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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

OUTOKUMPU ENGINEERING
A DIVISION OF OUTOKUMPU OY

AKi, TH January 1986

PYRITES, PHOSPHATES AND CHEMICALS LTD INDIA

INVESTIGATIONS TO PRODUCE ELEMENTAL SULPHUR FROM SALADIPURA PYRITE DEPOSIT

STUDY FOR A DEMONSTRATION PLANT

ATTACHMENT:
REPORT OF THE MINI PILOT PLANT TESTS FOR SALADIPURA PYRITE CONCENTRATE, OKMT-33/85

1 SUMMARY

1.1 Introduction

1.1.1 Background of the Study

The feasibility study reported in this document is an additional work to the feasibility study for Amjhore pyrite beneficiation, UNIDO Contract No. 82/91 SM.

For this additional study, refer to UNIDO Contract No. 85/16.

The purpose of the study is to calculate and present the necessary technical, operational and economical data on a pilot size demonstration smelter plant for production of elemental sulphur from Saladipura pyrites.

The capacity of the plant is 1 tonne/h of pyrite. The size of the plant was agreed in negotiations in Pori, Finland, between PPCL and Outokumpu on 17 May 1985.

The basic data and information for the study were received in negotiations between PPCL and Outokumpu in Finland on 16 - 17 May and 22 - 23 July 1985 and by telexes 16 and 22 August 1985.

1.1.2 Scope of the Study

Scope of the work was originally negotiated in Vienna between UNIDO, PPCL and Outokumpu on 29 November 1984, and it was finalized in negotiations in Finland in May and July 1985.

The scope of the study includes also mini pilot smelting tests of Saladipura pyrite concentrates at Outokumpu's Research Centre, Pori, Finland. The tests were performed on 15 - 17 May 1985 and the report was issued at the beginning of July 1985, and is attached to this study document.

The scope of the plant areas covered by this study is limited to the process equipment of the pyrite smelting, sulphur separation and handling processes. Other areas, like the concentrator plant, steam and water handling, power generation, etc. are not included.

1.1.3
Benefits of the Demonstration Plant

Several arguments for an investment in a demonstration size smelter plant can be stated.

Although the principle of the smelting process is well-known to Outokumpu, and a commercial size plant could be built without further tests in the European conditions, it is reasonable to confirm some parts of the process in Indian conditions using a pilot size plant.

The main points to be tested would be as follows:

1. The suitability of coarse grained pyrite for flash smelting. Outokumpu has always smelted fine grained flotation concentrates in flash smelting furnaces. However, considerable cost savings would be reached in ore treatment and pyrite drying if coarser material could be allowed.

2. The oxidation degree of the smelting process can be confirmed in order to find the most economical process for a commercial size plant.

3. The reduction process by using coal of Indian origin can be tested. Outokumpu's experience is based on coal from the USSR and Botswana, and these coal qualities differ to a certain degree from the Indian qualities.

4. The exact behaviour of the flue dust can be tested. After test runs in a demonstration plant, a more accurate design of the cleaning device for the waste heat boiler and dimensioning of the electrostatic precipitator for a full size plant can be made.

5. Dimensioning of the gas washing equipment would be more accurate on the basis of demonstration plant experiences.

Generally, the dimensioning of a commercial size plant will be more accurate, and considerable investment and operating cost savings could be reached by reduced safety margins in the design.

The training purpose of a demonstration plant would be of great importance. In case a full size plant is supplied later, the commissioning period of the plant would be shorter and the full capacity production would be reached sooner if the operation crew had experience of long term operation at the demonstration plant. Training is even more efficient because of several variating smelting conditions to be arranged in the demonstration plant.

Additionally, even after the possible supply of a full scale plant, the demonstration plant could be used for test runs e.g. for other potential ore deposits in India. The same plant can be used for test smelting of copper, nickel and lead concentrates as well. The demonstration plant can also be used for commercial purposes, e.g. smelting tests for customers from abroad.

1.1.4 Commercial Size Plant

No complete economic study for a commercial size plant is performed for Saladipura pyrites, only a short calculation is shown in Item 1.4.2 of this study with an accuracy of ± 30 %.

However, according to the calculations made for the Amjhore pyrite beneficiation it seems to be feasible to supply an industrial size plant for Saladipura pyrites, taking into account the better mining conditions in Saladipura, which reduce the costs of the raw material.

A full scale plant could be dimensioned to smelt 2 000 tonnes per day of pyrites of 36 % sulphur. The sulphur production would be about 600 and steam production (65 - 70 bar) about 2 000 tonnes per day. Smelting would be performed with process air oxygen enrichment, with full oxidation system.

1.1.5 Outokumpu's Services in Training and Operation

Outokumpu can offer services for the training of smelter personnel and for operation assistance.

The training before the starting of the demonstration plant can be performed both in Finland at Outokumpu's full scale smelters or the pilot smelter of Outokumpu Research Centre, and at the pilot plant of Saladipura during its erection and also during the start-up.

The training would include lessons as well as practical training in smelters.

Operational assistance can be provided during the start-up of the plant, as well as for a longer period during plant operation. The assistance would be given by specialists in the form of overall control of operation as well as advice.

The training and operation assistance personnel have gained experience at the company's own Kokkola pyrite smelter and at Pori pilot smelter as well as at the sulphur plants of smelters built by Outokumpu in Norilsk, USSR and BCL, Botswana.

1.1.6
Guarantees

A long term operation of the demonstration plant will provide an accurate basis for the industrial scale plant design and operation under local conditions. Therefore on basis of the operational results and experiences Outokumpu as designer of the plant and supplier of process technology and equipment will be prepared to guarantee the process performance and equipment as follows:

a) Plant capacity will be guaranteed as daily throughput of a certain type of pyrite.

b) Recovery of sulphur in gas and further as elemental sulphur. Quality of feed and reduction agent has to be defined.

c) Quality of sulphur

d) Maximum sulphur emissions to atmosphere

e) Consumption of reductant provided that quality of reductant and feed as well as oxidation conditions in flash smelting furnace will be defined.

The above guaranteed performance figures will be verified during a guarantee run period operated according to the instructions of Outokumpu.

A mechanical guarantee for the equipment supplied by Outokumpu will be given usually for one year of operation.

Extent of guarantee is closely related to the supply of Outokumpu. It is obvious that Outokumpu cannot guarantee performance or equipment in areas where design, equipment, selection, erection or operation is out of its control.

1.1.7
Outokumpu's Experience

Outokumpu Oy has extensive experience in the flash smelting system and elemental sulphur production. The flash smelting method of sulphidic ores to produce non-ferrous metals was in fact developed by Outokumpu in the late 1940's.

Several flash smelting plants have been designed and supplied by Outokumpu since then to produce copper or nickel in variating degrees of pure metal. Nowadays the system is developed also for smelting of lead concentrates.

For flash smelter references see Appendix 1-1.

For some copper or nickel smelters special sulphur separating plants are supplied to produce elemental sulphur, and a plant for smelting pyrite concentre in industrial scale has been supplied.

The reference list of commercial size sulphur plants, giving customer, country and year of start-up, is as follows:

Outokumpu Oy (Pyrite smelter)	Finland	1962
BCL Limited	Botswana	1973
Phelps Dodge Corporation	USA	1976
Kombinat Norilsk (Plants for copper and nickel)	USSR	1981

The pyrite smelter of Outokumpu was stopped in 1977 due to the market situation of that time.

In addition to the full size sulphur plants mentioned above, experience is gained at the Metallurgical Research Centre of Outokumpu in Pori, Finland, where a pilot smelter plant was erected in the 1950's and several smelting tests have also been performed for pyrites.

The mini-pilot scale smelting tests for Saladipura pyrites were performed at the pilot plant in May 1985.

OUTOKUMPU OY
ENGINEERING DIVISION

REFERENCE LIST

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FLASH SMELTING

Customer	Country		Smelter start-up
Outokumpu Oy, Harjavalta	Finland	Copper smelter	1949
Outokumpu Oy, Pori	Finland	Pilot plant	1950's
Outokumpu Oy, Harjavalta	Finland	Nickel smelter	1959
Outokumpu Oy, Kokkola	Finland	Pyrite smelter	1962
Furukawa Co. Ltd., Ashio	Japan	Copper smelter	1956
Combinatul Chimico-metalurgic, Baia Mare	Romania	Copper smelter	1966
The Dowa Mining Co. Ltd., Kosaka	Japan	Copper smelter	1967
Nippon Mining Co. Ltd., Saganoseki	Japan	Copper smelter	1970
Sumitomo Metal Mining Co. Ltd., Niihama	Japan	Copper smelter	1971
Hindustan Copper Limited, Ghatsila	India	Copper smelter	1972
Peko-Wallsend Metals Ltd., Mount Morgan	Australia	Copper smelter	1972
Mitsui Mining and Smelting Co. Ltd., Hibi	Japan	Copper smelter	1972
Norddeutsche Affinerie, Hamburg	Federal Republic of Germany	Copper smelter	1972
Nippon Mining Co. Ltd., Hitachi	Japan	Copper smelter	1972
Western Mining Corporation Limited, Kalgoorlie	Australia	Nickel smelter	1973
Karadeniz Bakir İşletmeleri A.S., Samsun	Turkey	Copper smelter	1973

Peko-Wallsend Metals Ltd., Tennant Creek	Australia	Copper smelter	1973
Nippon Mining Co. Ltd., Saganoseki	Japan	Copper smelter	1973
BCL Limited, Pikwe	Botswana	Nickel smelter	1973
Hindustan Copper Limited, Khetri	India	Copper smelter	1974
Rio Tinto Minera, S.A., Huelva	Spain	Copper smelter	1975
Phelps Dodge Corporation, Hidalgo County, New Mexico	USA	Copper smelter	1976
Kombinat Gorniczo-Hutniczy Miedzi Lubin, Glogow	Poland	Copper smelter	1978
Korea Mining and Smelting Co. Ltd., Onsan	The Republic of Korea	Copper smelter	1979
Kombinat Norilsk	USSR	Nickel smelter	1981
Kombinat Norilsk	USSR	Copper smelter	1981
Caraiba Metais S.A., Camacari	Brazil	Copper smelter	1982
Philippine Associated Smelting and Refining Corporation, Leyte	Philippines	Copper smelter	1983
La Générale des Carrierès et des Mines, Luilu	Zaire	Copper smelter	
Quixi Smelter, Kiangzi Province	China	Copper smelter	
Mexicana de Cobre S.A. Sonora	Mexico	Copper smelter	
Kombinat G. Damianov, Srednogorie	Bulgaria	Copper smelter	
Corporacion Nacional del Cobre de Chile (Codelco-Chile) Chuquicamata	Chile	Copper smelter	
Jinchuan Smelter Gansu Province	China	Nickel smelter	

1.2
Scope of the Plant and the Selected Process

The benefits of the demonstration plant investment are discussed in Chapter 1.1.3 above.

The scope of the plant has been reduced to a minimum. Only the most critical parts for checking are included. Thus no complete sulphur separation line is included.

The system comprises the smelter furnace with concentrate drying and feeding equipment, waste heat boiler, electrostatic precipitator, sulphur condensing boiler, sulphur demister, and gas washing equipment as the main units.

Discussions of the process were held originally at the Vienna meeting and later at the Pori meeting in May.

In the Pori discussions a system of total oxidation was agreed upon, the products of the smelting being sulphur rich gases and silica and iron rich slag. The possibility of producing separate matte for iron production - as was originally discussed in Vienna for a commercial size plant - was rejected mainly because of the small size of the plant. In addition, a roaster plant and a roaster gas circulation system would cause extra investment costs.

The process system and the scope of the demonstration plant study were finalized at the July meeting. Slag was accepted to be dumped instead of being granulated, and the flue dust to be recirculated as slurry and mixed to pyrite concentrate feed. For sulphur recovery a "short line" was agreed upon.

The mini pilot smelting tests were made with three different oxidation degrees.

1.3 Economic evaluation

1.3.1 Capital cost

The capital costs within the agreed scope are estimated on overall cost basis. The only missing cost is the site preparation (earth flattening, roads and drainages).

The price level is according to November of the year 1985.

Engineering, commissioning and equipment are estimated as foreign supplies, freight, construction, erection and duties being of indigeneous origin. The total fixed capital amounts are as follows:

Foreign supplies:		
- Engineering	Rs	5 531 000
- Commissioning of erection and start-up	Rs	6 638 000
- Equipment including piping, electrification and instrumentation	Rs	41 447 000
- Spare parts	Rs	2 072 000
Indigeneous supplies:		
- Buildings, construction	Rs	1 688 000
- Freight and insurances	Rs	1 306 000
- Erection	Rs	5 100 000
- Custom duties	Rs	21 477 000
Subtotal	Rs	85 259 000
Miscellaneous 5 %	Rs	4 263 000
Total	Rs	89 522 000

1.3.2
Operating cost

The estimate covers the required utilities and supplies for the plant operation, wages and salaries of the staff as well as the maintenance expenses.

The estimated costs are indicative and they will depend on the demonstration programs.

The costs are estimated on annual level assuming that the plant shall operate 7 500 hours per year.

The cost of pyrite concentrate is not in the estimates.

The summarized estimation results in the following annual operating expenses:

Variable cost:	Rs/a	12 670 000
Fixed cost	"	3 966 000
Total	Rs/a	16 636 000

1.3.3
Revenues

The nominal sulphur production will be 1 080 tons per annum. With the sulphur price of Rs 2 573 per ton the annual revenues will be Rs 2 778 000.

1.4
Discussion

1.4.1
Plant Capacity with Amjhore Pyrite

The process gas flow out from the smelting furnace in total oxidation of pyrite is about 30 % bigger when Amjhore pyrite is used than when Saladipura pyrite is used. The reason for this is the higher sulphur content in the pyrite. Top shale also gives somewhat more sulphur in the gas in the Amjhore case.

However, by increasing the oxygen enrichment in the process air, the same smelting rate, i.e. 1 t/h, can easily be reached.

1.4.2
Costs of a Commercial Size Plant for Saladipura Pyrite

General

The estimate is made for a plant of 2 000 t/d Saladipura pyrite concentrate. It is a rough approach without detailed planning. The accuracy of the figures is ± 30 %.

Investment Cost

Following the same scope as in the Amjhore study, the estimate for fixed capital is Rs 1 320 000 000. The corresponding estimate for Amjhore pyrite was Rs 1 469 041 000. This estimate is without off-site facilities.

Operating Cost	Rs 1 000/annum
Pyrite	delivery price not available
Utilities and supplies	
- smelter	38 800
- sulphur plant	56 100
- power plant and coal treatment	11 400
- slag dumping	5 800
- miscellaneous 5 %	5 600
	117 700

Fixed Operating Cost	Rs 1 000/annum
- wages and salaries	8 400
- spare parts and maintenance materials	36 000
- miscellaneous 5 %	2 200
	46 600

1.4.3
Flash Smelting Furnace Cooling

In this study the cooling is designed to be arranged with two closed primary circulations, i.e. spray water and jacket water circulations. The spray water system uses semi-soft water and the jacket water system demineralized water. Both circulations are cooled with a secondary cooling system by heat exchangers.

According to the received information the water amount available to the plant area - 25 million imperial gallons per day (about 4 600 m^3/h) - seems sufficient also for direct cooling of the FSF. The total need of water is about 200 m^3/h.

However, because we do not know the analysis of the raw water, a primary circulations system is selected. In case the raw water is pure enough for direct circulation - especially for jacket (cooling element) water system - some capital and operational cost savings are reached. E.g. heat transformers 4 pcs, cooling towers and some pumps could be rejected. The cooling water flow through cooling elements is 40 - 50 m^3/h (jacket cooling water).

1.4.4
Origin of the Equipment

The process equipment of the scope of this study is proposed to be supplied as a complete package. Thus, because the main part and the most important items such as dryer, flash smelter furnace, waste heat boiler, electrostatic precipitator, sulphur pumps and instrumentation would be of foreign origin, it would be reasonable to supply all of the package from abroad. Smaller parts like tanks, vessels, ductings, some supports etc. may of course be manufactured indigeneously, but they should be included in the total package of supply.

Keeping the package complete would give some advantages. The delivery time for the package would become shorter, interferences at the delivery limits would decrease and all supplying works of the order would become easier.

Outside the process equipment all other parts of the investment such as buildings, infrastructures, erection and installation work will be of Indian origin.

1.4.5
Price of Oxygen

Oxygen has a major role in the operation costs. In the cost estimate the price of oxygen is only a guess, because no relevant delivery price was available. It is reasonable to check the price.

1.4.6
Delivery Time for the Equipment Package

The delivery time for the total equipment package (CIF) included in tnis study is about 18 months calculated from the order.

2 BASIC DATA

2.1 Raw Materials

2.2 Plant Site, Utilities and Consumables

2.3 Cost Data

2.3.1 Local Unit Prices for Building and Structural Materials

2.3.2 Local Wages and Salaries

2.3.3 Costs for Utilities and Supplies

2.3.4 Sulphur Price

2.3.5 Taxes and Duties

2
BASIC DATA

2.1
Raw Materials

2.1.1
Pyrite Concentrates

Sulphur	36.0	w-%
Silica	12.0	"
Iron$_{tot}$	44.6	"
Alumina	3.0	"
Lead	0.11	"
Zinc	0.25	"
Copper	0.03	"
Magnesium	0.30	"
Arsenic less than	0.01	"

Moisture before drying about 5 %.

2.1.2
Silica Flux

Silica	90	w-%
Hematite	2	"
Alumina	6	"

2.1.3
Coal

C_{fix}	38	w-%
Volatiles	30	"
Ash	31.5	"
Moisture	0.5	"

Net heat of combustion 21 MJ/kg

2.1.4
Fuel Oil

Bunker C

Carbon	85 %
Sulphur	3.5 %
Hydrogen	11 %
Nitrogen	0.1 %
Oxygen	0.4 %

Net heat of combustion 40.5 MJ/kg

2.2
Plant Site, Utilies and Consumables

The plant site is in a "non-industrial" area, i.e. without any ready-built services such as steam, compressed air, laboratory facilities, maintenance facilities etc.

Water is available in necessary amounts on site. The temperature of cooling water to Outokumpu's area of scope is designed to be 31 °C. The water to be pumped to Outokumpu's area is treated in a separate water treatment plant.

Electric line network to the site:

-	voltage	11 kV
-	frequency	50 Hz
-	phase	3

Infrastructures on the site will have to be built.

Coal will be transferred to the site by trucks.

Oxygen will be supplied in vessels in liquid form to the smelter area.

Oil will be carried to site by trucks and stored in tanks.

2.3
Cost Data

2.3.1
Local Unit Prices for Building and Structural Materials

- concrete mass, ready installed including boarding and steel reinforcements

- foundation	Rs	1,350/m^3
- column	Rs	2,800/m^3
- slab	Rs	1,850/m^3
- beam	Rs	2,100/m^3

- supporting steel constructions, ready installed, painted — Rs 10,000/t
- walls and roofings of industrial buildings — Rs 65/m^2
- offices — Rs 1,500/m^2

- earth excavation	Rs	11/m^3
- earth filling	Rs	20/m^3
- rock blasting	Rs	35/m^3
- asphalt covers	Rs	100/m^2

	Materials and manufacturing	Transport and erection
- Mild steel construction, ready installed	Rs	Rs
- sheets	20/kg	3/kg
- profiles	30/kg	3/kg
- Acid proof steel sheets construction, ready installed	180/kg	3/kg
- Service platforms, stairs etc. of mild steel	15/kg	3/kg

2.3.2
Local Wages and Salaries, incl. Social Costs

	Rs/month
Managers	3,000
Operating engineers, foremen	2,500
Skilled labour	1,800
Unskilled labour	1,200

Daily, weekly and annual operating time of personnel:

Daily	8 hrs
Weekly	48 hrs
Annually	2 400 hrs

2.3.3
Costs for Utilities and Supplies

	Rs	Unit
Filtered raw water	1	m^3
Semi-salt water	2.50	m^3
Demineralized water	3.50	m^3
Coal	250	t
Fuel oil, Bunker C	3 141	t
Electricity	0.65	kWh
Sulphuric acid	1 500	t
Liquid oxygen	3	m^3
Refractory bricks	8	kg

2.3.4
Sulphur Price

Elemental sulphur (solid) Rs 2,573/t

2.3.5
Taxes and Duties

Taxes and duties of equipment, materials, erection etc.

- local supplies 12 % excise duty; 4 % sales tax
- foreign supplies 45 % customs duty of CIF prices
- engineering, commissioning etc. 25 % customs duty

Note: The cost data above for building and structural materials, wages and salaries, sulphur, rates of taxes and duties as well as prices for most of the utilities and supplies were received from PPCL in negotiations in July 1985. The same prices were used in final calculations for Amjhore pyrite study.

Prices for the different water types and oxygen are estimated by Outokumpu Oy.

The price for electricity is the same as earlier given for the Amjhore study.

3 PROCESS DESIGN

3.1 Process Description

3.1.1 Flash Smelting Area
3.1.1.1 Drying of Feed Materials
3.1.1.2 Flash Smelting
3.1.1.3 Reduction and Process Gas Handling

3.1.2 Sulphur Plant Area
3.1.2.1 Sulphur Recovery

3.2 Process Calculations
3.2.1 Flash Smelting Area
3.2.2 Sulphur Plant Area

3.3 Material Balance of the Flash Smelting Furnace

3.4 Heat Balance of the Flash Smelting Furnace

Diagram:
Flash Smelter and Sulphur Plant
Process Flow Sheet
Dwg. No. 252 300 901 001-1 Rev. 0

3
PROCESS DESIGN

3.1
Process Description

3.1.1
Flash Smelting Area

3.1.1.1
Drying of Feed Materials

The ground and predried pyrite is the starting material of the sulphur production. The grain size of the pyrite is 80 % - 74 µm and moisture 5 %.

