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PROBLEMS CONNECTED WITH THE DEVELOPMENT OF A METALLURGICAL WORKS WITH A CLOSED PRODUCTION CYCLE

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Summary

This report deals with the question of closing the production cycle, by means of the example of the development problems of a metallurgical works supplying steel for construction and for the mining industry.

Several alternative methods of supplying an open hearth plant with pig iron are considered, namely by the construction of a blast furnace section within the works, by the use of cupolas or by continuing to supply the steel plant with cold pig iron.

It is concluded that the closing of the production cycle depends on the scale of production and the rate of development of the metallurgy of the country.

1. Introduction

An open production cycle occurs in a metallurgical plant when the products of the various manufacturing services are not in balance amongst themselves, which makes it necessary either to bring in semi-finished products from outside or to dispose of them outside the works. This position can also arise with the supply of energy or with auxiliary services.

From the economic point of view this comes back to the question of whether it is rational to have production services, sources of energy or auxiliary services which are not in balance with each other.

In the following report these problems will be discussed by means of the example of a metallurgical works characterized by an open production cycle, the development and modernization of which bring forward the question of the benefit of closing the cycle.

We will generalize the experience of this works which could have a wider application, going beyond the limits of a single country.

2. Analytical data

The following data are assumed as a starting point:

The production of the works fulfils the demands for structural steel and is growing so as to meet the increasing requirements of its customers.

The supply conditions are governed by balances relating to the whole of the country.

Several large metallurgical works have also been built in the country, from which the plant can draw on supplies of pig iron, sinter, coke or semi-products, in case it is shown to be more rational to adopt this solution instead of creating a closed cycle in the works in question.

The conditions of transport, supply of energy, and the manpower position permit various solutions to be reached, both for open and closed production cycles.

The works is not out-of-date, and its installations are in good order. It is thus capable of being modernized and developed, especially as it satisfies the necessary conditions from the points of view of the available site and of covering the increased requirements of energy, water, supply of raw materials and despatch of the finished products.

The works is of moderate size. Having regard to its production programme, which includes the commonest grades of steel, its development problems could be of interest to countries, the metallurgical development of which is directed in the first instance to the needs of construction programmes.

3. Description of the works - present position

The works is located in an industrial basin comprising coal mines, metallurgical works and chemical plants. This situation is very favourable, especially for the supply of raw materials and the despatch of finished products.

The works is situated at the junction of two double-track railway lines; it has a branch 0.4 km in length and is connected by a navigable canal with the sea ports about 400 km away. The distance of the sources of raw materials (scrap, pig iron and fluxes) is not more than 100 km. The iron ore used for refining in the steelworks is imported.

The works does not produce its own sources of energy. Electrical power is supplied by the national grid, and the coke oven gas by the regional gas grid. The principal fuel is oil, obtained partly from national sources, and partly from abroad.

The works possesses an open hearth plant, a blooming mill D = 750, a section mill D = 650, a universal mill and ancillary services. The steelworks produces about 500,000 (metric) tons per annum of ingot steel (of which 75,000 tons are sold) in ordinary grades.

The blooming mill produces about 390,000 tons of blooms per annum, and the section mill about 280,000 tons of NP sections and special sections for pit retaining walls. Part of the production of this mill is sold in the form of billets 75 or 42 mm diam.

54% by weight of the production of the works consists of semi-products (ingots, blooms, billets, wide flats and sheet bars, 5 to 40 mm thick) sold as such. The remainder consists of finished products.

The works covers an area of about 80 hectares, 37 hectares of which are partly prepared for extensions. It is also possible to increase the amount of land available.

4. **Description of the production services and the direction of their development**

4a. **Steelworks**

The steel plant is the section which is the deciding factor governing the size of the works and the direction in which modernization will take place. The typical ingot for use within the works weighs 2 tons; the ingots for despatch are 5 tons in weight. The plant possesses 9 basic open hearth furnaces with a nominal capacity of 75 tons (hearth area 35 m^2). The furnace burners are designed for liquid fuels.

The plant has 4 5-ton chargers, and sufficient travelling cranes in the charging and casting bays and above the stocks of scrap, pig iron and fluxes.

The steelworks is equipped with a stripper bay, a scrap breaker and a slag grading yard.

The main production data covering the last few years are as follows:

Average production per furnace	11.13 t/h
Average duration of a heat	8.6 h
Annual utilization of the working area	85.5%
Charge per kg of metallics	1.145 kg
Total consumption of refractories	44 kg/t
Production in terms of manpower	860.0 t per worker per annum

To meet the increasing requirements of customers it is intended to increase the production of the steelworks to 700,000 tons per annum. This can be done, without enlarging the steelworks, by the use of oxygen in the open hearth furnaces (supplied by a central oxygen plant serving several works in the area), and by charging hot metal.

The use of oxygen will increase production by about 20%, or up to 600,000 tons per annum. Charging hot metal will add 10-15% to the amount of steel produced, which will make up the production to about 700,000 tons required.

As the D-750 blooming mill will be unable to absorb this increase, with the same ingot weight of 2 tons, it is intended to install a continuous casting unit with an annual capacity of about 300,000 tons.

The local conditions will enable two 3-strand machines of moderate depths to be installed in the auxiliary bay next to the casting shop, by means of which the necessary amount of steel can be produced in the form of billets 200 x 240 mm or a similar size.

4b. Rolling mills

The works intends to maintain its present type of production, and the mills will be developed so as to cover the requirements for structural steel.

1. Rolling mill - roll diameter 750 mm

This mill is an adjustable 3-high stand driven by a 2500 kW motor.

The charge is reheated in three pusher-type furnaces with a hearth area of 24 x 4 m and a capacity of 35 t/h. If the charge consists of ingots the furnaces operate in two rows.

