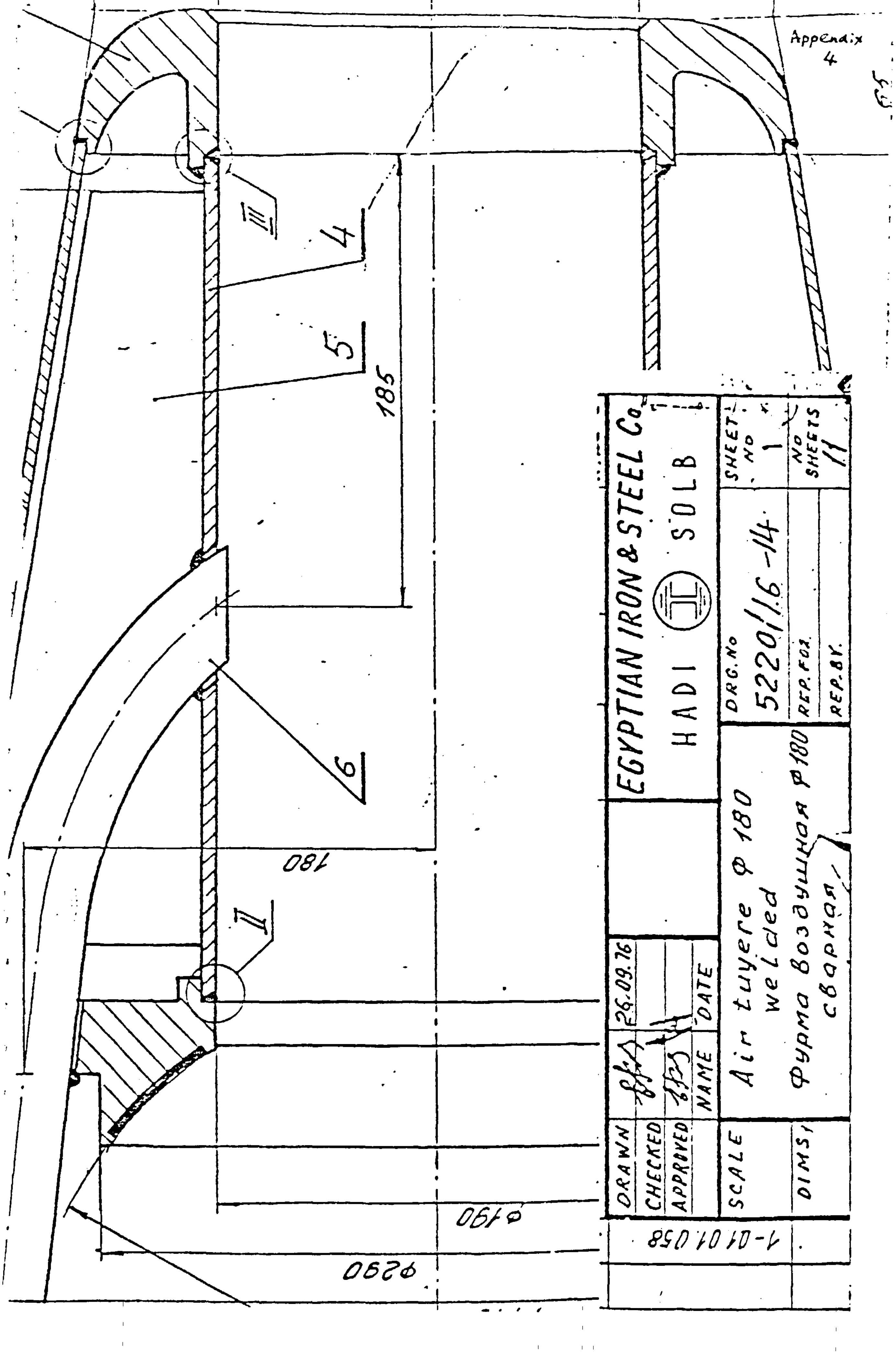
It was very obvious that no one appeared to fully appreciate the real danger potential of the operation in hand.

During the following weeks, discussions reference the importance of gas safety procedure took place with management, and a full scale gas safety training/rescue proceedure for Hadisolb blast furnace plant was developed, including the designing of a system with necessary certificates etc. for entry/work in confined space. More is said about this under the section on Safety and Safe Working Procedure.

A copy of the Gas Safety/Rescue procedure suggested to Hadisolb blast furnace management is found in Appendix no. 8. Also included is a copy of the certificate developed for entry/work in confined space,(see appendix no. 9)

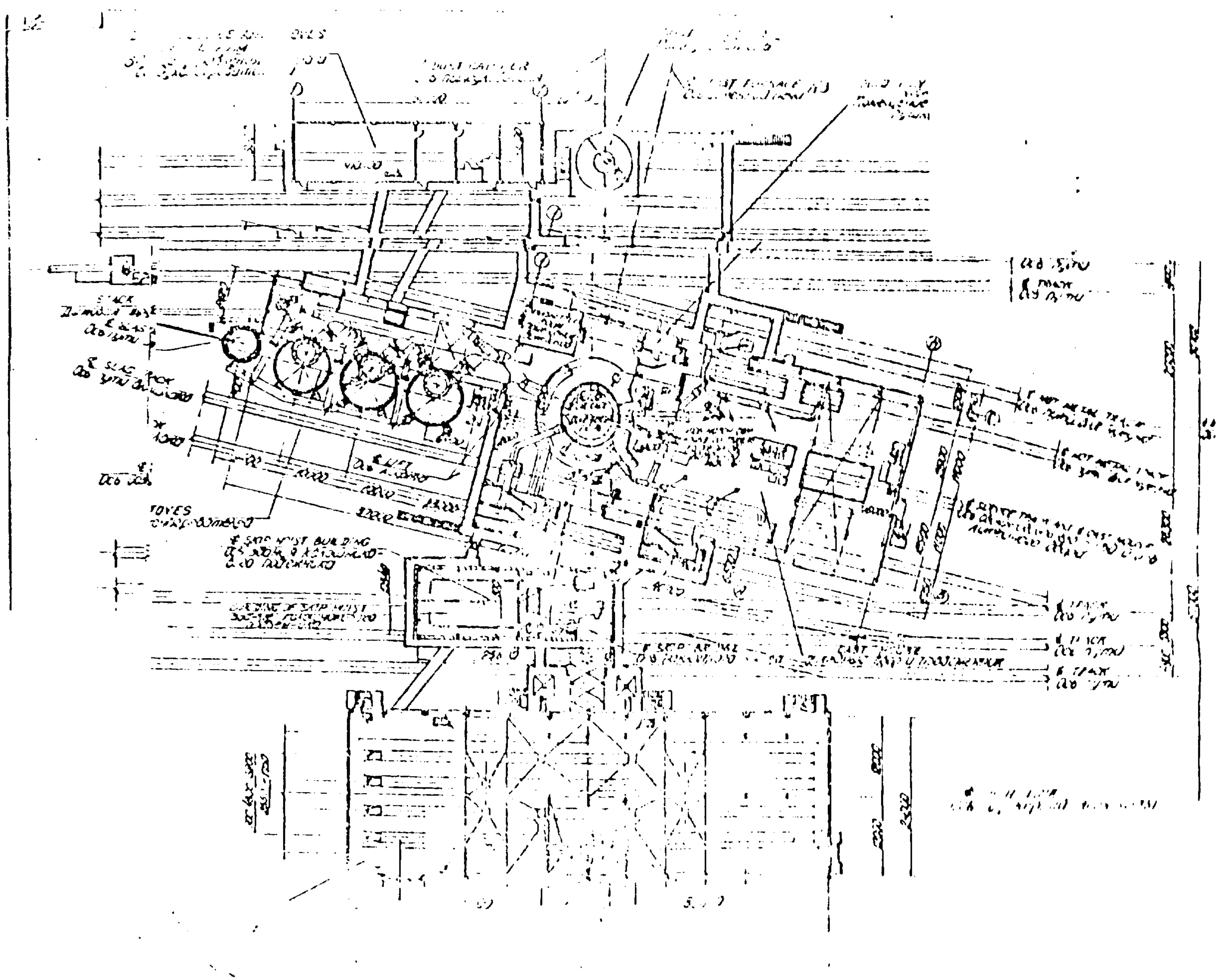
The furnace continued to work satisfactorily during the period of two stove practice, with a steady increase in iron production and decrease of coke rate (see appendix nos. 1 and 2).