The pyrite with the recycled flue dust and sand are dried separately. Wet material is fed to drying in a steam heated dryer. In the dryer the wet material is dried by hot steel tubes, which are heated from the inside by steam at 5.5 bar.

The moisture content of the dried material is less than 0.2 % and the temperature of the exhaust gas is about 100 °C. The exhaust gas contains dust, which is separated in the bag filter. The dried material is pneumatically conveyed to the feed bin.

3.1.1.2
Flash Smelting

The feed material mixture consists of pyrite, flue dust and sand. The sand amount is regulated so that all the iron of the pyrite can be slagged. The process air is enriched with technical oxygen. With oxygen enrichment the temperature of the furnace is controlled and with the total oxygen amount the oxidation of sulphur and iron is controlled.

The feed mixture is fed through the roof of the reaction shaft by means of the concentrate burner. Inside the reaction shaft the well distributed pyrite and sand particles react with air and oxygen. The retention time for the suspension in the shaft is about 1 - 2 seconds, in which time the solids are heated up and smelted after many different chemical reactions. As a result of the reactions slag and sulphur containing gas are produced.

In the horizontal settler part slag is separated from gas. The slag is tapped and cooled in slag pots and conveyed to casting. The produced gas mainly consists of sulphur dioxide, water, carbon dioxide and nitrogen.

3.1.1.3
Reduction and Process Gas Handling

After the reaction shaft the gas contains SO_2 and therefore reduction of the gas is carried out in the uptake shaft of the flash smelting furnace in order to produce elemental sulphur. The following main reactions take place in reduction:

$$C + CO_2 \quad \text{---->} \quad 2\ CO$$

$$SO_2 + 2\ CO \quad \text{---->} \quad 0.5\ S_2 + 2\ CO_2$$

$$SO_2 + 2\ H_2 \quad \text{---->} \quad 0.5\ S_2 + 2\ H_2O$$

$$S_2 + 2\ H_2 \quad \text{---->} \quad 2\ H_2S$$

At the same time the oxidic dust components are sulphidized.

In the rear end of the settler coal dust is burned with oxygen enriched air to raise the temperature of the smelting gas for the reduction.

The reduction is performed by injecting coal dust (70 % - 74 µm) agains the gas flow.

The maximum sulphur production is obtained when the gas after reduction contains a little less SO_2 than half of the sum ($H_2S + H_2 + CO + COS$).

The reduction is endothermic and the temperature decreases. The temperature after the reduction is 1 230 °C.

The reduced process gas together with molten dust is fed into the waste heat boiler, where cooling and solidifying of dust compounds take place. The boiler consists of a radiation chamber and convection section. The gas is cooled to 350 °C by the boiler and saturated steam is produced at 65 bar. A minor part of the dust is separated in the boiler and the remaining dust in an electrostatic precipitator at a temperature of 360 °C.

The dusts from the boiler and electrostatic precipitator are taken out through water seals and fed to a thickener tank.

When the gas is being cooled in the waste heat boiler, many reactions take place between gas components:

$2\ CO + SO_2 \ ---> \ 2\ CO_2 + 1/n\ S_n$

$2\ CO + S_2 \ ---> \ 2\ COS$

$2\ H_2 + SO_2 \ ---> \ 2\ H_2O + 1/n\ S_n$

$2\ H_2 + S_2 \ ---> \ 2\ H_2S$

Also sulphur vapour S_2 polymerizes to S_4, S_6 and S_8.

3.1.2
Sulphur Plant Area

3.1.2.1
Sulphur Recovery

After the electrostatic precipitator the cleaned gas is led into the sulphur condensing boiler, where the gas is further cooled down to 170 °C and at the same time the elemental sulphur is condensed. The boiler produces saturated steam at the pressure of 5.5 bar.

Part of the condensed sulphur is taken from the bottom of the boiler and the rest is carried over by the gas. These sulphur drops are caught from the gas in the agglomerator and demister.

The recovered sulphur is pumped to the sulphur tank, from which sulphur is piped to casting.

After the demister all the sulphur compounds in the gas are burned to sulphur dioxide in an incinerator. Sulphur dioxide is washed from the gas and directed into the stack.

3.2
Process Calculations

The temperature of the air is supposed to be 25 °C and its relative humidity 30 %. The oxygen percentage of the technical oxygen is 95 %.

Note: All gas volumes are at normal state i.e. 1 bar, 0 °C.

Boiler pressure figures are absolute values.

3.2.1
Flash Smelting Area

Steam Dryer

Pyrite ore (wet)		kg/h	1 050
- moisture (wet basis)		%	5.0
Sand (wet)		kg/h	168
- moisture (wet basis)		%	5.0
Flue dust (wet)		kg/h	24.6
- moisture (wet basis)		%	35
Steam 5.5 bar, 155 °C		kg/h	280
Dryer exhaust gas		m^3/h	370
- temperature		°C	100

Flash Smelting Furnace

Pyrite		kg/h	1 000
Sand		kg/h	160
Flue dust		kg/h	160
Fuel oil		kg/h	110
Air to reaction shaft		m^3/h	1 390
Oxygen to reaction shaft		m^3/h	260
- temperature		°C	25
- oxygen enrichment		%	33
Distribution and leakage air		m^3/h	20
Slag		kg/h	1 020
Gas after smelting		m^3/h	1 690
- temperature		°C	1 370
- analysis	H_2	%	0.5
	H_2S	%	0.1
	CO	%	2.0
	SO_2	%	12.8

	S_2	%	0.8
	H_2O	%	8.2
	CO_2	%	9.7
	N_2	%	65.9
Coal to settler		kg/h	53
Combustion air		m^3/h	160
Oxygen		m^3/h	30
- temperature		°C	25
- oxygen enrichment		%	33
Coal for reduction		kg/h	210
Injection air		m^3/h	40
Flue dust after furnace		kg/h	160
Gas after furnace		m^3/h	2 120
- temperature		°C	1 230
- analysis	H_2	%	1.2
	H_2	%	0.8
	CO	%	5.2
	COS	%	0.2
	SO_2	%	2.8
	S_2	%	3.7
	H_2O	%	10.0
	CO_2	%	15.9
	N_2	%	60.2

Waste heat boiler

Flue dust from boiler		kg/h	30
Steam production		kg/h	1 640
- pressure		bar	65
- feed water temperature		°C	145
Gas after boiler		m^3/h	2 140
- temperature		°C	350
- analysis	H_2	%	0.2
	H_2S	%	1.2
	CO	%	2.5
	COS	%	1.4
	SO_2	%	2.8
	$S_2...S_8$	%	1.1
	H_2O	%	10.5
	CO_2	%	17.0
	N_2	%	63.3

Electrostatic precipitators

Flue dust from precipitators		kg/h	130
Insulator steam		kg/h	150
Gas after precipitator		m^3/h	2 440
- temperature		°C	360
- analysis	H_2	%	0.2
	H_2S	%	0.5
	CO	%	1.7
	COS	%	1.4
	SO_2	%	3.0
	$S_2,\ldots,S_8$	%	1.0
	H_2O	%	17.5
	CO_2	%	15.3
	N_2	%	59.4

3.2.2
Sulphur Plant Area

Sulphur condensing boiler and demister

Sulphur production	kg/h	145
Steam production	kg/h	370
- pressure	bar	5.5
- feed water temperature	°C	145
Gas after demister	m^3/h	2 410
- temperature	°C	160

Incinerator

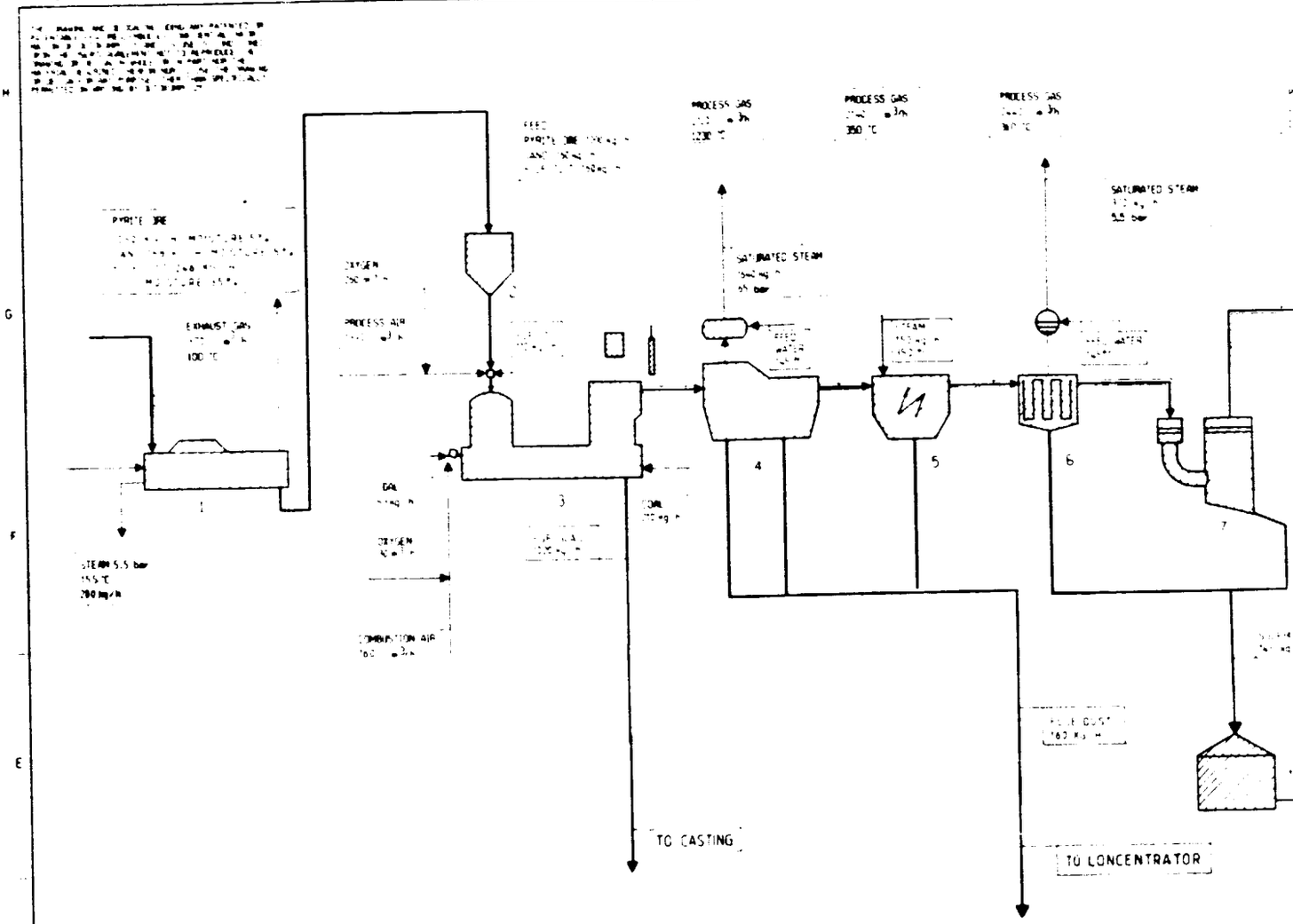
Oil		kg/h	28
Combustion air		m^3/h	390
Secondary air		m^3/h	580
Gas after incinerator		m^3/h	3 400
- temperature		°C	450
- analysis	CO	%	2.3
	SO_2	%	4.0
	H_2O	%	14.3
	CO_2	%	12.3
	O_2	%	2.0
	N_2	%	65.1

3.3
Material Balance of the Flash Smelting Furnace

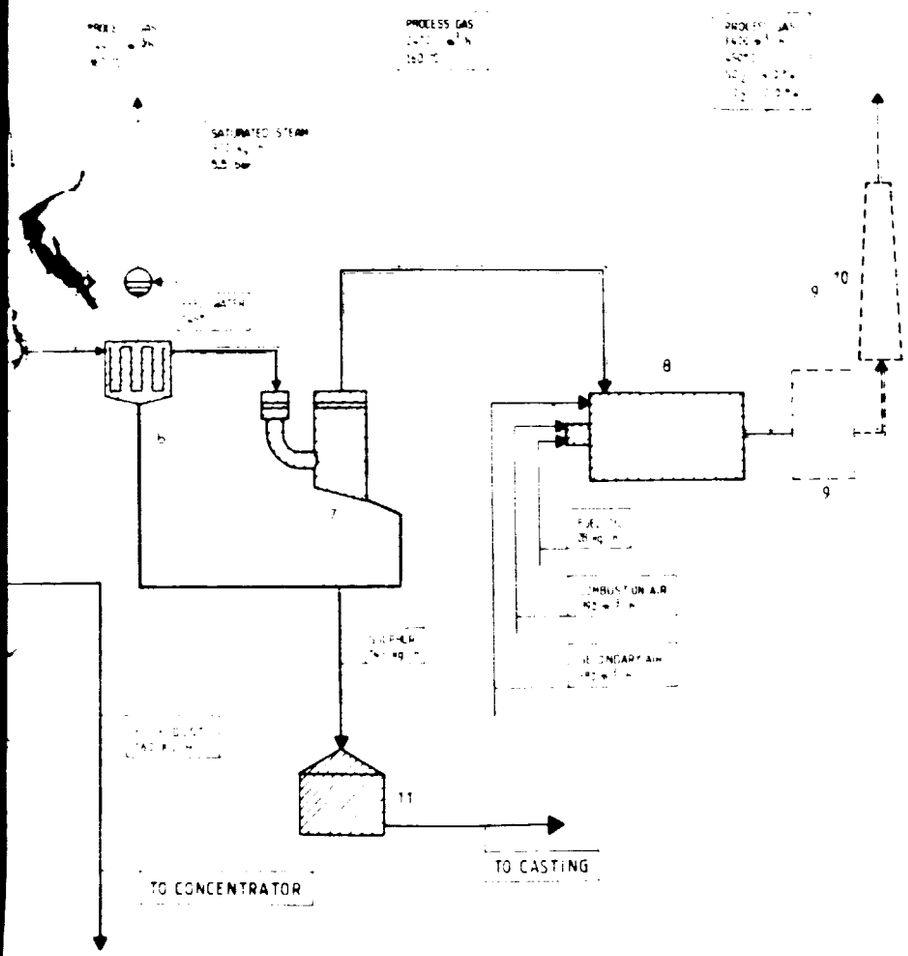
	Amount kg/h	%	S kg/h	%	Fe kg/h	%	SiO_2 kg/h	%	Al_2O_3 kg/h	%	C kg/h
In:											
Pyrite	1 000	36	360	44.6	446	12	120	3	30		
Sand	160			1.4	2	90	144	6	10		
Flue dust	160	10	16	23	37	31	50	14	22	7.3	12
Fuel oil	110	3.5	4							85	94
Coal	263	0.6	1	4.4	12	13	34	6.3	17	56	147
			381		497		348		79		253
Out:											
Slag	1 020	2.5	26	45.1	460	29.2	298	5.6	57		
Flue dust	160	10	16	23	37	31	50	14	22	7.3	12
Furnace gas			339								241
			381		497		348		79		253

3.4
Heat Balance of the Flash Smelting Furnace

	Amount kg,m^3/h	Temperature °C	Heat content kJ/kg,m^3	Total heat MJ/h
In:				
Pyrite	1 000	40	9	9
Sand	160	40	10	2
Flue dust	160	40	10	2
Fuel oil	110		40 490	4 454
Coal	263		21 390	5 625
Air	1 610	25	0	0
Oxygen	290	25	0	0
Reaction heat of smelting				3 412
Reaction heat of reduction				-4 259
				9 245
Out:				
Slag	1 020	1 300	1 470	1 496
Flue dust	160	1 230	1 640	263
Furnace gas	2 120		1 950	4 136
Heat losses				3 350
				9 245


PROCESS GAS
350 °C
SATURATED STEAM
PYRITE ORE
EXHAUST GAS
100 °C
OXYGEN
PROCESS AIR
STEAM 5.5 bar
155 °C
OXYGEN
COMBUSTION AIR
TO CASTING
TO CONCENTRATOR
1
3
4
5
6
7

SECTION 1



1 STEAM DRYER
2 DRIED CHARGE BIN
3 FLASH SMELTING FURNACE
4 WASTE HEAT BOILER
5 ELECTROSTATIC PRECIPITATOR
6 SULPHUR CONDENSING BOILER
7 AGGLOMERATOR/DEMISTER
8 INCINERATOR
9 GAS CLEANING
10 STACK
11 SULPHUR TANK

NOTE: ALL GAS VOLUMES AT NORMAL STATE (101.325 kPa, 0°C)

SECTION 2

OUTOKUMPU OY ENGINEERING DIVISION	DESIGNED	5 SEPT 85
	CHECKED	5 SEPT 85
	APPROVED	5 SEPT 85
CLIENT: PYRITES, PHOSPHATES & CHEMICALS LTD	CLIENTS DWG. NO.	
PROJECT: SALADIPURA DEMONSTRATION		
DRAWING NO. / TITLE: FLOW DIAGRAM	SCALE: —	DWG. NO. 202 300 991 001

4 PLANT DESCRIPTION

4.1.1 General
4.1.2 Dryer and FSF Feed Area 210
4.1.3 Flash Smelting Area 220
4.1.4 Gas Handling Area 230
4.1.5 Flue Dust Handling Area 240
4.1.6 Sulphur Separation Area 310
4.1.7 Sulphur Handling Area 320

4.2 List of Equipment with Main Technical Data

4.2.1 Coding
4.2.2 Equipment List

4.3 Electrification

4.3.1 Description of Electrification
4.3.2 Motor List

4.4 Instrumentation

4.4.1 General Description of Instrumentation
4.4.2 Preliminary Loop Number Schedule for Instrumentation

4.5 Civil Works

4.5.1 Description of Buildings
4.5.2 Building Material Quantities

4.6 Laboratory Facilities

4.7 Drawings

Dwg Title	Dwg No.	Rev. No.
Flash Smelter and Sulphur Plant Equipment Diagram	252 300 901 002-9	0
Flash Smelter and Sulphur Plant Plant Layout, Plan	252 300 902 001-1	0
Flash Smelter and Sulphur Plant Plant Layout, Sections A-A, B-B, C-C and D-D	252 300 902 002-1	0

4
PLANT DESIGN

4.1
Plant Description

4.1.1
General

The pyrite smelter plant is a complete pilot size plant producing elemental sulphur from Saladipura pyrite concentrate.

This description covers the following plant areas:

- drying and FSF feeding
- smelting
- gas handling
- flue dust handling
- sulphur separation
- sulphur handling.

The additional areas on the site not included in this description are e.g. concentrator plant, steam handling equipment, electric power generator, pressure air station, water handling equipment etc.

4.1.2
Dryer and FSF Feed Area 210

The pyrite concentrates mixed with recycled flue dust are conveyed from the storage bin(s) at the concentrator plant to the dryer plant and fed into the multicoil dryer.

Silica flux (sand) is separately fed into the dryer with the same conveyor.

In the multicoil dryer the concentrate/dust mixture or sand is dried with rotating steam coils heated by 5.5 bar saturated steam. Condensate can be reutilized as boiler feed water.

Dryer exhaust gases are purified in a bag filter.

Dried materials are lifted up to feed bins pneumatically. Concentrate/dust mixture and sand have their own feed bins. Conveying air is purified in a bag filter common for both bins.

The main parts of the pneumatic conveyor system are air blowers, sending vessel, transportation piping, bag filter, and exhaust air fan.

Dried concentrate/dust is fed from the bin into the smelting furnace with a belt feeder and sand with a screw feeder. Rotation speed of each feeder can be controlled.

Both feed bins are assembled on load cells.

4.1.3
Flash Smelting Area 220

In the flash smelting furnace (FSF) - which is the heart of the sulphur production - pyrite smelts forming sulphur containing gases and iron and silica rich slag.

The furnace consists of three main parts, namely reaction shaft, settler and uptake shaft.

Concentrate/dust and sand are charged into the reaction shaft through a concentrate burner (distributor). Also oxygen enriched process air is blown into the burner.

The smelting occurs in the reaction shaft.

Molten drops fall down to the settler part, where they differ from the gas stream and form a slag layer on the bottom of the furnace. Slag is occasionally tapped through the three tapping holes located on the wall of the settler.

Slag is conducted by launders to slag pots in which it cools and solidifies. Slag blocks are poured from pots to a storage heap. Launders are of cast steel construction. Pots are of mild steel, protected for each tapping with refractory castable.

Sulphur rich smelting gases are reduced in the uptake shaft by injecting milled and dried coal into the lower end of the shaft. Coal is transferred to the smelting area and further into the FSF pneumatically.

Additional heat to the exothermic smelting heat is needed in the reaction shaft due to the relatively high heat losses because of the small size of the furnace. Therefore an oil burner is installed on the roof of the shaft. Additional heat is generated also at the rear end of the furnace by coal burners.

The smelting furnace is of steel construction protected inside by refractory lining. It is cooled by spray water on mantle outer surface and by cooling copper elements in the brick lining. Surface cooling water is sprayed on the reaction shaft and on the side walls of the settler. Cooling elements are located at the lower end of reaction shaft (connection to settler) and at each tapping hole.