Present production: 390,000 tons per annum of blooms of 800-1800 kg, 105-240 mm thick, 140-300 mm wide and 6-15 m long.

The principal production data are as follows:

Hourly production	54.3 t
Gross weight to produce 1 kg	1.160 kg
Annual utilization of working area	80.2%
Power consumption	22.9 kWh/t

The increase in steel production to about 700,000 tons per annum which is envisaged would require the mill to roll about 470,000 tons per annum instead of the present 4?2,000 tons.

This production will not require supplementary blooming mill capacity, because the additional material can be supplied by the 65,000 tons of billets which will be made by continuous casting. The production programme will remain unchanged, except that all the charge for the universal mill will be provided by the blooming mill.

i.i. Section mill - roll diameter 650 mm

This consists of an aggregate of three D-650 stands with arrangements for changing all the rolls at the same time.

The first and second stands are driven by a single 2500 kW motor and the third by a 1650 kW motor. The charge is reheated in a pusher furnace having a hearth area of 9.0 x 7.0 m.

The present production is 260,000 tons per annum of NP sections 120-200 and special sections for mining requirements, together with 20,000 tons of 75 and 42 mm diam.billets.

The principal operating data for 1962 were:

Hourly production	45.3 t
Gross weight to produce 1 kg	1.073 kg
Annual utilization of the working area	68.7%
Power consumption	59.7 kWh/t

The planned increase of production to 315,000 tons per annum will be achieved by installing a tilting device in front of the first stand, the replacement of the present saws by saws with an automatic movement and by detailed improvements in the technology of production.

i.i.i. Universal mill

This is a three-high stand D-620/445/620 with D-420 vertical rolls. The charge is reheated in a pusher furnace with a 21 x 2.3 m hearth.

The present production is 79,000 tons per annum of wide flats and sheet bars 5-40 mm thick, 160-500 mm wide and 7-30 m long.

Principal production data for 1962 are:

Hourly production	12.0 t
Gross weight to produce 1 kg	1.108 kg
Annual utilization of working area	75.2%
Power consumption	44.8 kWh/t

This mill is old and so is the building. It is not suitable for modernization, but will be kept in use until worn out, with an unchanged production programme.

4-c. Installation of new rolling mills

In order to cover the conversion of the increased steel tonnage two new rolling mills have been planned, namely an intermediate mill D-550 and a small section mill D-380/280.

i. Intermediate mill - roll diameter 550 mm

A straight-line layout is planned - an off-line roughing stand and 3 in-line D-550 stands.

The charge will be reheated in two pusher furnaces supplying 2 x 30 t/h. It will consist of billets 200 x 240 mm x 2.5 m, from the continuous casting plant.

The following rolling schedule is proposed:

- billets 75 mm sq.	30 000 t
- billets 120 mm sq.	70 000 t
- rails for narrow-gauge railways	15 000 t
- NP girders 80-120	35 000 t
- angles 70-120	10 000 t
- round bars 35-70	30 000 t
- square bars 30-60	20 000 t
	210 000 t/annum

This mill will supply the charge for the new small section train.

i.i. Small section mill - roll diameter 380/280

It comprises:

A roughing group: 4 three-high stands D-450 with lifting tables behind stands I, II and III and in front of and behind the skid transfer tables.

An intermediate group: 3 + 2 stands D-350. Stands I and II are 3-high, the others alternating 2-high.

A group for rods: 2 + 2 stands D-280/350.

A pusher furnace of 30 t/h capacity.

The following programme is planned for this new train:

- rods 5.5-14 mm diam.	25 000 t
- joists NP 50-80 mm	20 000 t
- angles NP 40-70 mm	25 000 t
- bars 12-35 mm diam.	50 000 t
- various sections and flats	10 000 t
	130 000 t/annum

i.i.i. Workshop for welding sections

Complementary to the production of heavy structural sections, it is intended to install near the universal mill an automatic welding plant for producing double T sections 250-250 from flat bars from the universal mill. The annual production will be 25 000 t.

5. Problem of the charge for the steel plant

Three basic variants have been considered for supplying the steel plant with raw materials:

(a) Operating with hot metal from blast furnaces installed inside the works.

(b) Operation with hot metal obtained from cupolas.

(c) Continuation of the present procedure using solid pig iron from various works which have an excess of pig iron from their own blast furnaces, which have various capacities.

These variants correspond to the present state of the metallurgy of the country. The construction of blast furnaces in large units is planned; these would be capable of supplying other works with solid pig iron. An alternative solution under these conditions is to build a section of medium capacity blast furnaces also supplying the steel plant with solid pig iron. A third possibility is the solution in which the construction of cupolas is involved.

These considerations were completed by studying the case where no further developments in the sources supplying cold pig iron to the works are envisaged due to a shortage of investment capital. In this case the provision of cupolas would become one possibility of intensifying the steelworks production.

5-a. Supplying hot metal from blast furnaces installed in the works

The requirements in liquid pig iron for a production of 700 000 t/annum of steel would be as follows:

with 25% pig iron in the charge	200 000 t/annum
with 45% pig iron in the charge	360 000 t/annum
with 60% pig iron in the charge	480 000 t/annum

It has been considered justifiable to construct blast furnaces not only able to develop the works at present being studied, but also possessing sufficient capacity to enable the production of steel to be increased again at a later date, in accordance with long-term development plans. With this in mind the construction has been planned of a blast furnace section comprising 2 units of 483 m^3 capacity and 5.03 m hearth diameter. The documentation for these furnaces is in the possession of the research bodies of the country.

The furnaces will operate at a top pressure of 2.5 atm., and the section will be equipped with the necessary ancillary installations.