Appendix 4

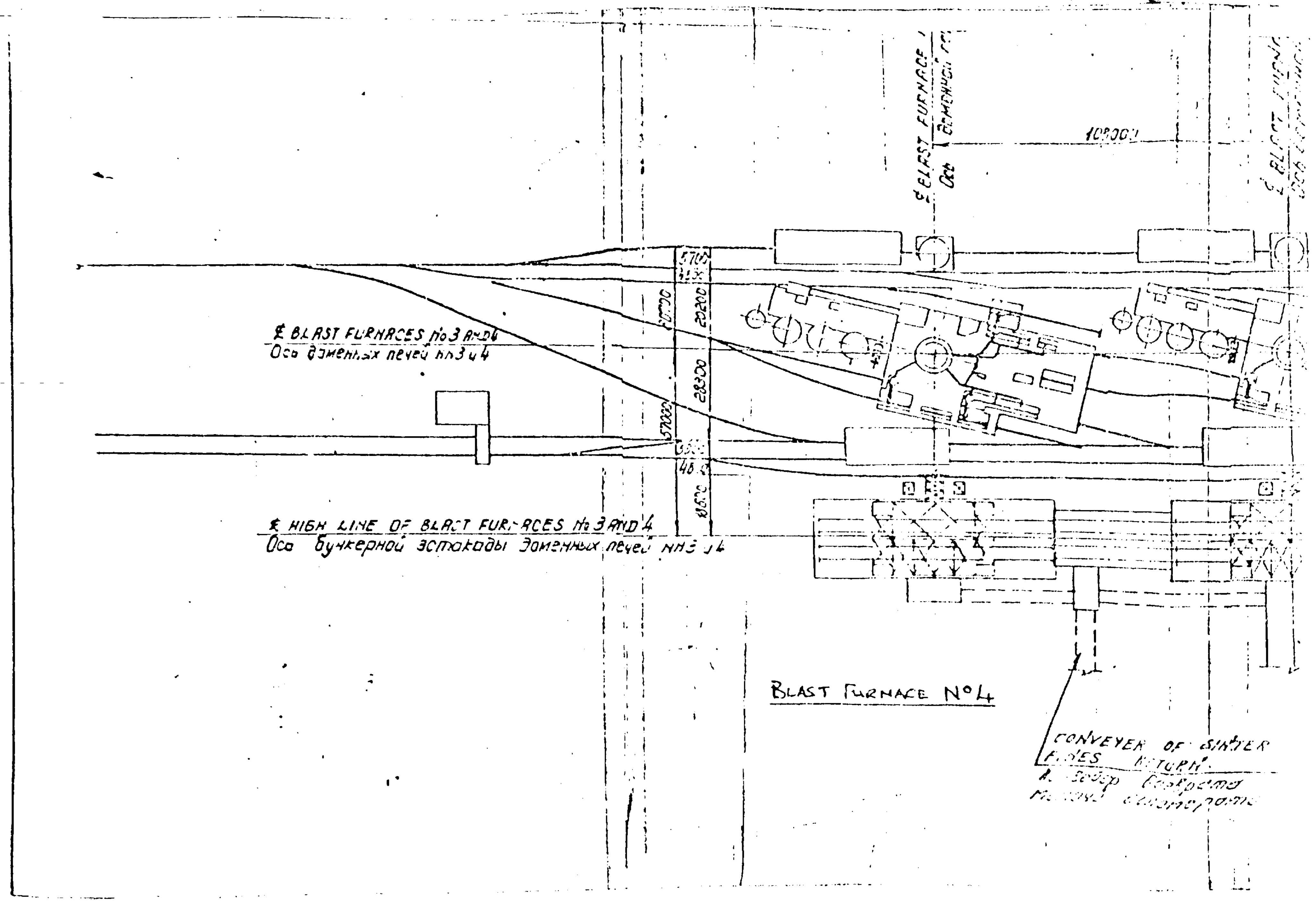


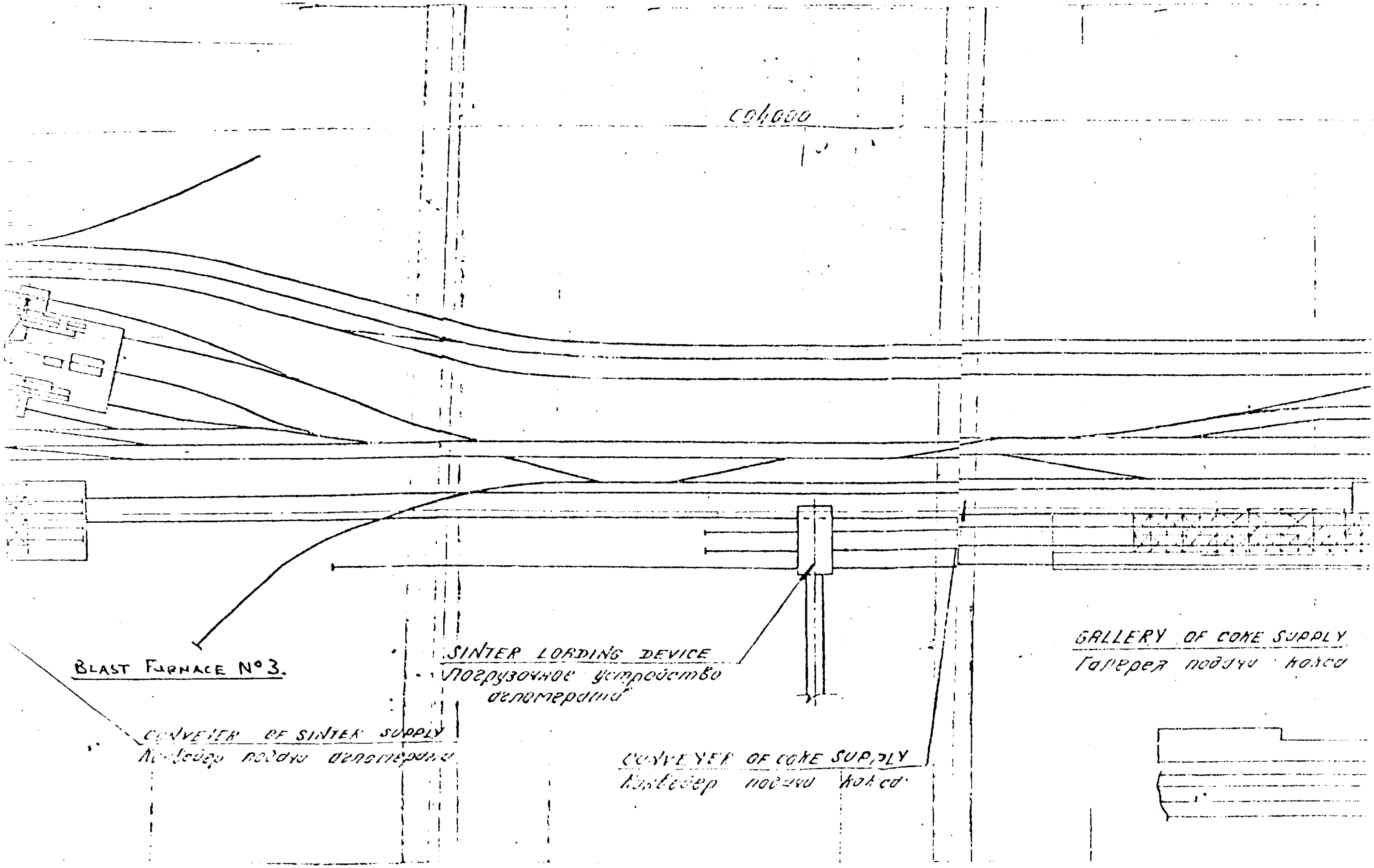
EGYPTIAN IRON & STEEL Co.
HADI SOLB
DRG.No
5220/1.6-14
SHEET No 1
No SHEETS 11
REP.FOR.
REP.BY.
DRAWN
CHECKED
APPROVED
NAME
DATE
26.09.76
SCALE
DIMS
Air tuyere Φ 180 welded
Фурма воздушная Ф180 сварная
1-01.01.058
185
180
φ190
φ290
4
5
6
II
III

APP. NO. 6

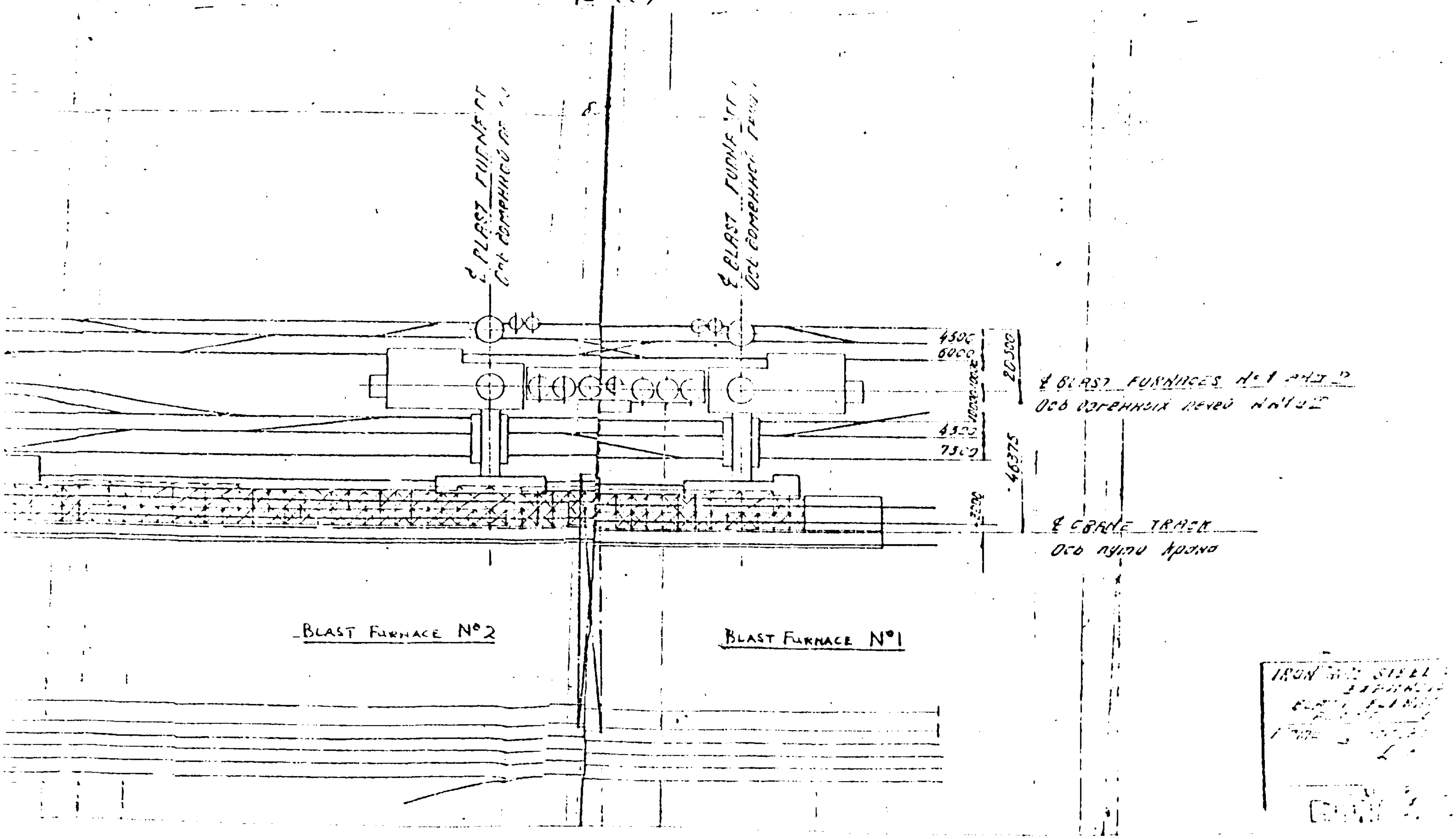


APPENDIX No. 6





60000
BLAST FURNACE N°3.
SINTER LOADING DEVICE
Погрузочное устройство агломерата
CONVEYER OF SINTER SUPPLY
Конвейер подачи агломерата
CONVEYER OF COKE SUPPLY
Конвейер подачи кокса
GALLERY OF COKE SUPPLY
Галерея подачи кокса


℄ BLAST FURNACES No 1 AND 2
℄ CRANE TRACK
20500
46375
4500
6000
4500
7500
3000
BLAST FURNACE N°2
BLAST FURNACE N°1
IRON AND STEEL

APPENDICIES 5 AND 6 ARE IN THE ENVELOPE

APPENDIX 7

ESTIMATED IRON PRODUCTION PER DAY

Downtime - 4%
Coke quality maintained

YEAR	MONTH	No1 FCE	No2 FCE	No3 FCE	No4 FCE	TOTAL	+ 5mm Sinter Required/day 1780kg/t.Iron
1982	July	450	Reline	1800	1900	4150	7400
	Aug	"	-	1850	1900	4200	7500
	Sept	"	-	1900	-	4250	7600
	Oct	"	-	"	-	4250	7600
	Nov	"	-	"	-	4250	7600
	Dec	"	-	"	-	4250	7600
1983	Jan	450	250	1900	1900	4500	8050
	Feb	-	300	"	"	4550	8100
	March	-	350	"	"	4600	8200
	April	-	400	"	"	4650	8300
	May	Reline	450	1900	1900	4250	7600
	June	-	"	"	"	4250	7600
*	July	-	"	2000	2000	4450	8000
	Aug	-	"	2000	2000	4450	8000
	Sept	250	450	2100	2100	4900	8800
	Oct	300	"	"	"	4950	8850
	Nov	350	"	"	"	5000	8900
	Dec	400	"	"	"	5050	8900
1984	Jan	450	450	2100	2100	5100	9100
	Feb	"	"	"	"	5100	9100
	March	"	"	"	"	5100	9100
	April	450	450	2100	Reline	3000	5400
	May	"	"	"	-	3000	5400
	June	"	"	"	-	3000	5400
	July	"	"	"	-	3000	5400
	Aug	450	450	2100	1100	4100	7300
	Sept	"	"	"	1300	4300	7700
	Oct	"	"	"	1400	4400	7900
	Nov	"	"	"	1500	4500	8050
	Dec	"	"	"	1700	4700	8400
1985	Jan	"	"	"	1900	4900	8750
	Feb	"	"	"	2000	5000	8900
	March	450	450	2100	2100	5100	9100
	April	"	"	"	"	5100	9100
	May	"	"	"	"	5100	9100
	June	"	"	"	"	5100	9100
	July	"	"	"	"	5100	9100
	Aug	"	"	"	"	5100	9100