The furnace is equipped with an emergency damper (cooled with water) and a removable emergency stack, both to be used in case that FSF is wanted to keep hot but no gases are allowed to flow into the waste heat boiler.

4.1.4
Gas Handling Area 230

Hot smelting gases from the FSF are cooled in a waste heat boiler (WHB) connected directly to the FSF outlet collar.

The boiler consists of a radiation section and a convection section. The radiation section is a large empty room, the walls of which are constructed of boiler tubes. In this part gas cools down enough to solidify small molten drops it contains. Solidified dust particles partly fall down into the hopper beneath the radiation section, part of the dust continues in the gas stream into the convection section of the boiler.

The convection section consists of vertical boiler tube banks which further cool down the gas. Again part of the flue dust falls down into the hoppers.

The boiler is of forced cicrulation type and it produces saturated steam of 65 bar. For circulation one electrical and one steam turbine powered pump (stand-by) are installed. The steam turbine utilizes the boiler's own steam. The boiler with pipings and steam drum is totally thermally insulated.

The cooled gases flow from the WHB into an electrostatic precipitator (EP) where the rest of the flue dust is separated.

The precipitator consists of three cells in sequence. It is equipped with automatic rapping devices. The hopper beneath the EP is electrically heated.

Superheated steam is piped into the boxes of the electrical isolators on the roof of the precipitator to prevent the sulphur-containing gases from flowing into the box and sulphur condensating there. The boxes are also heated electrically.

Between the WHB and the EP a disc valve is installed. With this valve the EP can efficiently be isolated for repairs.

4.1.5
Flue Dust Handling Area 240

Flue dust separated from gas stream in the WHB fall to a drag conveyor supplied with a screen as intermediate bottom. With this screening conveyor the bigger lumps are separated into a dust bucket, the underflow being taken into a water seal box where it is mixed with water.

The electrostatic precipitator dust is gathered in a drag conveyor beneath the hopper and mixed with water in a water seal box.

Dust slurry from both the water seals is conducted by concrete launders into a pump tank, from where it is pumped into a settling tank.

The settling tank is of vertical cylinder shape, supplied with a cone at the lower end. Gravity precipitates the slurry, but some flocculants can be used to help.

The settled dust is pumped as underflow to the concentrator plant. Overflow water is returned by gravity to slurry making.

4.1.6
Sulphur Separation Area 310

The elemental sulphur in the gas is condensated partly in a condensing boiler, partly in an agglomerator/demister unit.

In the condensing boiler sulphur condensates on the vertical boiler tubes and flows down on the bottom of the boiler, from where it is taken off by means of a special sulphur seal system.

The boiler generates 5.5 bar saturated steam and it is of forced circulation type. One pump is electrical, the other (stand-by) of steam turbine type.

The boiler is completely thermally insulated.

In the agglomerator bed - through which the gas flows - the small sulphur droplets grow bigger after which they further flow in the gas stream to the demister unit, which has a similar bed of mineral wool. Now that the gas flows upwards, the grown drops fix on the strings of the wool until they grow big enough to fall on the bottom of the demister.

The agglomerator/demister unit can be by-passed for bed change.

For safety reasons the gas line is supplied with a water seal to prevent too big pressures or vacuums in the system. The seal is located between the condensing boiler and the agglomerator/demister.

Gases from the demister are blown by a process gas fan into an incinerator to combust the remaining sulphur components to sulphur dioxide. Heavy fuel oil is used in combustion.

The incinerator is a cylinder of steel, lined inside with refractory. In the incinerator chamber secondary air is mixed with the process gases to obtain excess oxygen in the mixture. The process gas is now heated up by mixing it with fuel oil combustion gases, and sulphur components of the gas are oxidized.

All the sulphur separation area equipment is thermally isolated.

Gas washing equipment will be designed by others.

4.1.7
Sulphur Handling Area 320

Sulphur separated in the condensing boiler and the agglomerator/demister unit is conducted via steam heated and isolated pipes onto a gravity filter of mineral wool. The filter separates the dust particles of the sulphur.

From the bottom of the filter casing sulphur flows further by gravity to a pump tank. From the tank it is pumped to a sulphur day tank of steel construction. A pipe from the pump tank to the agglomerator bed is installed for occasional washing of the bed by sulphur. Pumping of sulphur from the filter pump tank to the sulphur day tank is controlled by the surface level of the pump tank.

From the day tank sulphur is occasionally conducted onto one of the two casting pits by gravity. On the other section sulphur is solidifying while the other half is being emptied. Sulphur blocks can be broken from the solid slab by a small payloader or by hand tools. Sulphur blocks are transferred to a covered storage.

All the sulphur handling equipment is kept hot with 5.5 bar steam and they are thermally isolated.

4.2
List of Equipment with Main Technical Data

4.2.1
Coding

CODE	AREA
200	FLASH SMELTER AREA
210	DRYER AND FSF FEED AREA
220	FLASH SMELTER FURNACE AREA
230	FSF PROCESS GAS HANDLING AREA
240	FSF FLUE DUST HANDLING AREA
300	SULPHUR PLANT AREA
310	SULPHUR RECOVERING AREA
320	SULPHUR HANDLING AREA

EQ. GROUP	EQ. TYPE	EQ. CODE
Basins	Granulation basin	108
Bins	Day bin	116
	Dried charge bin	117
	Feed bin	117
	Storage bin	118
Boilers	Steam boiler	122
	Superheater	123
	Waste heat boiler	124
	Boilers, others	129
Burners	Coal dust burner	131
	Oil burner	133
	Concentrate burner	435
Casting eq.	Launder	140
Conveyors	Belt conveyor	167
	Drag conveyor	168
	Pneumatic conveyor	170
	Screw conveyor	172
	Scraper conveyor	174
	Conveyors, others	179
Dryers	Steam dryer	194
Ducts, gas and dust pipes	Hopper	202
	Stack	204
	Water lock	209
Fans	Fan	212
	Blower	214
Feeders	Air lock feeder	216
	Belt feeder	218
	Drag feeder	223
Filters	Drum filter	243
	Gravity filter	244
Furnaces	Flash smelting furnace	261
	Incinerator	263
Heat-transfer equipment	Feed water heating/cooling heat exchanger	280
	Gas reheater	281
	Heat exchangers, others	289

EQ. GROUP	EQ. TYPE	EQ. CODE
Lifting devices	Overhead travelling crane	318
	Crane	
Mills	Mill	325
Pumps	Pump	
	Dosage pump	370
	Ejector	371
	Slurry pump	372
	Vacuum pump	374
	Water pump	375
		376
Screens	Vibrating screen	411
Separating eq.	Bag filter	
	Cyclone	417
	Demister	419
	Electrostatic precipitator	420
	Scrubber	421
		423
Special machines and equipment	Agglomerator	
	Hot catalyzer	431
	Cold catalyzer	433
	Sulphur condensing tower	433
	Sulphur prilling tower	464
		509
Tanks	Tank	
	Autoclave	510
	Feed tank	511
	Measuring tank	514
	Mixing tank	515
	Pump tank	516
	Jacket and spray water tank	518
	Storage tank	519
	Reactor tank	519
		521
Thickeners	Thickeners	532
Turbines	Steam turbine	556
Valves	Disc valve	562
	Emergency valve	569

4.2.2
Equipment List

Smelter and Sulphur Plant

Equipment diagram,
Dwg No. 252 300 901 002-9, Rev. 0

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

200-----0

EQUIPMENT TYPE	FLASH SMELTER AREA

210-----0

EQUIPMENT TYPE	DRYER AND FSF FEED AREA

210-117-0100

EQUIPMENT TYPE	DRIED CHARGE BIN
SERVICE	FOR DRIED PYRITE CONCENTRATE FEEDING.
VOLUME	(TOTAL) 10 M3
MATERIAL	MILD STEEL
REMARKS	ASSEMBLED ON LOAD CELLS

210-117-0200

EQUIPMENT TYPE	DRIED CHARGE BIN
SERVICE	FOR DRIED SILICA FLUX
VOLUME	4 M3
MATERIAL	MILD STEEL
REMARKS	ASSEMBLED ON LOAD CELLS

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

210-170-0100

EQUIPMENT TYPE	PNEUMATIC CONVEYOR SYSTEM
SERVICE	FOR DRIED PYRITE AND SAND MATERIALS
CAPACITY	3 T/H
MOTOR NO./RATING (Kw) MOTOR TITLE	***210-170-0100-M1*** 11 *** AIR BLOWER ***210-170-0100-M2*** 11 *** AIR BLOWER,STAND BY ***210-170-0100-M3***0,75*** AIR LOCK ***210-170-0100-M4***0,75*** AIR LOCK ***210-170-0100-M5***1,5 *** EXHAUST AIR FAN
REMARKS	INCL:AIR COMPRESSORS,SENDING VESSEL TRANSPORTATION AND PRESSURE AIR PIPINGS,BAG FILTER,EXHAUST AIR FAN AND NECESSARY AUTOMATION EQUIPMENT.

210-194-0100

EQUIPMENT TYPE	MULTICOIL DRYER
TYPE	STEAM DRYER
SERVICE	FOR FSF FEED MATERIAL DRYING
CAPACITY	1,5 T/H
PRESSURE	(STEAM) 5,5 BAR (ABS)
MATERIAL	AISI 316
MOTOR NO./RATING (Kw) MOTOR TITLE	*** 210-194-0100-M1*** 30 *** MULTICOIL DRYER

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

210-212-0100	
EQUIPMENT TYPE	EXHAUST AIR FAN
SERVICE	EXHAUST GAS FAN FOR BAG FILTER
CAPACITY	500 NM3/H
MATERIAL	AISI 316
MOTOR NO./RATING (Kw)	***210-212-0100-M1 *** 1,5 ***
MOTOR TITLE	EXHAUST AIR FAN
210-417-0100	
EQUIPMENT TYPE	BAG FILTER
SERVICE	FOR DRYER EXHAUST GASES
CAPACITY	500 NM3/H
TEMPERATURE	110 C
MATERIAL	HOUSING:AISI316,BAGS:POLYACRYLNITR.
220-----0	
EQUIPMENT TYPE	FLASH SMELTING FURNACE AREA
220-131-0100	
EQUIPMENT TYPE	COAL DUST BURNER
SERVICE	FOR FSF SETTLER HEATING
CAPACITY	8-25 KG/H
REMARKS	PARALELL ITEMS 3 PCS (0200-0400)
220-133-0100	
EQUIPMENT TYPE	OIL BURNER
SERVICE	REACTION SHAFT OIL BURNER
CAPACITY	130 KG/H
FUEL	HEAVY FUEL OIL

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PM

CLIENT NO :
REVISION :0 DATE :29.10.85

220-133-0200

EQUIPMENT TYPE	AUXILIARY BURNER
SERVICE	START UP OIL BURNER
CAPACITY	6-24 KG/H
FUEL	LIGHT OIL

220-134-0100

EQUIPMENT TYPE	COAL TUYERE
SERVICE	FOR GAS REDUCTION IN FSF UPTAKE SHAFT
CAPACITY	30 -100 KG/H COAL POWDER
REMARKS	PARALELL ITEMS:3 PCS(0200-0400)

220-140-0100

EQUIPMENT TYPE	SLAG LAUNDER WITH COVERS
SERVICE	FOR SLAG TAPPING
DIMENSIONS	LENGTH 6000 MM
MATERIAL	CAST STEEL
REMARKS	PARALELL ITEMS:2 PCS (0200-0300)

220-144-0100

EQUIPMENT TYPE	SLAG POT
SERVICE	FOR SLAG TRANSPORTATION FROM FSF BY FORK LIFT TRUK.
VOLUME	0,5 M3
DIMENSIONS	
MATERIAL	MILD STEEL
REMARKS	PARALELL ITEMS:9 PCS (0200-1000)

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO : CLIENT NO :
DESIGN :PW REVISION :0 DATE :29.10.85

220-198-0100

EQUIPMENT TYPE	GAS DUCTWORK
SERVICE	PROCESS AND COMBUSTION AIR DUCTING
INCLUDING	PROCESS AND COMBUSTION AIR DUCTINGS FROM FANS TO BURNERS.
DIMENSIONS	TOTAL LENGTH: 20 M DIAM:250,200 AND 70 MM
MATERIAL	MILD STEEL

220-198-0200

EQUIPMENT TYPE	GAS DUCTWORK
SERVICE	OXYGEN DUCTING FOR SMELTER PLANT.
INCLUDING	
DIMENSIONS	TOTAL LENGTH:30 M DIAM:100 AND 30 MM
MATERIAL	STAINLESS STEEL

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW
CLIENT NO :
REVISION :0 DATE :29.10.85

220-204-0100

EQUIPMENT TYPE	GAS DUCT
TYPE	REMOVABLE, LOCATED ABOVE UPTAKESHAFT
SERVICE	FSF EMERGENCY STACK
DIMENSIONS	LXD 3000X900 MM
MATERIAL	MILD STEEL

220-212-0100

EQUIPMENT TYPE	PROCESS AIR FAN
TYPE	CENTRIFUGAL
CAPACITY	2000 NM3/H
PRESSURE	8 KPA
TEMPERATURE	35 C
MOTOR NO./RATING (KW)	*** 220-212-0100-M1*** 7,5 ***
MOTOR TITLE	PROCESS AIR FAN

220-212-0200

EQUIPMENT TYPE	COMBUSTION AIR FAN
TYPE	CENTRIFUGAL
CAPACITY	200 NM3/H
PRESSURE	7 KPA
TEMPERATURE	35 C
MOTOR NO./RATING (KW)	***220-212-0200-M1*** 1,1 ***
MOTOR TITLE	COMBUSTION AIR FAN

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

220-218-0100

EQUIPMENT TYPE	BELT FEEDER
SERVICE	TO FEED PYRITE CONCENTRATE INTO FSF.
CAPACITY	150-1500 KG/H
BELT LENGTH	4000 MM
BELT WIDTH	300 MM
MOTOR NO./RATING (KW)	*** 210-218-0100-M1*** 3,0 ***
MOTOR TITLE	BELT FEEDER

220-228-0100

EQUIPMENT TYPE	SCREW FEEDER
SERVICE	TO FEED SAND INTO FSF
CAPACITY	50-200 KG/H
MAIN DIMENSIONS	L:4000 M, D:100 MM
MOTOR NO./RATING (KW)	*** 210-228-0100-M1*** 2,2 ***
MOTOR TITLE	SCREW FEEDER

220-239-0100

EQUIPMENT TYPE	PNEUMATIC FEEDER SYSTEM
SERVICE	TO FEED COAL TO FSF
CAPACITY	30-300 KG/H
MOTOR NO./RATING (KW)	***220-239-0100-M1*** 0,55***
MOTOR TITLE	AIR LOCK
	220-239-0100-M2 0,55***
	AIR LOCK
	220-239-0100-M3 0,75***
	AIR LOCK
REMARKS	2 DOSING BINS ASSEMBLED ON LOAD CELLS, 3 AIR LOCK FEEDERS WITH PNEUM.AIR CONNECT.,VALVES,PIPING&CONTROL EQ.

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PM

CLIENT NO :
REVISION :0 DATE :29.10.85

220-261-0100

EQUIPMENT TYPE	FLASH SMELTING FURNACE
SERVICE	FOR PYRITE SMELTING
CAPACITY	T/H
MAIN DIMENSIONS	REACTION SHAFT D=2,0 M H=3.4 M SETTLER L=5,5 M UPTAKESHAFT BXL=2,3X1,7M H=3,2 M
NO. OF TAP HOLES	SLAG HOLES 3
BURNER OPENINGS	SETTLER:4 FOR BURNERS,4 FOR TUYRES REACT.SHAFT:1FOR BURNER,1 FOR CONC.

220-289-0100

EQUIPMENT TYPE	SPRAY WATER HEAT EXCHANGER
SERVICE	FOR FSF COOLING WATER
CAPACITY	150 M3/H
TEMPERATURE RANGE	IN:50 DEG.C. OUT:40 DEG.C.
MATERIAL	MILD STEEL
REMARKS	PARALELL ITEMS: 1PCS.(0200) FOR STAND-BY

220-289-0300

EQUIPMENT TYPE	JACKET WATER HEAT EXCHANGER
SERVICE	FOR FSF COOLING WATER
CAPACITY	50 M3/H
TEMPERATURE RANGE	IN:50 DEG.C.,OUT:40 DEG.C.
MATERIAL	ACID PROOF STEEL
REMARKS	PARALELL ITEMS: 1PCS(0400) FOR STAND-BY

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

220-317-0100

EQUIPMENT TYPE	MONORAIL HOIST
LIFTING CAPACITY	3 T
LIFTING HEIGHT	15 M
MOTOR NO./RATING (KW)	***220-317-0100-M1*** 4 ***
MOTOR TITLE	MONORAIL HOIST
	220-317-0100-M2 0.75***
	MONORALI HOIST

220-376-0100

EQUIPMENT TYPE	SPRAY WATER PUMP
SERVICE	FOR FSF COOLING (PRIMARY CIRCUIT)
CAPACITY	200 M3/H
PRESSURE	300 KPA
MOTOR NO./RATING (KW)	***220-376-0100-M1 *** 30 ***
MOTOR TITLE	SPRAY WATER PUMP
	(INCL.ONE PARALELL ITEM:0200 30 KW)
REMARKS	PARALELL ITEMS: 1 PCS(0200)
	STAND BY

220-376-0300

EQUIPMENT TYPE	JACKET WATER PUMP
SERVICE	SPRAY WATER PUMP FOR FSF COOLING
	(PRIMARY CIRCUIT)
CAPACITY	60 M3/H
PRESSURE	300 KPA
MOTOR NO./RATING (KW)	***220-376-0300-M1 *** 11 ***
MOTOR TITLE	JACKET WATER PUMP
	(INCL.ONE PARALELL ITEM:0400 11 KW)
REMARKS	PARALELL ITEMS:1 PCS.(0400)
	FOR STAND -BY.

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

220-377-0100

EQUIPMENT TYPE	OIL PUMP
SERVICE	FOR FSF REACTION SHAFT
CAPACITY	150 KG/H HEAVY FUEL OIL
PRESSURE	3500 KPA
MOTOR NO./RATING (KW)	***220-377-0100-M1 *** 0,37 ***
MOTOR TITLE	OIL PUMP

220-435-0100

EQUIPMENT TYPE	CONCENTRATE BURNER
CAPACITY	2 T/H

220-519-0100

EQUIPMENT TYPE	SPRAY WATER TANK
SERVICE	FOR FSF COOLING WATER
VOLUME	100 M3
MATERIAL	MILD STEEL

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

220-519-0200

EQUIPMENT TYPE	JACKET WATER TANK
SERVICE	FOR FSF COOLING WATER
VOLUME	30 M3
MATERIAL	MILD STEEL

220-519-0300

EQUIPMENT TYPE	WATER TANK
SERVICE	HEAD WATER TANK FOR FSF EMERGENCY COOLING.
VOLUME	20 M3
MATERIAL	MILD STEEL

220-569-0100

EQUIPMENT TYPE	EMERGENCY DAMPER BETWEEN FSF-WHB
MAIN DIMENSIONS	1,5 X 1 M
TEMPERATURE	WATER IN:30 DEG.C. OUT:60 DEG.C.
REMARKS	-
	WATER FLOW:3 M3/H
	WATER PRESSURE:4 BAR

230-----0

EQUIPMENT TYPE	PROCESS GAS HANDLING AREA

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

230-124-0100

EQUIPMENT TYPE	WASTE HEAT BOILER
TYPE	FORCED CIRCULATION
SERVICE	FOR FLASH SMELTING FURNACE OFF-GAS COOLING
CAPACITY	SATURATED STEAM 2.0 T/H
PRESSURE	65 BAR
GAS FLOW	2500 NM3/H
TEMPERATURE	INLET 1230 C
	OUTLET 350 C

230-198-0100

EQUIPMENT TYPE	GAS DUCTWORK
SERVICE	PROCESS GAS DUCTING FOR AREA 230
DIMENSIONS	TOTAL LENGTH:25 M DIAM:450 MM WALL THICKNESS:3 MM
MATERIAL	MILD STEEL

230-212-0100

EQUIPMENT TYPE	PROCESS GAS FAN
TYPE	CENTRIFUGAL
CAPACITY	2900 NM3/H
PRESSURE	3 KPA
TEMPERATURE	360 C
MOTOR NO./RATING (KW)	***230-212-0100-M1 *** 15 ***
MOTOR TITLE	PROCESS GAS FAN
REMARKS	INLET VANE CONTROLLED

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PM

CLIENT NO :
REVISION :0 DATE :29.10.85

230-376-0100	
EQUIPMENT TYPE	WATER PUMP
SERVICE	WHB CIRCULATION WATER PUMP
CAPACITY HEAD	16 M3/H 30 M
MOTOR NO./RATING (KW) MOTOR TITLE	***230-376-0100-M1 *** 0,37 *** WHB CIRCULATION WATER PUMP
230-376-0200	
EQUIPMENT TYPE	WATER PUMP
TYPE SERVICE	TURBINE DRIVE WATER PUMP WHB CIRCULATION WATER PUMP FOR EMERGENCY
CAPACITY HEAD	16 M3/H 30 M
230-421-0100	
EQUIPMENT TYPE	ELECTROSTATIC PRECIPITATOR
TYPE SERVICE	 FOR WHB FOR SMELTING GAS CLEANING
CAPACITY TEMPERATURE	2500 NM3/H 350 C
MOTOR NO./RATING (KW)	*** SEVERAL,TOTAL *** 26 ***
230-562-0100	
EQUIPMENT TYPE	DISC VALVE
SERVICE	FOR EP. SEPARATION
MAIN DIMENSIONS	DIAMETER: 0,4 M