The burden will be 100% self-fluxing sinter produced on site. This will enable about 500 000 t/annum of pig iron to be manufactured, giving a temporary excess which could be sold to other works in the country. It is assumed that this section will have the following production characteristics:

-	Production per m^3 capacity	1.5 $t/m^3/24h$
-	Coke rate	750 kg/t
-	Consumption of self-fluxing sinter	2030 kg/t
-	Slag	1000 t/24h
-	Blast volume	144 000 Nm^3/h
-	Blast pressure	3.75 atm.

5-b. The solution making use of cupolas provides for the supply to the steel plant of a 45% hot metal charge, i.e. about 360 000 t/annum.

The cupola section would be made up of units of 1.6 m diam. giving an average production of 18 t/h, corresponding to a productive capacity of 130 000 t/annum per cupola.

To ensure the required amount of hot metal 4 cupolas are planned, of which 3 will be in production and 1 under repair.

The production characteristics for this solution would be:

Coke consumption	200 kg/t
Annual utilization of working area	85.0%
Average production per 24 h	1000 t
Proportion of pig iron in the cupola charge	80%
Proportion of scrap in the charge	20%
Increase in steelworks production	15%

5-c. <u>General remarks</u>

The following are appended to the report: a sketch of the general plan of the works, Sankey diagrams and tables showing the production characteristics before and after the proposed developments.

The following comments on these tables and diagrams may be made:

The location of the various sections of the works presents a number of disadvantage which will be removed when a new works is constructed. For example: the steelmaking plant is in an unfavourable position in relation to the rolling mills, because the supply lines for the raw materials intersect with the more direct lines of supply of the ingots to the mills. Turning the principal steel plant building round by 180° would be more favourable.

The universal mill is situated at the edge of the works, which makes extensions and transport problems more difficult. The position of the maintenance workshops on the periphery is a disadvantage, because of the elongated shape of the works site.

The proposed location of the new sections offers several advantages: the position of the blast furnace section is particularly favourable, as it enables the canal wharf to be utilised, as well as being conveniently located with respect to the possible future use of the unoccupied land for extensions to the works.

The new rolling mills have been sited parallel to the existing D-750 and D-650 mills, but a production flow in the opposite direction has been planned, which will prevent the intersection of the movement of billets from the continuous casting plant with the conveyance of ingots from the steel plant, and with the transportation of the charge materials for the steel plant. The space for the transport of the blooms is certainly fairly extensive, but cold charging has been planned for the roughing stand of the D-550 mill.

The section welding shop has been located at the side of the universal mill. This is a confined position, and disadvantageous from the point of view of communication, but it will enable the flat billets to be conveyed directly.

6. Problems of the supply of energy to the modified plant

The main sources of energy which are available to the works are: fuel, oil, coal, steam, compressed air, industrial and potable water, and electric power.

Due to the open nature of the production cycle, only a few of these sources are produced in the works; most of them come from outside.

The fuel oil, which is the basic fuel for the works, comes by rail, and is discharged into two storage tanks having a combined capacity of 5500 m^3. On being drawn from the tanks the oil is heated to 50°C, and passes to supply points at the steel plant and the rolling mills. The present consumption of fuel oil is about 90 000 t/annum which will be increased, after the plant is modernized, to 120 000 t/annum; this will involve the construction of a third storage tank of 3000 m^3 capacity.

Coal is the basic fuel used for works transport; the present consumption being of the order of 6500 t/annum. As it is expected that the use of diesel locomotives will form part of the modernization plans, this consumption figure will not increase.

Steam, which is used solely for heating, is conveyed by a main from a neighbouring thermo-electric plant. At present the works uses about 80 000 t of steam per annum. After modernization, due chiefly to the increased consumption of fuel oil, this figure will increase to about 110 000 t/annum. The works will then install recuperative boilers on the 6 open hearth furnaces which will yield about 150 000 t of steam, the excess of which will be diverted to the common supply grid of neighbouring works.

Compressed air for the technological and ancillary processes is generated in the works in a compressor station, comprising 4 electrically operated units, giving a total production of 28 000 Nm^3/h. Due to the increased output of the steel plant and new rolling mills, the amount of compressed air required will rise to 200 millions Nm^3/annum, and it will be necessary to install two new compressors, which will increase the rated capacity of the compressor station to 44 000 Nm^3/h.

The industrial water, which is used for cooling in open circuit, is drawn from the neighbouring navigable canal by a pumping station with an hourly rated capacity of 3600 m^3/h. This water is purified in 12 high-speed filtering units. The pumps return the water to the canal under a pressure of 4 atm. The amount of air pumped is 25 million m^3 per annum. The development of the works will not cause any water supply difficulties, in spite of a heavy rise in consumption due to the construction of the blast furnaces.

All the electrical energy for the motors and for lighting is at present supplied from the national grid. The works is connected at a voltage of 6 kV. The motors utilize voltages of 6 and 0.5 kV, and the lighting circuits 380 and 220 V. The amount of electrical energy consumed at present is in the region of 65 million kWh. After modernization the amount required will be about 140 million kWh per annum, and this will need an available power of 26 MW.

The gas balance must be specially examined. At present, the coke oven gas also constitutes a metallurgical fuel. It is drawn from the regional grid in quantities of about 73 million Nm^3 per annum. In spite of the construction of a blast furnace section it is not proposed to install a coke oven plant, which would be too small and uneconomic, when the works is located in a coal-bearing area and the supply of coke from modern coke oven plants is assured. There will be an excess of blast furnace gas of the order of 120 000 Nm^3/h.

A suitable solution would be to heat the rolling mill furnaces with mixed gas and to supply the excess blast furnace gas to the nearby thermo-electric stations or to an outside coke oven plant operating for the works.

