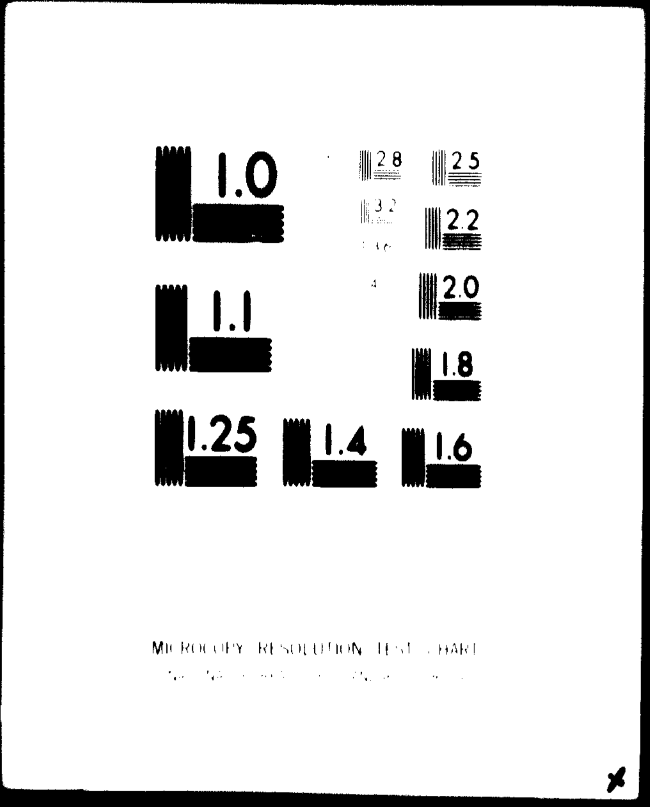
1 OF 4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Outokumpu Oy

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02321
(1 of 2)

Study of Electrolytic Copper Production

at Etibank in Turkey

The United Nations Industrial Development Organization

Volume I
Feasibility Study

20th December, 1976.

Outokumpu Oy

CONTENTS

Outokumpu Oy

1. SUMMARY

CONTENTS

1. SUMMARY

1.1 General

The purpose of this study has been to examine the site selection of the electrolytic copper refinery on Turkey, its capacity, final products, marketing study, investment and operating costs and the profitability.

1.2 Markets

According to the marketing study copper wires with a diameter of 0.4 - 8.0 mm have been chosen as the final product of the plant. Copper wire will find the best markets both in Turkey and abroad.

1.3 Site selection

The optimum location for the plant will be in Samsun, in connection with the copper smelter of Karadeniz Bakir Isletmeleri A.S.

1.4 Capacity

The plant should be built in two stages.

- 1st stage: capacity 25 000 tons of copper wires per year
- 2nd stage: expansion of the capacity to 50 000 tons per year

1.5 Capital costs

The total capital costs for process equipment, civil engineering and utility services are as follows:

1st stage, 25 000 tons per year

Fixed capital

- anode casting	58 430 000 TL
- electrolytic refining	100 218 000 TL
- wire production	120 161 000 TL
- plant area	5 729 000 TL
- others	37 415 000 TL
sub-total	321 953 000 TL

Working capital

- liquid assets	52 548 000 TL
- inventories	88 110 000 TL
sub-total	140 658 000 TL
TOTAL	462 611 000 TL

2nd stage, from 25 000 to 50 000 tons per year

Fixed capital

- anode casting	-
- electrolytic refining	78 794 000 TL
- wire production	107 539 000 TL
- plant area	2 330 000 TL
- others	18 459 000 TL
Sub-total	207 122 000 TL

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Working capital

- liquid assets	167 932 000 TL
- inventories	234 367 000 TL
Sub-total	402 299 000 TL
TOTAL	609 421 000 TL

Total stages 1 and 2	1 072 023 000 TL

1.6
Operating costs

The annual operating costs for both stages are as follows:

1st stage, 25 000 tons per year

- import blister	598 703 430 TL/a
- variable costs	47 806 855 TL/a
- fixed costs	11 368 000 TL/a
TOTAL	657 878 285 TL/a

2nd stage, 50 000 tons per year

- domestic blister	1 904 076 200 TL/a
- variable costs	99 017 136 TL/a
- fixed costs	16 905 000 TL/a
TOTAL	2 019 998 336 TL/a

Total labour requirements (included in operating costs)

- 1st stage	94 + 21 = 115
- 2nd stage, additional	47 + 4 = 51
TOTAL	166

1.7
Incomes

Annual gross incomes at design capacity will be

- 1st stage 713 865 000 TL/a
- 2nd stage 2 704 654 000 TL/a

1.8
Profitability

The profitability for both stages, taking the pay-back period of investment into consideration, is as follows:

a) 10 years with an interest of 15 %, without escalation, financing and income taxes on profits

b) considering escalation and financing expenses of loans; 60 % of total investments, interest 15 % and pay-back period 8 years, the investment does not pay itself back during the production years.

The rate of return in the a) case will be 25.8 %.

The profitability is very sensitive to the price of blister and wire. The influence of investment costs, sales and operating costs are smaller.

1.9
Recommendation

Considering the results of the study we would suggest that the plant is built as follows:

- The plant is based on the capacity 25 000 tons of Cu wires per year. The production could start in 1980 using import blister. Its products would be marketed either wholly on domestic demands or surplus production abroad. Applications will be made for investments and production to get them tax and duty free.

- Domestic blister will be used as soon as possible

- When the domestic production of blister has been developed, the capacity will be expanded to 50 000 tons per year.

It would not be profitable to base the plant only on imported blister and foreign markets.

The plant will be located in Samsun.

A market organization for the production of the plant will be formed in such an early stage as possible.

2. INTRODUCTION

CONTENTS

2. INTRODUCTION

2.1 Contract

This work has been based on the contract entered into by the United Nations Industrial Development Organization and Outokumpu Oy, stated as the Study of Electrolytic Copper Production at Etibank, dated 23rd April, 1976.

Etibank is an organization which is responsible for the operation of the majority of the non-ferrous metallurgical sector in Turkey.
At present, Etibank produces, however, only blister copper in the copper section.

2.2 The aim of the project

The aim of this project is to assist the Turkish government in further development of the copper industry by preparing a techno-economic feasibility study for the establishment of an electrolytic copper refinery and the establishment of a plant which will further process the copper cathodes into wires.

2.3 Execution of the study

At the first stage of the study the design criteria have been stated which determine the selection of the plant site, capacity and products.

This phase is based on the field work carried out in Turkey, which included the research of the present status of Turkish copper industry, and the market research of present and potential marketing of electrolytic copper as well as of by-products concerned.

The next stage of the work consists of the plant design which has been performed by a project team from Outokumpu Oy Engineering Division. The experience of specialists from various plants of Outokumpu Oy has been utilised.

Considering the criteria obtained from the market research, like the products and capacity of the plant, and local circumstances the process has been selected among various alternatives which has provid to meet best the technical and economic requirements imposed on the electrolytic refining of blister copper and on further processing into copper wires.

In the design, the most advantageous solution for the Turkish national economy as a whole has been pursued using the already existing production capacity and supplying all equipment from Turkey as far as possible.

In the economical syrvey, the capital costs and operating data have been utilized to determine the profitability for each production alternative considered. Based on these data, final recommendations have been made for the plant size and raw materials.

2.4
Team

Composition of the team:

Olli Hyvärinen
Raimo Rantanen
Jouko Sinisalo
Heikki Savolainen
Mauri Rantanen
Bengt Norrman
Martti Harju
Pekka Kuisma
Erkki Jauhiainen
Seppo Torasvirta
Markku Heikkilä
Raimo Saari
Tapio Bohm
Eva Tuomikoski

3.
DESIGN CRITERIA

CONTENTS

3.1
Site selection

3.1.1
General

Research on the site selection for the electrolytic refinery have been based on the assumption that the economically most favourable site would be:

either in connection with the smelter, when transportation costs of blister and copper scrap would be minimised.

In this case the following sites could be chosen:
- K.B.I. smelter in Samsun
- Etibank smelter in Ergani
- Etibank smelter in Murgul

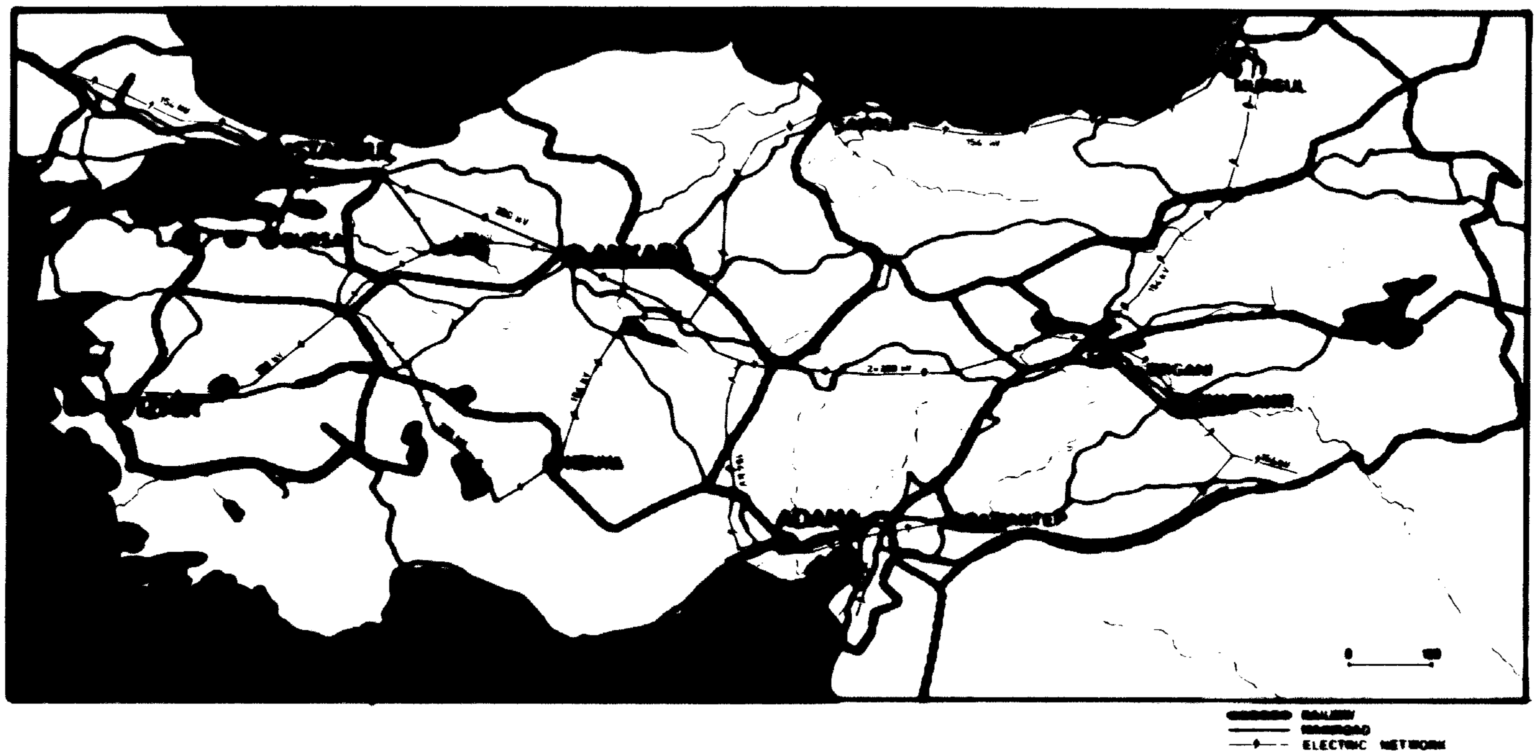
or near markets and consumers, when transportation costs of the product would be more favourable.

In this case the site would be in the Istanbul area according to the enclosed market research. (see Market Study, Volume II, Chapter 7, fig. 7-1).

In addition the selected site should fill the requirements as well as possible regarding
- environmental conditions
- availability of utilities, as electic power, steam, water, pressure air etc.
- man power
- transportations

The afore mentioned areas have mainly been discussed in the market research.

TURKEY TRANSPORT CONNECTIONS AND ELECTRIC NETWORK



3.1.2

Etibank copper smelter in Ergani-Maden

General

The smelter is situated in a mountainous region in southeastern Turkey. The ore reserves in the mine located near the smelter is about 13 years at the present mining rate of 750 000 tons per year. Small ore deposits have found in the area. These deposits are not, however, economically feasible under present conditions.

The preset capacity of the smelter is about 10 000 - 12 000 tons of blister copper per year. The possibilities of expanding the capacity are limited.

Area

There is a suitable site for the electrolytic refinery of about 40 x 60 m near the smelter. This area will only be large enough for a tank house with a capacity of 10 000 tons per year. An expansion of the site for a larger capacity would require demolition of buildings not in use and earth moving work. The site available would then be 40 x 100 m, and the maximum estimation of the capacity would be about 20 000 - 30 000 tons per year.

The anode casting plant could be located close to the existing converter aisle.

No suitable area has been found for the wire production plant near the smelter. An area of about 2000 m^2 would be required for a capacity

20 000 tons for copper per year. Significant site preparation work would be needed for a suitable site in the Maden area.

Transportation

The rail way and one of the main roads in Turkey go through this area. Raw materials and products can be transported either by train or trucks.

Utilities

There will be sufficient free capacity for the refinery in the smelter network of compressed air, water and available steam. Acid requirements would be from the plant situated in connection with the smelter.

Electricity

The electric power, 5-10 MW, required in the refinery would need new transmission lines, 125 km, and main and distribution transformers. According to Turkiye Elektrik Kumuru there is power capacity in the area.

Labour

Adequate manpower exists in the area.

3.1.3
Etibank copper smelter in Murgul

General

The smelter is located in the mountains of eastern Turkey, about 1200 m above sea level.

Near the smelter there are two mines and concentrators, Damar yatag and Cakmakkaya, with ore reserves for 13 and 10 years with the present mining rate , 1.5 million and 3 million tons per year.

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One of the concentrators serves the smelter and concentrate from the other is transported to Samsun.