* Oxygen enrichment available (estimate) No. 3 & 4 Furnaces

PS/050783

YEAR	MONTH	No1 FCE	No2 FCE	No3 FCE	No4 FCE	TOTAL	+ 5mm Sinter Required/Day 1780kg/t.Iron
	Sept	"	"	"	"	5100	9100
	Oct	"	"	"	"	5100	9100
	Nov	"	"	"	"	5100	9100
	Dec	"	"	"	"	5100	9100
1986	Jan	"	"	"	"	5100	9100
	Feb	"	"	"	"	5100	9100
	March	"	"	"	"	5100	9100
	April	"	"	"	"	5100	9100
	May	"	"	"	"	5100	9100
	June	"	"	"	"	5100	9100
	July	450	450	Reline	2100	3000	5400
	Aug	"	"	-	"	3000	5400
	Sept	"	"	-	"	3000	5400
	Oct	"	"	-	"	3000	5400
	Nov	"	"	1100	"	4100	7300
	Dec	"	"	1300	"	4300	7700
1987	Jan	"	"	1400	"	4400	7900
	Feb	"	"	1500	"	4500	8050
	March	"	"	1700	"	4700	8400
	April	"	"	1900	"	4900	8750
	May	"	"	2000	"	5000	8900
	June	"	"	2100	"	5100	9100
	July	450	Reline	2100	2100	4650	8300
	Aug	"	-	"	"	4650	8300
	Sept	"	-	"	"	4650	8300
	Oct	"	-	"	"	4650	8300
	Nov	"	250	"	"	4900	8300
	Dec	"	300	"	"	4950	8300

NOTES - DAILY IRON PRODUCTION

(1) Daily iron production is the estimated maximum production with all available furnaces making basic iron.

(2) The manufacture of high silicon pig iron suitable for foundry work is not taken into account in these figures as it will only be made according to market demand and spare furnace availability.

(3) + 5 mm sinter requirement per day allows for furnace demand only. The figures do not include the development of stock piles.

(4) Oxygen enrichment of the blast will allow increase in the natural gas injection rate giving corresponding reduction in coke rate and increased production of iron for a given blowing rate.

(5) Planned major repairs at sinter plant and steel plant should, where possible, coincide with the periods of reduced furnace availability.

(6) There is some room for manouvre with furnace reline dates to meet planned sinter and steel plant major repairs without reducing iron production.

(7) The building of no. 5 furnace is not taken into account.

GAS SAFETY/RESCUE PROCEDURE AT BLAST FURNACE PLANTS

The following must be considered:-

(1) Blast furnace plants operate with a very high level of potentian hazard.
(2) During plant operations blast furnace gas is made and used in large volumes - it is toxic and extremely dangerous to human life.
(3) In relatively low levels of concentration of blast furnace gas, a person has only minutes to live, and in a correspondingly less period of time, is rendered helpless, and with possible brain damage.
(4) Clean blast furnace gas is colourless and odourless at all times, and uncleaned gas is colourless and odourless within minutes of entry into the atmosphere.
(5) Blast furnace gas has the same density as air, and so remains within the surrounding atmosphere.

The general works system of training prior to actual employment at the blast furnace plant should ensure that all employees are made fully aware of the real danger of atmospheric pollution (contamination) with blast furnace gas, and that they should know the correct procedures to be adopted in such conditions, with respect to personal safety and notification of authority, etc.

Within modern plants, escape of gas into the atmosphere is usually well controlled, but past experience throughout the world has proved that periodically, serious accidents from gas leakage do occur through:- instrument failure, plant failure, human error, adverse weather conditions, explosion, etc., and it is very essential that as far as possible a system is incorporated into everyday plant practice to ensure that the safety of all employees is catered for when serious accidents, involving leakage, do occur.

MANAGEMENT RESPONSIBILITY

Management must at all times ensure that any necessary gas leakage to atmosphere is done under strict supervision and control, and that entry into confined space at blast furnace plants is at all times fully supervised by responsible people and that the 'permit to enter' certificate system is always used.

Should an uncontrolled escape of gas occur, then the system must cater for the following:

(1) A reliable alarm system that can be operated by affected personnel, if necessary, indicating the area of contamination/emergency to all people present at the Plant, and including the Gas Rescue Station and the Works Safety Department.
(2) Mobile rescue facilities are immediately available if required, for safe removal of casualties from contaminated areas and, if necessary, able to give immediate resuscitation safely within the contaminated area - under such circumstances time is very vital.
(3) Resuscitation facilities are immediately available outside the area of contamination.
(4) Transport is available for removal of seriously affected casualties to hospital with resuscitation still being carried out during the journey.

(5) An investigation is carried out immediately to determine the cause of the leakage of gas.
(6) Remedial action follows immediately to stop the leakage, ensuring that all persons taking part in the action to stop the leakage are correctly protected.

REQUIREMENTS FOR AN EFFICIENT SYSTEM OF GAS SAFETY/RESCUE

A. PERSONNEL REQUIREMENTS

(1) Supervisory

(a) The blast furnace management must be seen to be fully in support of the system and giving personal help as required. This will ensure that the workforce recognise the seriousness of the situation and will be encouraged to volunteer their services and accept correct training.

(b) A Gas Safety Officer must be appointed to supervise all operations and training connected with gas safety and rescue. He sould liase continually with plant management, have direct access to the Ironworks Manager, and have complete charge of the Gas Rescue Station. The person appointed to this position should be dedicated, intelligent, and highly active, with plenty of drive to get things done. He should possess self confidence and be able to keep calm and think clearly in times of real emergency. He should be sent to the United Kingdom along with the senior Accident Prevention Manager for specialised training.

(c) Shift Operator/Engineers to be appointed with responsibility for the maintenance of all equipment, gas masks, resuscitators, rescue tackle, etc.
They will operate the oxygen and compressed air compressors and organise maintenance to ensure 100% availability.
They will be responsible for the safe condition of all equipment and ensure that all compressed air and oxygen cylinders are filled to stipulated pressure and are tested 'leak free', prior to replacement in the store etc.
The most efficient operator/Engineer should be trained to deputise for the Gas Safety Officer.
These jobs will by classified as GAS SAFETY ENGINEERS.

(2) GAS RESCUE TEAMS

Ten volunteers to be selected from each shift to form a shift rescue team and each man must possess the following personal characteristics:

(a) aged between 25 and 40 years
(b) have worked at Hadisolb blast furnace plant for at least 1 year
(c) be employed in the type of work that can be left immediately (all Rescue Team Members must be readily available in emergency)
(d) physically strong, healthy and with no disabilities
(e) not claustrophobic
(f) not nervous of heights
(g) after initial training be prepared To undergo entry into the obstacled gas chamber prior to final selection into the shift team
(h) after selection be prepared to be intensively trained **, so that he can go into immediate action fully understanding what is required of him and have the confidence of his team leader
(i) be prepared to stay in the rescue team once he has been fully trained.

** - The Gas Safety Officer will be responsible for the standard

Preferably the shift team leader should be a dynamic staff grade production/maintenance engineer with several years of plant experience coupled with a good working knowledge of plant operation, and who can operate 100% in co-operation with the shift manager in times of real emergency.

All rescue team members will wear special identification while at work, in the form of a badge, arm band, epaulette, etc., for immediate identification purposes.

The team leader's safety helmets should be a special colour for the purpose of identification at a distance (in times of serious emergency this is essential).

The gas masks of team members will be in sealed containers or lockers close to their area of occupation. It is the responsibility of the Gas Safety Engineer to renew the cylinder of the mask once it has been used, even if only for a minute. He should, at the same time, sterilize the face piece and remake the locker seal.

Any broken locker seals should be investigated immediately, the gas mask tested and the locker re-sealed by the G.S.E.

Disciplinary action should be taken immediately against any unauthorised person found interfering with the locker seals.

3. ALL MEMBERS OF THE BLAST FURNACE WORKFORCE

The workforce require training, and it is the responsibility of the plant management to ensure that the workforce know how to conduct themselves in times of serious emergency and are fully aware of the following:-

(a) the reasons for rescue team development at the blast furnaces
(b) the correct way to use the gas alarm system
(c) how, and when, to render artificial respiration
(d) every person should be fully trained to use a gas mask and how to proceed once it has been used, to ensure that it is serviced as soon as possible
(e) the procedure to be adopted when the gas alarm operates.

As soon as the Rescue Teams have had satisfactory INITIAL TRAINING the training of the workforce should commence immediately with demonstrations, films, etc., and should personally take part in all the activity associated with training.

It is the responsibility of the management to ensure that all personnel who work on the blast furnace plant receive this training which will be carried out by the Gas Safety Officer and the Gas Safety Engineers.

4. ACCIDENT PREVENTION DEPARTMENTS

The rescue teams, team leaders, Gas Safety Engineers and Gas Safety Officer are all directly responsible to the blast furnace Manager, and he will bear the ultimate responsibility for the efficiency of the organisation. However, there should be an indirect link with the Works Accident Prevention Department and especially to the Accident Prevention Managers who are directly responsible to the various Works Departments, in case the Rescue Teams are required to deal with emergency elsewhere in the Works.

The senior management should organise a function once per year for the rescue team members, G.S.E.'s, and G.S.O., and all members of the blast furnace management, to recognise the voluntary effort.. Outstanding devotion to duty or bravery during rescue should be recognised by a Works Award or Certificate.

B. THE GAS ALARM SYSTEM

A system must be built throughout the plant so that people in difficulty can:

(1) notify their position to the Gas Rescue Station
(2) warn the plant that there is an emergency

The system must fail safe, i.e. any failure of the system must react as an alarm.
Many different systems are in operation throughout the world. The following design suggested was in operation for some 25 years until the plant was closed down, and over this period was instrumental in saving a number of lives, as well as alerting the plant generally, when conditions deteriorated. It never failed to operate when required and was serviced on a regular basis.

Basic Design

A robust push button system, with adjoining speaker point, was set up around the entire plant, i.e. blast furnace, gas washing system, etc. The buttons and speaker points were strategically placed 1½ metres above walkway level at all places where escape of, or contamination from gas might occur, i.e. around Cowper hot blast stoves, at all levels at each blast furnace, all levels at dustcatchers, furnace charging and tap levels, gas cleaning plants, gas holders, etc.
All wiring was heavy guage and well protected in strong conduit tubing, which was run where it would sustain least damage.
The speaker points and push buttons were of robust design, dust proof, water proof, and guarded by a heavy steel band against accidental knocking by moving objects. The steel band was so designed to act as support for a partially gassed man, while he communicated his position and/or pressed the alarm button.
All alarm buttons must be adequately identified.
The pressing of one of the alarm buttons does two things:
(1) activates a loud siren with distinctive note and sounds for one minute throughout the loud speaker system
(2) activates an illuminated panel in the Gas Rescue Station, identifying exactly where the button has been pressed.

As soon as the siren stops blowing the Gas Rescue Station attendant notifies the plant via the loud speaker system as to where the casualty/emergency is situated. The Rescue team members hear the loudspeaker message and assemble immediately with their gas masks and are at the discretion of the team leader within 1½ minutes of the alarm being raised, knowing exactly where the emergency/casualty is situated.