7. Final remarks

This development conception relies on clearly defined conditions of collaboration with other establishments as far as the supply of raw materials, semi-products and energy is concerned. Obviously these conditions cannot serve as a basis for solutions arrived at in other countries.

It is also necessary to point out some fundamental problems which should be examined where the basic data for construction and extensions may differ for similar works.

7-a. The results of the analysis of the alternative systems of supplying the raw materials of the steelworks charge (Table 1) have led us to the choice of the solution involving the construction of a blast furnace section within the works, in spite of the parallel construction in the country of other blast furnaces which would be in a position to supply the pig iron in the quantities required.

The construction of a blast furnace section is in fact an economic proposition, because the saving between the cost of pig iron produced in large and small units, allowing for the investment and manufacturing costs, does not compensate for the additional costs of a steel plant operating with a cold pig iron charge, even when the pig iron is supplied by large units.

Under our own conditions, the costs of construction in terms of the useful volume in m^3 of the blast furnaces are presented as follows, as a percentage of the cost of the smallest unit.

	unit	Blast furnaces - capacity in m^3				
		486	760	1033	1719	2002
construction costs	%	100	89	79	76	67

The production costs are similarly aligned.

The conditions we have taken into consideration can differ to a variable extent according to the rate of development of metallurgical production and therefore with the possibility or otherwise of building rapidly plants which are able at the same time to supply the pig iron requirements of efficient small or medium-sized works.

A change in supply conditions, and in particular a change in the pig iron-scrap ratio, could also be decisive. The possibility of increasing supplies of scrap or even a tendency to slow metallurgical development could favour the construction of a cupola section.

7-b. The problem of the construction or extension of a blooming mill to deal with the increased production of the steel making plant is clearly resolved by the development of the continuous casting process for steel manufacture. This process is less expensive, from the points of view of capital and manufacturing costs, than the traditional processes involving a blooming mill. It is also an elastic technique, suitable for progressive increases in line with works requirements, and avoids the construction of blooming mill capacity in excess of current requirements.

Another real advantage of this process is a substantial increase in the billet yield from the liquid steel, which enables the amount of finished products manufactured to be increased without a proportionate increase in the quantity of steel produced.

7-c. The specific position of the works in question from the point of view of energy supplies indicates that it would serve no useful purpose to close the energy balance within the works. In the case where collaboration of the type described with other establishments would be impossible, it would be necessary to adopt solutions which would close the energy balance.

7-d. On the basis of the example studied in this report and in view of the metallurgical experience in the country, the development of which is rapid and centrally co-ordinated, it can be stated that in spite of a tendency to close the production cycles, this tendency is on rather a long-term basis. It does not exclude, and indeed takes into account, the construction or modernization of open-cycle works which operate in co-operation with works possessing large modern units.

Table 1

Manufacturing and investment costs of various open hearth steelmaking alternatives

	Nomenclature	Unit of measurement	Alternatives I	II	III	IV	V	VI
1	2	3	4	5	6	7	8	9
1	Consumption characteristics of materials and fuels							
	(a) charge - open-hearth pig iron	kg/t steel	450	450	450	450	450	[illegible]
	(b) technological fuels	1000 kcal/t	1100	1150	1350	1350	1100	[illegible]
	coke in the cupolas	kg ton	90	-	-	-	90	-
2	Cost price of production	zl/t steel	2634	2580	2625	25[illegible]	2634	[illegible]
	comprising: charge (net)	"	2110	2150	2155	2110	2110	[illegible]
	technological fuels	"	159	90	105	105	159	[illegible]
	conversion costs	"	365	340	365	365	365	[illegible]
3	Total investment costs	zl/t steel	1070	940	1130	1010	370	[illegible]
	comprising: blast furnaces	"	260	340	340	260	-	-
	sintering	"	250	300	300	260	-	-
	cupolas	"	70	-	-	-	70	-
	steelmaking plant	"	300	300	450	450	300	[illegible]
	sundry	"	180	-	40	40	-	-

Explanatory notes to Table 1

1. The figures in Table 1 relate to the following alternatives:

   1.1. Alternative I envisages the supply of solid pig iron supplied by large modern blast furnace units, with the construction in the works of cupolas for melting the iron.

   1.2. Alternative II presupposes the construction at the works of a blast furnace section with two furnaces each of 483 m^3 capacity.

   1.3. Alternative III provides for the supply of solid pig iron from the blast furnaces (1.2).

   1.4. Alternative IV involves the supply of solid pig iron from blast furnaces of 1720 m^3 capacity.

   1.5. Alternative V assumes that the production of pig iron in the country does not increase and that the present supplies are assured. This alternative implies the supply of solid pig iron and the construction of cupolas in the works.

   1.6. Alternative VI is based on the same data as alternative V, but with the direct supply of pig iron to the steel plant.

For the purposes of comparative calculations it is assumed that 450 kg pig iron per ton of steel is used and that 700 000 t per annum of steel is produced; the calculations are confined to questions concerning blast furnaces and steel-making plants. It is also assumed that the development of other sections of the works has no effect on the choice of alternatives concerning the supply of the charge for the steel plant.