The smelter production is about 8 000 tons of blister per year. The production will be increased to 11 000 tons per year in connection with the new H_2SO_4 plant.

Area

The anode casting plant of the refinery can be located close to the converter isle in the smelter. A site of 40 x 70 m will be reserved for the tank house. This will be adequate for a capacity of 10 000 tons per year. Enlargement of this site would not be readily achieved.

No suitable area has been found for the wire production plant near the smelter.

Transportation

The only communication to the site is by a poor montain road. All transportations from the plant would have to be performed by trucks to the nearest harbour town Hopa and from there either by ship or truck.

Utilities

There is free capacity for the copper refinery in the smelter system of compressed air, water and steam. Production of steam will, however, be expensive with the present system; burning of oil in reverberatory furnace waste heat boiler.

The present H_2SO_4 plant is not in use, but a new plant has been designed to be taken into use in 1979.

Electricity

The capacity of present feed lines and transformers will not be enough for the refinery.

According to TEK the installation of additional power, 5-10 MW, to the area would be a very difficult and expensive operation with present resources. A separate power plant must be built in the area for the refinery.

Labour

There is adequate unskilled labour available. Skilled labour must be drawn from other areas.

3.1.4

K.B.I. copper smelter in Samsun

General

The smelter is situated on the Black Sea coast on a plane field about 10 km from the Samsun town.

There are a smelter, a slag concentrator and a H_2SO_4 plant in the area. The designed capacity of the smelter is 40 000 tons of blister copper per year. For various reasons the production capacity has been only 10 000 - 15 000 tons per year during the last few uears.

Area

Near the smelter there is a plane, open area for the tank house and production plant, both for the present capacity and for possible expansions in the future.

The anode casting plant can be placed in the present blister casting plant without special changes in the building.

Transportation

Transportation from the smelter area to Samsun will be made by trucks, and from Samsun to other locations by road, rail or sea.

A rail way connection from the smelter area to Samsun and the harbour is under construction.

Utilities

There is adequate capacity in the smelter for water, compressed air and steam for the electrolytic refinery. Acid will be supplied from the sulphuric acid plant located near the smelter.

Electricity

New transmission lines and transformers will be required for the power supply to the tank house. According to TEK the supply of electic power to the area will not be any problem, because the new 250 MW hydroelectric power station on Hasanugurlu, near Samsun, will be commissioned in 1977.

Labour

There is adequate labour available in the area.

3.1.5 Istanbul area

General

The market research showed that most of the product's consumers in Turkey exist in the Istanbul area. The present electrolytic refineries are also located in the same area.

Area

There is a suitable site for the plant in question in the Istanbul area. Etibank does not, however, own any suitable property there.

Transportation

Apparently it will be possible to build the plant in an area where the main road and railroad are near. Transportations both to consumers and to the harbour can be handled favourably. All blisters should be transported from the areas in various parts of Turkey to the plant.

Utilities

Utilities needed in the refinery would require additional investments.

Electricity

According to TEK it would not be recommendable to place the plant in the Istanbul area. The area is already overloaded and most of the power would have to be transmitted to Istanbul from other parts of Turkey.

Labour

Adequate labour is available in the area.

3.1.6 Conclusions

The investigations and calculations have shown that the most economic and favourable location for the electrolytic copper refinery would be the K.B. I. copper smelter area in Samsun.

Such a site is more favourable than the Istanbul area for the following reasons:

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1. Regarding investment costs it will be cheaper to place the plant in connection with the smelter than to build the plant separately from the smelter for the following reasons:
   - water, steam, compressed air and acid are already obtainable in this area
   - there is a site for the plant in this area
   - available electric power

2. Operating costs of the plant in connection with the smelter are lower, because
   - copper will be transferred in molten condition from the converter to the anode furnace, eliminating melting costs
   - one process stage ,no casting of blister
   - copper scrap, about 18 % of the anode amount, can be recycled to be used in cooling of converters instead of the present blister ingots. At present copper anode scrap from the tankhouse is remelted in the anode furnaces by oil.
   - steam is taken as waste heat free of charge
   - transportation costs will be lower
   - part of the organization exists, as administration, maintenance etc.
   - the wage level is lower

Samsun is the most profitable smelter area for the following reasons:

1. An area suitable for all buildings of the smelter can be found with no limitations for future expansions. In Ergani and Murgul only a tank house with the maximum capacity of 20 000 tons

per year can be located. The wire production plant must be located elsewere.

2. It will be possible to increase the capacity of the smelter in the future to correspond to the requirement of the refinery unit, 25 000 ÷ 50 000 tons per year.
In Ergani and Murgul the limit would be about 10 000 tons per year. A larger capacity would require additional transportation of materials between plants.

3. There is a harbour in Samsun, so the tank house can more economically be based on import blister.

4. Lower transportation costs

3.2
Capacity and products of the plant

3.2.1
General

The capacity of the plant can be based either on totally domestic raw materials and demand, on totally foreign raw materials with export of products, or on the optimum combination of the two cases.

3.2.2
Blister copper production in Turkey

Blister copper is produced in Turkey by three smelters; Ergani and Murgul, owned by Etibank, and Samsun smelter, owned by Karadeniz Bakir Isletmeleri S.A. Etibank is a government-owned company. About half of the shares of K.B.I. is in Etibank's possession.

Ergani

The Ergani smelter was founded in 1946. Its designed capacity is 18 000 tons of blister copper per year. The production capacity has, however, been 8 000 - 12 000 tons during the last few years, partly due to the old equipment and partly due to the decreasing contents of copper. Because of this the production of the smelter will also in the future be 10 000 - 12 000 tons of copper per year. There are no plans of expansion.

Murgul

The Murgul smelter was founded in 1953. Its production capacity is at present about 8 000 tons of blister copper per year. The concentrator and certain areas of the smelter limit the capacity of the plant.

It is planned to increase the capacity to 11 000 tons of copper per year by August, 1979. The possibility of increasing the capacity further is very limited with the present reverberatory smelting.

Samsun

The Samsun smelter, operating with the flash smelting method, was commissioned in 1970. Its designed capacity is 40 000 tons per year. The production capacity has been limited to only about 10 000 tons of blister copper per year, at present.

Increase in capacity will be achieved by improving concentrate grades and using oxygen for smelting according to the following schedule:

- 1976 23 000 tons per year
- 1977 30 000 "
- 1978-1981 50 000 "

Additional smelting capacity is planned for 1982. The capacity will then be 100 000 tons of copper per year.

A summary of the blister production in Turkey is shown in Fig. No. 1.

3.2.3
Blister

As shown in the marketing study it is possible to buy blister copper on international markets.

3.2.4
Marketing

As shown in Fig. No. 1 and in the marketing study sales of copper and primarily copper wires have steadily grown in Turkey. The estimated sales in 1976 are about 35 000 tons. The annual sales growth with 15-20 % is shown as a shadowed area.

3.2.5
Existing production capacity of electrolytic copper

At present there are three companies in Turkey which produce electrolytic copper.

- Makinakimiya	3 000	tons of cathodes per year
- Sarkuysan	10 000	" " " " "
- Rabak	20 000	" " " " "

Sarkuysan and Rabak have planned to double their production during 1977.

In addition to these plants a fourth plant has been planned; Bakirsan with a production of 10 000 tons per year. This plant should start its production in 1978.

In Fig. No. 1 the present and planned refining capacity in Turkey is shown graphically.

FIG. NO. 1: TOTAL BLISTER COPPER PRODUCTION, ELECTROLYTIC COPPER REFINERY CAPACITY AND COPPER WIRE DEMAND IN TURKEY

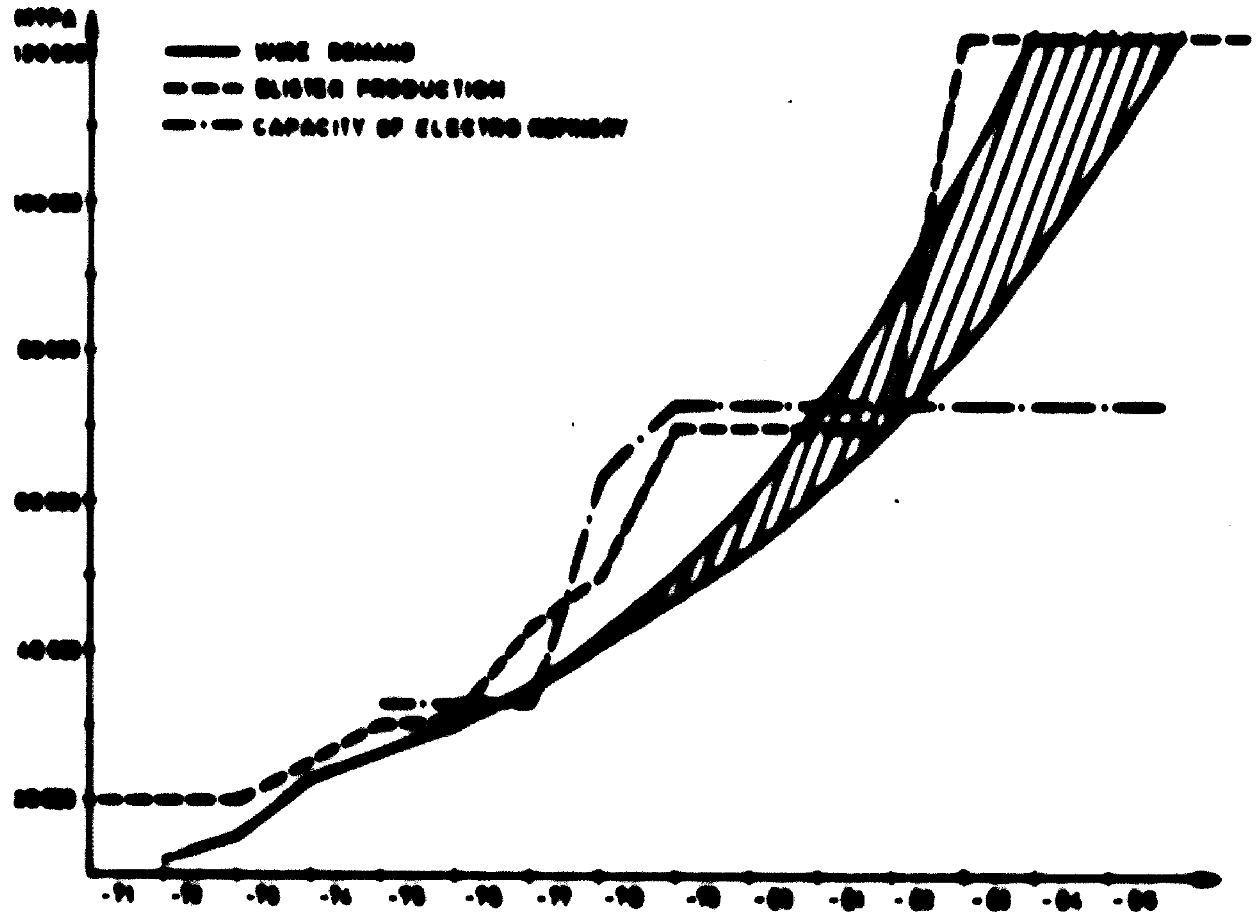
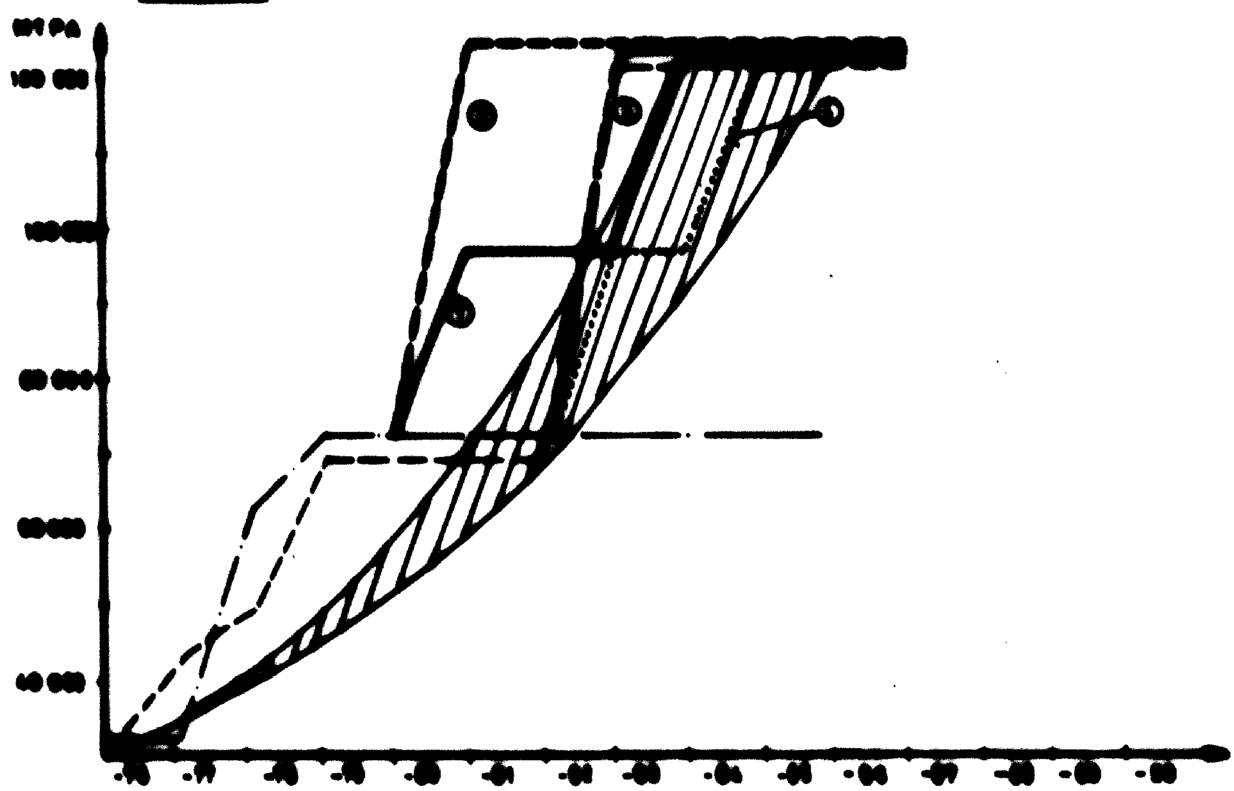


FIG. NO. 2: CAPACITY ALTERNATIVES OF THE ELECTROLYTIC REFINERY PLANT



3.2.6
Conclusions

Demand for copper wires in Turkey, growing 15-20 %, and production capacity of blister and electrolytic copper with planned expansions are shown graphically in Fig. No. 1.