If the emergency proves serious, the station attendant brings the rescue vehicle with extra supplies of equipment, assistance, etc.

C. ACCOMODATION

(1) Gas Rescue/Training Station

Ideally required is a building with six rooms, close to, and in full view of the blast furnace plant, but outside the area where contamination from gas could occur.
The rooms will be used for the following:-

Room 1 - Garage for Rescue Service Vehicle
Room 2 - Store for fully serviced equipment
Room 3 - Equipment maintenance and repair shop. This room will also house the CPA and Oxygen compressors
Room 4 - Lecture theatre and training room
Room 5 - Rest room with toilet facilities, etc.
Room 6 - Administration office

(2) Gas Training Chamber

Adjacent to the Gas Rescue/Training Station a chamber should be built to simulate difficult conditions of darkness, gaseous atmosphere, difficult access, unexpected obstacles, etc., that could be experienced in times of difficult rescue conditions.

The chamber is used to test a man's reflexes and his suitability for rescue team membership. Also it is used for intensively training of the teams under very difficult conditions, etc. at a later date.

It is essential that these buildings and services are maintained in first class condition at all times.

D. EQUIPMENT REQUIRED

(1) One fully enclosed four wheel drive, hard top, vehicle, as small as possible in size, but capable of seating the full rescue team along with all necessary rescue equipment.
The vehicle should be used only for rescue purposes and/or rescue training needs, and should be kept available on a 24 hour basis and always ready for immediate use.
The interior of the vehicle should be purposely fitted out and at all times kept fully equipped with extra gas masks, cylinders, resuscitation equipment, stretcher, blankets, slinging gear, atmosphere testing equipment, electric 'intrinsically' safe torches, etc. This equipment should never be removed from the vehicle, except to deal with emergency conditions and rescue, or for maintenance and cleaning.
The condition of the vehicle and equipment is the responsibility of the Gas Safety Engineer on duty, and should be checked each shift.
The engine of the vehicle should be run each day and the general mechanical condition checked by a fully trained mechanic. The petrol tank should be full at all times. It must be remembered that when this vehicle is wanted it is for real emergency with only minutes to spare.
Disciplinary action should be taken immediately against any person using this vehicle for any other purpose.

(2) Compressed air compressor for filling gas mask cylinders (several types are available)

(3) 50 complete C.P.A. gas masks with 50 spare cylinders

(4) Oxygen equipment for filling resuscitator oxygen cylinders (several types are available)

(5) 6 oxygen resuscitators with 20 spare cylinders
The 'Minuteman' resuscitator is recommended from experience. Four people can be revived from one set, which is easy to operate and easy to carry. This resuscitator is an ideal machine for use in areas of difficult accessibility

(6) 10 stretchers, 4 rocking stretchers, blankets, protective clothing, helmets, wellington boots, oilskins, etc.

(7) Safety belts, harnesses, ropework, slinging gear, pulley blocks, etc. (on no account must this equipment be used for any other purpose than rescue and rescue training)

(8) 10 portable atmosphere testers for carbon monoxide

(9) 3 oxygen testers

(10) supply of torches (intrinsically safe) *

(11) film projector and training films

(12) Instamatic camera. Pictures taken during rescue are very useful for future training purposes and general information about the emergency

(13) General office and administration equipment

(14) 2 'Resusi-Ann' inflatable models for training in mouth to mouth resuscitation

* - All electrical equipment used must by intrinsically safe.

COMMENTS

A system of this type or similar will ensure the following results once it is operating normally and accepted by both management and workforce as standard works procedure.

(1) reduce the serious accident frequency rate and prevent fatal accidents occurring from carbon monoxide poisoning

(2) give confidence to management in times of high production and in difficult plant operating conditions

(3) help to protect the blast furnace workforce from serious injury in times of real emergency and ensure that trained help is immediately available on a 24 hour basis

(4) gives confidence to the workforce when difficult tasks have to be accomplished yet making them aware of the potential hazard around the blast furnace plants

(5) improve standards of general training and the need for training is realised by the workforce.

(6) Increase the number of workers and <u>management</u> who can react correctly in times of real emergency and so reduce the tendency for panic to spread.

(7) give help and save life in other parts of the works when emergency conditions occur

(8) reduce the amount paid out annually in compensation for injury and death

(9) increases job satisfaction for all those involved

(10) improves management/workforce relations and thereby the workman's attitude to his work which must save the company a lot of money

NOTE

(1) training of rescue teams and plant personnel should be on-going at all times using a definite rota system. The training of employees should be compulsory and disciplinary action taken against anyone not turning up to training sessions.

(2) an unreliable alarm system is a greater hazard to plant personnel in times of real emergency than no alarm system at all, as everyone comes to rely on the system operating correctly.

Following is the design of Certificate suggested to the Egypt Iron and Steel Company to ensure safe entry/work in confined space, for all it's employees. (see appendix no. 9)

CERTIFICATE OF ENTRY INTO/WORK IN CONFINED SPACE

appendix no. 9 (2)

Submitted to Egyptian Iron and Steel Company as possible Document Design

EGYPTIAN IRON AND STEEL COMPANY DOCUMENT

General Works Certificate to authorise entry into/work in confined space
(note: this certificate to be made out in triplicate)

No person shall enter or remain in any chamber, tank, vat, pit, pipe, flue or similar confined space where there may be dangerous fumes or lack of oxygen, unless duly authorised on this form by a responsible person designated with this Authority.

Part A

(1) The confined space to be entered ....

(2) Department or area ....

(3) Name of responsible/designated person ....

(4) Name of person responsible for testing of the atmosphere ....

Part B

TEST CERTIFICATE FOR ATMOSPHERE IN CONFINED SPACE TO BE ENTERED

(note: A gas mask must be worn during all atmosphere testing within the confined space)

"I have carried out the test to determine whether the above mentioned confined space is free from dangerous fumes and has an adequate supply of oxygen for respiration, and I certify that entry into the confined space is permissable WITH / WITHOUT a gas mask" (delete accordingly)

(1) Result of test % Carbon Monoxide ....
% Oxygen ....

(2) The confined space is completely isolated and free from dangerous fumes YES NO (Delete accordingly)

(3) Burning and welding etc. can commence YES NO (Delete accordingly)

Signature of person responsible for atmosphere test ....

Time ....

Date ....

Part C

ENTRY INTO CONFINED SPACE WITHOUT BREATHING APPARATUS

(To be completed by the Shift Manager/Designated Person)

"I have checked as follows:-

(1)	Isolation is possitive	YES	NO	(delete accordingly)
(2)	Ingress of dangerous fumes is impossible	YES	NO	(" ")
(3)	All sludge and dust deposits liable to give off dangerous fumes are removed	YES	NO	(" ")
(4)	The confined space is adequately ventilated	YES	NO	(" ")
(5)	Testing for dangerous fumes gives acceptable results (below 50 P.P.M. for carbon monoxide)	YES	NO	(" ")
(6)	There is adequate air supply for respiration	YES	NO	(" ")

Note If any one of the answers is 'NO' or the atmosphere test shows contamination above a permissable level or oxygen deficiency, then gas masks MUST be worn and PART D only of this Document becomes applicable and must be filled in accordingly.

"I hereby authorise the following personnel from ....

.... (area, Department, or Company to be named)

to enter and work within the confined space indicated ....

.... (Name of confined space)

Names of Personnel entering the confined space

(1) .... (2) .... (3) .... (4) ....

(5) .... (6) .... (7) ....(8) ....

(9) ....(10) ....(11) ....(12) ....

EXTRA CONDITIONS DICTATED BY SHIFT MANAGER/DESIGNATED PERSON

....

....

....

....

For period commencing Time ....
(state time and date) Date ....

and finishing Time ....
(state time and date) Date ....

Signature of Shift Manager/Designated person ....
(See notes 1 and 2)

To be signed by the receiver of this 'completed' certificate
"I fully understand my responsibility as senior person in charge of the personnel entering and working within the confined space named as follows:

....

....

Signature (receiver of this Certificate) ....
(see note 3)

Part D.

ENTRY INTO CONFINED SPACE WEARING BREATHING APPARATUS

(To be completed by the Shift Manager/Designated Person)

As the atmospheric conditions within the confined space are uncertain/unsuitable, all the following conditions shall be strictly observed prior to entry.

(1) Suitable breathing apparatus MUST be worn
(2) All persons entering the confined space are fully trained in the use of breathing apparatus
(3) Safety belt or harness is worn by each person entering the confined space
(4) A life line is attached to each safety belt or harness
(5) One person remains outside the confined space holding continually the free ends of the lifelines
(6) Resuscitation equipment is immediately to hand

"Having satisfied myself that the above conditions are fully applied, I hereby authorise the following personnel from ....
.... (area, department, or company to be named)
to enter the confined space indicated ....
.... (name confined space)

Names of persons entering the confined space

(1) .... (2) .... (3) .... (4) ....
(5) .... (6) .... (7) .... (8) ....
(9) .... (10) .... (11) ....(12) ....

appendix no. 9 (7)

EXTRA CONDITIONS DICTATED BY THE SHIFT MANAGER/DESIGNATED PERSON

....

....

....

....

Entry for period commencing Time ....
(state time and date) Date ....

and finish Time ....
(state time and date) Date ....

Signature (Shift manager or designated person) ....
(see notes 1 and 2)

To be signed by the receiver of this completed certificate

"I fully understand my responsibility as senior person in charge of personnel entering and working within the confined space as follows:

....

....

Signature (Receiver of this Certificate) ....
(see note 3)

Part E

RETURN OF CERTIFICATE OF PERMISSION TO ENTER/WORK IN CONFINED SPACE.

When work within the confined space is (a) completed or (b) the time limit has expired, this certificate must be returned immediately to the shift manager/designated person by the senior person in charge of the work and signed accordingly by him.

"I hereby return the certificate for permission to enter/work in confined space, having assured myself that all the personnel in my charge are withdrawn from the confined space ....
....(confined space to be named)

Signature (senior person in charge of personnel) ....

Signature (Shift manager/Designated person) ....

If the work is not completed at the expiry of the time limit, all personnel will be withdrawn from the confined space as and until a new certificate of 'Permission to Enter' is issued by the Shift Manager/Designated person.

IMPORTANT NOTICES (PLEASE READ)

NOTE 1 This certificate is not valid unless fully completed and correctly signed by the persons involved with it's issue.