240-----0

EQUIPMENT TYPE	FLUE DUST HANDLING AREA

240-140-0100

EQUIPMENT TYPE	LAUNDER
SERVICE	FOR FLUE DUST SLURRY
DIMENSIONS	L:3000 MM W:200 MM DEPTH:200 MM
MATERIAL	CONCRETE 0,1M3, STEEL COVERS
REMARKS	PARALELL ITEMS: 1 PCS.(0200)

240-168-0100

EQUIPMENT TYPE	DRAG CONVEYOR FOR WHB DUST
SERVICE	FOR WHB DUST
CAPACITY	2 T/H
MAIN DIMENSIONS	LENGTH 8000 MM WIDTH 400 MM
MOTOR NO./RATING (KW)	***240-168-0100-M1 *** 2,2 ***
MOTOR TITLE	DRAG CONVEYOR FOR WHB DUST

240-168-0200

EQUIPMENT TYPE	DRAG CONVEYOR FOR EP DUST
SERVICE	FOR EP DUST
CAPACITY	1 T/H
MAIN DIMENSIONS	LENGTH 11000 MM WIDTH 200 MM
MOTOR NO./RATING (KW)	***240-168-0200-M1 *** 1,1 ***
MOTOR TITLE	DRAG CONVEYOR FOR EP DUST

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

240-209-0100

EQUIPMENT TYPE	WATER LOCK
TYPE	WITH WATER NOZZLES
SERVICE	FOR WHB AND EP. DUST
VOLUME	0,2 M3
MATERIAL	STAINLESS STEEL
REMARKS	PARALELL ITEMS: 1 PCS.(0200)

240-374-0100

EQUIPMENT TYPE	SLURRY PUMP
SERVICE	FOR FLUE DUST SLURRY
CAPACITY	15 M3/H
HEAD	10 M
MOTOR NO./RATING (KW)	*** 240-374-0100-M1***0,75 ***
MOTOR TITLE	DUST SLURRY PUMP
REMARKS	SLURRY THICKNESS 15 -20 G SOLIDS/L

240-374-0200

EQUIPMENT TYPE	SLURRY PUMP
SERVICE	FOR DUST SLURRY THICKENER TANK UNDERFLOW.
CAPACITY	1,5 M3/H
HEAD	20 M
MOTOR NO./RATING (KW)	*** 240-374-0200-M1***0,75 ***
MOTOR TITLE	DUST SLURRY PUMP
REMARKS	SLURRY THICKNESS 200 G SOLIDS/L

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

240-518-0100

EQUIPMENT TYPE	PUMP TANK
SERVICE	WHB AND EP. FLUE DUST SLURRY
VOLUME	10 M3
MATERIAL	CONCRETE WALLS,STEEL COVER CONCRETE VOLUME ABOUT 2 M3

240-534-0100

EQUIPMENT TYPE	TANK
TYPE	THICKENER TANK
SERVICE	FOR FLUE DUST SLURRY
DIMENSIONS	H (TOTAL)X DIA =6 X 5 M
MATERIAL	MILD STEEL

300-----0

EQUIPMENT TYPE	SULPHUR PLANT AREA

310-----0

EQUIPMENT TYPE	SULPHUR RECOVERING AREA

310-129-0100

EQUIPMENT TYPE	SULPHUR CONDENSING BOILER
CAPACITY	SATURATED STEAM 440KG/H(HIGH PRESS)
PRESSURE	5,5 BAR
GAS FLOW	2900 NM3/H
TEMPERATURE	INLET 360 C OUTLET 175 C
VOLUME	HEAT TRANSFER AREA 100 M2
MAIN DIMENSIONS	(OUTER) LXWXH 4,0X2,9X2,5 M
MATERIAL	STEEL

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

310-198-0100

EQUIPMENT TYPE	GAS DUCT
SERVICE	PROCESS GAS DUCTINGS FOR AREA 310
DIMENSIONS	LENGTH: M TOT.DIAM. M AND M
MATERIAL	STAINLESS STEEL WALL THICKNESS MM

310-209-0100

EQUIPMENT TYPE	WATER LOCK
SERVICE	FOR PROCESS GAS DUCTWORK
VOLUME	0,5 M3
MATERIAL	BODY OF MILD STEEL,LINED WITH STAINLESS STEEL

310-212-0100

EQUIPMENT TYPE	PROCESS GAS FAN
CAPACITY	2900 NM3/H
PRESSURE	3 KPA
TEMPERATURE	170 C
MOTOR NO./RATING (KW)	***310-212-0100-M1 *** 11 ***
MOTOR TITLE	PROCESS GAS FAN
REMARKS	INLET VANE CONTROLLED

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

310-212-0200

EQUIPMENT TYPE	COMBUSTION AIR FAN
TYPE	CENTRIFUGAL FAN
SERVICE	FOR INCINERATOR
CAPACITY	550 NM3/H
PRESSURE	6 KPA
TEMPERATURE	35 C
MOTOR NO./RATING (KW)	***310-212-0200-M1 *** 2,2 ***
MOTOR TITLE	COMBUSTION AIR FAN

310-212-0300

EQUIPMENT TYPE	SECONDARY AIR FAN
TYPE	CENTRIFUGAL
SERVICE	FOR INCINERATOR
CAPACITY	750 NM3/H
PRESSURE	8 KPA
TEMPERATURE	35 C
MOTOR NO./RATING (KW)	***310-212-0300-M1 *** 4 ***
MOTOR TITLE	SECONDARY AIR FAN

310-263-0100

EQUIPMENT TYPE	INCINERATOR
SERVICE	FOR PROCESS GAS H2S COMBUSTION
CAPACITY	INLET:2900 NM3/H OUT:4000 NM3/H
DIMENSIONS	D:1,8 M L:2,5 M
REMARKS	INCLUDING:BRICKLINING
	FUEL:HEAVY FUEL OIL
	TEMP:INLET/OUTLET 160/450 DEG C

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

310-376-0100

EQUIPMENT TYPE	WATER PUMP
SERVICE	SULPHUR CONDENSING BOILER CIRCULATION WATER PUMP.
CAPACITY	3,5 M3/H
PRESSURE	400 KPA
MOTOR NO./RATING (KW)	***310-376-0100-M1 *** 1,1 ***
MOTOR TITLE	WATER PUMP

310-377-0100

EQUIPMENT TYPE	OIL PUMP
SERVICE	FOR INCINERATOR
CAPACITY	50 KG/H HEAVY FUEL OIL
MOTOR NO./RATING (Kw)	***310-377-0100-M1 *** 0,18 ***
MOTOR TITLE	FUEL OIL PUMP

310-420-0100

EQUIPMENT TYPE	DEMISTER
CAPACITY	2900 NM3/H
TEMPERATURE	165 C
DIMENSIONS	DIAMETER 1100 MM DEMISTER BED: HEIGHT 150 MM
MATERIAL	CARBON STEEL, BED OF ACIDPROOF STEEL

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

310-431-0100

EQUIPMENT TYPE	AGGLOMERATOR
CAPACITY	2900 NM3/H
TEMPERATURE	165 C
DIMENSIONS	DIAMETER:600 MM AGGLOMETER BED: H:100 MM
MATERIAL	BED:ACIDPROOF STEEL,BODY:CARB.STEEL

320-----0

EQUIPMENT TYPE	SULPHUR HANDLING AREA

320-142-0100

EQUIPMENT TYPE	CASTING PIT
SERVICE	FOR SULPHUR CASTING
VOLUME	AREA 60 M2(TOTAL)
MATERIAL	CONCRETE
REMARKS	CONSITS OF TWO SECTIONS,ONE FOR SOLIDIFYING OF SULPHUR, THE OTHER BEING EMPTIED.

320-244-0100

EQUIPMENT TYPE	GRAVITY FILTER
TYPE	STEEL WIRE FILTER(ACID PROOF)
SERVICE	FOR SULPHUR
VOLUME	1 M3
DIMENSIONS	L X W X H : 2X1X0,5 M
MATERIAL	CONCRETE,STEEL COVER STEAM HEATING PIPES OF STEEL
REMARKS	STEAM HEATED. CONSISTS OF TWO 1X1 M PARTS,ONE OF WICH IS OPERATING,THE OTHER BED TO BE CHANGED.

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OJTJKJMPU NO : CLIENT NO :
DESIGN :PW REVISION :0 DATE :29.10.85

320-378-0100

EQUIPMENT TYPE	PUMP
	SULPHUR PUMP
SERVICE	FROM PUMP TANK TO SULPHUR TANK
CAPACITY	0,2 M3/H
HEAD	15 M
MOTOR NO./RATING (KW)	***320-378-0100-M1 *** 0,09 ***
MOTOR TITLE	SULPHUR PUMP
REMARKS	STEAM HEATED

320-378-0200

EQUIPMENT TYPE	PUMP
YPE	SULPHUR PUMP
SERVICE	SULPHUR PUMPING FROM PUMP TANK TO AGGLOMERATOR BED WASHING.
CAPACITY	0.2 M3/H
HEAD	15 M
MOTOR NO./RATING (KW)	***320-378-0200-M1*** 0,09***
MOTOR TITLE	SULPHUR PUMP
REMARKS	STEAM HEATED

320-518-0100

EQUIPMENT TYPE	PUMP TANK
SERVICE	SULPHUR PUMP TANK FOR FILTERED SULPHUR
VOLUME	5 M3
MATERIAL	CONCRETE, 2 M3
REMARKS	STEAM HEATING PIPES INCLUDING STEEL COVERS

CLIENT :PPCL
DOCUMENT:EQUIPMENT LIST (ATNB)
OUTOKUMPU NO : CLIENT NO :
DESIGN :PW REVISION :0 DATE :29.10.85

320-519-0100

EQUIPMENT TYPE	STORAGE TANK
SERVICE	SULPHUR STORAGE TANK
VOLUME	10 M3
MATERIAL	MILD STEEL
REMARKS	STEAM HEATED

4.3
ELECTRIFICATION

4.3.1
Description of Electrification

Contents:

Attached diagram:

Single Line Diagram
Dwg No. 252 300 701 001-3, Rev. 0

4.3.2
Motor list

1 GENERAL

1.01 General description of electrification

This technical specification describes and determines the main principles in electric distribution.

Electric equipment, possible drives, subcentres and materials included in machinery supplies are not specified separately. The main principles for all the electric equipment are in accordance with this specification.

1.02 Power supply

Electric power to the smelter plant will be supplied by others.

Power will be fed to a main switchboard in the plant area by cables.

1.03 Distribution

The general distribution system is shown in the attached single line diagram.

1.04 Voltages

Motor voltage	3 phase	415 V	50 Hz
Lighting device	1 phase	220 V	50 Hz
Control voltage	1 phase	220 V	50 Hz

1.05 Standards

The apparatus and equipment comply with the IEC Recommendations valid on the day of study. Should these lack the VDE standards shall apply. All electrical equipment is suitable for continuous use at the rated load at the ambient temperature of +35 °C. The mechanical dimensions are in accordance with the DIN standards.

1.06 Protection

Fuses are used for short-circuit protection in the distribution system. The rated currents of the fuses are selected so that a selective tripping is possible. The contactors of the motor feeders are provided with thermal overload relays in order to protect the motors against overload and operation at 2-phase.

1.07
Control

Major part of the motors of the plant are controlled from the control rooms. In addition they can be equipped with lockable local control switch where necessary. The local control switch will be placed near the motor. Interlocking relays, if any, will be mounted in rack. located in MCC room.

1.08
Measurings

Incoming feeder to switchboard is provided with V-meter, change over switch and A-meters. Incoming feeder is also equipped with kWh-meter.

A-meters for motor feeder are provided where necessary.

2
CONSTRUCTION OF MAIN ELECTRIC EQUIPMENT

2.01
415 V switchgears

Construction

Multi-cubicle-type switchgears for indoor installation. The cubicles are separated from each other with sheet steel partitions.

Also vertical cable ducts are separated from the apparatus cubicles.

Busbars are made of copper and closed to the section of their own in the upper part of the centre. A neutral bar is mounted in the lower part of the centre.

Protection

The structure of the 415 V switchgear is protected agains contact, the degree of protection is IP20 complying with the recommendations of IEC 529.

Technical data

Requirements	IEC 439
Rated voltage	415 V, 50 Hz
Rated current	630 A

Short circuit strength

* short circuit r.m.s	1 ls 20 kA
* peak short-circuit	1 dyn 50 kA

2.02
Local control switches and terminal boxes

Box with switches or terminal blocks for indoor or outdoor installation.

Degree of protection for local control switches according to IEC IP 55.

A local control switch rated current 10 A, in the control circuit.

Local control boxes will be used where necessary according to the process.

2.03
Lighting

The reflectors of floodlightings are made of anoidized aluminium.

Protection degree of lighting fixtures is IP34 in the process areas.

Lighting is mainly made by using fluorescent tubes and mercury vapour floodlights.

2.04
Plugs and socket outlets

Plugs and socket outlets for outdoor installation are made of insulating material.

Protection degree is splashproof, minimum IP44 in the process areas.

Domestic plugs and socket outlets, 10 A or 16 A.

2.05
415 V power and control cables

Motor cables:

Phase conductors of copper:
* 2.5...16 mm^2 single wire
* 25...240 mm^2 stranded, compacted and sectorshaped

- 3.5-core cables with plastic insulation and sheat
- standard IEC Publ. 502-1

Control cables:

- plastic insulated control cables

Phase conductors of copper: Mainly 1.5 and 2.5 mm^2 diameters will be used, if necessary the diameter can be also 4 mm^2.

2.06
Cable trays and protection conduits

When mounting the cables mainly racks and conduits will be used.

Racks and conduits are of aluminium alloy.

The cables are protected to 1.5 mm height, or at places susceptible to thermal or mechanical damages, by means of protective aluminium or steel conduits or tray covers.

2.07
Earthing materials

Switchgears and electric equipment will be earthed. Cable racks will be earthed from both ends.

Switchgear will be earthed by means of 50 mm^2 plastic insulated copper cables.

Motors and consumption equipment will be earthed through the protective concentric conductor of the supply cable.

4.3.2
Motor list

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

200-----0

EQUIPMENT TYPE — FLASH SMELTER AREA

210-----0

EQUIPMENT TYPE — DRYER AND FSF FEED AREA

210-117-0100

EQUIPMENT TYPE — DRIED CHARGE BIN

210-117-0200

EQUIPMENT TYPE — DRIED CHARGE BIN

210-170-0100

EQUIPMENT TYPE — PNEUMATIC CONVEYOR SYSTEM

MOTOR NO./RATING (KW)
MOTOR TITLE

210-170-0100-M1 11 ***
AIR BLOWER
210-170-0100-M2 11 ***
AIR BLOWER,STAND BY
210-170-0100-M30,75***
AIR LOCK
210-170-0100-M40,75***
AIR LOCK
210-170-0100-M51,5 ***
EXHAUST AIR FAN

210-194-0100

EQUIPMENT TYPE — MULTICOIL DRYER

MOTOR NO./RATING (KW)
MOTOR TITLE

*** 210-194-0100-M1*** 30 ***
MULTICOIL DRYER

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

210-212-0100

EQUIPMENT TYPE — EXHAUST AIR FAN

MOTOR NO./RATING (KW) — ***210-212-0100-M1 *** 1.5 ***
MOTOR TITLE — EXHAUST AIR FAN

210-417-0100

EQUIPMENT TYPE — BAG FILTER

220-----0

EQUIPMENT TYPE — FLASH SMELTING FURNACE AREA

220-131-0100

EQUIPMENT TYPE — COAL DUST BURNER

220-133-0100

EQUIPMENT TYPE — OIL BURNER

220-133-0200

EQUIPMENT TYPE — AUXILIARY BURNER

220-134-0100

EQUIPMENT TYPE — COAL TUYERE

220-140-0100

EQUIPMENT TYPE — SLAG LAUNDER WITH COVERS

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

220-144-0100

EQUIPMENT TYPE — SLAG POT

220-198-0100

EQUIPMENT TYPE — GAS DUCTWORK

220-198-0200

EQUIPMENT TYPE — GAS DUCTWORK

220-204-0100

EQUIPMENT TYPE — GAS DUCT

220-212-0100

EQUIPMENT TYPE — PROCESS AIR FAN

MOTOR NO./RATING (KW) — *** 220-212-0100-M1*** 7,5 ***
MOTOR TITLE — PROCESS AIR FAN

220-212-0200

EQUIPMENT TYPE — COMBUSTION AIR FAN

MOTOR NO./RATING (KW) — ***220-212-0200-M1*** 1,1 ***
MOTOR TITLE — COMBUSTION AIR FAN

220-218-0100

EQUIPMENT TYPE — BELT FEEDER

MOTOR NO./RATING (KW) — *** 210-218-0100-M1*** 3,0 ***
MOTOR TITLE — BELT FEEDER

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

220-228-0100

EQUIPMENT TYPE	SCREW FEEDER
MOTOR NO./RATING (Kw)	*** 210-228-0100-M1*** 2,2 ***
MOTOR TITLE	SCREW FEEDER

220-239-0100

EQUIPMENT TYPE	PNEUMATIC FEEDER SYSTEM
MOTOR NO./RATING (Kw)	***220-239-0100-M1*** 0,55***
MOTOR TITLE	AIR LOCK
	220-239-0100-M2 0,55***
	AIR LOCK
	220-239-0100-M3 0,75***
	AIR LOCK

220-261-0100

EQUIPMENT TYPE	FLASH SMELTING FURNACE

220-289-0100

EQUIPMENT TYPE	SPRAY WATER HEAT EXCHANGER

220-289-0300

EQUIPMENT TYPE	JACKET WATER HEAT EXCHANGER

220-317-0100

EQUIPMENT TYPE	MONORAIL HOIST
MOTOR NO./RATING (Kw)	***220-317-0100-M1*** 4 ***
MOTOR TITLE	MONORAIL HOIST
	220-317-0100-M2 0,75***
	MONORAIL HOIST

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

220-376-0100

EQUIPMENT TYPE — SPRAY WATER PUMP

MOTOR NO./RATING (Kw) — ***220-376-0100-M1 *** 30 ***
MOTOR TITLE — SPRAY WATER PUMP
(INCL.ONE PARALELL ITEM:0200 30 Kw)

220-376-0300

EQUIPMENT TYPE — JACKET WATER PUMP

MOTOR NO./RATING (Kw) — ***220-376-0300-M1 *** 11 ***
MOTOR TITLE — JACKET WATER PUMP
(INCL.ONE PARALELL ITEM:0400 11 Kw)

220-377-0100

EQUIPMENT TYPE — OIL PUMP

MOTOR NO./RATING (Kw) — ***220-377-0100-M1 *** 0,37 ***
MOTOR TITLE — OIL PUMP

220-435-0100

EQUIPMENT TYPE — CONCENTRATE BURNER

220-519-0100

EQUIPMENT TYPE — SPRAY WATER TANK

220-519-0200

EQUIPMENT TYPE — JACKET WATER TANK

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

220-519-0300

EQUIPMENT TYPE — WATER TANK

220-569-0100

EQUIPMENT TYPE — EMERGENCY DAMPER BETWEEN FSF-WHB

230-----0

EQUIPMENT TYPE — PROCESS GAS HANDLING AREA

230-124-0100

EQUIPMENT TYPE — WASTE HEAT BOILER

230-198-0100

EQUIPMENT TYPE — GAS DUCTWORK

230-212-0100

EQUIPMENT TYPE — PROCESS GAS FAN

MOTOR NO./RATING (Kw) — ***230-212-0100-M1 *** 15 ***
MOTOR TITLE — PROCESS GAS FAN

230-370-0100

EQUIPMENT TYPE — WATER PUMP

MOTOR NO./RATING (Kw) — ***230-370-0100-M1 *** 0.37 ***
MOTOR TITLE — WHB CIRCULATION WATER PUMP

230-375-0200

EQUIPMENT TYPE — WATER PUMP

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO : CLIENT NO :
DESIGN :PW REVISION :0 DATE :29.10.85

230-421-0100

EQUIPMENT TYPE	ELECTROSTATIC PRECIPITATOR
MOTOR NO./RATING (KW)	*** SEVERAL,TOTAL *** 26 ***

230-562-0100

EQUIPMENT TYPE	DISC VALVE

240-----0

EQUIPMENT TYPE	FLUE DUST HANDLING AREA

240-140-0100

EQUIPMENT TYPE	LAUNDER

240-168-0100

EQUIPMENT TYPE	DRAG CONVEYOR FOR WHB DUST
MOTOR NO./RATING (KW)	***240-168-0100-M1 *** 2,2 ***
MOTOR TITLE	DRAG CONVEYOR FOR WHB DUST

240-168-0200

EQUIPMENT TYPE	DRAG CONVEYOR FOR EP DUST
MOTOR NO./RATING (KW)	***240-168-0200-M1 *** 1,1 ***
MOTOR TITLE	DRAG CONVEYOR FOR EP DUST