The following can be seen from Fig. No. 1.

- production of blister and electolytic copper will be in balance until the end of 1981
- from the beginning of 1982 the extra production capacity of blister will be about 50 000 tons per year. Consumption of copper wire may correspond to the production two years later, 1983-84.
- in 1980-81 consumption of copper wire may be 10 000 - 20 000 tons greater than the production capacity 90 000 tons per year.

Taking the before mentioned into account the capacity of the plant in the basic alternative could be 25 000 tons per year and expansion possibility 25 000 tons per year, totally 50 000 tons per year.

As the demand may, however, grow faster than estimated, the economic profitability of the plant will be studied in such cases that blister will be imported until the blister production balances the refining capacity.

In order to examine what is the most economic capacity of the plant, considering expansion possibilities, foreign and domestic raw materials and marketing, comparative feasibility calculations will be made for four various alternatives. Final profitability calculations will be made for the most favourable of these.

Alternatives for profitability calculations

All capacity alternatives have been shown in Fig. No. 2 as follows:

1. The plant will be started in 1980 with a capacity of 25 000 tons per year using imported blister. The products will be exported.
   In the beginning of 1983 the capacity will be increased to 50 000 tons per year. The whole capacity will be based on Turkish blister and domestic markets.

2. In the beginning of 1980 the plant will be started with a capacity of 50 000 tons per year using imported blister. The products be exported. In 1982 the production will be changed to use Turkish blister and domestic markets.

3. The plant will be commissioned in early 1982 with a capacity of 50 000 tons per year using Turkish blister and domestic markets.

4. In the beginning of 1982 the plant will be started with a capacity of 25 000 tons per year using Turkish blister and domestic markets. In 1984 the capacity will be increased to 50 000 tons per year using domestic blister and markets.

All the alternatives are based on molten blister from the Samsun smelter. The deficiency in supply for other electrolytic refineries will be filled by imported blister.

3.3 Basis of design

3.3.1 Battery limits

- molten blister copper to anode furnace
- outlet of packed copper product from the plant
- feed of electric power to the main switchgear at the smelter area
- inlet of cooling and process water from the smelter
- inlet of pressure and instrument air from the smelter
- inlet of steam form the smelter
- inlet of chemicals to the storage tanks and bins
- outlet of anode slime in barrels form the plant
- outlet of waste water from the smelter area
- outlet of gypsum sludge to the tailing area

3.3.2 Raw materials

Blister

-	Cu	99.0 %
-	Ag	0.02 %
-	Au	0.002 %
-	Ni	0.057 %
-	S	0.1 %
-	O_2	0.1 %

3.3.3 Products

According to the market study the products have been chosen in the basic capacity alternative as follows:

1. Wires

- diameter	8 mm	6250 MTPA
- "	4 mm	6250 "

- diameter	3.5 - 1.4 mm	6350 MTPA
- "	1.4 - 1.0 mm	3750 "
- "	0.8 mm	833 "
- "	0.6 mm	833 "
- "	0.4 mm	833 "

Compared to the production distribution of various wire thicknesses as presented in the marketing study, the distribution has been based on the production of large diameter wire rod. This is due to the fact that the cable plants have a tendency to buy wire drawing plants of their own, when the demand for thicker wires on the markets will grow. For the same reason marketing on foreign markets will be easier.

2. Anode slime

- quantity	35 MTPM
- Au	1.4 %
- Ag	14 %
- Cu	<2 %

3.3.4
General site conditions

Atmospheric data

- ambient temperatures	
- average max.	+32°C
- average min.	+ 2°C
- pressure	760 mm HG
- relative humidity	
- average	70 %
- rainfall	710 mm per year
- wind	
- design velocity	27 m/s
- prevailing direction:	northwest

Environmental conditions

- type of soil — sand
- soil loads — 2.5 - 3.0 kg/cm^2
- ground water level — -1.3 m
- earthquake zone — 2 (10%)

The utilities steam, cooling and process water, instrument and compressed air are available at the smelter.

3.3.5
Accuracy of the study

The accuracy of the study is ± 20 %.

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4.7
Electrification, instrumentation and civil engineering

4.7.1 Electrification
4.7.2 Instrumentation
4.7.3 Civil engineering

4.8
Total labour requirement and utilities

4.8.1 Labour
4.8.2 Utility consumption

4.9
Flow sheet, lay-outs and equipment lists

4.9.1 Flow sheet
4.9.2 Layouts
4.9.3 Equipment lists

4.10
Additional capacity

4.10.1 Extended capacity
4.10.2 Principles of extension
4.10.3 New cost factors

4. PLANT DESIGN

4.1 Process outlines

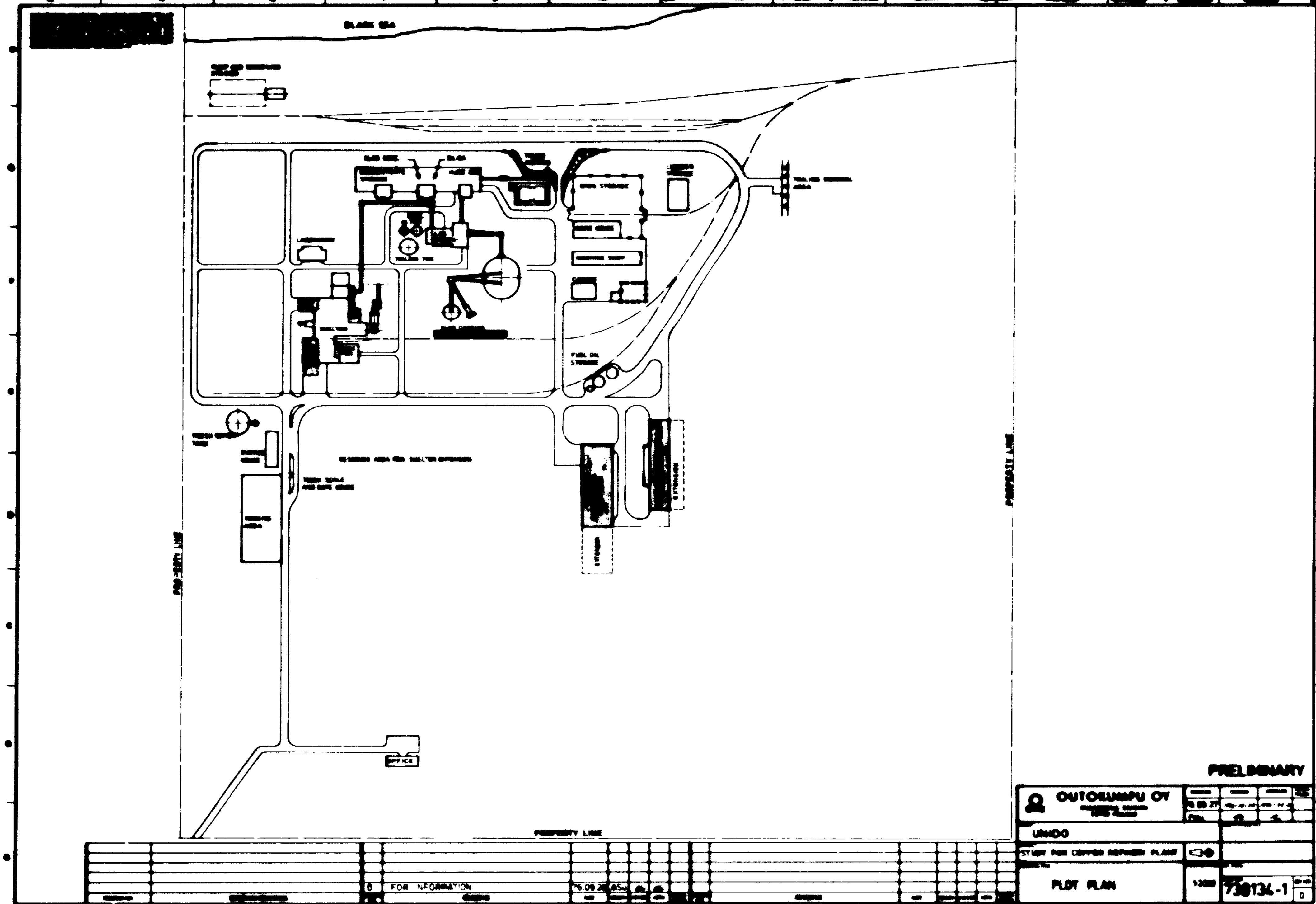
The following process stages are necessary for producing copper wire from blister copper:

1. blister refining and anode casting
2. electrolytic refining
3. cathode melting and wire rod casting
4. rolling and drawing to wire

4.2 Plot plan

The suggested location of the electrolytic tank house and the rod casting and wire drawing plants in the area of the Samsun smelter has been presented in the enclosed plot plan, drawing No. 738134-1.

The anode refining and casting shop will be constructed in the converter aisle of the existing smelter. The new buildings, the tank house, rod casting and wire drawing plant will be in the immediate vicinity of the smelter. A possible expansion of the smelter and these additional production departments have, however, been taken into consideration. With close locations the best results are obtained as to internal transportation of anodes, anode scrap, and cathodes, as well as to good connections to the already existing networks of electricity, steam, and compressed air.



BLACK SEA
FUEL OIL STORAGE
EXTENSION
OFFICE
PROPERTY LINE
PRELIMINARY
OUTOKUMPU OY
UNIDO
STUDY FOR COPPER REFINERY PLANT
PLOT PLAN
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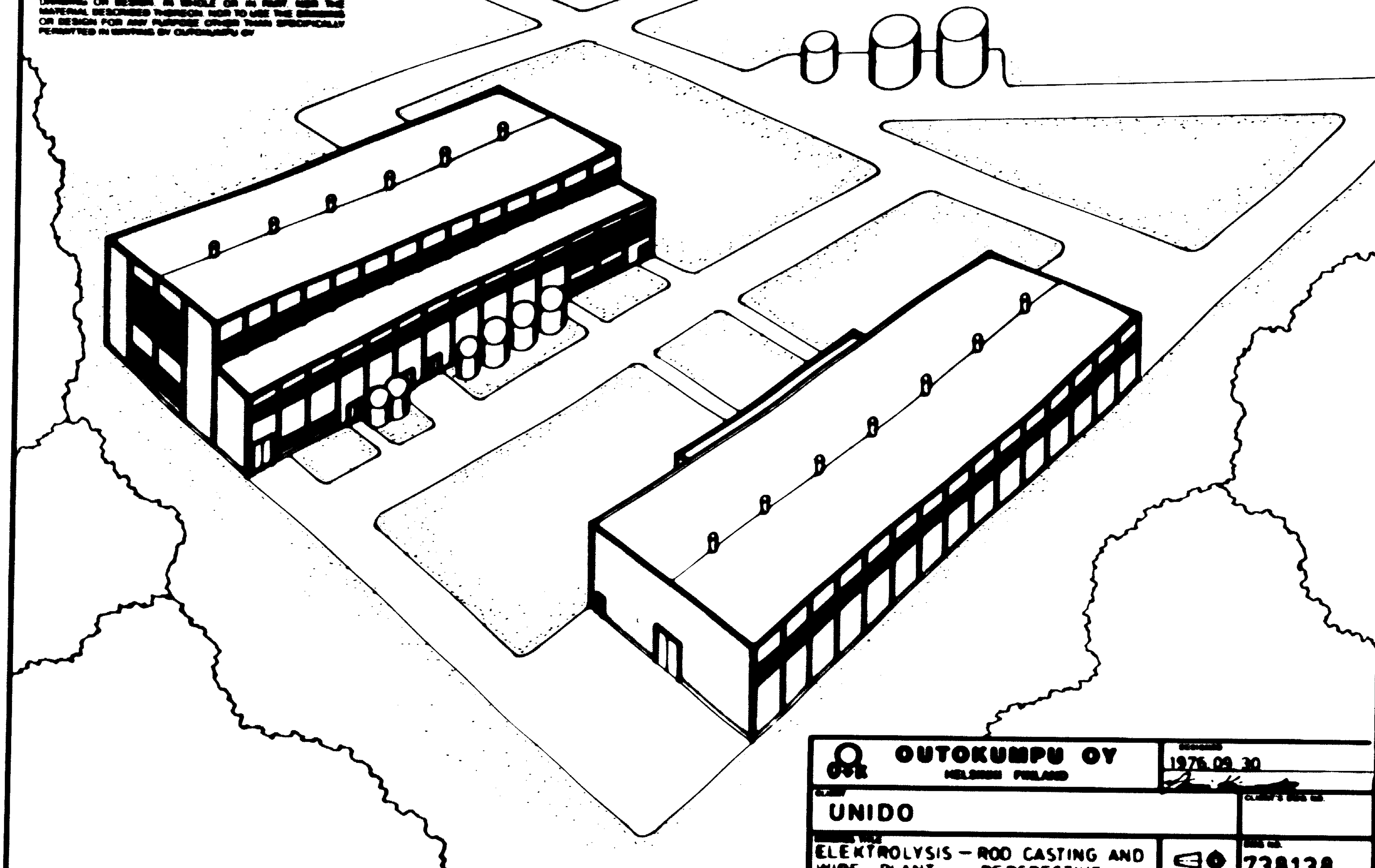


OUTOKUMPU OY
HELSINKI FINLAND

1976.09.30

UNIDO

ELEKTROLYSIS – ROD CASTING AND WIRE PLANT PERSPECTIVE

738138

4.3 Anode casting

4.3.1 General

A special feature of this process is the fact that reduction of copper melt is performed by propane gas instead of the traditional poling by wood. Propane poling is easier and more economic.