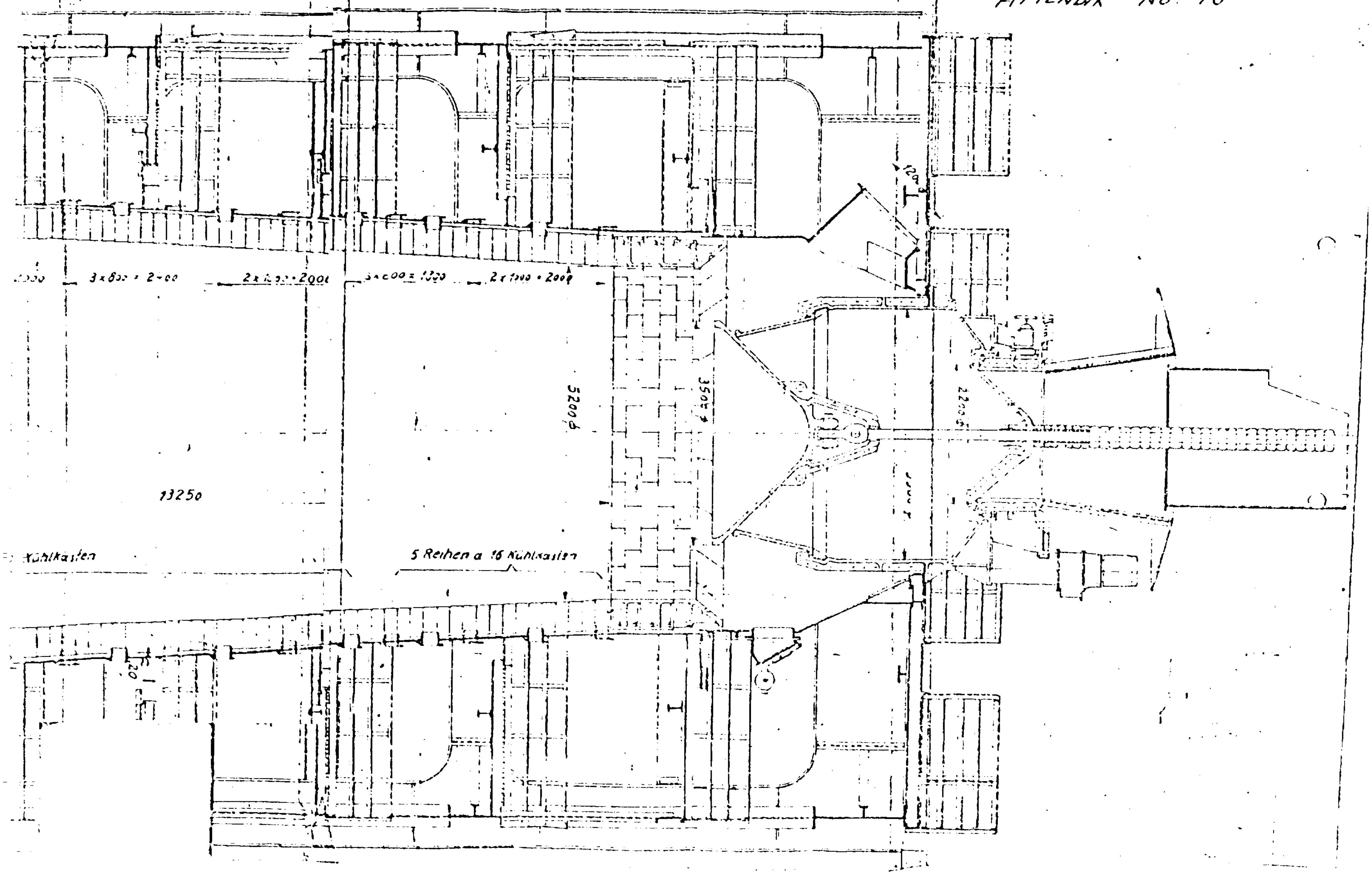
NOTE 2 If this certificate is not returned to the Shift Manager/Designated person by the expiry of the time limit, then investigation must proceed at once.
If, during investigation, re-entry into the confined space is necessary, then all personnel re-entering the confined space will wear a gas mask. This will apply irrespective of whether the certificate was issued under Part C or Part D.

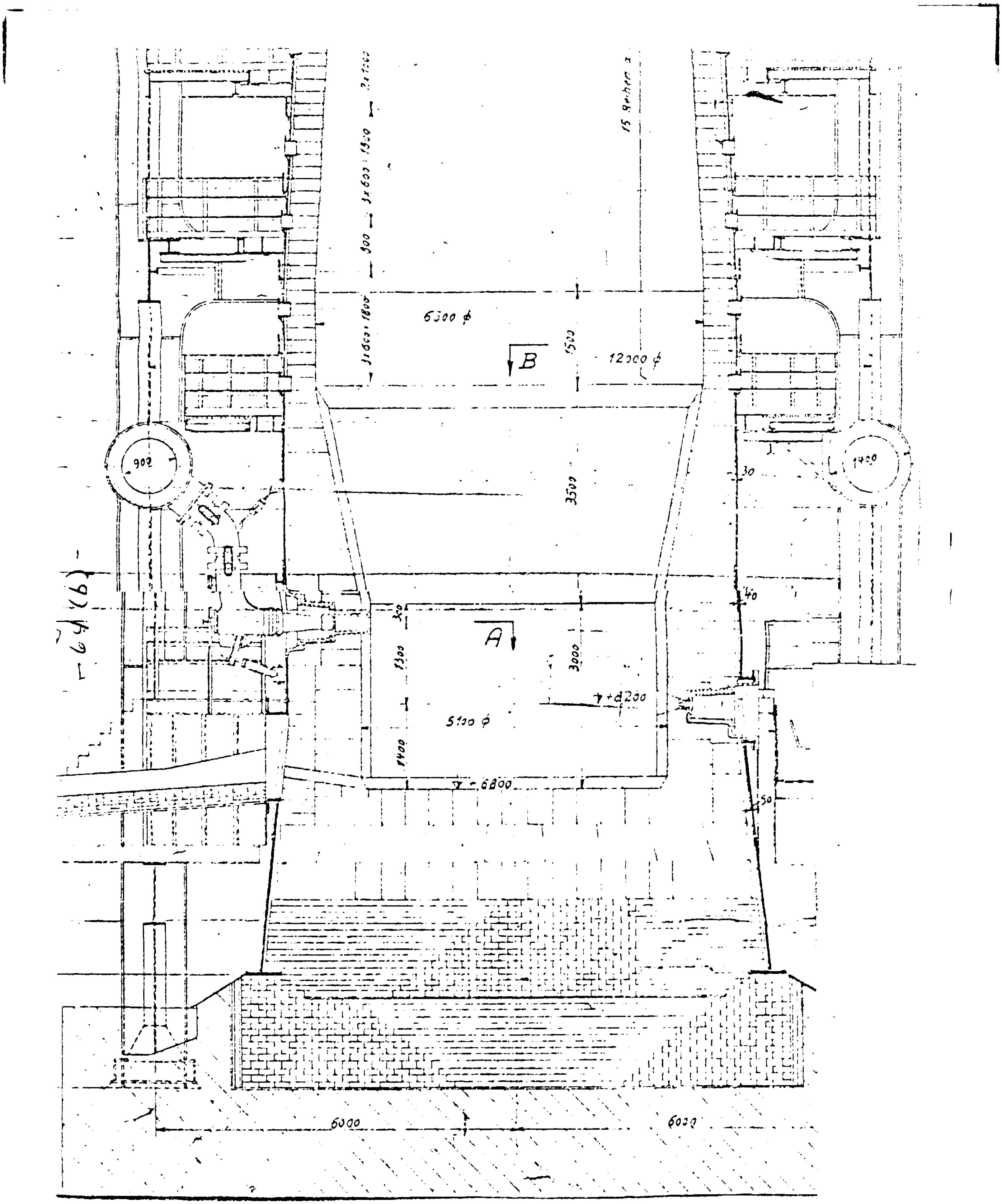
NOTE 3 The original copy of this certificate will be retained by the senior person entering the confined space as and until the work is completed or the time limit expires and all personnel are withdrawn.
After being returned and finally signed, this original copy will be filed for future reference in the respective plant administration office.
As the certificate was made out in triplicate the second copy will be sent immediately to the respective plant manager's office.
The third copy after completion will be retained in the office of the Gas Safety Station for future reference and training purposes.

APPENDICIES 10, 11(1), 11(2), 12(3) ARE IN THE ENVELOPE

-64(a)