240-209-0100

EQUIPMENT TYPE	WATER LOCK

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

240-374-0100

EQUIPMENT TYPE	SLURRY PUMP
MOTOR NO./RATING (KW)	*** 240-374-0100-M1***0,75 ***
MOTOR TITLE	DUST SLURRY PUMP

240-374-0200

EQUIPMENT TYPE	SLURRY PUMP
MOTOR NO./RATING (KW)	*** 240-374-0200-M1***0,75 ***
MOTOR TITLE	DUST SLURRY PUMP

240-518-0100

EQUIPMENT TYPE	PUMP TANK

240-534-0100

EQUIPMENT TYPE	TANK

300-----0

EQUIPMENT TYPE	SULPHUR PLANT AREA

310-----0

EQUIPMENT TYPE	SULPHUR RECOVERING AREA

310-129-0100

EQUIPMENT TYPE	SULPHUR CONDENSING BOILER

310-198-0100

EQUIPMENT TYPE	GAS DUCT

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO : CLIENT NO :
DESIGN :PW REVISION :0 DATE :29.10.85

310-209-0100

EQUIPMENT TYPE	WATER LOCK

310-212-0100

EQUIPMENT TYPE	PROCESS GAS FAN
MOTOR NO./RATING (KW)	***310-212-0100-M1 *** 11 ***
MOTOR TITLE	PROCESS GAS FAN

310-212-0200

EQUIPMENT TYPE	COMBUSTION AIR FAN
MOTOR NO./RATING (KW)	***310-212-0200-M1 *** 2,2 ***
MOTOR TITLE	COMBUSTION AIR FAN

310-212-0300

EQUIPMENT TYPE	SECONDARY AIR FAN
MOTOR NO./RATING (KW)	***310-212-0300-M1 *** 4 ***
MOTOR TITLE	SECONDARY AIR FAN

310-263-0100

EQUIPMENT TYPE	INCINERATOR

310-376-0100

EQUIPMENT TYPE	WATER PUMP
MOTOR NO./RATING (KW)	***310-376-0100-M1 *** 1,1 ***
MOTOR TITLE	WATER PUMP

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

310-377-0100

EQUIPMENT TYPE	OIL PUMP
MOTOR NO./RATING (Kw)	***310-377-0100-M1 *** 0.18 ***
MOTOR TITLE	FUEL OIL PUMP

310-420-0100

EQUIPMENT TYPE	DEMISTER

310-431-0100

EQUIPMENT TYPE	AGGLOMERATOR

320-----0

EQUIPMENT TYPE	SULPHUR HANDLING AREA

320-142-0100

EQUIPMENT TYPE	CASTING PIT

320-244-0100

EQUIPMENT TYPE	GRAVITY FILTER

320-378-0100

EQUIPMENT TYPE	PUMP
MOTOR NO./RATING (Kw)	***320-378-0100-M1 *** 0.09 ***
MOTOR TITLE	SULPHUR PUMP

CLIENT :PPCL
DOCUMENT:MOTOR LIST (B)
OUTOKUMPU NO :
DESIGN :PW

CLIENT NO :
REVISION :0 DATE :29.10.85

320-378-0200

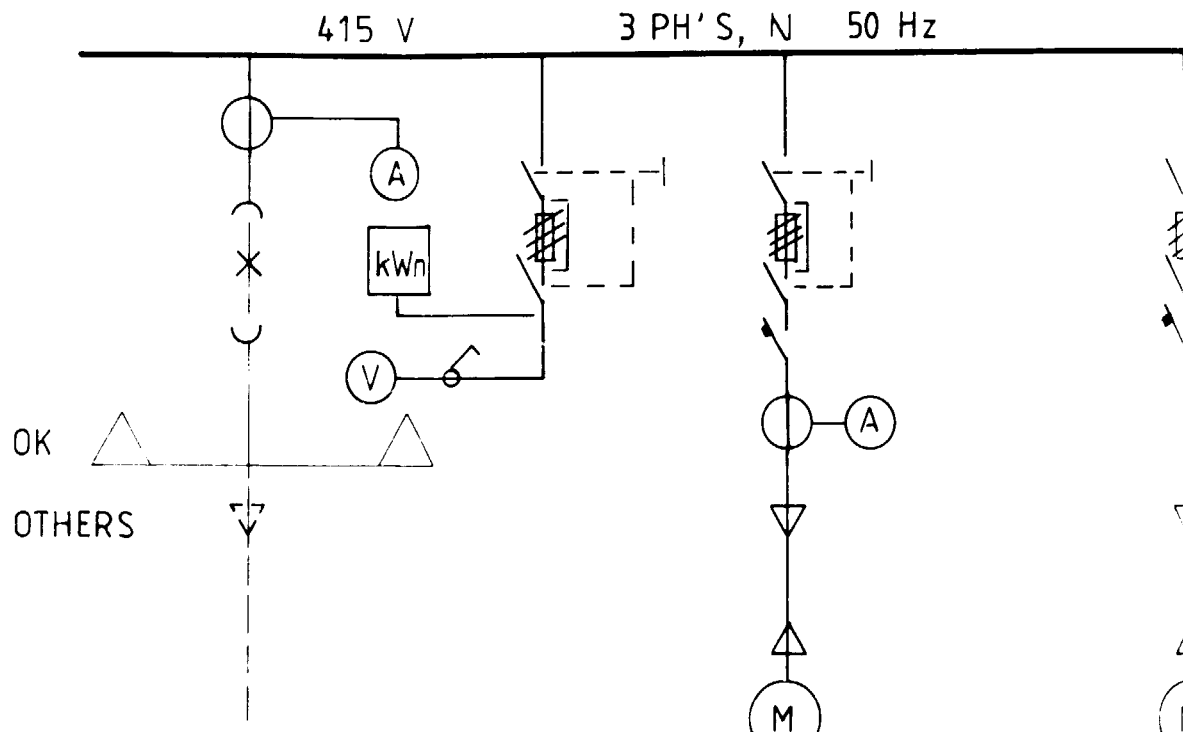
EQUIPMENT TYPE	PUMP
MOTOR NO./RATING (KW)	***320-378-0200-M1*** 0,09***
MOTOR TITLE	SULPHUR PUMP

320-518-0100

EQUIPMENT TYPE	PUMP TANK

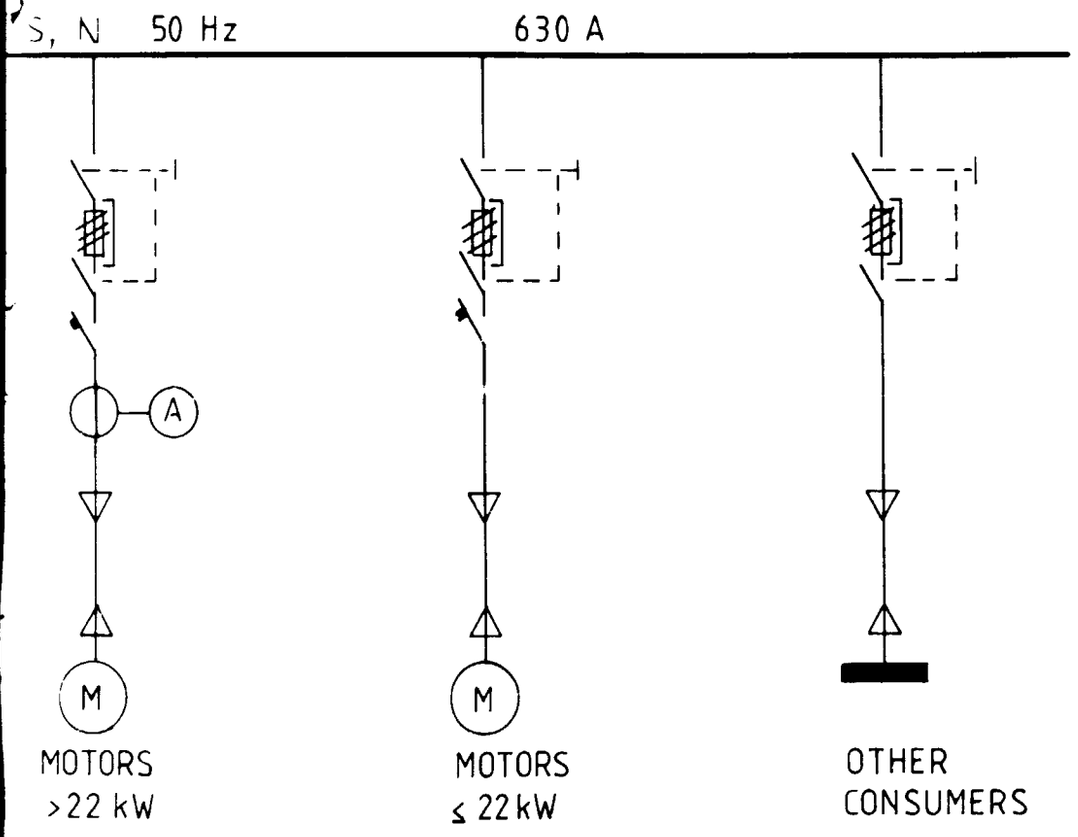
320-519-0100

EQUIPMENT TYPE	STORAGE TANK



SECTION 1

0	FOR FEASIBILITY STUDY	21.11.1985	TR	OH
	REVISIONS	DATE	DRAWN	CHECKED



SECTION 2

OUTOKUMPU ENGINEERING	DESIGNED	20.11.1985	OH
	CHECKED		
	APPROVED	21. NOV. 1985	AK
CLIENT: PYRITES, PHOSPHATES & CHEMICALS LTD.	CLIENT'S DWG NO.		
PROJECT: SALADIPURA DEMONSTRATION PLANT			
DRAWING TITLE: SINGLE LINE DIAGRAM	SCALE	REF.DWG	
		DWG NO. 252 300 701 001-3	REV. NO 0

DATE	DRAWN	CHECKED	APPROVED	MICRO FILMED
21.11.1985	TR	OH	AK	

4.4
Instrumentation

4.4.1
General Description of Instrumentation

Contents

4.4.2
Preliminary Loop Number Schedule for Instrumentation

Attached diagram:

Flash Smelter and Sulphur Plant Instrumentation
The Most Important Control Loops
Dwg No. 252 300 901 003-9, Rev. 0

1.0
DESIGN CONCEPTS

1.01 The instrumentation and control system is designed to provide the information and control necessary to operate the pilot plant efficiently and safely.

1.02 The controls shall be implemented using industry standard instruments and control systems. Use of custom designed or proprietary control systems shall be avoided to the extent possible.

1.03 Major instrumentation and controls shall be standardized.

The following factors shall be given special consideration:

- The availability and the location of vendor service and parts supply centers.
- The amount of flexibility demanded by plant operations.
- The maximum recovery of a high purity product and controlled pollutant levels in plant effluents.

1.04 Electronic type instruments shall be generally used. Use of pneumatic instruments shall be avoided, except for control valves, certain local control loops, and special applications where the pneumatic instrumentation has a definitive advantage over the electrical instrumentation.

1.05 The control room instrumentation shall be based on a conventional electronic analog system. The system shall be built up for a future addition of a computer system for high level controls, data acquisition, reporting and process management.

1.06 ISA symbols shall be used on preparing of Piping Instrumentation Diagrams (P & ID).

1.07 DIN standards and metric units shall be used in instrumentation design.

2.0
CONTROL ROOMS, CONTROL PANELS AND OPERATOR WORK STATIONS

2.01 A central control room (CCR) with control panels and operator work stations will be provided. The control room shall be the point of control for operating and/or monitoring the process and will contain the necessary instrumentation and controls to operate the process.

2.02 A free-standing control panel with semigraphic diagram on the top part shall be provided for CCR. The vertical section of the panel shall include complementary analog instruments. The sloping console section shall include start-stop push buttons for motors, selector switches, ammeters etc.

2.03 The CCR shall be pressurized with filtered air to exclude dust and noxious gases (SO_2 and H_2S) and shall be air conditioned to maintain a suitable constant temperature and humidity.

3.0
FIELD MOUNTED INSTRUMENTATION, WIRING AND PIPING

3.01 Field mounted transmitters shall be two (2) wire type wherever possible. For certain special applications, where two (2) wire transmitters are not available, four (4) wire transmitters may be used.

3.02 Enclosures for field mounted instruments shall be DIN IP54 dust tight and water tight construction. Classification for hazardous application location, if required, shall be specified on the data sheets.

3.03 Instruments located outdoors and subject to severe ambient conditions including moisture, freezing and corrosion, shall be protected either by heating and/or shall be installed in weatherproof housing or shelters. The use of protective housing or enclosures shall not inhibit the functioning of the instrument or detract from th ability to perform routine service.

3.04 All automatic control valves shall be provided with isolating block and bypass valves, unless duplication of equipment and lines allows control valve replacement without shutting down the process. Control valves which are not provided with isolating block valves and bypass shall be supplied with a manual handwheel or other means for manual operation.

3.05 Instrument signals and alarm wiring shall be designed with twisted pair cable with aluminum mylar electrostatic shielding, a bare copper drain wire and overall PVC jacket. The cable shall be suitable and approved for installation in cable trays.

3.06 Multipair cables shall generally be used to connect the field junction box to the control panel. The cable characteristics shall be the same as above except that each pair of conductors shall be individually shielded and have a bare copper drain wire.

3.07 The primary instrument connection shall be the responsibility of the piping section. These connections will include process block valves, thermowell or probe couplings and flanges.

3.08 The instrument process piping material including tube, valves and fittings shall be 316 stainless steel.

3.09 The tubing runs for pneumatic transmission signals, and connections between filter-regulators and instruments, shall be made with 6 mm outside diameter 316 stainless steel tubing with 1.0 mm wall thickness.

3.10 Tube fittings for pneumatic system shall be 316 stainless steel compression type.

4.0 POWER SUPPLIES, SIGNALS AND UNITS OF MEASUREMENT

4.01 The electrical supply for instruments will be 220 V, 50 Hz.

4.02 Supply of power to all instruments regardless of their location shall be the design responsibility of the instrument section. The supply of power to field instruments shall originate from the appropriate control panel. The instruments in the same loop shall be powered from the same source of power.

4.03 Pneumatic instruments shall operate from instrument air supply of 140 kPa gage pressure and shall yield a control signal over a range of 20 to 100 kPa gage pressure. Under special circumstances other signal ranges, and air supply pressures may be specified.

4.04 The piping section will supply a nominal 600 kPa gauge pressure dried and filtered instrument air supply source.

4.05 The following transmission signal levels shall be used:

Analog signals	- 4 - 20 mA DC
Alarm signals	- 24 V DC
Counters	- 24 V DC
Solenoid valves	- 220 V, 50 Hz
ON-OFF controls	- 220 V, 50 Hz
Status signals	- 220 V, 50 Hz
Interlocks	- 220 V, 50 Hz

5.0 DRAWINGS AND DATA

5.01 A set of basic engineering drawings and data shall be prepared for major instrumentation and control systems. The drawings and data shall be sufficient to allow a qualified engineering company to perform detail engineering. The basic engineering drawings and data shall include the following:

- General specification for instrumentation design
- Instrument index
- Piping and instrumentation diagrams (P & ID)
- Instrument data sheets
- Control panel specifications
- Control panel layout drawings
- Layout drawings for central control room
- Space reservations for local control rooms and desks
- General specification for main control functions and operation
- General specification for instrumentation installation

5.02 A complete set of detail engineering drawings and data shall be prepared for all instrumentation and control systems. The drawings and design data shall be detailed to allow a qualified contractor to submit bids for the procurement of installation material and completion of the work with a minimum of field engineering at the jobsite. The detail engineering drawings and data shall include the following:

- Updated basic engineering drawings and data
- Loop Diagrams
- Wiring diagrams
- Cable schedules
- Cable tray layout drawings
- Plot plan drawing of field instruments and junction boxes
- Installation details and bills of material
- Drawings of process couplings and tappings
- Vendors drawings and data for engineering, maintenance, construction and record purposes
- Drawings of auxiliary voltages supply system
- Drawings of installation racks and auxiliary equipment cabins
- Maintenance manuals for instruments

4.4.2
Preliminary Loop Number Schedule for Instrumentation

O+K

INSTRUMENT TAG NO SCHEDULE

Työnro / Job: SALADIPURA DEMONST PLANT

Kohde / Object: PYRITES, PHOSPHATES & CHEMICALS LTD

Piirt. / Drawn: 18.OCT.85

Muutos / Revision: 0.

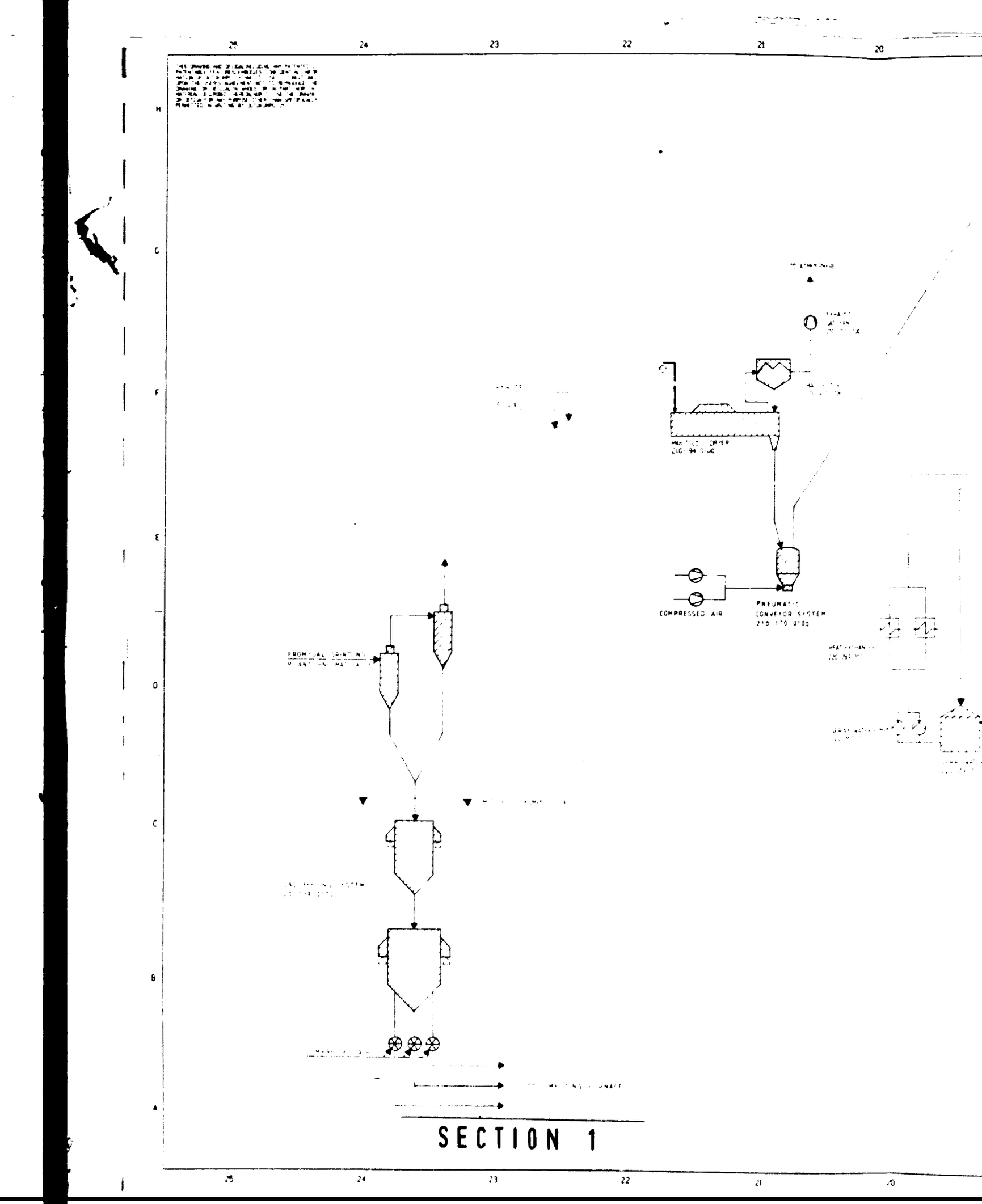
Paikka / Position	Sijainti / Location: ▭ = valvomo / control panel; ○ = kenttä / field; / = digitaalisäädin / digital controller; ✱ = merkkilamppu / ind. lamp.; Hälytys / Alarm: + = yläraja / upper limit; − = alaraja / lower limit; Kohde / Object	Osoitus / Indication	Rekisteröinti / Recording	Summaus / Integration	Käsiohjaus / Manual control	Asetusarvo / Set point	Säätö / Control	Hälytys / Alarm	Lukitus / Interlocking	Huom. / Notes
F-01	PROCESS AIR TO FURNACE	⊖					⊖			
F-02	COMBUSTION AIR TO FURNACE	⊖					⊖			
F-03	OXYGEN FEED TO PROCESS AIR	⊖					⊖			
F-04	OXYGEN FEED TO COMBUSTION AIR	⊖					⊖			
F-05	OIL FLOW TO BURNER			⊖						
F-06	STEAM FLOW FROM WHB	⊖	⊖							
F-07	FEED WATER TO WHB	⊖	⊖							
F-08	CIRCULATION WATER IN WHB	⊖	⊖							
L-09	WATER LEVEL OF WHB	⊖					⊖			
L-10	WATER LEVEL OF CONDENSING BOILER	⊖					⊖			
L-11	LEVEL OF SULPHUR TANK	⊖	⊖							
P-12	PRESSURE OF FURNACE	⊖					⊖			
P-13	STEAM PRESSURE OF WHB	⊖					⊖			
P-14	STEAM PRESSURE OF COND. BOILER	⊖					⊖			
P-15	GAS PRESSURE AFTER COND. BOILER	⊖					⊖			
S-16	SPEED OF FEEDER				⊖					
S-17	SPEED OF FEEDER				⊖					
T-18	TEMPERATURE OF FURNACE	⊖	⊖							
T-19	TEMPERATURE OF WHB	⊖	⊖							
T-20	SULPHUR TEMPERATURE	⊖	⊖							
T-21	OFF GAS TEMPERATURE						○			
T-22	TEMPERATURE OF SULPHUR TANK	⊖	⊖							
W-23	PYRITE BIN WEIGHING	⊖	⊖							
W-24	SAND BIN WEIGHING	⊖	⊖							