Table 2

Development of the principal technical and economic characteristics

Section	Basic characteristics	unit	before modernization	after modernization
Steelmaking plant	Annual utilization of working area	%	85.5	88.0
	mean production per m^2 hearth area	$t/m^2/24h$	6.35	8.8
	mean hourly production, 1 furnace	t/h	11.13	15.1
	mean duration of 1 heat	h	8.16	6.05
	gross charge for 1 kg product	kg	1.145	1.131
	heat consumption	$kcal \times 10^3/t$	1450	1100
	consumption of compressed air	Nm^3/t	230	200
	water consumption	m^3/t	20.0	14.5
Blooming mill D-750	Mill yield	t/h	54.3	59.0
	annual utilization of working area	%	80.2	81.5
	charge per ton yield	kg/t	1160	1132
	heat consumption	$kcal \times 10^3/t$	637	580
	consumption of electrical energy	kWh/t	22.9	21.0
	water consumption	m^3/t	17.0	15.5
Section mill D-650	Mill yield	t/h	45.3	51.0
	annual utilization of working area	%	68.7	70.0
	charge per ton yield	kg/t	1073	1063
	heat consumption	$kcal \times 10^3/t$	395	350
	consumption of electrical energy	kWh/t	59.7	55.0
	water consumption	m^3/t	14.0	13.6
Universal mill	Mill yield	t/h	12.0	12.1
	annual utilization of working area	%	75.2	75.5
	charge per ton yield	kg/t	1108	1104
	heat consumption	$kcal \times 10^3/t$	416	400
	consumption of electrical energy	kWh/t	44.8	41.0
	water consumption	m^3/t	14.0	12.3
Medium section mill D-550	Mill yield	t/h	-	30.0
	annual utilisation of working area	%	-	80.0
	charge per ton yield	kg/t	-	1050
	heat consumption	$kcal \times 10^3/t$	-	500
	consumption of electrical energy	kWh/t	-	45.0
Small section mill	Mill yield	t/h	-	20.0
	annual utilization of working area	%	-	75.0
	charge per ton yield	kg/t	-	1055
	heat consumption	$kcal \times 10^3/t$	-	400
	consumption of electrical energy	kWh/t	-	90.0
Section welding	hourly production	t/h	-	5.25
	charge per ton yield	kg/t	-	1010

The characteristics of the blast furnace section have been given in the text.

Key to numbering of the works plan

(a) Present position

1. Line to the slag dump
2. Open-hearth slag grading yard
3. Scrap and pig iron store
4. Sorting lines for the steel plant
5. Steel plant
6. Amenity block of the steel plant
7. Compressor shop
8. Refractories store
9. Fuel oil storage tanks
10. Pump and filter station
11. Stripper bay
12. Lines from the ingot mould store
13. Works office
14. Central laboratory
15. Ingot stockyard
16. Rolling mill shop D 750 and D 650
17. Roll turning shop
18. Amenity block for the rolling mills
19. Universal mill
20. Bloom store
21. Amenity block
22. Central stores
23. Maintenance workshop
24. Mill scale dumping area
25. Sorting, arrival and departure station

(b) Position after modernization

1. Sorting lines, blast furnace
2. Wagon tilting equipment
3. Ore grading
4. Ore mixing
5. Sinter plant

6. Blast furnaces
7. Ore bunkers
8. Mineral stocks
9. Canal wharf
10. Dorr thickeners
11. Gas cleaning
12. Amenity block of blast furnace sections
13. Pig casting machine
14. Pig iron stockyard
15. Granulated slag charging
16. Open-hearth slag grading yard
17. Scrap stockyard
18. Steel plant sorting lines
19. Steel plant
20. Continuous casting bay
21. Amenity block of steel plant
22. Compressor station
23. Refractories store
24. Fuel oil storage tanks
25. Stripper bay
26. Cooling lines for ingot moulds
27. Works offices
28. Central laboratory
29. Ingot stockyard
30. Rolling mill shop D-750 and D-650
31. Roll turning shop
32. Amenity block of the rolling mills
33. Bloom stockyard
34. Medium rolling mill shop D-550
35. Small section rolling mill shop
36. Pump and filter station
37. Universal mill
38. Bloom stockyard
39. Section welding workshop

40. Amenity block
41. Central stores
42. Maintenance workshop
43. Mill scale dumping area
44. Arrival, departure and sorting station