APPENDIX No. 10




6300 φ
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B
A
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3500
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+8200
-6800
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902
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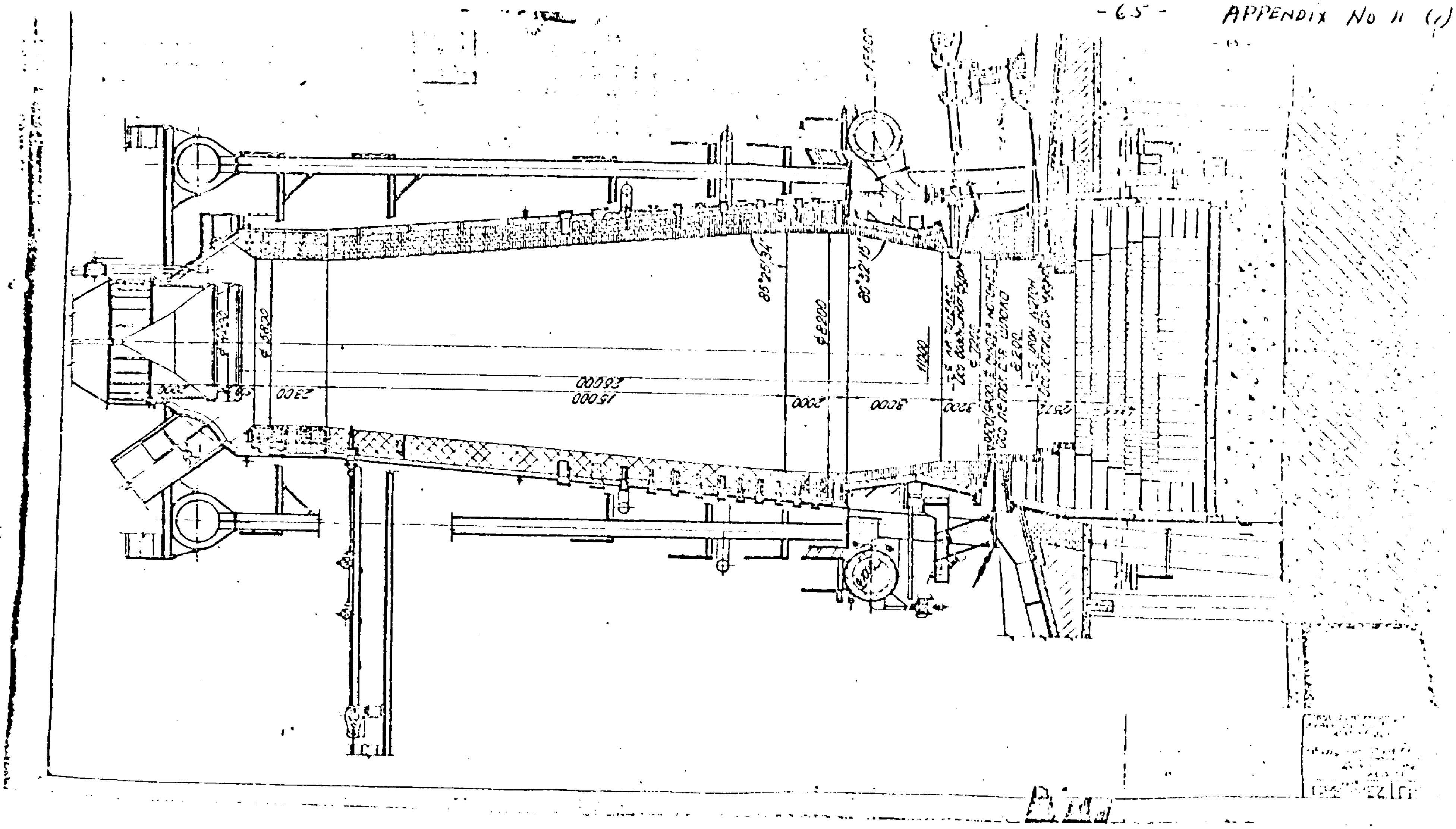
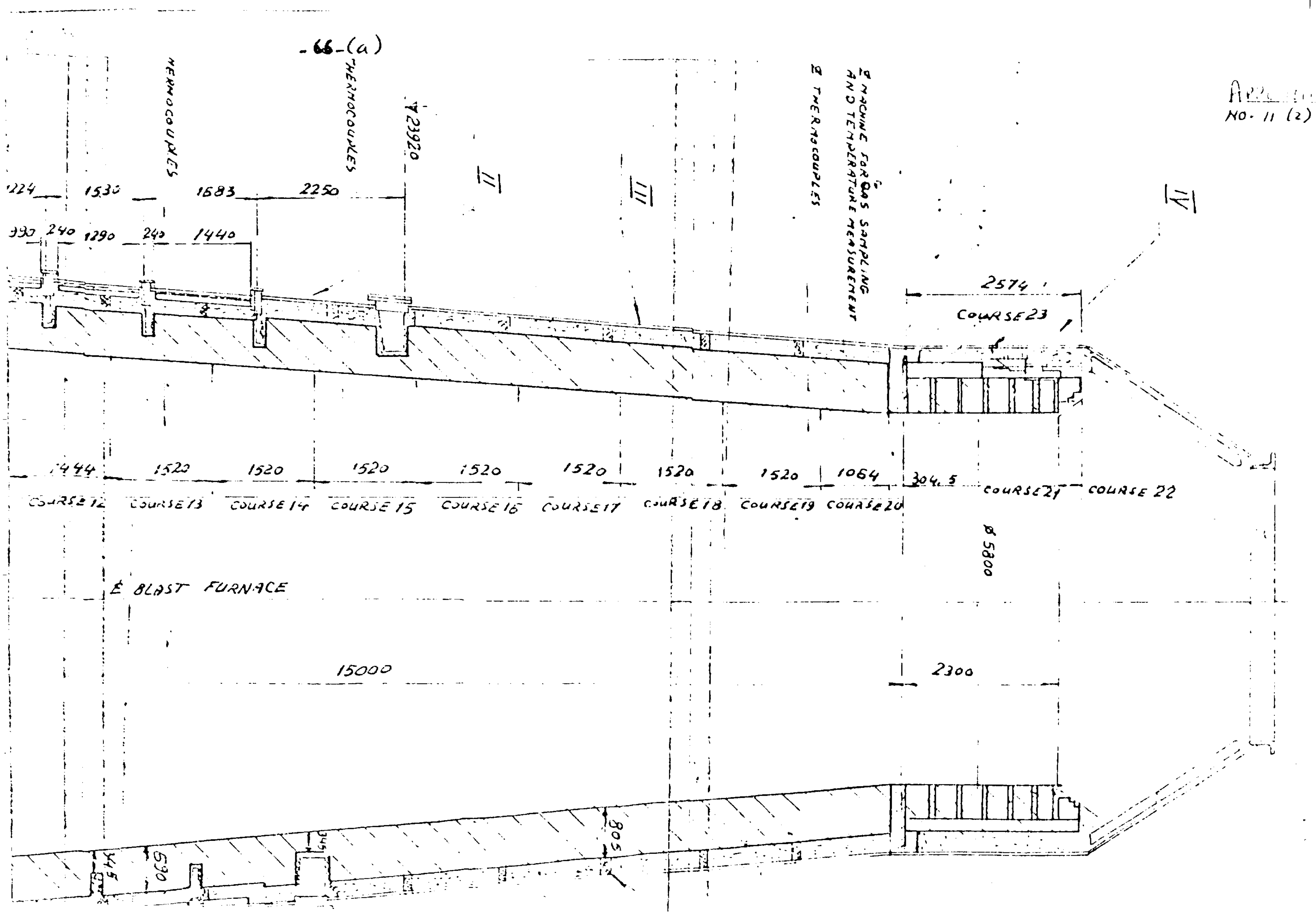
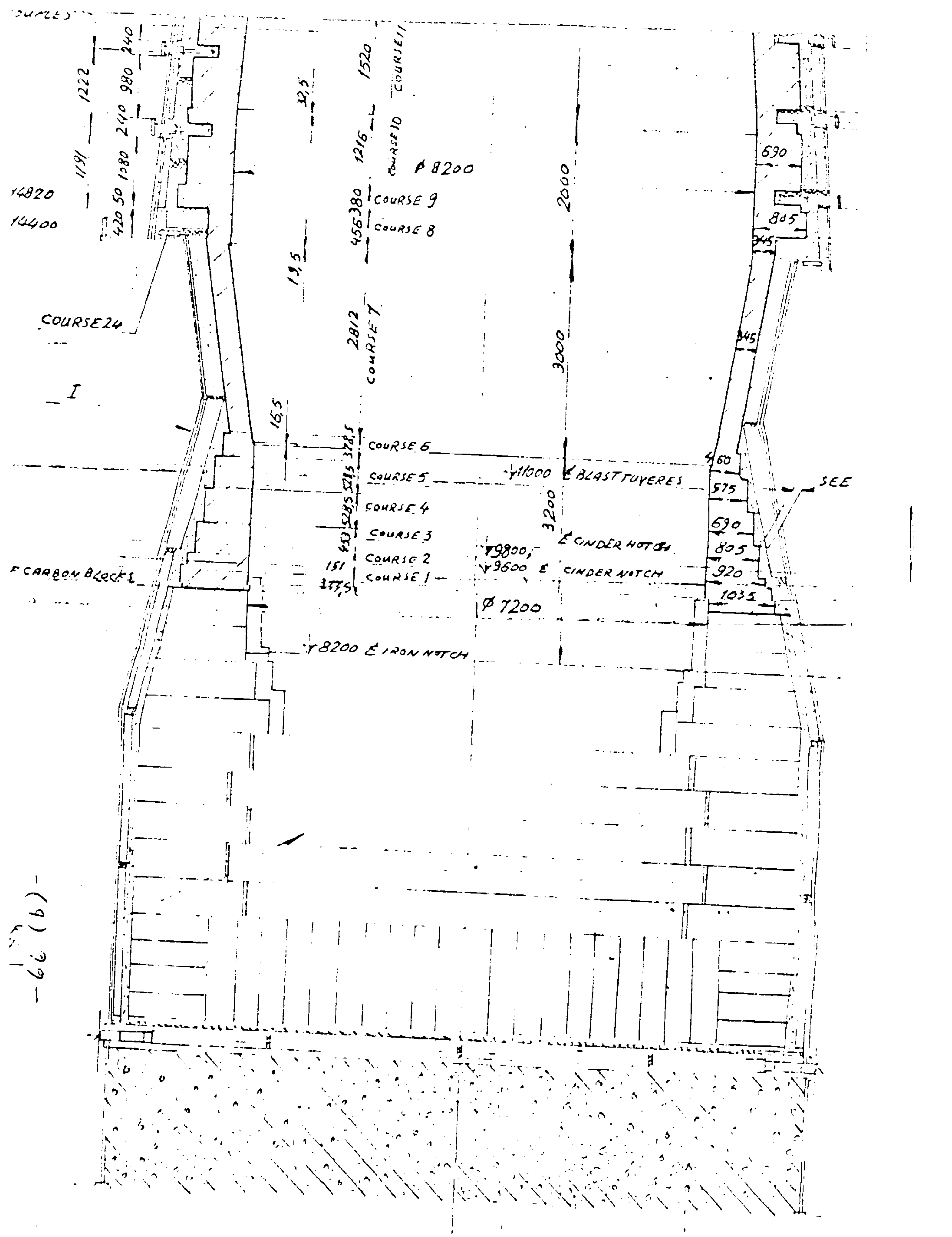
6000

APPENDIX No 11 (1)



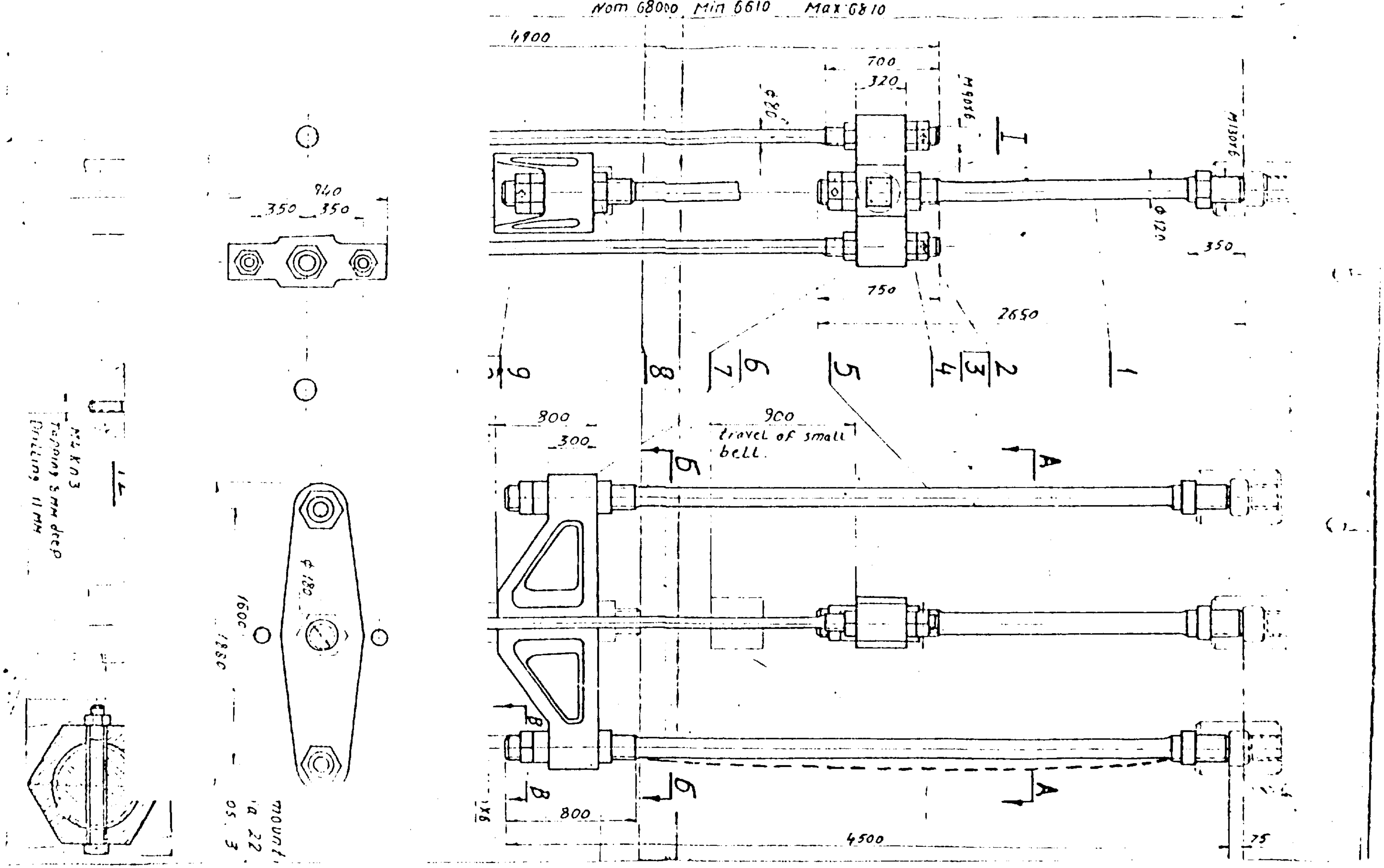
APPENDIX NO. 11 (2)





COURSE 24
COURSE 11
COURSE 10
COURSE 9
COURSE 8
COURSE 7
COURSE 6
COURSE 5
COURSE 4
COURSE 3
COURSE 2
COURSE 1
14820
14400
1222
1191
240
980
240
1080
420
50
32,5
19,5
16,5
1520
1216
456
380
2812
2000
3000
3200
378,5
528,5
528,5
453
151
277,5
Ø 8200
Ø 7200
690
805
345
345
460
575
690
805
920
1035
11000 ℄ BLAST TUYERES
9800 ℄ CINDER NOTCH
9600 ℄ CINDER NOTCH
8200 ℄ IRON NOTCH
CARBON BLOCKS
SEE
I

APPENDIX NO. 12
(3)



Report submitted to Egyptian Iron and Steel Company

INVESTIGATION INTO THE BENDING OF THE RIGHT HAND BELL LINK ROD, AT NO. 4 BLAST FURNACE ON SATURDAY, 3rd APRIL, 1982.