Laati / Designed: JHA

Tark. / Checked:

Hyv. / Approved:

Sivu / Page 1 / 1



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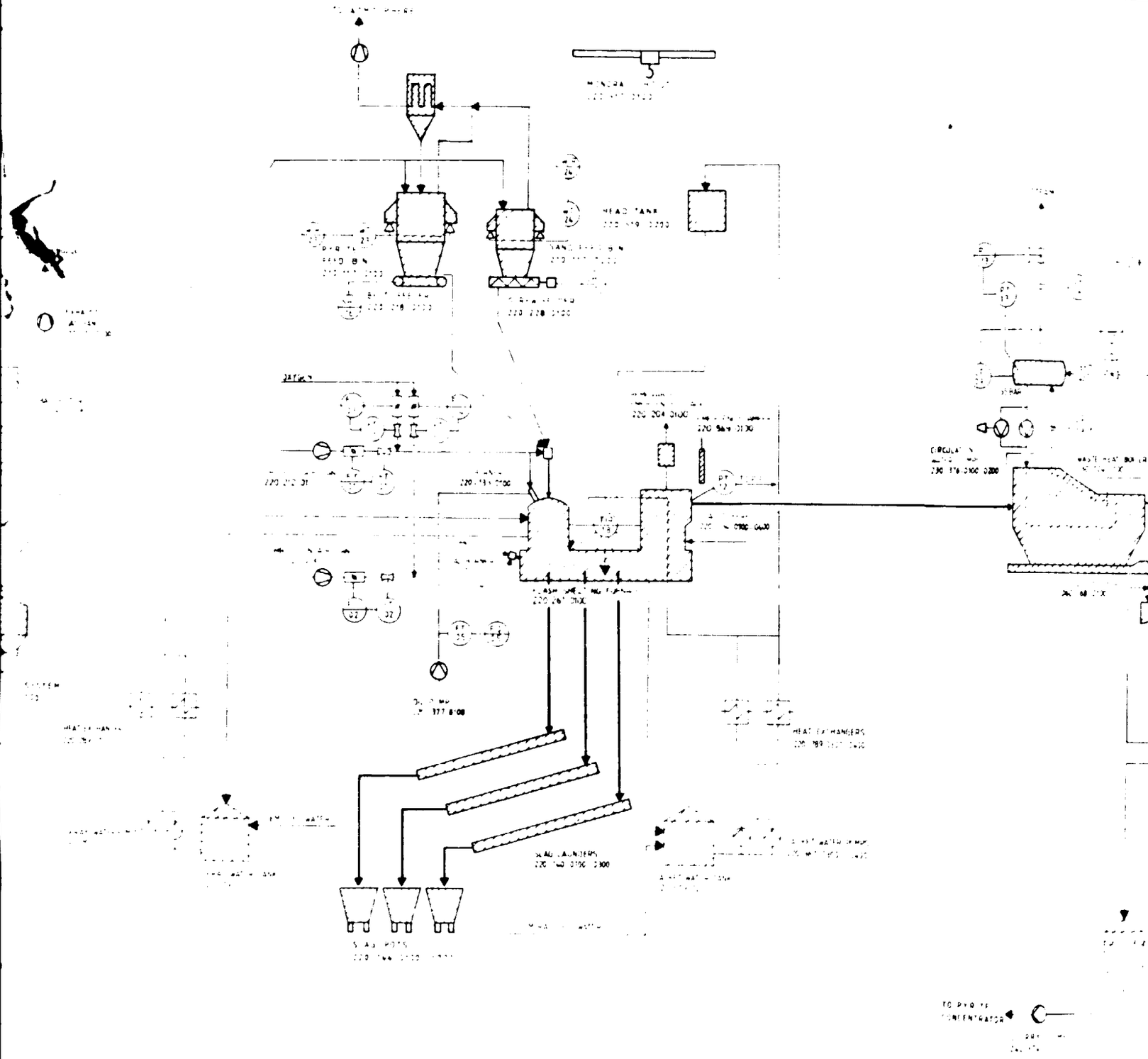

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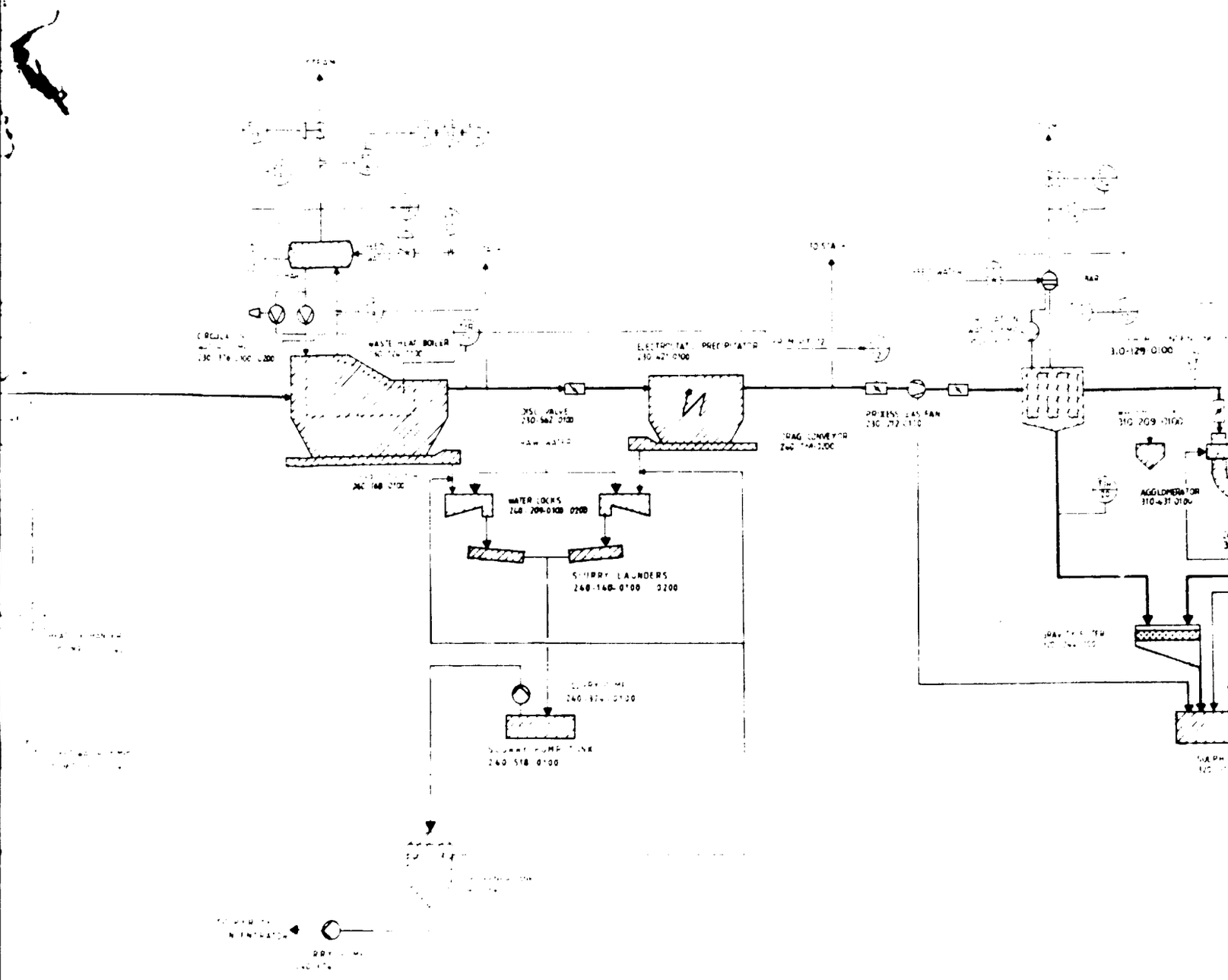
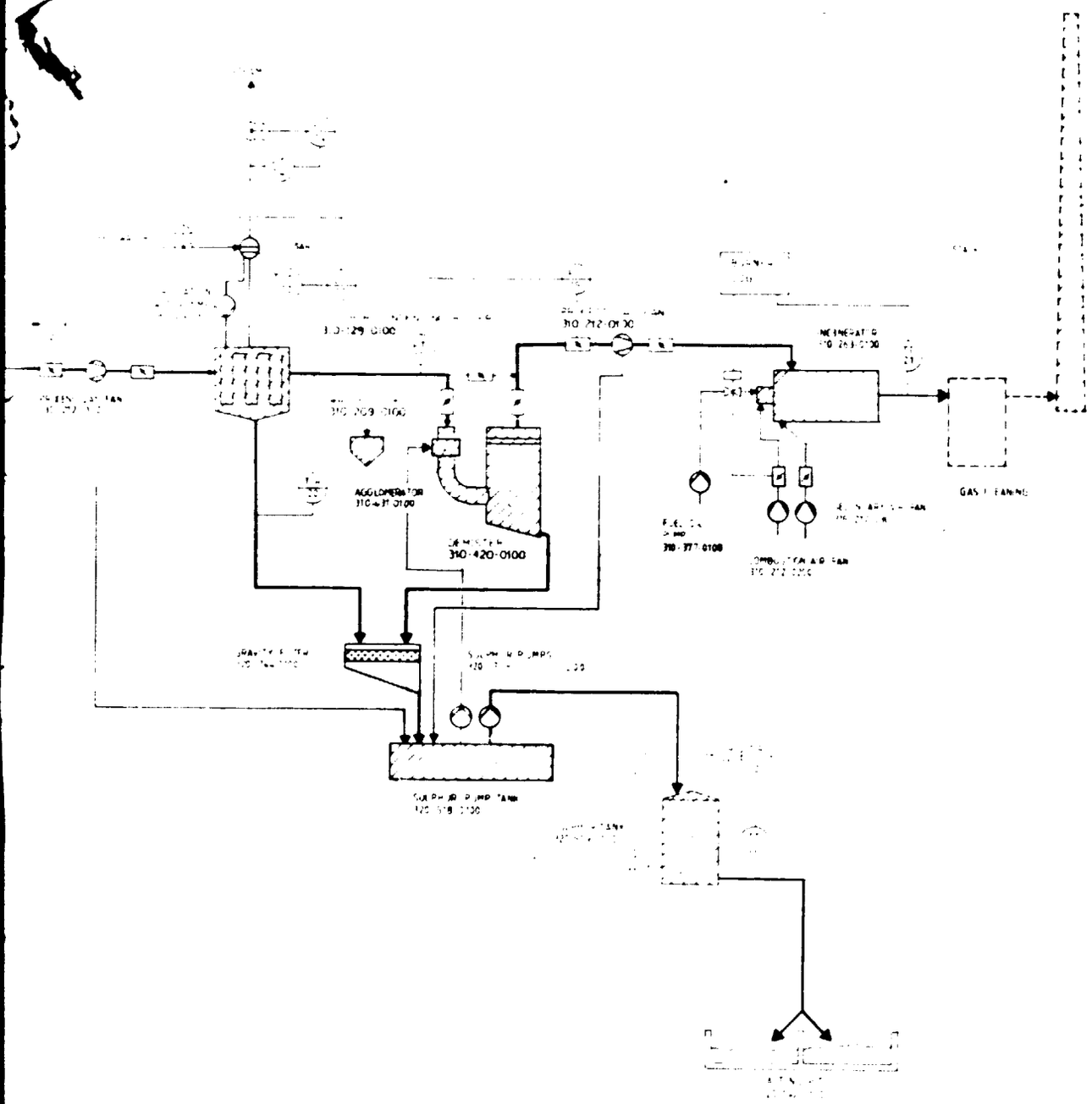

WASTE HEAT BOILER
ELECTROSTATIC PRECIPITATOR
DRAG CONVEYOR
PROCESS GAS FAN
AGGLOMERATOR
WATER LOCKS
SLURRY LAUNDERS
240-160-0100 0200

SECTION 3



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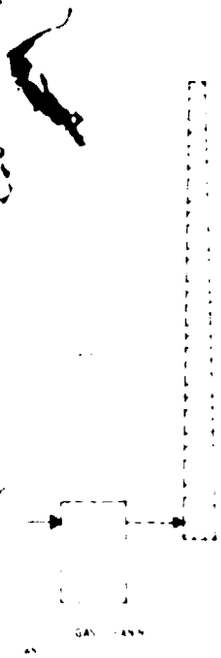


SECTION 5

OUTOKUMPU ENGINEERING

4.5 Civil Works

4.5.1 Description of Buildings

1. Office and control room building

Size 10 m x 10 m, total volume about 650 m^3.

The building has two floors. On the first floor are located the electric connection room and laboratory, on the second floor the control room and offices.

The structure of the building is of concrete pillars, floors are concrete slabs.

The external walls are built of 200 mm concrete blocks covered with plastering. Partition walls of the electric room, control room and staircase are made of the same blocks. Light partition walls consist of wooden or steel support frame and gypsum plate (or corresponding) on both sides.

Roofing: double bitumen felt roof insulation with crushed rock surfacing.

External doors are of steel construction, internal doors are made of hardboard with wooden frames.

Windows are of Louvre-type with aluminium frame.

2. Smelter aisle

Size (area) about 13 m x 11.5 m, total volume about 2 300 m^3.

The structure is of steel columns and beams, cladding and roofing of corrugated sheets (asbestos or steel). Part of the cladding is of corrugated transparent wall sheeting.

3. Sulphur storage

Size is about 20 m x 5 m.

Lower part (bins) are of reinforced concrete. The height of the rear wall of the bins is about 3 m, side wall at the rear 3 m, at the front 1 m. The bins are open at the front.

Above the bins only a roof is built, the sides are open in about 2 meters' height

The roof is made of corrugated plates and supported with steel columns.

4. Oxygen storage slab

Size 3 m x 9 m. The slab is built of reinforced concrete.

The storage is surrounded with a fence of galvanized wire mesh. The height of the fence is 2 m.

4.5.2
Building Material Quantities

The consumption of main building materials for the office building, FSF aisle, sulphur storage and oxygen storage slab is as follows:

-	Concrete for footings, pillars and slabs	180 m^3
-	Concrete reinforcement steel	14 000 kg
-	Steel constructions for buildings Steel constructions (supports) for the process equipment, 4 750 kg, are regarded as a part of the equipment	15 100 kg
-	Walls External and internal concrete block walls, total	270 m^2
	Light partition walls of wooden structure	110 m^2
-	Roofings Double bitumen felt roof insulation with crushed rock surfacing	120 m^2
	Corrugated roofing sheets (asbestos or steel)	300 m^2
-	Cladding Corrugated sheets (steel)	600 m^2
	Corrugated transparent cladding sheets	120 m^2
-	Doors and windows External doors of steel	7 pcs
	Internal doors of wooden structure	10 pcs
	Windows	50 m^2

Land excavations needed are about 400 m^3 and filling volume about 300 m^3.

Building costs for Outokumpu's scope are estimated on the basis of the above main material quantities, and the costs are included in the capital cost estimate in Section 6.

4.6
Laboratory Facilities

The laboratory can be located on the first floor of the office building. The room needed for a laboratory serving the smelter and sulphur plants is about 40 - 50 m^2. Depending on the need for offices, in a building of the size of about 100 m^2 (as proposed) possibly even more room could be arranged for the laboratory thus enabling it to serve also other plants on the site.

The laboratory facilities of this study are mostly designed for the service of the smelter/sulphur plant.

The selection of the equipment, of course, depends on the purpose for which the plant is used, i.e. for commercial needs, for research or for training purposes. The scope of devices of this study is defined keeping in mind the process research and developing function of the plant as well as the personnel training purpose.

In case a commercial size plant will be built later on and the demonstration plant is stopped, all the laboratory instruments can be used in the big plant.

The activities of the laboratory and the main equipment are as follows.

Solid materials handling to prepare the solid material samples for chemical analysing and also for determining e.g. humidity and screen size of the material. The equipment is used mostly for pyrite concentrate, silica flux, flue dust and FSF slag analysing.

The main equipment are crusher, mill, screening and fractioning device, drying box and moisture analysing device.

Duct flow measuring for gas streams. In the gas ducts both the gas flow rate and the dust amount and type are investigated.

The main equipment needed are manometer, Pitot-tube, dust content measuring device, thermometer, suction pump, glass ampullas for samples etc.

Gas analysing
The main piece of equipment for analysing the gases is a gas chromatograph. In addition, sampling pipettes or suction pumps are needed as well as manometers and bottles for calibration.

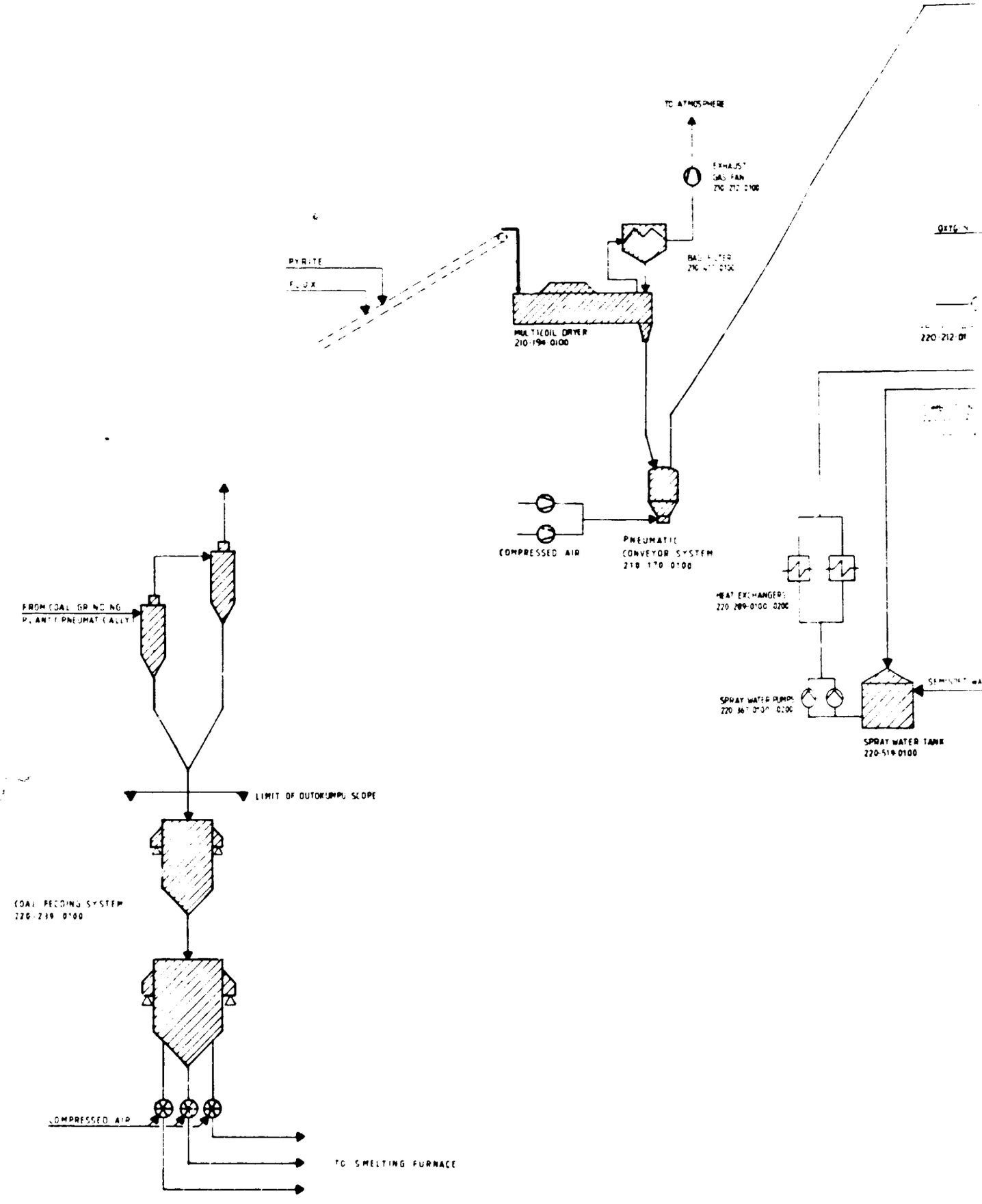
Solid materials analysing equipment is used in chemical analysing of e.g. pyrite, sand, flue dust, slag and sulphur samples.

The analysing device consists of apparatuses for determining sulphur and carbon contents, accurate analysis scale, drying and ventilation box and basic laboratory equipment consisting of burettes, decanters, different kinds of glasses etc.

Common equipment for the laboratory's needs consists e.g. of surface temperature and pH-meters, different kinds of scales, normal basic laboratory glassware, helium and nitrogen gas bottles, sampling vessels and bags, etc.

In addition, certain storage of chemicals for laboratory use is needed.

In the capital cost estimation of this study laboratory equipment is noted in the extent roughly described above.