FIGURES

Table 3

Works production in accordance with present position

Scrap Pig iron

Steelmaking plant

Blooming
mill D 750

Section
mill D 650

Universal
mill

Tableau 3

Production de l'usine d'après l'état actuel

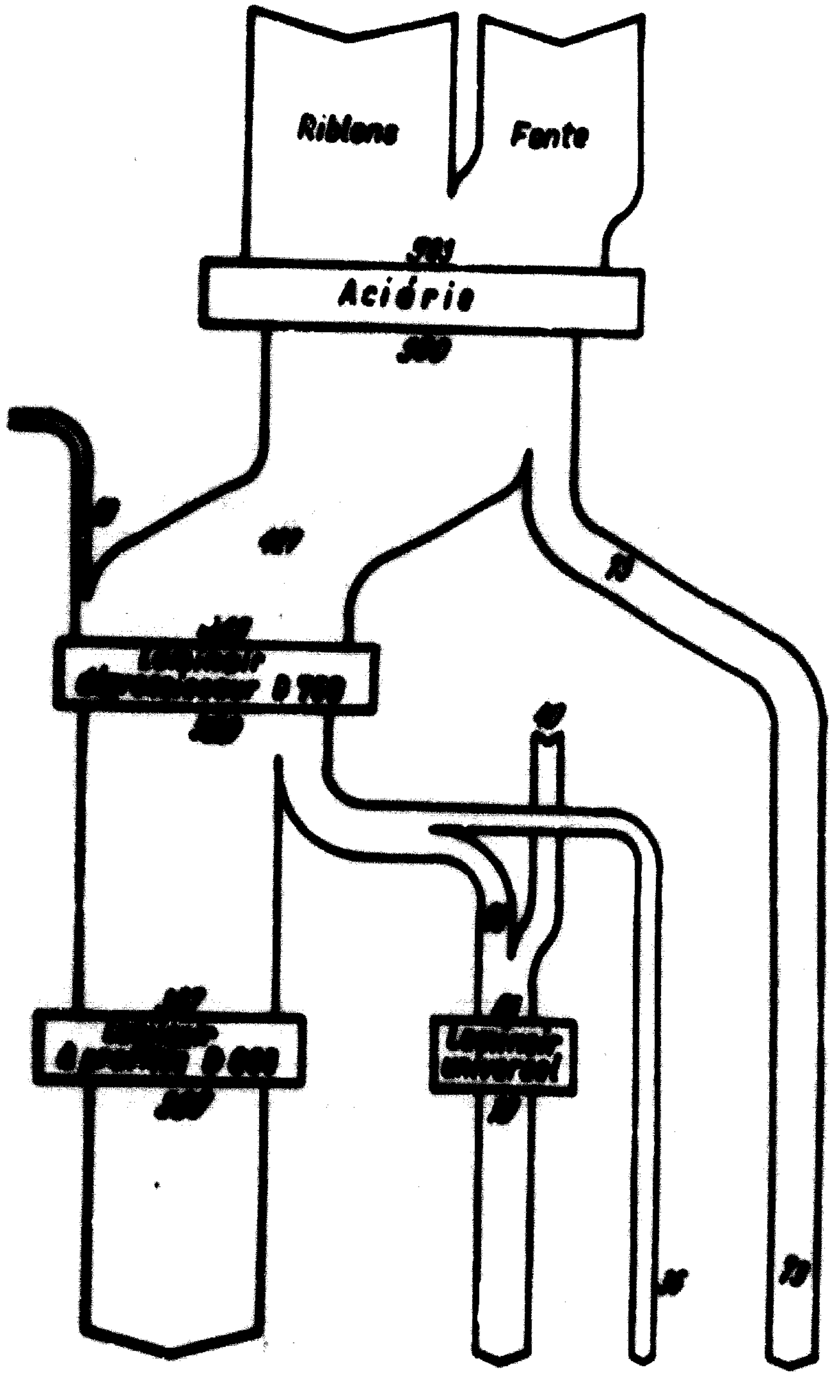


Table 4

Works production after modernisation

Blast furnaces

Bought-in scrap

Uprising scrap