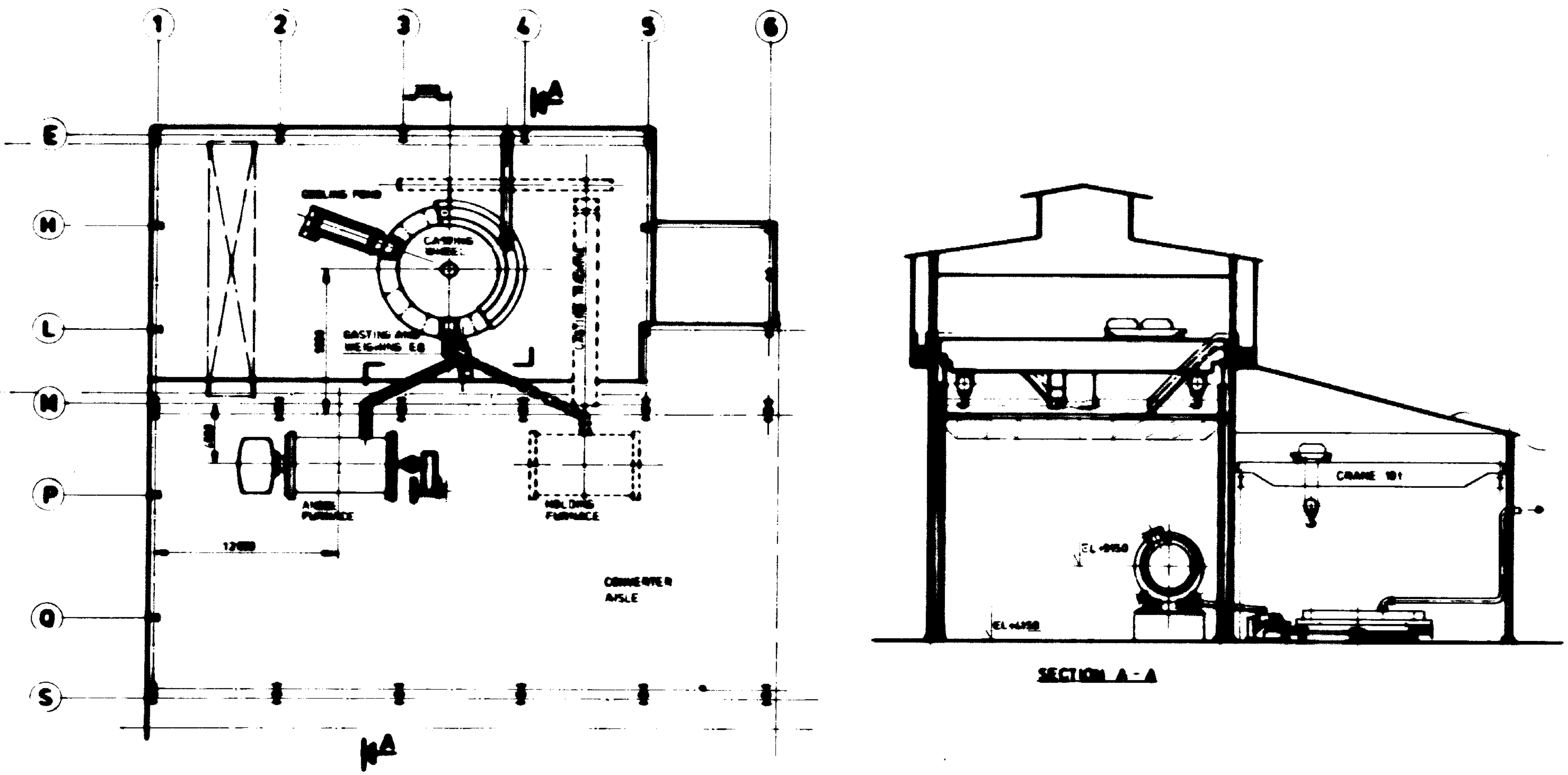
Another special feature is the automatic and exact weighing during casting giving small deviation in the weight of anodes. This enables a high current efficiency to be maintained in electrolytic refinery producing small amount of anode scrap.

4.3.2 Casting shop

The anode furnace is located in the converter aisle besides the existing holding furnace. The anode furnace has been dimensioned so that one batch is treated in it daily. The capacity of the furnace is 120 MT.

Charging of furnace is carried out by converter aisle crane. The furnace is filled about half full with molten blister copper from converters through the opening in the mantle. For that reason smelting operation is not needed. Anode casting operations are carried out in one 8 hour shift.

One overhead travelling crane of 2 x 5 MT is located above anode casting table and cooling tank to carry anodes to the racks outside of the building.



PRELIMINARY

OUTOKUMPU OY
ENGINEERING DIVISION
ESPOO FINLAND

UNIDO

STUDY FOR COPPER REFINERY PLANT

BLISTER REFINING AND ANODE CASTING LAY-OUT

DESIGNED	CHECKED	APPROVED
76-08-27		
PKu		

REV NO	REVISIONS	DATE	DRAWN
0	FOR INFORMATION	76.09.20	AS

DRAWING NO | REFERENCE DRAWINGS

DWG NO 738137-2 REV NO 0

To transport anodes from intermediate storage racks to the electrolytic tank house a special fork lift will be used.

Blister casting line can be used as before, during anode furnace repairing operations, or alternatively holding furnace can serve as anode furnace by installation of oxidation/reduction nozzles, incinerator and launder from furnace to the intermediate casting ladle.

4.3.3
Anode furnace

The anode furnace is tilting type, cylinder-shaped furnace.

The furnace will be lined with chrome magnesite bricks with a backing of chamotte bricks. There is an asbestos plate between the fire-proof lining and the steel mantle.

The oil burner will be located at one end of the furnace. The gas opening for off gas is opposite the burner.

Propane for poling and air for oxidation are fed to furnace through special nozzles. The duration of the poling and the oxidation periods are 1-2 h.

The anode furnace is charged with blister copper from an opening on the top of the furnace.

Molten anode copper is tapped through tap holes in the side wall of the furnace.

4.3.4
Automatic anode casting and weighing operations

Molten copper flows continuously out of the furnace into the intermediate ladle of the casting and weighing equipment, which fills up the casting ladle.

The casting ladle is supported on a weighing mechanism.

The weight of the ladle and a small amount of copper is counterbalanced mechanically. The rest of the copper is compensated and measured with a load cell.

In this phase the numerical indication at the control desk shows copper load in the casting ladle. When the required amount of copper has been poured into the casting ladle, the intermediate ladle breaks off the pouring. The weight of the casting ladle is then recorded into the electronic storage.

The casting then begins, provided that the casting wheel is in the correct position.

When casting copper, the tilting of the casting ladle is regulated according to a preset program, depending on the instantaneous weight of the casting ladle.

The casting wheel is turned by the hydraulic cylinder controlled by a servo valve so that acceleration in the beginning of the turning and deacceleration at the end of the turning are controlled. When the casting wheel has stopped the casting is repeated.

The operations of the casting machine and the casting wheel are phased together. In that way the casting capacity can be increased without raising actual pouring speed.

After casting the anodes are cooled with cooling water sprays onto moulds and anodes. Steam is removed by an exhaust fan. Cooled moulds turn to the location where the mould is locked by a lever actuated by hydraulic cylinder and the anode is loosened by the lifting pins. If an anode is distored it will be removed by a separate hoist or if it is fastened in the mould so that the trunnions have not lifted it the whole mould with anode can be changed after the whole casting cycle has been completed.

The released anodes move on to the take-off device, where they are lifted from the moulds to the cooling tanks. There is an automatic lifting device for good anodes.

When the casting wheel is turning the lift frame of the take-off machine is in a waiting position near the moulds. When the casting wheel stops the lift frame goes down. The anode cups fasten to the shoulders of the anode and the lift frame turns up and lifts the anode onto the chain conveyor of the cooling tank.

After the cups have loosened the anode the lift frame turns back to the waiting position the packing device pushes the anode close to the former and the chain conveyor moves a step forward.

When the required anodes are on the conveyor, the conveyor moves automatically about 300 mm forward so that suitable bundle is formed.

From the take-off point the moulds turn to the dressing stage. The pneumatic cylinders control that the lifting pins are in their correct position at the bottom of the moulds and also check if the mould is empty. If there is a mould with an anode there will be an alarm in an electronic memory circuit and the casting and weighing equipment do not pour copper to such a mould.

Before the moulds go to the casting position a detector controls the height of a mould with anode and if the mould is too high, damages to the weighing and casting machine are prevented by stopping the casting wheel.

All these functions are automatically controlled except the hoist lifting of distorted anode and mould dressing. However equipment can be controlled manually if required by operating control switches in the control room.

4.3.5

Equipment description

Casting and weighing equipment

Weighing mechanism is an electro-mechanical scale of steel construction with a tension load cell with a shock damper and with removable shields aganist splashing.

The casting and intermediate ladles are made of cast iron with 50 mm thick brick-lining. Tilting cradles, frame construction and base framework are made of sectional and welded steel.

Casting wheel

Casting wheel is of welded steel construction which is supported on the concrete by a vertical shaft equipped with one ball bearing. The wheel is supported on track rollers (16) located on the concrete foundation under the moulds.

Wheel drive arm actuated by hydraulic cylinder is connected to the vertical shaft.

For mould locking and anode lifting there is one lever actuated by hydraulic cylinder and hydraulic cylinders with lifting pins.

Take-off machine

The construction is welded and the lift frame is provided with two hydraulic torque cylinders and pneumatically operated anode lifting cups.

Cooling tank with conveyor

The water capacity of tank is about 10 m^3 and number of stored anodes closely packed is about 40.

The tank is of welded steel plate. The chain conveyor and the packing device with their driving mechanisms are located in the tank. The conveyor has its chains and wheels with shafts stainless steel and the sliding parts of the chain support structures are plastic.

Mould dressing

Mould dressing will be done manually using $BaSO_4$ slurry, which is the most suitable dressing agent.

Mould cooling spray system

Piping material is copper. The hood covers the cooling area and it collects steam which is exhausted by an extraction fan.

4.4 Electrolytic refining

4.4.1 General

In the design of the tank house the following criteria have been considered:

- good cathode quality
- low energy consumption
- low investment costs

The main parameters affecting on the aforementioned are as follows:

- current density
- spacing
- anode quality
- starting sheet quality
- electrolysis duration
- composition of electrolyte
- temperature of electrolyte
- circulation of electrolyte
- purification of electrolyte
- addition agents to electrolyte

In technical solutions, optimum factors should be reached in order to fulfill the above criteria. In addition, possible extension of the capacity has been considered.

4.4.2
Process selection

The main factor influencing investment costs in the electrolytic refining of copper is current density, which determines the number of tanks, the size of a tank house, etc. Thus the current density should be as high as feasible. During the last decade, current density has been increased using special techniques, i.e. periodic current reversal (PCR). The basic characteristics of the process is the periodical reversal of the direct current, i.e. at certain intervals and for a brief period of time the direction of the current is changed, and the cathode and the anode change their polarity. Plants already in operation have been adapted to this system. Using this technique, a current density of 280-350 A/m^2 has been obtained instead of the conventional 200-240 A/m^2.

The quality of cathodes is a crucial factor. Although it is claimed that using PCR the same quality can be achieved as with conventional techniques, it is advisable to start with the latter. This applies particularly to the case now under consideration to guarantee the production of high quality oxygen free copper wire. It is advisable, however, to design for the techniques of PCR so that in the design of rectifiers the possibility of changing them to this system is considered. This system could be installed later if an expansion is required.

4.4.3
Process calculations

Capacity: 25 000 t/a electrolytically refined copper cathodes of ASTM quality

Anode analysis:	Cu	99 %
	Ag	200 g/t
	Au	20 g/t
	Ni	570 g/t

These values are on design basis. The following process variables and units have been based on operating experience of refinery in Outokumpu Oy Pori Works, on visits to other refineries and papers published on them.

Electrodes and electrolytic tanks

Anode dimensions:	890 x 890 mm
Cathode dimensions:	950 x 970 mm
Cathode area:	0.92 m^2
Number of cathodes per tank:	44
Number of anode per tank:	43
Spacing:	105 mm
Inside dimensions of tank:	1100 x 1330 x 4775 mm

Electrodes of about 1 m^2 have been found to be most practical to tank house handling.

Current density

Cathodic current density of 240 A/m^2 used.
A margin should be allowed, however, so that current can be later raised up to 270 A/m^2 according to operating experience.
This value is used for current distribution system and design of rectifier.

Current efficiency

Due to the selected current density, spacing of electrodes, process parameters and quality of anode it is expected that the current density of 93 % will be reached. Efficiency increases with the spacing, but this would mean bigger energy consumption as the ohmic resistance between electrodes increases.

Electrode periods

Anode period and cathode period of 21 and 10-11 days respectively would be used.

Operating efficiency

Operating efficiency is the period of the electrical current flow in the tank. It is reduced by the time spent for the change of electrodes and for the wash and repair of cells. Hence, the longer cathode and anode cycle the better operating efficiency.
In practice, 21 days is suitable for anode cycle. If it is longer, the weight of anode grows and will make the handling difficult and require heavy construction. 10-11 days are sufficient for a cathode cycle. There is no use adapting a longer period because the longer the cathode period is, the lower the quality of cathodes. It is expected that with these periods the operating efficiency of 96 % will be reached.

Number of tanks

The number of tanks in relation to the cathode production is 144 units when calculated on basis of total currency and current and operating efficiencies.

Number of stripping tanks

The starting sheet requirement is 18 000 per month. About 10 per cent more of cathode loops are needed, and if the yield is 90 %, nine stripping tanks are required in case the stripping is performed once a day.

Weight of anodes

A new anode weighs 290 kg; 238 kg utilised in 21 days and thus 18 per cent of anode scrap is produced.

Weight of cathodes

Cathodes of 10 to 11 days weigh from 118 to 130 kg and the weight of cathodes from one tank is from 5100 to 5600 kg when pulling.

Amount of discarded electrolyte

To remove impurities dissolving from anode into electrolyte, part of electrolyte has to be discarded continuously from the system. The controlling impurity is nickel. When the nickel amount in the anode is 0.057 % and the level of 10 g/l is maintained in the electrolyte, the discarded solution amount is 1425 m^3/a, i.e. 4 m^3/day.