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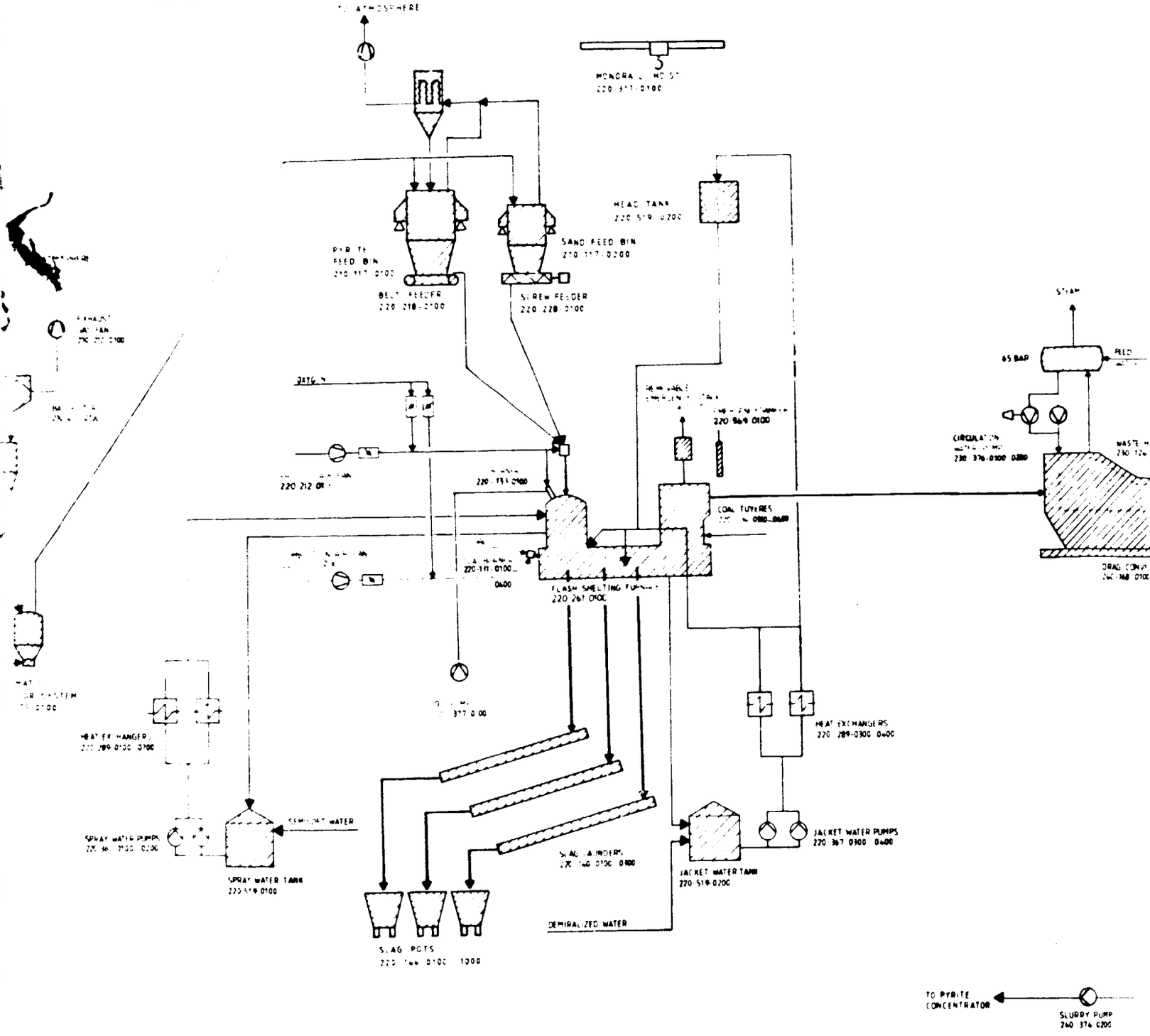
TO ATMOSPHERE
MONORAIL HOIST
220 317 0100
HEAD TANK
220 519 0200
SAND FEED BIN
220 117 0200
PYR TE FEED BIN
220 117 0100
BELT FEEDER
220 218-2100
SCREW FEEDER
220 228 0100
STEAM
65 BAR
FEED
CIRCULATION
230 376-0100 0200
WASTE HEAT
230 126
220 212 01
COAL TUYERES
FLASH SMELTING FURNACE
220 261 0100
DRAG CONVEYOR
HEAT EXCHANGERS
220 289-0300 0400
HEAT EXCHANGER
SPRAY WATER PUMPS
SPRAY WATER TANK
220 519 0100
DEMINERALIZED WATER
SLAG GRINDER
JACKET WATER PUMPS
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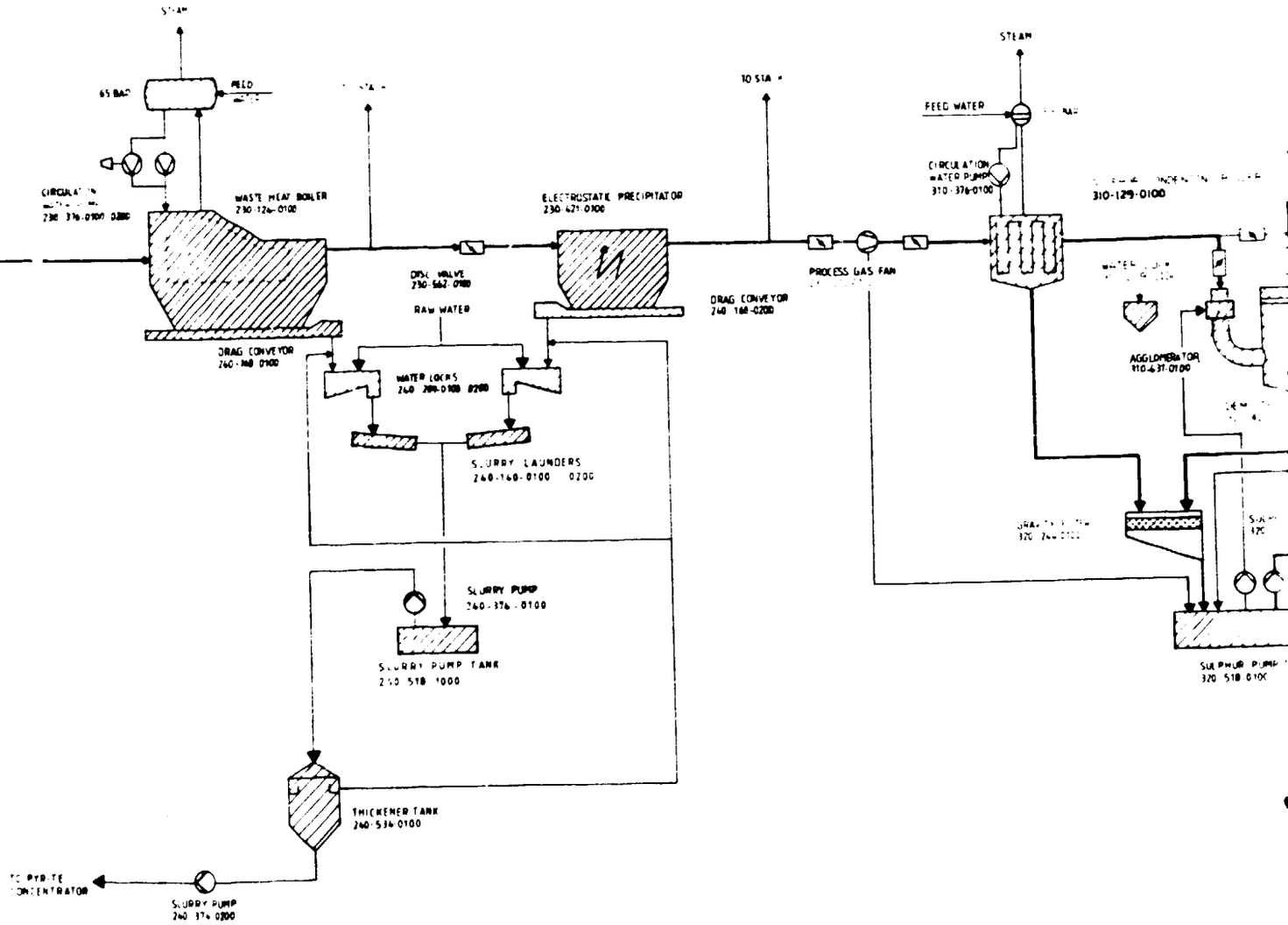
220 519 0200
SLAG POTS
TO PYRITE CONCENTRATOR
SLURRY PUMP
240 376 0200

SECTION 2


STEAM
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CIRCULATION
WASTE HEAT BOILER
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ELECTROSTATIC PRECIPITATOR
230-621-0100
10 STEAM
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CIRCULATION WATER PUMP
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310-129-0100
DISC VALVE
230-662-0100
DRAG CONVEYOR
240-168-0200
PROCESS GAS FAN
DRAG CONVEYOR
240-168-0100
RAW WATER
WATER LOCKS
240-209-0100 0200
AGGLOMERATOR
310-631-0100
SLURRY LAUNDERS
240-160-0100 0200
SLURRY PUMP
240-376-0100
SLURRY PUMP TANK
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THICKENER TANK
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SULPHUR PUMP
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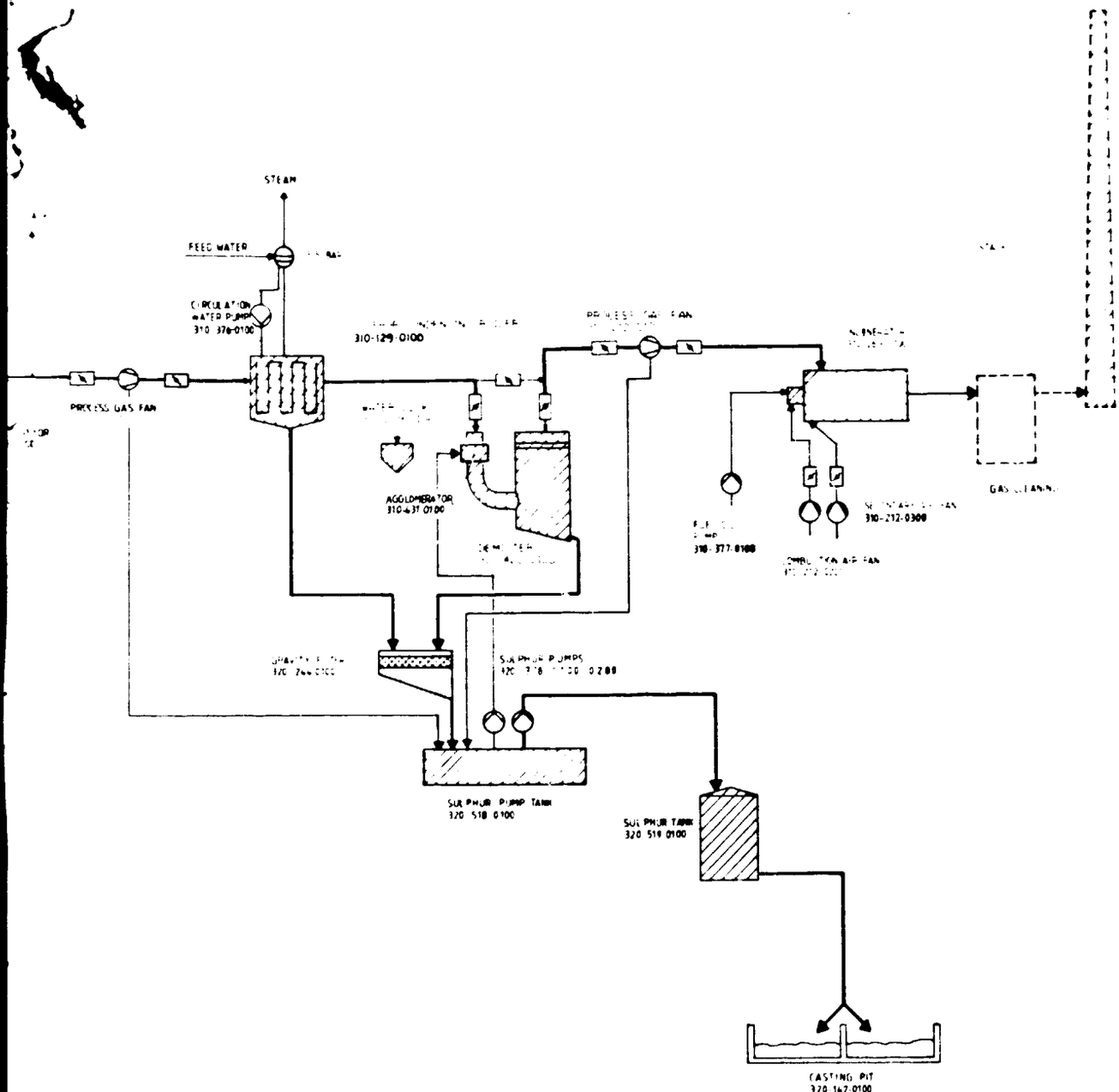
SECTION 3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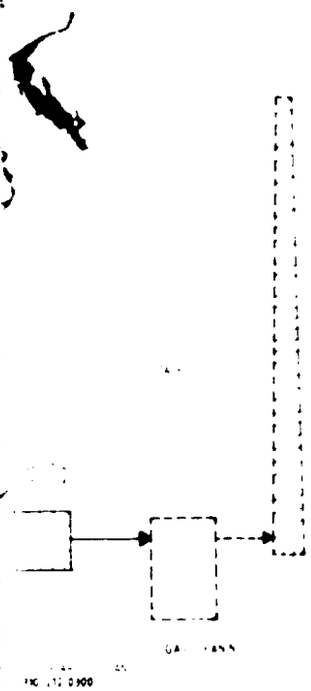
PROCESS GAS FAN
AGGLOMERATOR 310-437-0100
310-377-0100
310-212-0300
GAS CLEANING
SULPHUR PUMPS
SULPHUR PUMP TANK 320 518 0100
SULPHUR TANK 320 519 0100
CASTING PIT 320 142-0100

SECTION 4



SECTION 5

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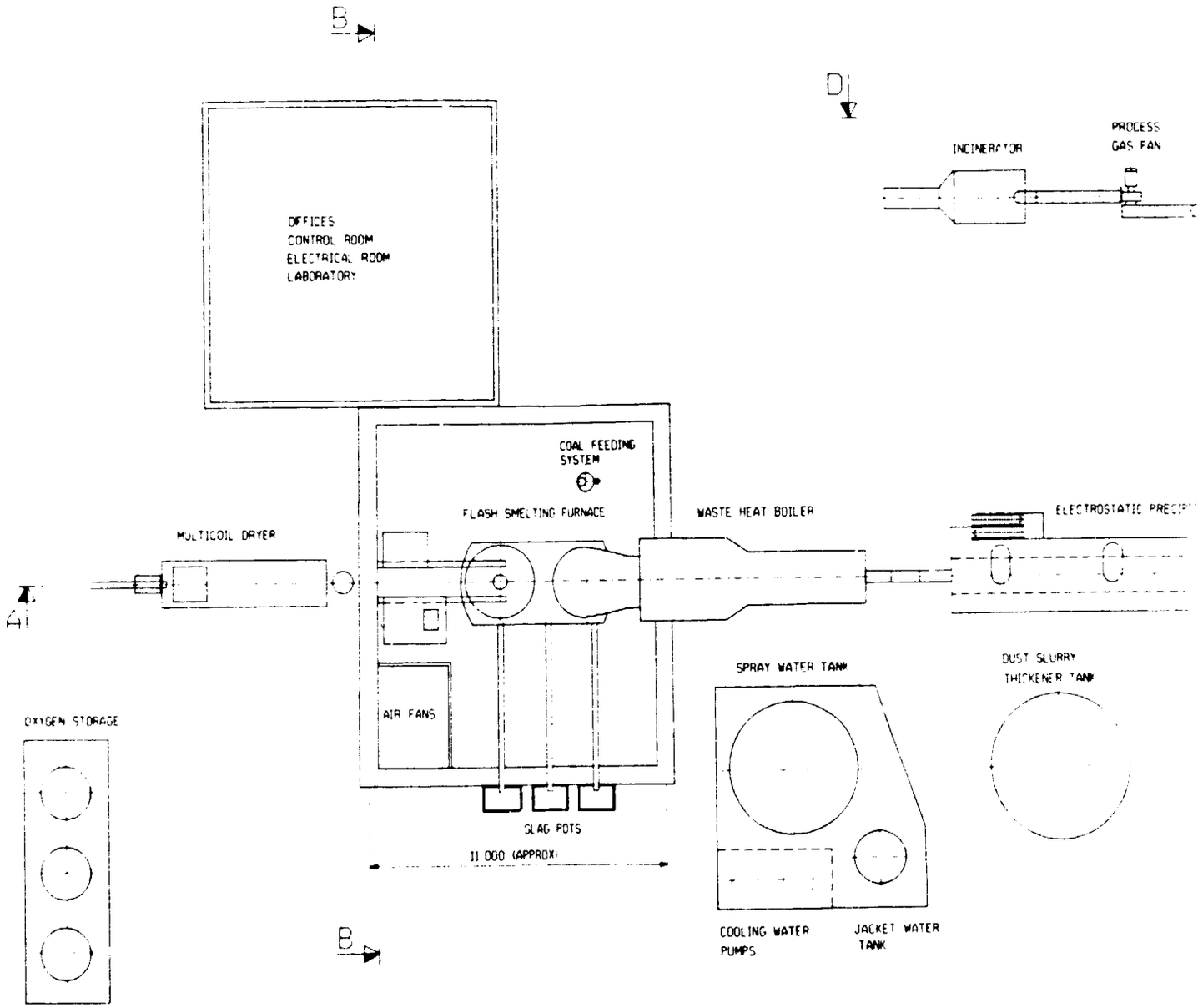
	DRAWN	5 SEPT 1985	P.W
	APPROVED	5 SEPT 1985	A.K
CLIENT: PYRITES, PHOSPHATES & CHEMICALS LTD		CLIENT'S DWG NO.	
PROJECT: SALADIPURA DEMONSTRATION PLANT			
DRAWING TITLE: FLASH SMELTER AND SULPHUR PLANT EQUIPMENT DIAGRAM	SCALE: —	DWG NO. 252 300 901 002	REV. 9

C FOR FEASIBILITY STUDY 18 OCT 1985 EKK PW AK



SECTION 1

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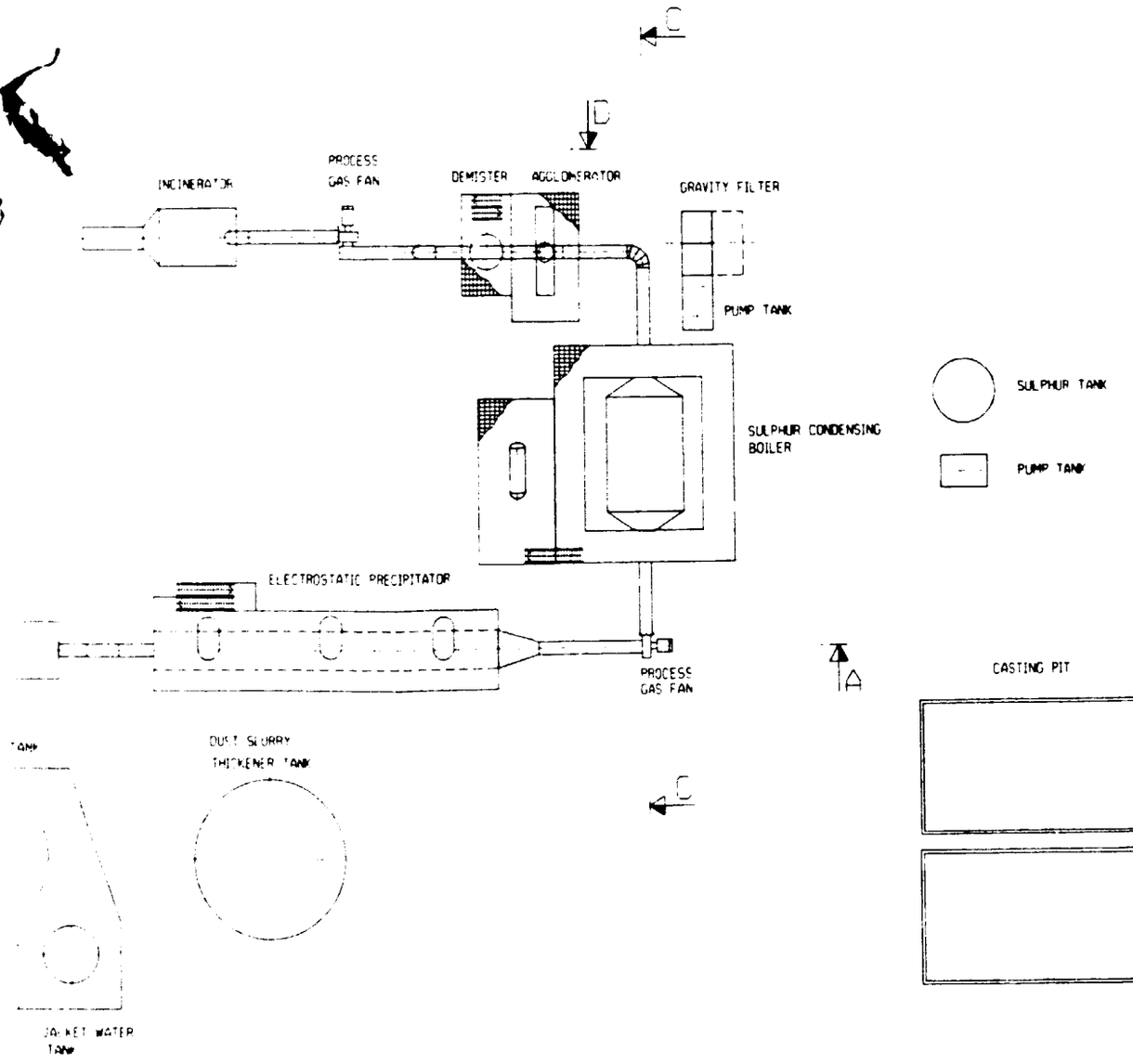