Steelmaking plant

Continuous casting bay

Mill D 750

Mill D 550

Mill D 650

Universal mill

Small section mill

Section welding shop

Sections

Wide flats and sheet bars

Welded sections

Small sections

Medium sections and bars

Production de l'usine après modernisation

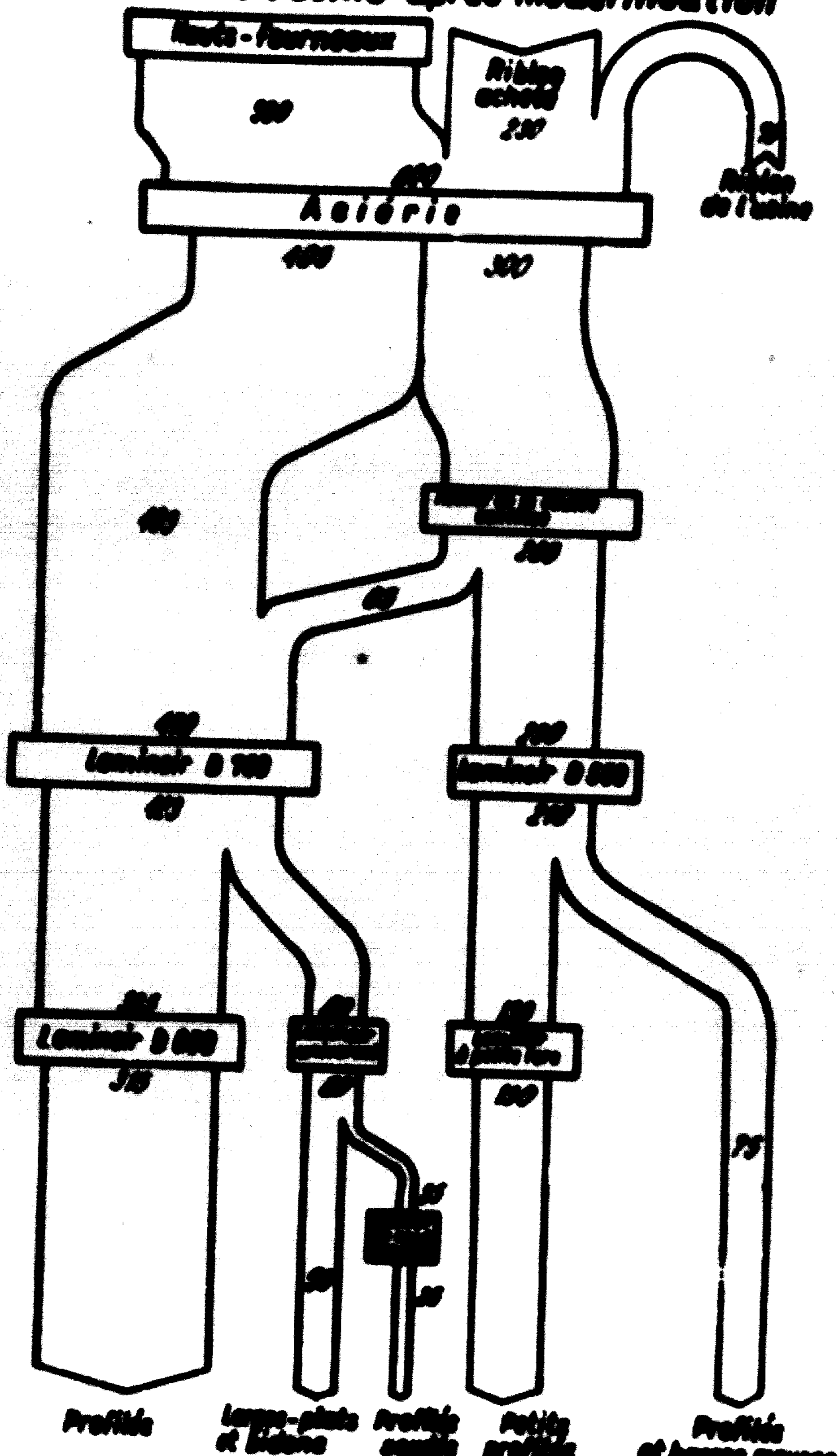


Table 5

Sketch of the works plan
Present position