Number of decopperising tanks

Before discarding the remaining solution, copper is liberated from it electrolytically in tanks, which have lead anodes. The amount of removed copper is 175 kg Cu/day when the concentration of the electrolyte is initially 45 g/l and after liberating less than 1 g/l. The electric power requirement is 247 Ah/day. The average current efficiency is low, i.e. about 60 %, due to the low copper concentration.

The necessary capacity is achieved by using 6 kA current for cell, which has been divided electrically into two halves so that power of 288 kAh/day can be fed to the cell and the current density in the tank is 150 A/m^2. Although one tank would be sufficient to handle the bled electrolyte it is reasonable to build two tanks from the start so that possible changes in impurity level of the anode does not interfere with the operation. In addition a space for two additional tanks has to be reserved in case more impure raw materials than present ones should be used.

Power requirements

With the design current density of 270 A/m^2, the total current is 21330 A. The corresponding cell voltage is 0.35 V, which includes voltage losses in bars and contacts. The total voltage of 144 cells is then 50.4 V. Temporarily in some commercial tanks lead anodes have to be used to decrease the copper concentration in the circulating electrolyte. In these tanks the cell voltage is 2 V. Therefore, the voltage of the rectifier has to be greater than calculated. The characteristics of the rectifier are selected to be:

Current	21 kA
Voltage	60 V
Power	1260 kAV

Following rectifier is selected for decopperizing tanks:

Current	6 kA
Voltage	20 V
Power	120 kAV

Consumption of electricity

With the operating current density of 240 A/m^2, the cell voltage is 0.30 V, when the DC power required for copper deposition is 273 Wh/kg Cu.

Amount of anode slime

The anode is reasonable pure, approximately 2 kg/t of anode is produced. Thus the annual slime production is 50 000 kg. The composition of the slime has been estimated to be:

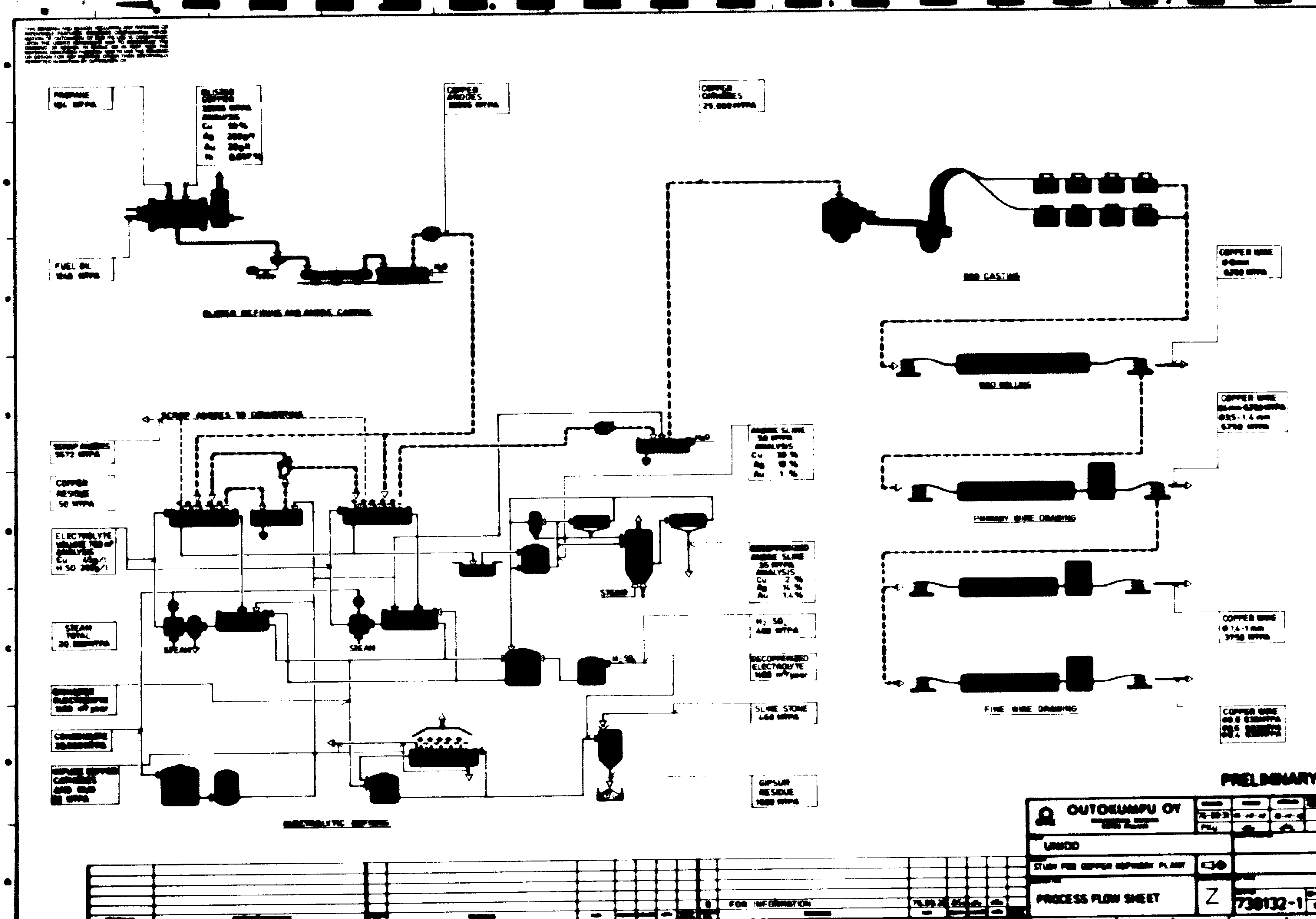
Cu	30 %	
Ag	10 %	(5000 kg/a)
Au	1 %	(500 kg/a)

After copper leaching the total amount of the slime is 35 t/a of the following composition:

Cu	less than 2 %
Ag	14 %
Au	1.4 %

Copper balance

Copper cathodes to rod casting	25 000 t/a
Copper sludge to smelter	50 t/a
Impure copper cathodes and mud from liberator cells to smelter	80 t/a
	25 130 t/a
Dissolved anodes (99 % Cu)	25 384 t/a
Scrap anodes (18 %) to converters	5 572 t/a
Anodes to electrolytic refining	30 956 t/a



PROPANE
COPPER ANODES
COPPER CATHODES 25 000 WTPA
ROD CASTING
ROD ROLLING
PRIMARY WIRE DRAWING
FINE WIRE DRAWING
FUEL OIL
SCRAP ANODES TO CONVERTING
COPPER RESIDUE 50 WTPA
STEAM
SLIME STONE 460 WTPA
GIPSUM RESIDUE 1000 WTPA
ELECTROLYTIC REFINING
PRELIMINARY
OUTOKUMPU OY
UNIDO
PROCESS FLOW SHEET
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Copper inventory

Anodes in process	1 059 t
Anode storage (1 day)	100 t
Cathodes in process	360 t
Starting sheet storage (7 days)	
including process	30 t
Electrolyte	32 t
Anode slime	2 t
Decopperizing system	2 t
Copper residues	2 t
Total	1 587 t

4.4.4

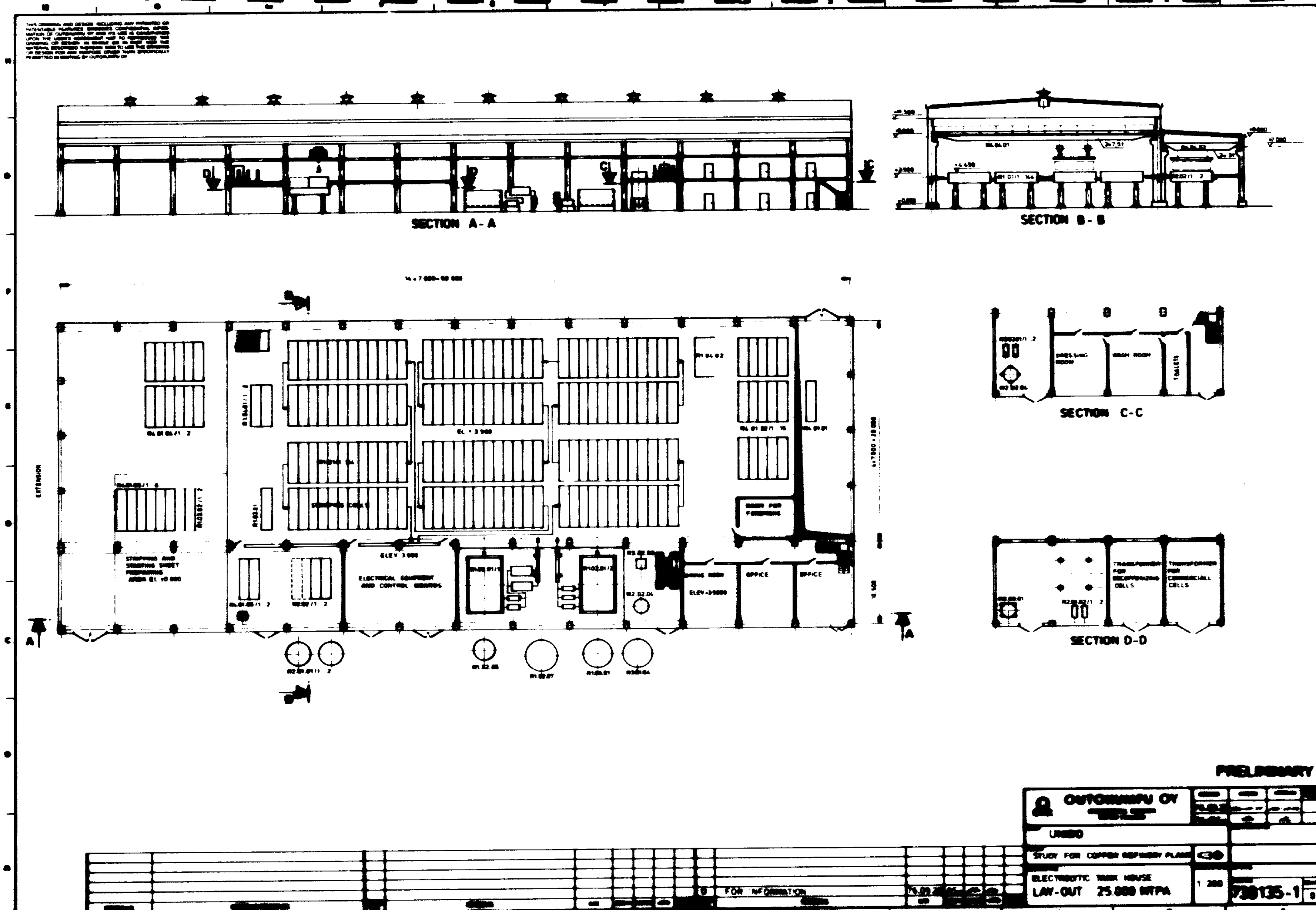
Process and plant description

General

The electrolytic copper refinery is designed to treat anodes to produce 25 000 tons of cathodes per year.

Anodes dissolve electrolytically in the tanks and pure copper is deposited on the cathodic starting sheet. The precious metals (Ag, Au and Pt-metals) in the anodes do not dissolve and they are removed in the anode slime fallen on the bottom of the tanks with other insoluble impurities (Pb, Sn, Se, Te). Impurities (Ni, Fe, As, Sb, Bi) dissolving electrolytically from the anode are removed by bleeding off part of the electrolyte continuously.

The nominal capacity of the tank house is obtained with cathodic current density of 240 A/m^2 and with 144 cells, which have been arranged in 6 sections, each section including 2 groups of 12 cells.


SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
DRESSING ROOM
WASH ROOM
TOILETS
ELECTRICAL EQUIPMENT AND CONTROL BOARDS
OFFICE
OFFICE
EXTENSION
PRELIMINARY
OUTOKUMPU OY
UNIDO
STUDY FOR COPPER REFINERY PLANT
ELECTROLYTIC TANK HOUSE
LAY-OUT 25.000 MTPA
1:200
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The design of the tank house is based on six working daye per week for anode and cathode extraction and on seven days a week for etarting sheet stripping.

Anode handling

Anodes are transported by a truck from the anode casting shop to the other end of the tank house to the anode handling area where spacing 105 mm is done manually on a special rack. Anodes are lifted by an overhead crane of 15 tons' capacity in groups of 43 directly either into the tanks or onto the storage racks.

The life time of one anode is 21 days. The spent anodes are transported from the cells to the anode washing tank, where adhering anode slime is washed from the anodee by water eprays. The washed spent anodes are dropped to piles and transported to the anode casting plant by a truck. During a working day anodes are changed in 8 tanks.

Cathode handling

The cathode period is 10 to 11 days, so two cathodes are produced from one anode.

The pulling operation of the first cathodes only comprises the removal of cathodes which are replaced by new starting sheets, the anodes remaining in their places. After the second cathodes, the operation comprises also the removal of scrap anodee, the loading of new anodes and new starting sheete.

The cathodes extracted from the cells are taken to the other end of the tank house and are cleaned by submerging them into the wash tank. The cathodes are tipped down to stacks and suspension rods are removed. The rods are transported to the starting sheet preparation. Cathode stacks are weighed and transported to the storage area.

In a working day cathodes are pulled from 16 tanks.

Production of starting sheets

The starting sheets to be used as cathodes for commercial cells are produced in 9 electrolytic cells located at one end of the tank house, near the stripping area.

The cathodes for starting sheet deposit consist of titanium sheets called blanks, on which 0.7 mm copper layer is deposited during 24 hours. This layer is stripped and used as stripping sheet.

Cell construction, anode dimensions, number of electrodes per cell, current and electrolyte have the same characteristics as those of commercial cells.

Numerous advantages offered by titanium blanks, the most important of which is the good quality of the sheets, justify their use in spite of their high price compared with usual copper blanks.

The blanks are extracted from the cells every 24 hours and dipped in a wash tank before being placed on a stripping rack, on which the starting sheets are detached manually from the blanks.