SECTION 2

OUTOKUMPU ENGINEERING	DESIGNED	08.11.1985	AM
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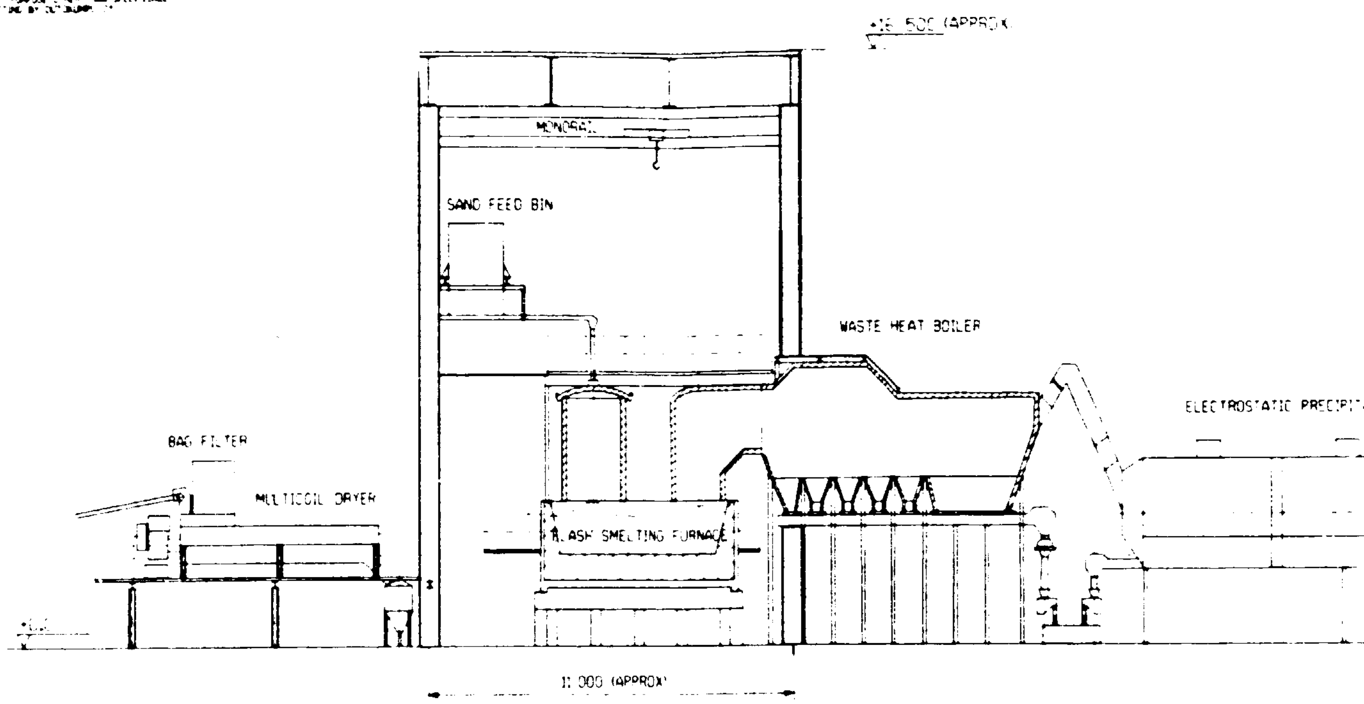
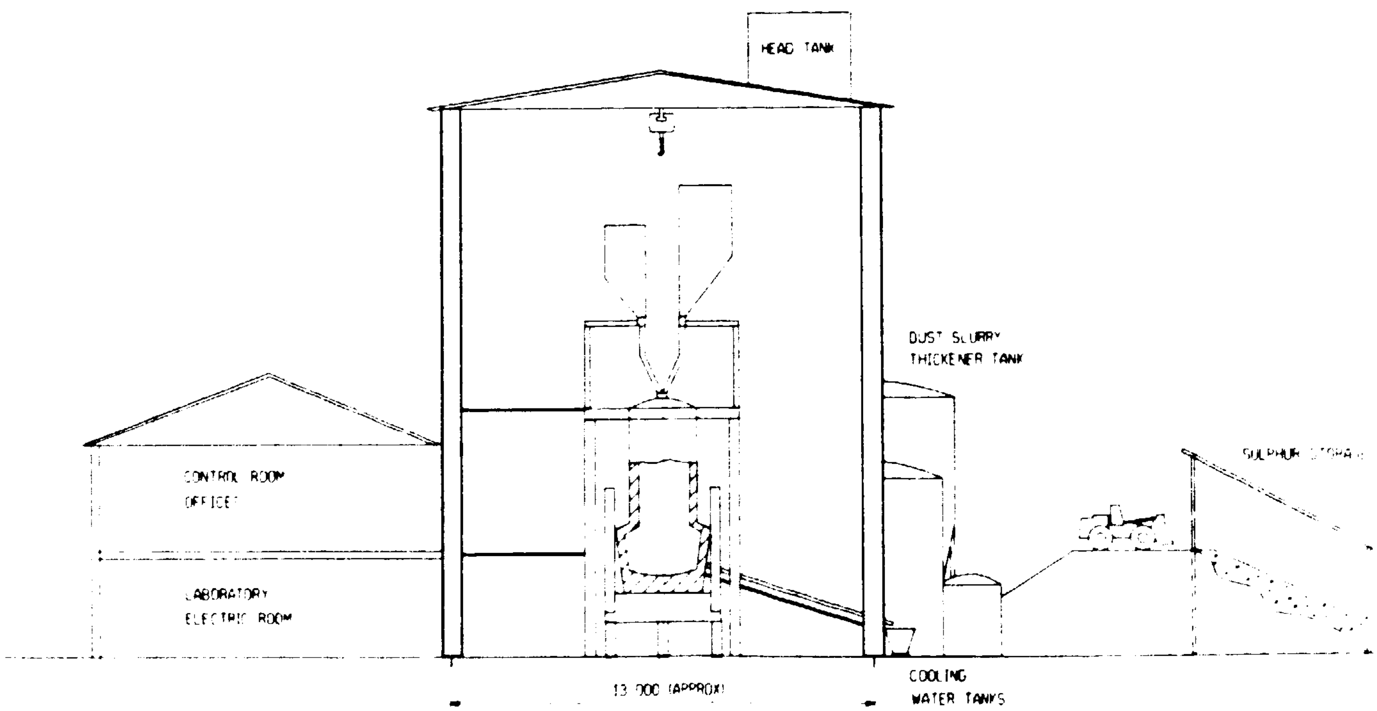
PROJECT: SALAQUIPUKA DEMONSTRATION PLANT			
DRAWING TITLE: FLASH SMELTER AND SULPHUR PLANT PLANT LAYOUT PLAN	SCALE: 1:100	REF. DWG	
		DWG NO. 250 300 9101 001	

2	FOR FEASIBILITY STUDY	08.11.1985	AMS	
REV.	REVISIONS	DATE	DRAWN	CHECKED / APPROVED / AGREED / FILED

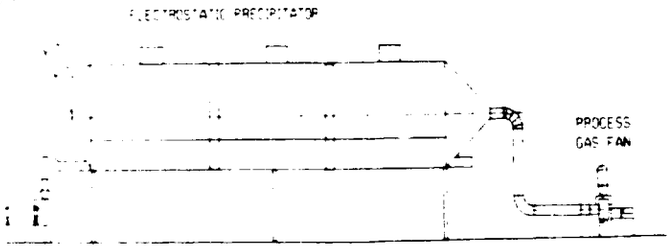


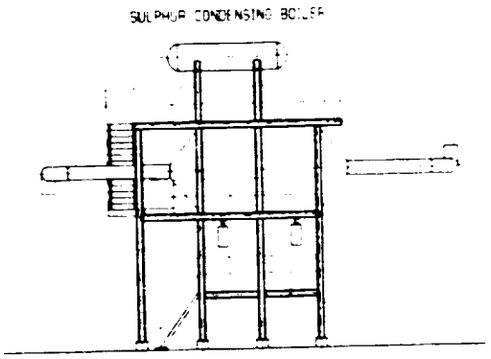
SECTION A-A



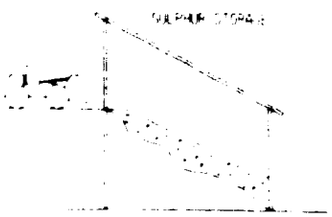
SECTION B-B

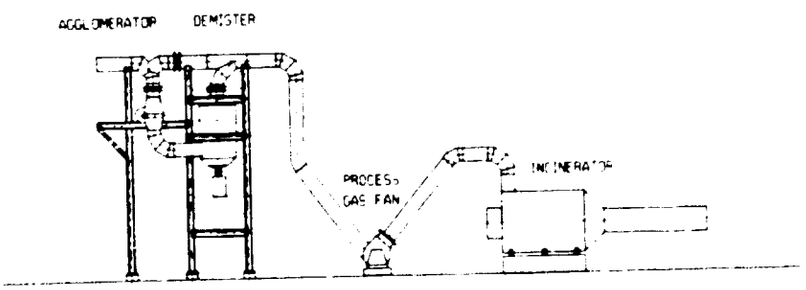
SECTION 1





SECTION C-C





SECTION D-D

SECTION 2

OUTOKUMPU ENGINEERING	DESIGNED	08.11.88	AMS
	CHECKED		
	APPROVED		
CLIENT: PYRITES, PHOSPHATES & CHEMICALS	CLIENT DWG. NO.		
PROJECT: SALAIPURA DEMONSTRATION PLANT			
DRAWING TITLE: FLASH SMELTER AND SULPHUR PLANT PLANT LAYOUT SECTIONS A-A, B-B, C-C, D-D	SCALE: 1:100	REF. DWG.	
		DWG. NO.	REV. NO.

C.I.E.R. FEASIBILITY STUDY — 08.11.1988 — AMS

DATE — DRAWN — CHECKED — APPROVED — REVISION NO. — REVISIONS

5 OPERATING DATA

5.1 Supervision and Labour Requirements

5.2 Requirements of Utilities and Consumables

5
OPERATING DATA

5.1
Supervision and Labour Requirements

Supervision and labour requirements for the smelter plant operation are presented below. Personnel needed for areas not belonging to the scope of this study are excluded.

5.1.1
Total Personnel

Plant manager	1
Engineers	2
Foremen	8
Crew	39
Total	50

5.1.2
General Supervision

Plant manager	1
Metallurgist	1
Total	2

5.1.3
Operating Personnel

	Day shift	3-shift	Total
Engineers	1		1
General foremen	1		1
Foremen (operating)	1	4	5
Operating crew	2	20	22
Maintenance foremen	1		1
Maintenance and assisting crew	5	4	9

5.1.4
Laboratory Personnel

	Day shift	3-shift	Total
Foremen	1		1
Crew		8	8

5.2
Requirements of Utilities and Consumables

Annual consumptions are based on an estimation of 7 500 operating hours per year with full capacity.

5.2.1
Flash Smelting Area

Coal	t/a	2 000
Heavy fuel oil	t/a	820
Light fuel oil	t/a	100
Oxygen	m^3/a	2 250 000
Electric energy	MWh/a	690
Steam 5.5 bar, saturated	t/a	2 100
Steam 40 bar, 350 °C, superheated	t/a	1 100
Demineralized water	m^3/a	2 300
Semisoft water	m^3/a	30 000
Filtered raw water	m^3/a	5 300
Refractory bricks	t/a	60
Mortar for bricklining	t/a	5
Oxygen lances	t/a	3
Tapping clay	t/a	4

5.2.2
Sulphur Plant Area

Heavy fuel oil	t/a	210
Electric energy	MWh/a	100
Steam 5.5 bar, saturated	t/a	2 250
Demineralized water	m^3/a	140
Filtered raw water	m^3/a	
Glass wool	m^3/a	30

6 ECONOMIC SURVEY

6.1 Estimation of investment cost
6.2 Estimation of operating cost
6.3 Estimation of revenues

6
ECONOMIC SURVEY

6.1
ESTIMATION OF CAPITAL COST

6.1.1
Basis of Capital Cost Estimate

Scope of Outokumpu's Estimates

The evaluation of the investment cost is limeted to the agreed scope of work and all the costs outside the battery limits are excluded.

Within the scope the investment is estimated on turnkey basis including the engineering, equipment and material supplies, construction,transportation, erection, commissioning and start-up assistance. The only missing cost is the site preparation (earth flattening, roads and drainages).

According the the scope, the following areas are included in the estimates:

- pyrite drying
- flash smelting
- flash smelting furnace gas handling
- dust handling
- elemental sulphur separation
- sulphur purification and casting
- office and control building, including laboratory

Terminal Points of Outokumpu's Estimates

The estimates are limited within the following terminal points

Pyrite:	inlet to the dryer feed funnel
Coal:	inlet to the separation cyclone near the flash smelting furnace (pneumatic transport)
Bunker C oil:	inlet to the feed pipe at the smelter area
Light fuel oil:	inlet to the feed pipe at the smelter area
Sulphur:	outlet from the casting pit, sulphur storage is included, transportation vehicles excluded
Dust:	outlet of settled dust slurry pump
Slag:	outlet from slag pot

Filtered raw water:

inlet to the smelter area/outlet to drain

Demineralized and semisoft water:

inlet to the smelter area/outlet from the smelter area

Secondary cooling water:

inlet to the heat exchangers/outlet from the heat exchangers

Electric energy: inlet to the MCC in smelter area

Tail gases: outlet from the incinerator

Plant and instrumentation air:

inlet to the smelter area

The items outside Outokumpu's estimate

The investment of the following required items is not in the Outokumpu's estimate:

- Pyrites supply and concentrator plant
- Liquid oxygen supply, storing and vapourizing
- Fuel oil supply, storage and preheating (heavy and light fuel oil)
- Coal storage, milling and drying
- Water supply system with softening and demineralization equipment
- Feed water plant for the boilers
- Cooling tower system with circulation
- Tail gas washing
- Stack of tail gas
- Power supply/generation equipment
- Fire fighting equipment
- Land, land development, roads and drains
- Workshop
- Wash and change rooms
- Township facilities
- Transport vehicles
- Pay loaders, fork lift trucks, tractors etc.
- Working capital (storage inventories of raw materials, supplies etc.)

Accuracy of the estimation

The estimates are within the limits of ± 15 %.

Indigeneous/foreign supplies

It is assumed, that the CIF supply of process facilities as well as engineering, erection supervision and start up assistance will be of foreign supplies.

Civil construction, inland transportation and erection will be of indigeneous origin.

Taxes and Duties

Supplies of indigeneous origin:

The freight, insurance and erection cost as well as the cost of buildings and civil work are free on duties and taxes.

Custom duty of foreign supplies

A custom duty of 40 % is added to the CIF cost of foreign equipment supplies and 25 % for the foreign engineering and commissioning work.

Price level

The foreign supplies are according to European price level in November 1985. In estimation of the main equipment Outokumpu has been in contact with the manufactures.

The Indian supplies are estimated using the unit prices received from PPCL in July 1985.

When converting the foreign currency to the Indian Rupees, the following rates of exchange have been used:

RS 1 = Finnish Marks 0.46
RS 1 = United States Dollars 0.082

6.1.2
Fixed capital, Rs 1000

Items	Basic price CIF		Freight & Insurance	Custom duty for foreign supplies 45 % (25%)	Cost at site		
	Indian Supplies	Foreign supplies			Indian supplies	foreign supplies	Total
Engineering		5531		1383	1383	5531	6914
Commissioning, supervision of erection and start up		6638		1660	1660	6638	8298
Equipment, foreign							
-smelter		31066	932	13980	14912	31066	45978
-sulphur plant		2777	83	1250	1333	2777	4110
-laboratory		2553	77	1149	1225	2553	3778
Electrification		1276	38	574	612	1276	1888
Piping		2234	67	1005	1072	2234	3306
Instrumentation and automation		1541	46	693	740	1541	2281
Spare parts		2072	62	933	995	2072	3067
Erection and installation	5100				5100		5100
Building constructions	1688				1688		1688
Subtotal	6788	55688	1306	22626	30720	55688	86408
Miscellaneous, 5 %	339	2784	65	1131	1536	2784	4320
TOTAL COST INSIDE OUTOKUMPU'S SCOPE	7127	58473	1371	23757	32256	58473	90728
Total cost without duties and taxes	7127	58473	1371		8498	58473	66971

ANNUAL BREAK DOWN OF INVESTMENT COST Rs 1000

YEARS	1	2	3	TOTAL
Engineering	6914			6914
Commissioning, supervision of erection and start up		4149	4149	8298
Equipment, foreign				
-smelter	18391	27587		45973
-sulphur plant	1644	2466		4110
-laboratory	756	3022		3778
Electrification	378	1510		1888
Piping	661	2645		3306
Instrumentation and automation	456	1825		2281
Spare parts		1534	1534	3067
Erection and installation		4080	1020	5100
Building costructions	338	1350		1688
Subtotal	29537	50168	6703	86408
Miscellaneous, 5 %	1477	2508	335	4320
TOTAL COST INSIDE OUTOKUMPU'S SCOPE	31014	52677	7038	90728

6.2
ESTIMATION OF OPERATING COST

6.2.1
Basis of operating cost estimates

Scope and extent of estimates:

The operating cost are estimated according to the same scope and within the same terminal points as the investment cost (item 6.1.1).

This estimate excludes the delivery cost of pyrite concentrate.

The consumption figures of utilities and supplies are based on the process and plant design as well as on the experience received from Outokumpu's own pilot flash smelter.

It must be noticed, that the operating costs are indicative and they will be depend on the pilot test programs.

The cost are estimated on annual level asuuming, that the plant shall operate 7500 hours per year.

Unit prices used in the estimates

The unit prices are the same as used in the Amjhore pyrite study in August 1985 with the exception that the price of water and liquid oxygen are based on the assumptions of Outokumpu.

- Wages and salaries including social cost:

- managers	Rs	3,000 /month
- operating engineers	"	2,500 / "
- foremen	"	2,500 / "
- skilled labour	"	1,800 / "
- helpers	"	1,200 / "
- Bunker C oil	Rs	3,141 /ton
- Light fuel oil	"	3,500 / "
- Coal	"	250 / "
- Refractory bricks	"	8,000 / "
- Electric energy	"	650 /MWh
- Mortar for bricks	"	6,000 / "
- Oxygen lances for tapping	"	10 / kg
- Tapping clay	"	2,000 / ton
- Glass wool	"	700 / m^3
- Demineralized water	"	3.5 / "
- Semisoft water	"	2.5 / "
- Filtered raw water	"	1.0 / "
- Liquid oxygen	"	3.0 / Nm^3

It is important to check the relevant delivery price of liquid oxygen, because the oxygen cost will be very remarkable in the plant operation.

6.2.2
Annual operating cost

Variable cost

Smelter:	Annual consumption		Unit Price Rs	Annual cost Rs 1000/a
*Coal	2,000	t	250	500
*Heavy fuel oil	820	t	3141	2,575
*Light fuel oil	100	t	3500	350
*Oxygen	2,250,000	m^3	3.00	6,750
*Electric energy	690	MWh	650	449
*Steam, 5.5 bar, saturated	2,100	t	produced in the process	
*Steam 40 bar, 350 °C	1,100	t	55	60
*Demineralized water	2,300	m^3	3.50	8
*Semisoft water	30,000	m^3	2.50	75
*Filtered raw water	5,300	m^3	1.00	5
*Refractory bricks	60	t	8000	480
*Mortar for bricks	5	t	6000	30
*Oxygen lances	3	t	5000	30
*Tapping clay	4	t	2000	8
Sulphur plant:				
*Heavy fuel oil (Bunker C)	210		3141	660
*Electric energy	100	MWh	650	65
*Steam, 5.5 bar, saturated	2250	t	produced in the process	
*Demineralized water	140	m^3	3.50	1
*Glass wool	30	m^3	700	21

Subtotal of variable cost	Rs 12,067,000/a
Miscellaneous 5 %	603,000/a
Total variable operating cost	Rs 12,670,000/a

Fixed operating cost

		Rs 1000/a
Wages and salaries,		
- plant manager (1)	(Rs 3000/month)	36
- engineers (2)	(" 2500 ")	60
- foremen (8)	(" 2500 ")	240
- operating crew (39)	(" 1800 ")	842
Total wages and salaries		1,178
Spare parts and maintenance		2,600
subtotal		3,778
General and miscellaneous cost 5%		188
Total fixed operating cost		Rs 3,966,000/a

6.3
ESTIMATION OF REVENUES

The production of elemental sulphur with the nominal capacity will be 3,480 kg per day.

In case the plant will operate 7,500 hours per year, the sulphur output will be 1080 ton per year. With a sales price of Rs 2,573 per ton the annual revenues will result in Rs 2,778,800.