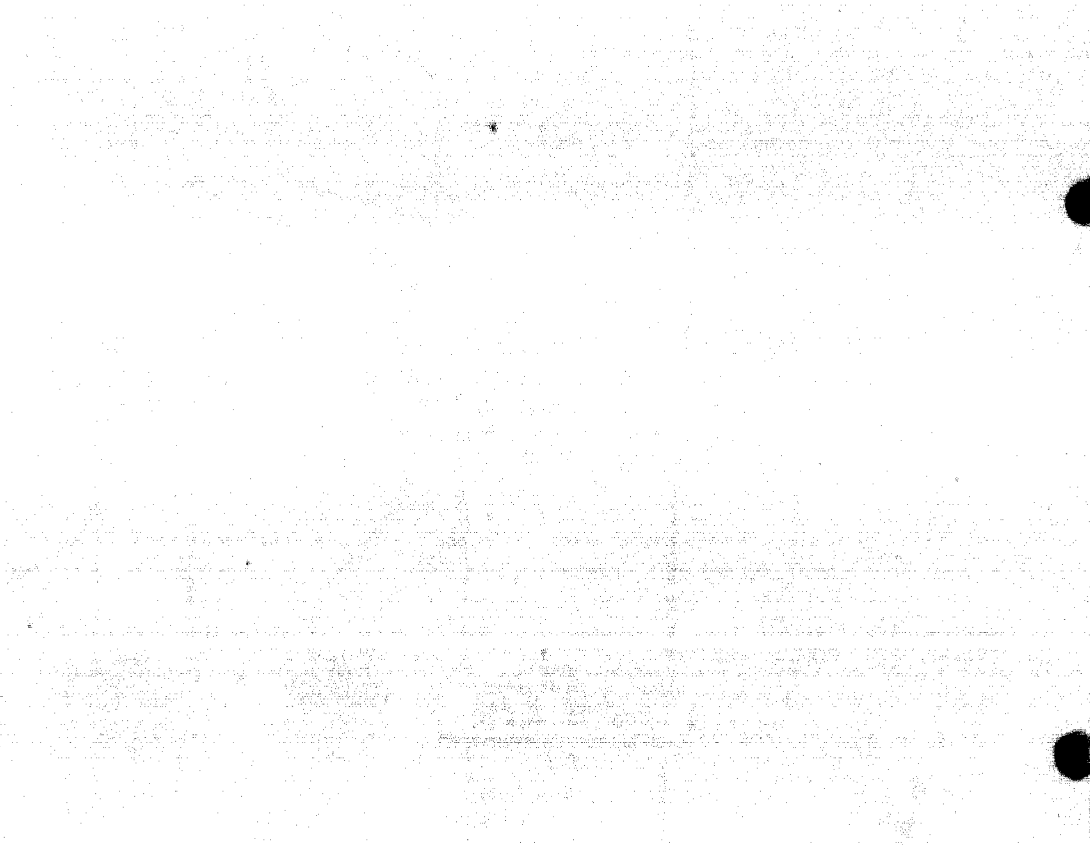


Tableau 5

Le croquis du plan de l'usine
Etat actuel

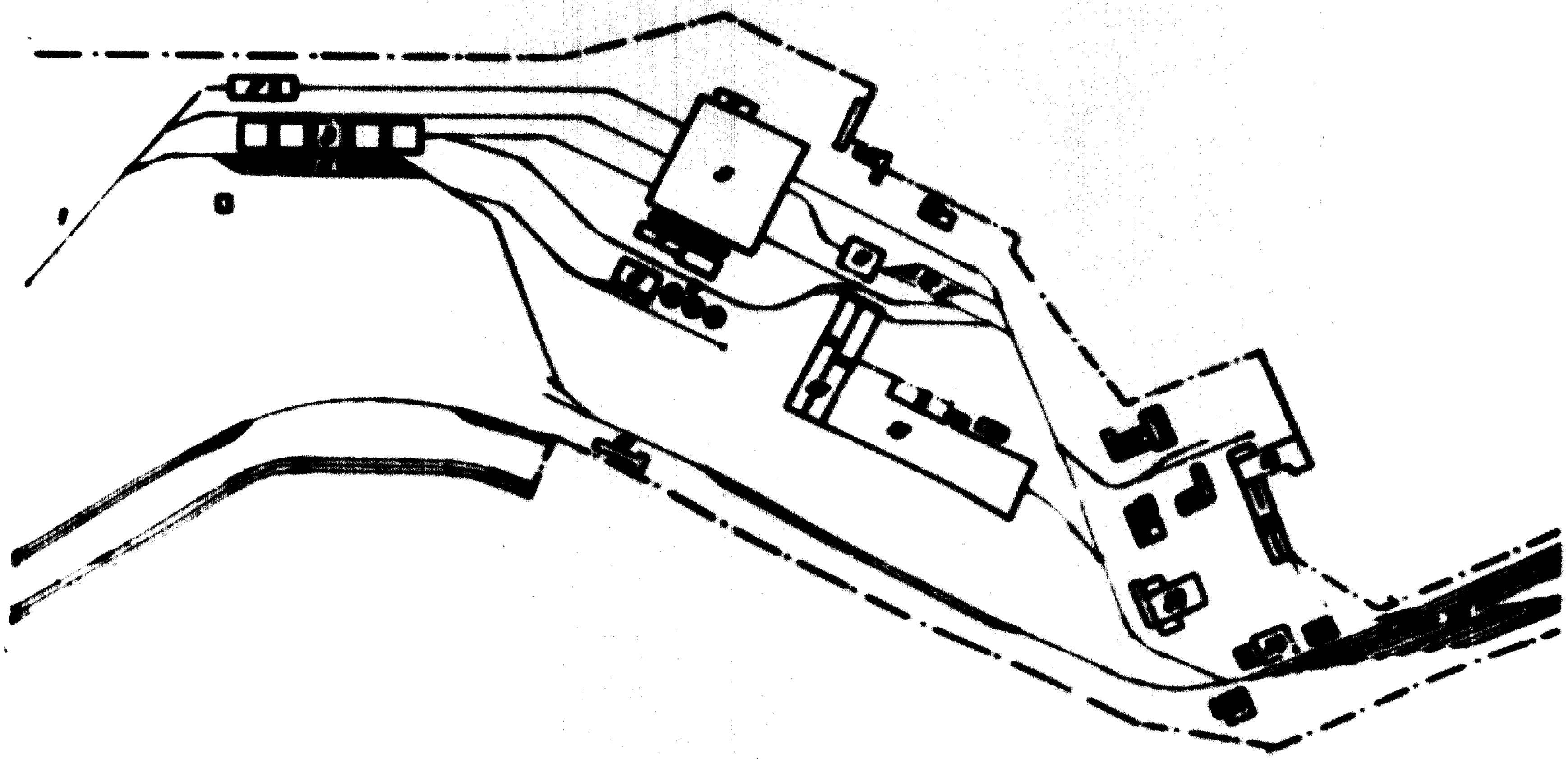


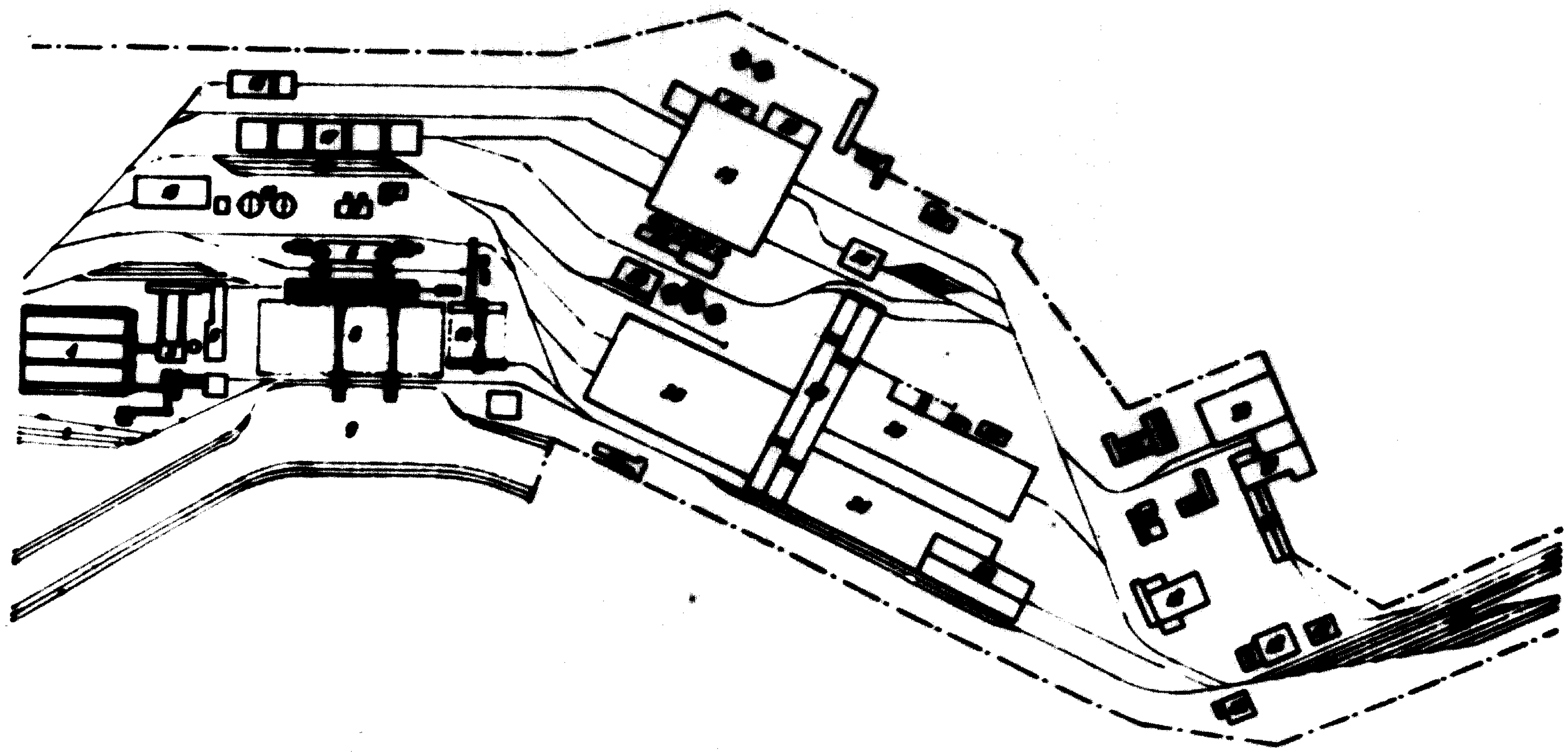
Table 6

Sketch of the works plan

Position after modernization

Tableau 6

Le croquis du plan de l'usine
Etat après modernisation.



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