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Simultaneously only one third of the blanks are lifted from the stripping tank so that the current continues to pass through the cell and short-circuiting is not needed.

Part of the stripped sheets are cut by the loop cutting machines. Two loops and a straightened and cutted sheet are assembled with a suspension rod to form a starting sheet.

The starting sheets coming from the preparation machine are stored on static racks and loaded in the commercial cells in complete sets of 44 sheets.

Electrolytic cells

The electrolytic cells are constructed of precast concrete elements with steel reinforcement. The cells are assembled in units of 12 cells each. The same design is used both for commercial and stripper cells. The liberator cells are similar in construction but have a deeper and more angled bottom to allow for accumulation of copper mud.

The cells rest on horizontal concrete beams supported by concrete columns, where it is electrically insulated.

The inner lining of the cells is manufactured of 3 mm antimonial lead sheets. So far the lead lining is still considered more reliable and more economical than the plastic lining.

Electrolyte

The commercial electrolyte is a solution of diluted sulphuric acid and copper sulphate with a composition of approximately:

200 g/l H_2SO_4
40 to 45 g/l Cu

During the electrolysis, such impurities as Ni, As, Fe, Sb and Bi, dissolve from the anodes.

The different electrolyte compositions are controlled regularly and the required corrections can be made:

- By adding condensed water when H_2SO_4-content is too high
- By adding fresh acid when H_2SO_4-content is too low
- By regulating the quantity of electrolyte sent to the decopperizing or to the purification installation.

Specific reagents are added to the electrolyte in order to improve the quality of the deposit and the microstructure of the cathode. Reagents added most commonly are glue and thiourea. They are fed with water to the circulating electrolyte at a rate that corresponds to the consumption of 20 to 50 g of thiourea and 20 to 100 g of glue per ton of copper. Furthermore, hydrochloric acid is added in the electrolyte so that its chlorine content is about 30 mg/l. Primarily the purpose of chlorine is to precipitate silver from the electrolyte.

Circulation of electrolyte

The electrolyte flow in the cells must be regulated very carefully at its optimum value, taking into account following points:

- The electrolyte flow should not disturb the calm decantation of anodic slime. Therefore, it is not allowed to circulate too quickly.
- The circulation should not be too slow, which would cause excessive cooling or irregularities of concentration in the solution.
- The circulation must furthermore be arranged so that the flow is even in the whole cell, and no dead points will be created in the flow.

The tank house is divided into two solution circuits. The larger circuit has 4 sections and the smaller 2 sections; also stripping is done in the latter.

Each solution circuit consists of a solution tank, a graphite heat exchanger with another as a stand-by, a horizontal centrifugal pump with another as a stand-by, and a main feeding pipe system. Each cell has its own feeding pipe. PVC pipe is used for all solution piping. Overflow electrolyte from each cell is collected and returned to the solution tank.

The circulation of electrolyte in the cells is of the "bottom-to-top" type. This principle ensures the best distribution of the electrolyte across the face of the electrodes. The feeding rate per a cell is 25 to 30 l/min. The temperature of the electrolyte at the inlet to the cells is 65°C and falls by 2 to 4°C towards the outlet.

The smaller circulation system, which includes stripping, is provided with a Scheibler filter. This continuously operating polishing filter can for its part help the production of high-quality starting sheets.

Condensate from the heat exchangers is collected in a separate storage tank, from where it is taken into the circulating electrolyte to compensate evaporation losses, and it is used for washing of cathodes and scrap anodes, too.

Slime handling

Because the anodes to be handled are relatively pure and thus the amount of anode slime is small, anode slime is removed from the tanks after two anodes have been dissolved in them. Accordingly, four tanks are totally emptied daily. First cathodes and scrap anodes are removed, then anodic slimes are drained out with the electrolyte through the bottom hole and washed down through a launder system into a holding tank. Copper nuggets, greater than 5 mm, remain on the screen in the launder and are returned to the melting.

Washing water from scrap anodes are stand in the same holding tank. The solution is pumped through a Scheibler polishing filter to the electrolyte storage tank.

Slime is separated by a press filter, and the clear filtrate is led to the electrolyte storage tank. The filter cake is pulped in a leaching reactor to the electrolyte so that the solid material content is 200 g/l, and steam and air are blown into the reactor when the copper in slime is oxidised and dissolves in the acid of the electrolyte. The temperature in the reactor is about 80°C. The blowing time is 5 to 10 hours.

After the leaching, the slime free of copper is separated onto the press filter, washed with water, and dried by pressure air, and finally packed in barrels to be transported elsewhere for processing.

The leaching reactor is a 10 m^3 tank, which has an effective volume of 5 to 7 m^3 because of the foaming during the leaching. The leaching of anode slime has to be done once a week.

The leaching reactor can be used also for preparation of copper sulphate solution, if the solution is needed for the circulating electrolyte, and also in the start-up of the plant. Then as raw materials can be used anode shots, copper mud, residue, etc.

Electrolyte purification

The copper concentration in the electrolyte must be kept between 40 to 45 g/l. This balance is maintained by controlling the oxygen content in anodes. If the copper content of the electrolyte starts to decrease, less anode poling must be done, when more chemically dissolvable copper oxide is left on the anode. If the copper concentration in the electrolyte increases, more poling is done, or a certain number of cells located in the commercial section can be adapted by replacing the normal copper anodes by lead anodes. In these cells, no anodic copper enters the electrolyte but a certain part of the copper sulphate is transformed into H_2SO_4 and into a copper deposit on the cathodes.

The electrolyte leaving these cells joins the circulating electrolyte from the commercial cells. The cells produce cathodes of commercial quality.

Because of impurity build-up, a part of the electrolyte (4 m^3/day) has to be bled off. This solution is handled in one or two liberator cells, where there are insoluble lead anodes. The solution is circulated until the copper content is less than 1 g/l. Partly the copper precipitates on the starting sheets and partly it drops as mud on to the bottom of the cells. Both are contaminated by such impurities as As, Sb, Bi and are returned to the smelter.

The liberator cells are emptied once a week, the solution is pumped to the storage tank, and the copper mud on the bottom is drained off by the hole in the bottom on to the filter box underneath the tank. The mud is transported to the smelter in the filter box.

Copper removal from the electrolyte is a batch process. When after a day's or so circulation a chemical test proves that the copper content is less than 1 g/l, the solution is pumped from the cells and a new solution is taken from the electrolyte solution tank.

The copper-free solution, which includes about 260 g/l H_2SO_4 and Ni and Fe as main impurities, is neutralized with lime stone in an agitator reactor, and the formed precipitate is dumped.

Because of its low total amount, the refining of nickel does not pay. If later the nickel content of the anode exceeds 0.2 %, the refining of nickel as crude nickel sulphate can become economical with the purchase of a vacuum evaporator, by which the copper-free solution is evaporated to a concentration of approximately 1200 g/l H_2SO_4. Then the impure nickel sulphate crystallizes and it can be separated from the acid by filtering and sold to elsewhere for purification, or a purification system can be adapted.

Acid can be returned to the circulating electrolyte.

Because acid mist is formed with the oxygen gas evolving on the anode in the liberator cells, and due to the arsenic dissolved in the electrolyte there is a possibility of evolving of arsine gas, these cells must be placed separately from other tanks and provided with rigid plastic covers. The gases are exhausted along a plastic dust system into an exhaust fan situated outside the plant.

Process control

Short circuits are continuously controlled by gaussmeters during every work shift.

Recorders are measuring uninterruptedly following factors:

- total current
- total voltage
- section voltage (6)
- 0-point
- temperature of circulating electrolyte (2 circuits)
- steam consumption

The circulation and storage tanks of the electrolyte and the condense storage tank have continuously operating surface level indicators.

The feed of the electrolyte into the tanks has to be controlled by a measuring vessel according to a certain program.

Cu and H_2SO_4 have to be analysed from the electrolyte daily and the main impurities approximately once a week.

4.5
Rod casting

4.5.1
Process selection

The modern technique handles the cathodes directly, in a continuous process, into copper rods, thus avoiding the traditional cathode melting into wire bars and further the hot-rolling into copper rods.

The capacity of 25 000 tons of copper rod a year requires a melting capacity of approximately 4 t/h, which is in the small capacity category. This small production excludes such processes developed for greater capacities as Southwire and Contirod processes. Processes already used, developed for a small capacity, and producing oxygen free copper, are Outokumpu Upward-casting and Dip-forming of General Electric. Outokumpu process is recommended to be used because it is considerably simpler in construction, has smaller operation costs and thus also safer in operation. In addition, this process is not so sensible to changes in cathode quality, which is an important factor, since all cathodes produced by electrolytic refining are cast into copper rods and therefore, it is not possible to select the best cathode for melting as is usually done.

The capacity of one Outokumpu Upward-casting unit of 16-strands is approximately 16 000 t/a 20 mm dia copper rod, so two units are needed. When operating with two units, safer operation and undisturbed production are achieved. The plant has an excessive capacity of at least 7000 t, when the circulation of scrap wire mill, about 5 %, to be remelted, is also considered.

4.5.2
Process and plant description

General

The rod casting shop is situated in the near vicinity of the tank house. Two melting units are at the other end of the building side by side. Weighed cathodes are transported there by a truck.

Melting

Copper cathodes are automatically fed into a channel type induction melting furnace under charcoal cover.

Intermittently the molten copper will be poured through a gas tight electrically heated launder into a holding furnace. This is a channel type induction furnace provided with one inductor. The temperature of the molten material is kept within the allowed limits by a temperature control loop.

Rod casting

The withdrawal machine for 16 strands is located above the holding furnace. Graphite dies are immersed to a fixed depth into the molten metal and the solified rod is pulled upwards by tandem pinch rolls. These are driven by two adjustable hydraulic motors each driving 8 strands.

The design allows the dies to be changed individually without interrupting the working of the others. Time needed for one die change is approximately 10 minutes.

The withdrawal machine moves up and down according to the metal level in the furnace so that the dies are always in the same position in regard to the surface of the molten material.

For each strand there is a coiling machine which makes up to 4000 kg coils of 20 mm diameter in special racks. When the rack is filled, the strand will be cut individually with a hydraulic shear, the full rack lifted away and replaced by an empty one. The coiling machines are driven with hydraulic motors and the speed is adjusted automatically according to the casting speed.

The plant operates continuously (7 days a week). Based on the experience, interruption of casting on Sunday is not recommendable.

Power consumption

Power consumption in the melting is about 300 kWh/t. The additional consumption of electricity during continuous operation including the holding furnace, the withdrawal machine and the coilers, is approximately 140 kWh.

Utilities

The amount of cooling water needed is 30 l per strand in a minute. Pressure should be approximately 0.4 MPa and the temperature 30°C maximum.

By using good quality graphite and with careful surface finishing the average die life will be approximately 8 tons of cast rod.

The consumption of charcoal and graphite powder will be 5 l and 0.7 kg per ton, respectively.

Maintenance

The maintenance of the plant includes relining of melting and holding furnaces and their inductors, and the maintenance of mechnically wearing parts. The life of the inductor lining is 6 to 12 months and of the melting furnace lining 5 to 10 years.

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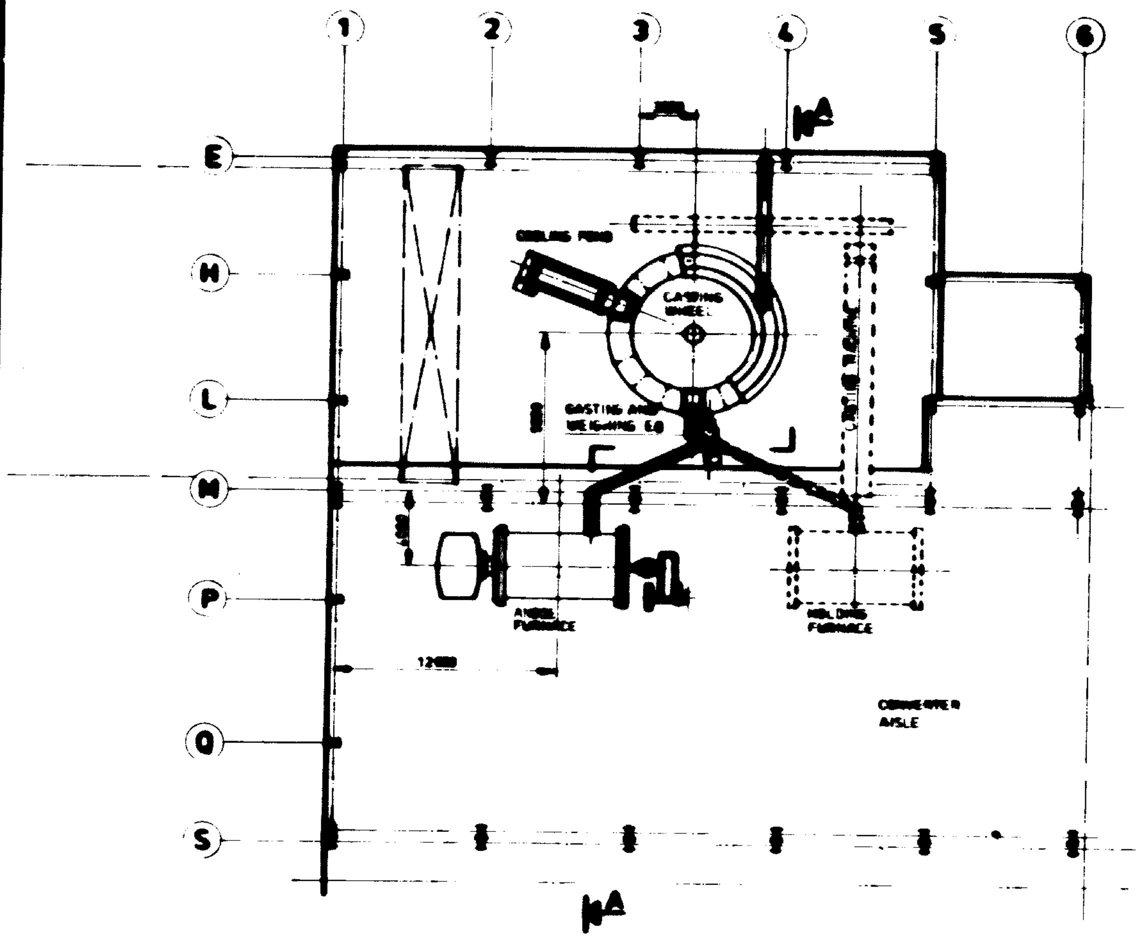
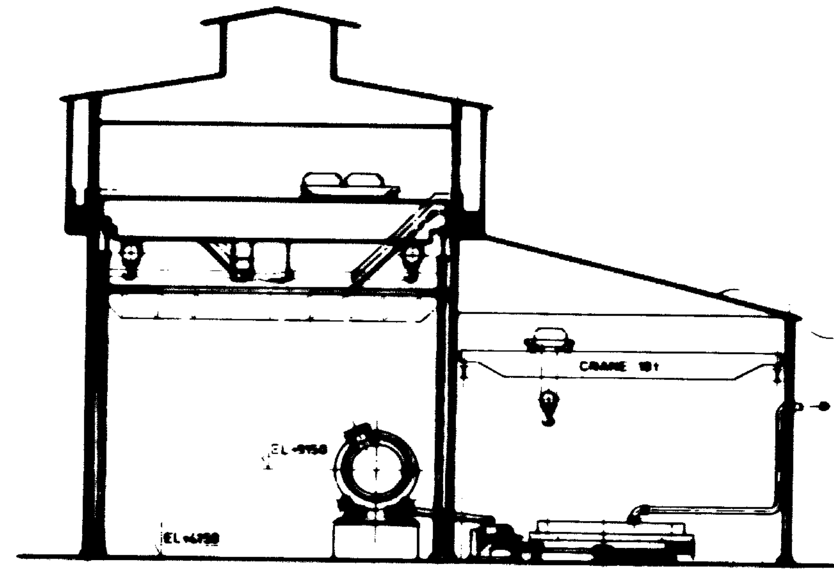