Past History relating to Large Bell Operation

(1) There is gas leakage past the large bell seat in two places and to try and minimise wear and tear to the seating the large bell counter weight had been increased on two occasions since the furnace was blown in during April, 1979.

(2) The large bell had been closing very heavily for some time - several weeks.

(3) It was reported that on a previous occasion both large and small bells had operated together giving evidence of binding between the inner large beel rod and the outer small bell sleeve.

(4) The furnace bleeder relief pressure stat was supposed to be set at 1½ A.T.M.

(5) High Top Pressure was set at 1 A.T.M.

Available evidence at the time of the Link Rod Failure

(1) The crude gas main between the dust catcher and the primary scrubber was heavily made up with approximately 15% free crosssectional area in places.

(2) There were faults in both pressure recording and control instruments for the large bell operation.

(3) While the large bell link rod replacement was in progress, it was noticed that the link plate connecting both small bell ropes to the small bed arm was out of true to a maximum angle. In other words one rope was stretched at least 30 cms. longer than the other one.

(4) The bending of the right hand link rod was discovered while investigating as to why the large bell would not operate.

(5) The pressure under the large bell had to be released before the large bell would operate.

(6) The equalising pressure between the bells is controlled from the semi-clean gas pressure after the venturi scrubbers.

CONCLUSIONS

(1) The made up crude gas main caused back pressure under the large bell and this pressure was not being correctly recorded.

(2) A considerable differential pressure existed across the large bell.

(3) Instrument malfunction allowed the bell lowering mechanism to operate despite high differential pressure, but the excess pressure under the bell prevented the bell from lowering.

(4) Simultaneously the uneven pull on the small bell rope linkage plate caused some misalignment of the outer sleeve small bell rod and this resulted in partial binding between large and small bell rods, further increasing resistance to the lowering of the large bell.

(5) Initial adjustment of the large bell linkage rods may not have been completely correct, i.e. one rod slightly longer than the other.

(6) The total load exerted through resistance to the large bell and partial binding of the large bell rod exceeded the bending moment of the 'longest' large bell linkage rod.

ACTION TO BE TAKEN

(1) The interior condition of the crude gas main must be examined every six months and cleaning done accordingly. Washing of the Bahariya ore to remove alkalie, chloride, zinc, etc., and nitrogen purging instead of steam will help to reduce the amount of make up in the main.

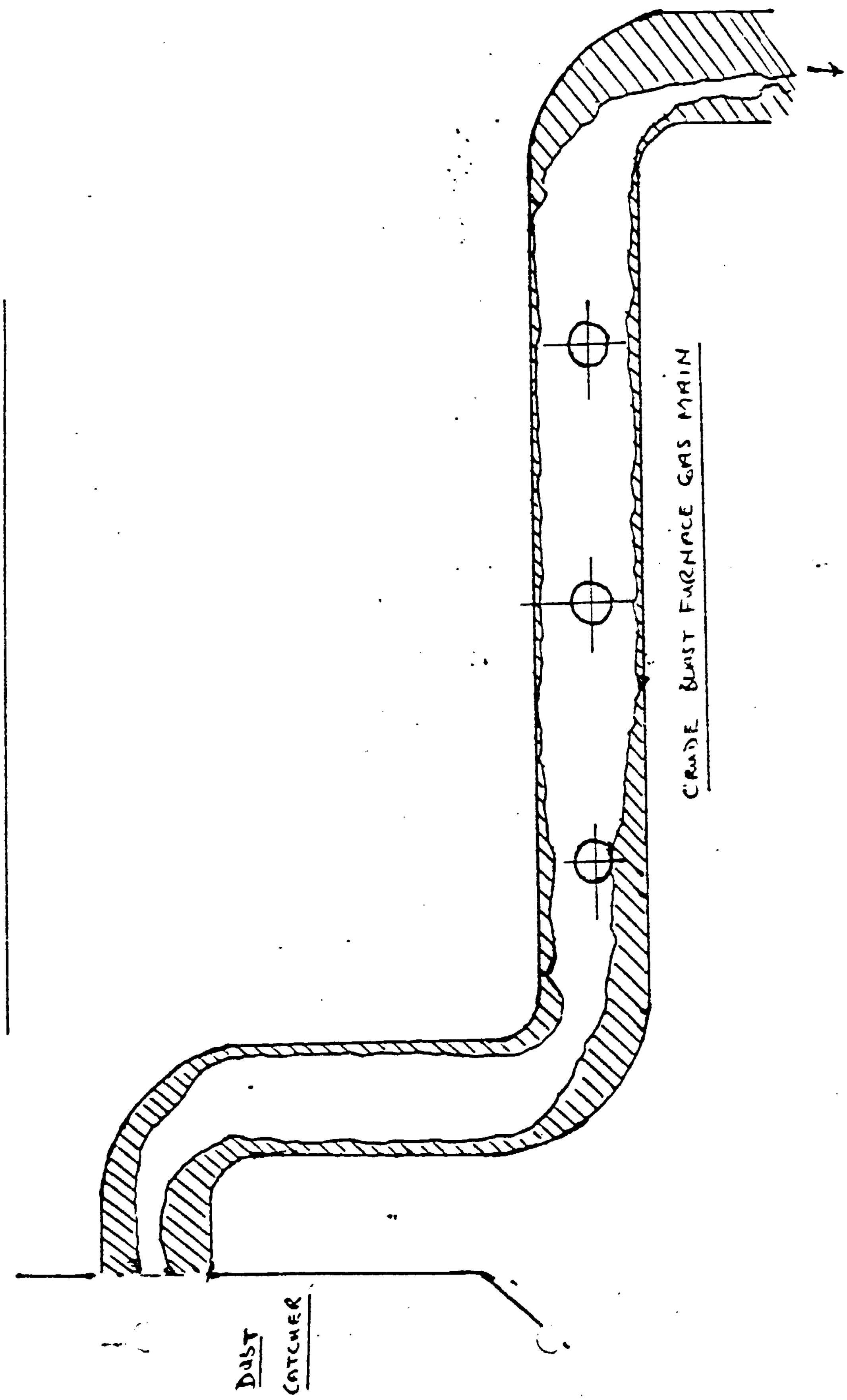
(2) Instrumentation for control of large bell operation needs re-vamping to ensure more reliability of operation.

(3) A more detailed examination of ropes and bell operating equipment should be made on a regular basis and immediate action taken when maladjustment occurs.

(4) A study is being made of large bell and seat design along with a check on material used in manufacture.

CONDITION OF No 4 BLAST FURNACE CRUDE GAS MAIN

AT THE TIME OF LARGE BELL LINK ROD FAILURE



Report submitted to the Egyptian Iron and Steel Company

INVESTIGATION TO DETERMINE THE CAUSE OF CHILLED HEARTH CONDITIONS AT NO. 3 FURNACE DURING 10th APRIL, 1982.

Past History of the Furnace

(1) The furnace is under tuyered, i.e. there is too much circumferential distance between tuyeres.

(2) The problems of scaffold formation from high alkalie, chloride and zinc content in the furnace burden are well known.

(3) From the initial 'blow in' during December, 1981, until mid-March, 1982, the furnace operated on reduced blowing rates due to lack of Cowper stove capacity.

(4) There have been excessive periods of furnace downtime, due to the lack of burden materials, maintenance periods, etc.

(5) The furnace has been charged continually with sinter of high fines content, poor quality stock sinter and, at times, unblended raw Bahariya ore of variable physical and chemical quality because of the sinter shortage.

(6) With the commissioning of No. 3 stove in mid-March, blowing rates were steadily increased, and lack of furnace stack permeability became apparent.

(7) Because of the continuance of the above conditions, a cleaning down programme was put into practice, lasting 4/5 days, immediately prior to the No. 3 blowing cooler failure on 8th April.

Available Evidence

(1) No.3 blowing cooler was badly burned at the inner base. This was caused by contact with molten iron and there was cold iron adhering to the cooler after withdrawing from the furnace.

(2) A high percentage of hydrogen was evident in the gas when the furnace was taken off blast to withdraw No. 3 blowing cooler.

(a) a gas explosion occurred when attempting to backdrought, and it was some 45 minutes before this operation could be safely carried out.

(b) There was an exceptionally high pressure of gas at the tuyeres after the furnace was taken off blast, igniting immediately on access to the atmosphere, typical of a furnace hearth that has taken excessive water. There was no activity at the tap hole.

(3) The three copper members of no. 2 slag notch were lost due to the presence of molten iron when attempting to slag the furnace after no. 3 blowing cooler had been changed and attempts made to cast the furnace at the taphole failed.

(4) After replacing the three units of no. 2 slag notch, failure occurred again within a very short time. All units were burned, including the outer main cast iron casting that houses the main notch cooler. Slag was not being run at the time of this second failure and there was again evidence of molten iron collected behind the notch.

Procedure

Dry slag notches, built inrefractory brickwork, were installed in the furnace, as iron was evident at the slag notch level, and normal chilled hearth procedure was adopted, with only the tuyeres around the taphole and no. 1 slag notch (6 in total) left open. The furnace responded as expected.

While on blast after the installation of the dry slag notches, there was evidence of excessive quantities ofscar/scaffold arriving at the tuyeres and this continued for approximately 24 hours. It must be remembered that during this period the furnace was operating on much reduced blowing rate.

Conclusions

(1) over a period of time, due to unavoidable adverse operating conditions, the furnace developed areas of reduced activity in the stack, despite the changing of charging sequences etc. This caused loose build up in the stack and maybe some scaffolding due to alkalie sublimation.

(2) The extended period of furnace wall cleaning caused movement of this agglomerated material down through the furnace faster than the tuyeres (blowing rate) could deal with it, and at the same time, causing rapid reduction in hearth operating temperature.

(3) Packing below tuyere level occurred in the area around no. 2,3,4 and 5 tuyeres and caused an area of impaired drainage or iron and slag.

(4) A pool of iron formed in this area which eventually led to the failure of no. 3 blowing cooler and the furnace took a large volume of water before the failure was discovered.

(5) For a period of time after blowing up there was evidence of temporary non-connection between the area behind nos. 2,3,4 and 5 tuyeres, and the rest of the furnace, i.e. blast blowing slag through the taphole and iron tapping at a higher level from the brick slag notch area.