SECTION A - A

PRELIMINARY

OUTOKUMPU OY
ENGINEERING DIVISION
ESPOO FINLAND

DESIGNED	CHECKED	APPROVED
76-08-27		
PKu		

UNIDO

STUDY FOR COPPER REFINERY PLANT

BLISTER REFINING AND ANODE CASTING LAY-OUT

DRWG NO 738137-2 REV NO 0

NO	REVISIONS	DATE		
0	FOR INFORMATION	76.09.28	AS	

DRAWING NO — REFERENCE DRAWINGS

Scrap wire and rod are cut by a mechanical device and are fed with cathodes to the melting.

4.6
Rod rolling and wire drawing

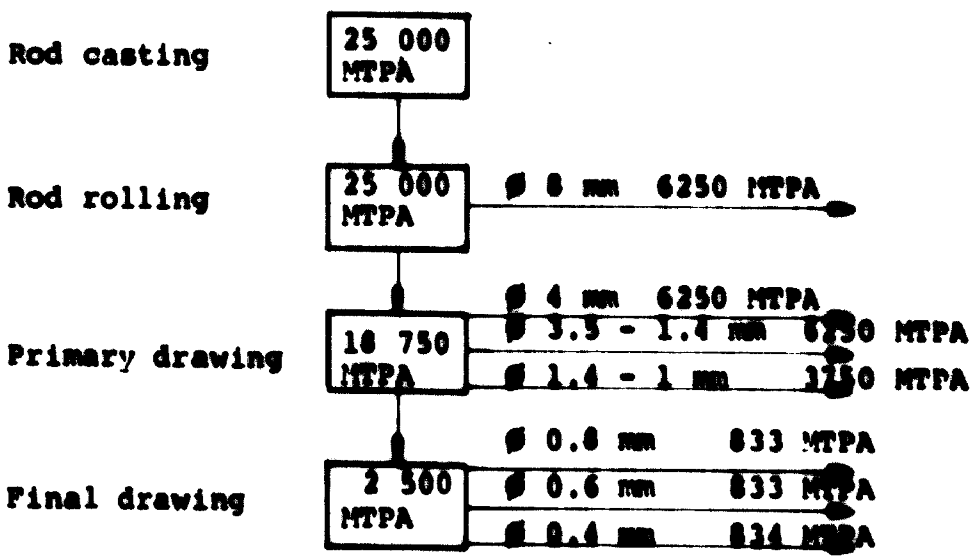
4.6.1
General

Every copper coil of 20 mm dia rod produced by the upward-casting is weighed and rolled into wire of 8 mm dia.

In addition to the rolling, wire is drawn into various diameters according to the attached production program.

A rolling mill with 10 stands has been selected on the basis of wire characteristics and reduction.

The annual capacity of 25 000 MTPA can be achieved at the rolling speed of approximately 4 m/s with an operation time of 6000 hours. The maximum speed of the primary wire drawing machine is 38 m/s and of the final wire drawing machine 60 m/s.



4.6.2

Process and plant description

General

The rod rolling and wire drawing shop is located in the same building as the rod casting shop.

The shop consists of one wire rolling line and three wire drawing lines and necessary product and intermediate storage rooms. In the connection of the building there are in addition the necessary maintenance shop for the maintenance of the drawing machines, the laboratory rooms, and the necessary social and office rooms.

Rolling

Coiled wire rod from rod casting is placed under the pay-off device and the end of the wire rod is guided to the rolling machine pushing-in device. The first pinch rolls are pressed pneumatically in order to ease the starting. After the pushing-in device, there are five rolls for straightening the rod.

From the straightening the rod comes to the rolling with 5 stands arranged horisontally and 5 stands vertically. Every second stand can be adjusted so that all three rolling grooves of the rolls can be utilized to produce 8 mm square wire starting from continuously cast 20 mm dia wire rod.

The stands are driven by a strong cardan joint shaft. Each stand has guides for automatic leading-through of wire from the pushing-in device to the bending and coiling device. The shafts and rolls are internally and externally cooled with cooling emulsion continuously during rolling.

From the rolling mill, the wire is led to the bending and coiling device. The weight of the coil is 4000 kg. In the coiling device the ready coil is tied manually with steel bands. The ready coils are weighed before the next stage.

Drawing

Coils to be sold are transported with a crane to the product storage area. Coils to be drawn further are transported with a crane to the wire drawing line through a small balancing storage area. Before the wire drawing line there is a pay-off device, through which the wire is guided into the drawing machine. The drawing machine has 13 drawing stages and immediately after the last drawing stage the wire is led through the resistance annealer to a spooler of bundle packer type. Wire carriers are made of both steel and wood, and the capacity is 2 to 4 tons. Ready wire carriers are weighed and carriers to be sold are transported with a crane to the product storage area.

Empty carriers return to respooling. Wires to be drawn further are transported to the next two wire drawing lines through the intermediate storage area with a crane.

Both final drawing lines are similar and they comprise pay-off device of coil, drawing machine, resistance annealer and spooler of bundle packer type. The drawing machine has 17 drawing stages. Wires from these production lines are spooled also to steel carriers, the capacity of which is 500 to 1000 kg. Ready carriers are transported through the weighing to the product storage area by trucks and from there to marketing. All the drawing machines have a common emulsion handling and cooling station. The protection gas needed by the resistance annealers is generated by a common steam generator. The power demand of rod rolling and wire drawing is 1900 kW.

The product and intermediate storage areas have been dimensioned rather large, for packages of 500 kg to 4000 kg, but according to our experience however, later also smaller packages have to be marketed. These require their own handling equipment and the new equipment can be placed in the existing hall.

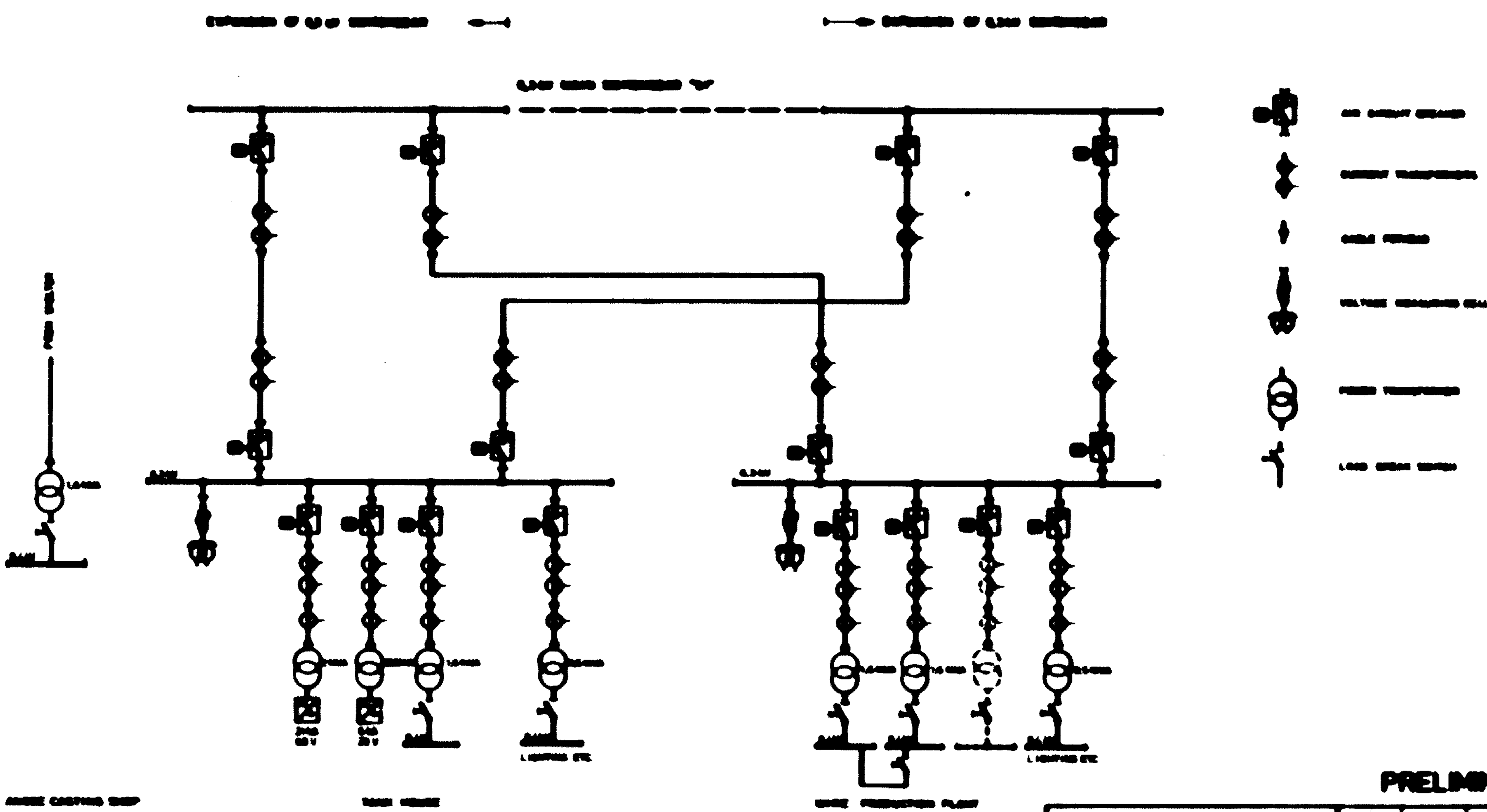
4.6.3 Quality control

A continuous quality control is necessary for an undisturbed operation of the wire plant and for maintaining the high quality standards set for copper wire.

A quality control laboratory is needed for this function. It will carry out conductivity and tensile testing of the wire, and when needed, metallographic analysing. Following equipment is recommended to be purchased:

- lab annealing furnace
- conductivity balance
- metallographic microscope
- tensile testing machine
- lab weighing scale
- grinding and polishing machine for metallographic specimens

The total price of these instruments is approximately $ 15 000. For the laboratory, a space of about 30 to 50 m^2 and a staff of one quality controller and two laboratory assistants are needed.



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OUTOKUMPU OY

UNIDO

STUDY FOR COPPER REFINERY PLANT

SINGLE LINE DIAGRAM

730 130-2

Rev. 0

4.7
Electrification, instrumentation and civil engineering

4.7.1
Electrification

General principles

6.3 kV switchgears

The 6.3 kV switchgears of the anode casting plant, electrolytic refinery and wire plant will be placed as showed in the layout drawings.

Supplies to the switchgears of electrolytic refinery and wire plant will be taken from the 6.3 kV main switchgear "S 1" in the area. The main switchgear will have to be expanded in both directions by two cells (totally four cells). The supply to the transformer of anode casting plant will be taken from the present switchgear of the smelter. This switchgear will be expanded by one cell, if there is no spare cell. (6.3 kV Single Line Diagram, No. 738139).

0.4 kV motor control centers

The electrification of the processes needs appr. 5 to 10 0.4 kV motor control centers which will be placed in the same electric rooms as the 6.3 kV switchgears.

Transformers

It is estimated that the plant needs:

- 1 transformer 2 MVA for electrolysis
- 1 transformer 0.2 MVA for electrolysis
- 4 transformers 1.6 MVA for motors
- 2 transformers 0.5 MVA for lighting etc.

Emergency power

The system needs emergency power for the most important equipment. In the wire plant one 1000 kVA diesel-aggregate will be needed for the induction and holding furnaces.

The small motors to be switched after the emergency power in the anode casting plant could be connected to the present motor control center of emergency power.

Control system

The control of electrical motors shall be centralized in the control rooms, except in the wire plant where most of the motors are controlled locally.

Lighting and welding points

Illumination will provide necessary lighting for the process lamps.
Mercury lamps and fluorescent tubes will be used.
Welding outlets will be located in all the necessary working areas.

Busbars of the tank house

Commercial cells

The busbars of commercial cells are of copper. The cross-section of main busbars is 16 000 mm^2 (1.3 A/mm^2) and the cross-section of distribution bars is 20 000 mm^2 (1.05 A/mm^2).

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Decopperising cells

The cross-section of main busbars is 4 600 mm^2 (1.3 A/mm^2) and of distribution bars 6 000 mm^2 (1 A/mm^2).

Short circuiting is done on one side of the group of 2 x 12 cells by manually operated switches.