Action Required

(1) The practice of cleaning down the furnace stack brickwork after evidence of burden build up should be done over shorter periods of time and especially if for some reason the furnace has been operating on reduced blast. The number of times the practice is repeated being governed by the results obtained.

(2) The programme for improved cold sinter screening at the sinter plant and blast furnaces should not be delayed.

(3) The incidence of chilled hearth conditions further supports the need for more investigation into the washing of Bahariya ore with a view to its early adoption.

(4) The speed with which this chilled hearth occurred should be taken intc account when considering decreasing still further the slag basicity for the 'removal'? of alkalis, etc., from the furnace and relying on external desulphurisation of the hot metal, as slag basicity i.e. slag melting point, is one of the factors controlling hearth operating temperature.

(5) The total cost of this incident and the risk of future similar incidents occurring should be taken into account when assessing the validity of the ore washing scheme, and especially when steel works and rolling mills are on full target production.

The Total Cost should include:

(1) loss of iron, slag, gas, etc.

(2) cost of extra coke

(3) effect on steelworks operation

(4) effect on rolling mills operation

(5) damage to furnace, railroads, equipment, etc.

(6) extra wages cost, use of extra equipment, etc.

(7) potential <u>total loss</u> of the furnace

It must also be borne in mind that during the periods of chilled hearth conditions, especially during the early stages where there is a tendency for molten iron to collect in the water cooled tuyere and slag notch areas, there is considerable danger to those people working around the furnace hearth area.

Report submitted to Egyptian Iron and Steel company.

SMALL BELL ROPE FAILURE AT NO. 4 FURNACE ON 7th APRIL, 1982

Evidence

(1) The rope parted at the base of a main splice.

(2) The splice had stretched badly, away from the apex of the thimble.

(3) Several other splices examined showed similar tendences.

(4) There was evidence that the failure had been developing over a long period as close examination showed that an estimated 50% of the strands had been fractured long enough to turn completely rusty and old looking.

(5) The splicing technique was open to doubt. The splice in question was very uneven and with many broken strands in areas other than the area of failure.

(6) The rope fracture was very ragged with many of the strands having been initially broken some 50/60 cms. inside the splice.

(7) According to engineering staff, the rope was changed approximately one year ago.

(8) This particular rope was purchased from a different manufacturer to normal.

(9) The link plate connecting both small bell ropes to the small bell operating arm was out of true to the maximum angle.

Conclusions

(1) The failure of this rope was not a direct result of the large bell link rod trouble of the previous three days.

(2) The failure of the rope would have occurred irrespective.

(3) It was suspected that on some previous occasion in the more distant past the rope had been under abnormal strain.

Action to be taken

(1) Ensure that all ropes when purchased are suitable for intended use.

(2) Review splicing techniques and compare with effective use of Bulldog clips.

(3) Weekly examinations ofall ropes, splices, clipped joints, etc., should be carried out, and adjustments made where necessary. The results of these examinations should be recorded.

(4) Under normal circumstances, bell ropes should be changed irrespective after a predetermined life. An expected life would be around three years, using quality ropes.

COMMENTS ON A SUGGESTED SCHEME FOR ALKALIE REMOVAL FROM THE FURNACE BY THE FURTHER REDUCTION OF SLAG BASICITY AND EXTERNAL DESULPHURISATION IN THE LADLE FOR REMOVAL OF SULPHUR FROM THE HOT METAL.

The present composition of the slag is dictated by the 100% use of Bahariya ore and to some extent the coke quality. The magnesia content is lower than is desired for good slag fluidity and higher melting point, but it is purposely limited to ensure acceptance after granulation by the local cement manufacturers.

Furnace basicity is kept as low as possible conducive with hot metal sulphur control to eliminate alkalie retention in the furnace as much as possible, and to date slag total basicities in the range of 0.75 - 0.90 have been achieved, without loss of hot metal quality.

It has been suggested that an improved control of alkalie removal from the furnace could be achieved with a further reduction in slag basicity and adopting the practice of external desulphurisation of the hot metal in the ladle, using the lance technique, and at the same time, obtaining other advantages from lower slag basicity, such as better furnace economy, lower manganese content in the hot metal, less wear and tear on the furnace inwall refractories, etc.

However, the following should also be taken into consideration, when considering a further reduction in slag basicity at the Hadisolb works. (A report reference this was submitted to the Hadisolb blast furnace Management)

(1) Allowing for the effects of high alkali content of the burden and the poor physical quality of the sinter, the blast furnace operations is relatively steady and under good control, due mainly to:
  (a) the good physical quality of the coke, allowing a satisfactory level of permeability in the lower stack, bosh, and hearth
  (b) the effect of the high top pressure
  (c) the careful monitoring of burden distribution

(2) Coke rates per ton of iron made are high when compared with world standards, but so also is the furnace slag volume high, and this is dictated by the ore supply. There has been a steady decrease in the coke rate over the past two years, and it is still decreasing (see appendix no. 2) and further decreases will be obtained in the future from:
  (a) the continual availability of higher blast temperatures achieved from the use of four stove practice or the redesign of the present system to incorporate external combustion chambers
  (b) the use of oxygen enrichment of the blast
  (c) increased use of natural gas injection made possible because of oxygen enrichment of the blast
  (d) moisture injection to control flame temperature at the tuyeres
  (e) improved sinter quality

The decrease in coke rate achieved by the adoption of the above mentioned points will give corresponding increase in iron production for a given blowing rate.

(3) Present iron production is well in excess of steelworks demand and 98% within steelworks specification.

(4) The furnaces have good recovery from disturbed operating conditions at present levels of slag basicity, and hearth operating temperature. A further decrease in slag basicity would upset this balance.

(5) External desulphurisation using lance techniques increases wear and tear on metal ladle refractories and the need for extra top skulling and this is an important factor when iron production rates are being increased.

(6) The more acid the slag, the lower will be the melting point and slag melting point is one of the factors controlling hearth operating temperature (with acceptable Al_2O_3 content). Too high slag melting point produces hearth problems and loss of furnace economy, but similarly, too low slag melting point produces a lower hearth operating temperature and makes the hearth more vunerable to operational irregularities and recovery from chilled hearth condition more difficult.

(7) The rate of wear and tear on furnace refractory linings due to alkalies is an unknown quantity and may be reduced to some extent by lowering the slag basicity levels. However, attack on the refractories will not be eliminated, so long as present high level of alkalies continues to be charged to the furnace irrespective of the percentage discharge rate from the furnace.

(8) With present practice, periodic action is needed to reduce alkali build up on the furnace inwall refractories, but this is a very temporary upset to the furnace, and under present operating conditions recovery is rapid.

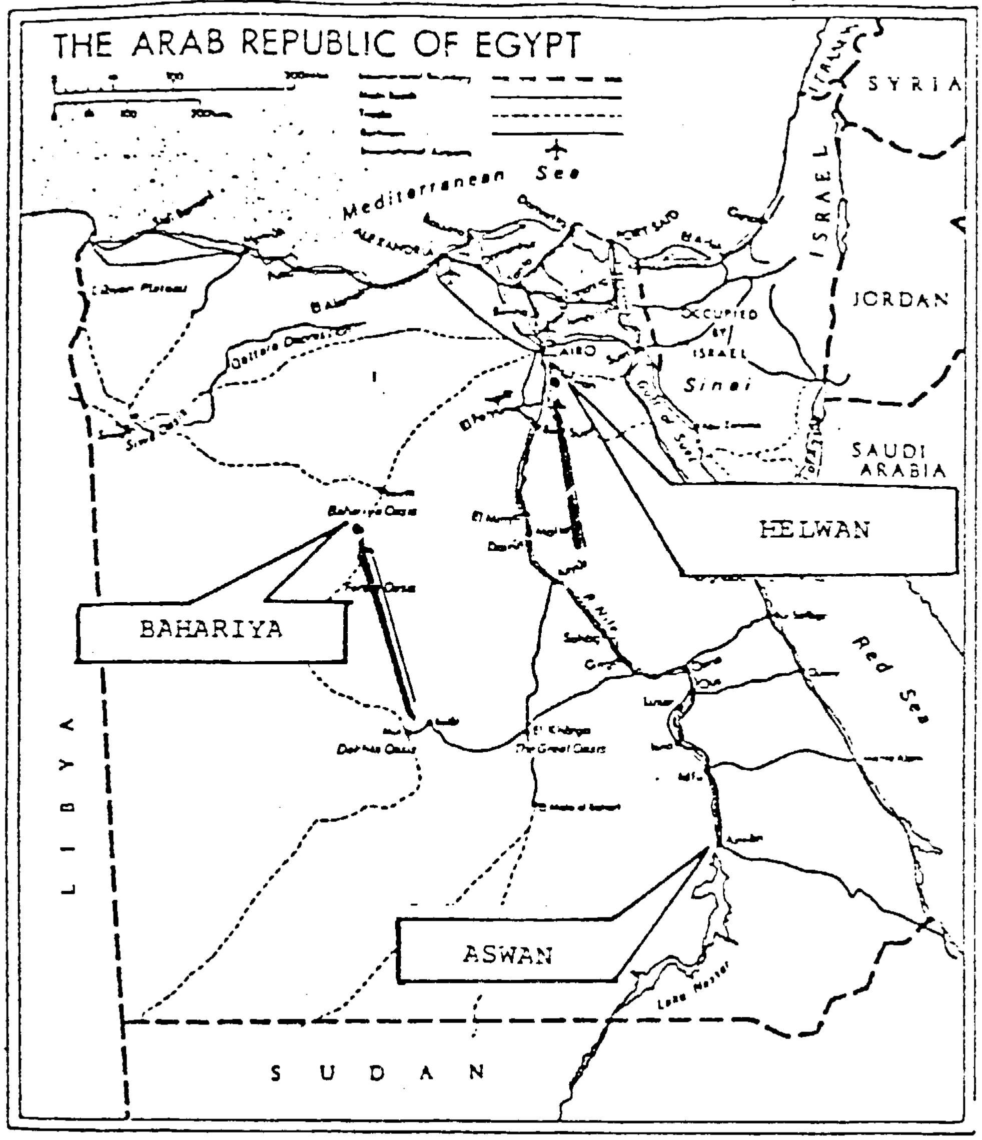
(9) If, in the future, very low sulphur iron is required on a regular basis, then desulphurisation can still be carried out in the ladle without upsetting furnace operation, and maintenance of ladles to meet future increased demand can be studied as a separate project.

The Consultants involved in improvement and rehabilitation studies at Hadisolb have quoted slag basicities of 0.9 as a satisfactory level for furnace operation to counteract the effects of alkali in the furnace burden etc. It should be noted that the present slag basicity levels at Hadisolb are well below this level, as follows:

	no. 3 Furnace		no. 4 Furnace	
DATE	21.1.82	22.1.82	21.1.81	22.1.81
iron production tons/day	1430*	1464*	2033	1868
proximate Si content	0.65	0.60	0.80	0.80
proximate S content	0.040	0.045	0.040	0.040
Mn content of slag	up to 2%		up to 2%	

(* no. 3 furnace operating on two stove practice since blow in)

With present basicity levels, all slags are full glass in consistency, and jet black in colour.



• EGYPTIAN IRON AND STEEL COMPANY

• BAHARIYA IRON ORE MINE