Power demands

General

The values of the installed power are estimated and partly calculated on the basis of other factories. Therefore the power demand is not final.

Installed power

Total installed power is about 6 MW.

It can be divided into the following parts:

-	anode casting plant	about	0.5	MW
-	tank house	"	2	MW
-	wire production plant	"	3.5	MW
		$P_{inst.}$	6	MW

Maximum running load	P_{max}	4.5	MW
Normal running load	P_{med}	3.7	MW

Engineering criteria of electrification

Voltages

-	primary distribution	6.3 kV, 3 ph, 50 Hz
-	motors over 160 kW	6.3 kV, 3 ph, 50 Hz
-	motors up to 160 kW	0.4 kV, 1 ph, 50 Hz
-	control	220 V, 1 ph, 50 Hz
-	control	110 V, DC

Short circuit capacities

-	6.3 kV	max. 400 MVA,	1 sec thermal withstand
		max. 100 kA	crest momentary withstand
-	0.4 kV	max. 40 kA,	1 sec thermal withstand
		max. 100 kA	crest momentary withstand

4.7.2 Instrumentation

Basic system

The main idea of instrumentation associated with a limited automation is to facilitate operation maintenance and expansion.

The instrumentation will be an electronic and/or pneumatic system with signal ranges of 4 to 20 mA and 0.2 to 1.0 bar.

All signals from field to a control panel and from the panel to field will be electric standard signals 4 to 20 mA. These signals will be changed with e/p-converters to pneumatic standard signals 0.2 to 1.0 bar for pneumatic diaphragm motors or cylinders of control valves.

All local control loops will be totally pneumatic.

Structure of system

All the signals from the field-situated devices will be wired to local distribution boxes. From these boxes signals will be carried to the cross connection box near the control room with a trunk cable. From cross connection signals will be taken to the control panel.

Control signal from the panel goes through the same way as before which is thus, panel - cross connection - trunk cable - distribution box - equipment cubicle (for e/p - transducers etc) - pneumatic actuator.

All cables from a distribution box to a cross connection box and to a control panel will be twisted and shielded pair by pair.

Electrical and pneumatic supplies will be taken from electric and pneumatic supply panels which are connected to the main supply nets.

All the temperature transmitters, square root extractors and auxiliary devices will be installed into the electric room of its own. This room should be furnished with air conditioninig.

Control panels

Control panels for instrumentation will consist of three main parts: the panel, the pult and the scema parts. Panels will be furnished with doors in the back side.

All the instruments and alarm centers will be installed on the panel part. On-off switches, indicating lamps, Am-meters etc. will be installed on the pult part.

4.7.3 Civil engineering

Tank house

The tank house building is presented in drawing No. 738135-1/0.
The total volume of the building is about 41 000 m^3.
The body of the building will be made of profile steel frames, the walls and roof of profile steel plates.
The ground and operating floors will be made of concrete with acid-proof coating and sloped to a central launder system. The electrical and office rooms of the building will be separated from the other parts by brick walls.

Ventilation is carried out by fans which are placed on the roof. The effeciency of the ventilation is five times per hour.

The foundations of the cells will be made of concrete. All horisontal surfaces are acid-proof coated.

Wire production plant

The building is presented in layout drawing No. 738136-1/0. The total volume of the building is 23 350 m^3 and the structure is of the same kind as the tank house. The efficiency of ventilation is 2-3 times per hour. It will not be necessary to coat the structure of the building with acid-proof coating.

Anode casting shop

As the equipment will be placed in the existing blister casting shop of the smelter, building constructunal work will be needed only for equipment foundations, for the crane trail and to change the present wall structure so that the crane can be taken out from the casting shop.

Main switchgear

Because it is not known if there is room for needed additional equipment in the existing main switchgear building, a reservation has been made in the plans to expand the building with about 160 m^3.

Roads

It has been estimated that the new plant will need about 300 m of paved additional roads.
No railway has been planned to be built in the area, because the goods can be transported by trucks to the spur road going to the existing blister casting shop.

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4.8
Total labour requirements and utilities

4.8.1
Labour

Labour for the plant with a capacity of 25 000 MTPA will be required as follows:

Anode casting shop

	Persons/shift				Total
	I	II	III	IV	
Furnace operator	1	1	1	1	4
Casting operator	1				1
Mould painter	1				1
Helper	4				4
Truck driver	1				1
Crane driver	1				1
Total	10	1	1	1	12
Foreman	1				1
Total					13

Tank house

	Persons/shift				Total
	I	II	III	IV	
Anode man	2	2			4
Cathode man	4				4
Strippers		4			4
Starting sheet prep.	4				4
Inspector	2	2	2	2	8
Crane driver	1	1			2
Truck driver	1				1
Process helper	5				5
Circulation att.	2	1	1	1	5
Slime worker	1				1
Total	22	10	3	3	38

	Persons/shift				Total
	I	II	III	IV	
Foreman	3	1			4
Office clerk	1				1
Process engineer	1				1
Metallurgist	1				1
Superintendent	1				1
	7	1			8
Total for tank house					46

Wire production

	Persons/shift				Total
	I	II	III	IV	
Casting operator	4	4	4	4	12
Rod roller	1	1	1		3
Drawing operator	4	4	4		12
Truck driver	1	1	1		3
Helper	5				5
Maintenance	3	1	1		5
Total	18	11	11	4	44
Foreman	3	1	1		5
Office clerk	2				2
Quality controller	1				1
Laboratory assistant	2				2
Process engineer	1				1
Superintendent	1				1
	10	1	1		12
Total for wire production					56
Total for the plant					115
- workers	94				
- staff	21				

4.8.3
Utility consumptions

The annual consumption will be as follows:

Anode casting			
	Electricity	1 600 MWh	64 kWh/ton Cu
	Cooling water	70 000 m^3	2.8 m^3/ton Cu
	Oil	1 240 tons	50 kg/ton Cu
	Propane	124 tons	5 kg/ton Cu
	Baryte	50 tons	2 kg/ton Cu
Electrolytic refining			
	Electricity	80 000 MWh	320 kWh/ton Cu
	Steam	2 000 tons	80 kg/ton Cu
	Process water	3 500 tons	140 kg/ton Cu
	H_2SO_4	400 tons	16 kg/ton Cu
	Limestone	460 tons	18.5 kg/ton Cu
Wire production			
	Electricity	20 360 MWh	815 kWh/ton Cu
	Cooling water	1 090 000 m^3	43.6 m^3/ton Cu
	Graphite dies	3 300 pcs	0.13 pcs/ton Cu
	Graphite powder	19 tons	0.8 kg/ton Cu
	Charcoal	130 m^3	5.2 dm^3/ton Cu
TOTAL	Electricity	29 960 MWh	1.2 MWh/ton Cu
	Steam	2 000 tons	80 kg/ton Cu
	Process water	3 500 tons	140 kg/ton Cu
	Cooling water	1 160 000 m^3	46.4 m^3/ton Cu
	Oil	1 240 tons	50 kg/ton Cu
	Propane	124 tons	5 kg/ton Cu
	Baryte	50 tons	2 kg/ton Cu
	H_2SO_4	400 tons	16 kg/ton Cu
	Limestone	460 tons	18.4 kg/ton Cu
	Graphite dies	3 300 pcs	0.13 pcs/ton Cu
	Graphite powder	19 tons	0.8 kg/ton Cu
	Charcoal	130 m^3	5.2 dm^3/ton Cu

4.9 Flow sheet, layout and equipment list

4.9.1 Flow sheet

The process flow sheet which comprises the annual amounts of

- raw materials
- utilities
- products

is shown in Chapter No. 9.

4.9.2 Layouts

Layouts with sections of different departments are shown in Chapter No. 9.

4.9.3 Equipment list

Equipment with preliminary specifications are listed in Appendix 3, Chapter No. 10.
Main equipment are shown in the equipment diagram, which is presented in Chapter No. 9.

4.10
Extension of capacity

4.10.1
Extended capacity

The capacity of the designed plant will be 25 000 tons of electrolytic refined copper per year. Here the possibilities of doubling the capacity to 50 000 MTPA will be discussed. This capacity has been presented as an alternative (see item 3.2.6).

4.10.2
Principles of extension

Blister refining and anode casting

It will be possible to double the capacity of this department when two furnace charges are handled per day. The refining and casting of one charge take about eight hours, so the department will have to work in two shifts. There will not be any changes regarding equipment or building.

Tank house

The parameters of operation will remain as before. The amount of production tanks has to be doubled and another rectifier must be supplied. The building will have to be expanded at one end correspondingly. Handling of slime and electrolyte purification can be performed with existing equipment and in the previous rooms. Stripping and preparation of starter sheets can be made by previous facilities, but two shifts will at least partly be needed.

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Cathode melting and rod casting

For the production of wire rod one additional melting and upward casting unit will be needed. An annual capacity of about 56 000 ton will be obtained with three units, as one unit produces about 2.4 t/h and the efficiency is 0.9.

Wire rolling and drawing

The amounts of both rolling and drawing equipment will have to be doubled when the production program of wires remains unchanged.

4.10.3
New cost factors

Equipment

The additional equipment list, Appendix 3, shows those equipment which will have to be bought in addition to equipment in the previous list, when the capacity is increased.

Utilities

The consumption of utilities per ton of copper remains unchanged. The total consumption is doubled.

Labour

The additional need for labour is according to department:

-	Blister refining and anode casting	8 workers 1 foreman
-	Tank house	15 workers
-	Wire production plant	24 workers 3 foremen
	TOTAL	47 workers 4 foremen

Electrification

The capital costs of electrification will increase by about 80 % in connection with the extension.

Civil engineering

The building volume will increase by 65 % in connection with the extension.

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5.
PROJECT DESCRIPTION

CONTENTS

5.1
General

Certain phases will be included in the construction of the plant, like design, equipment deliveries and installations. These will require an effective project organization.

5.2
Project organization

The scheme for project organization is shown in Fig. No. 5.1.

5.3
Project time schedule

The preliminary project time schedule is shown in Fig. No. 5.2.

5.4
Engineering

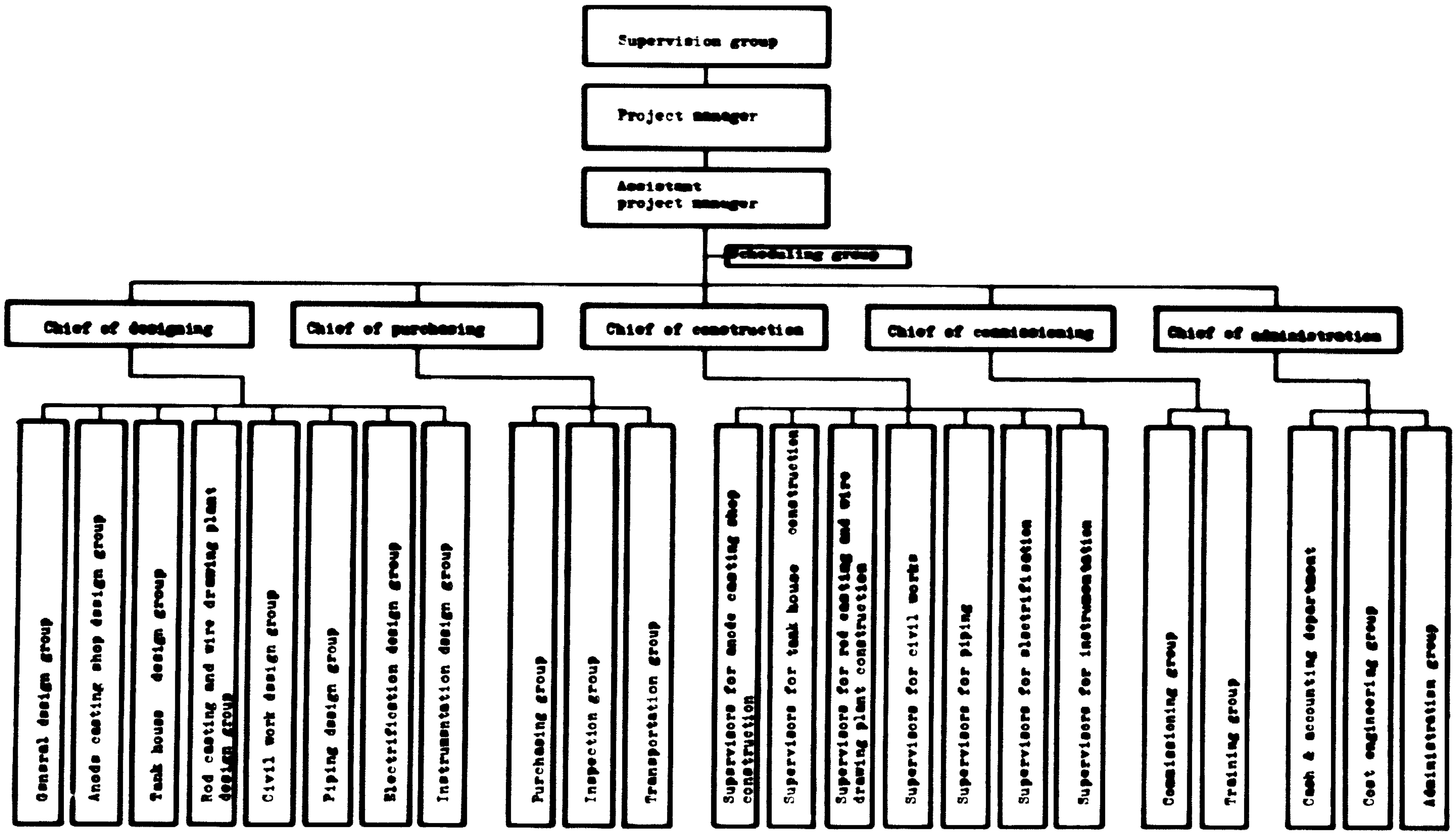
The total amount of design hours, appr. 40 000, for the first stage for a capacity of 25 000 MTPA has been estimated for the following departments:

- anode casting shop
- tank house
- wire production plant

Basic engineering is included in the estimated design hours as follows:

- process design
- plant design

FIG NO 5.1



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Scheme for project organization

FIG NO 32

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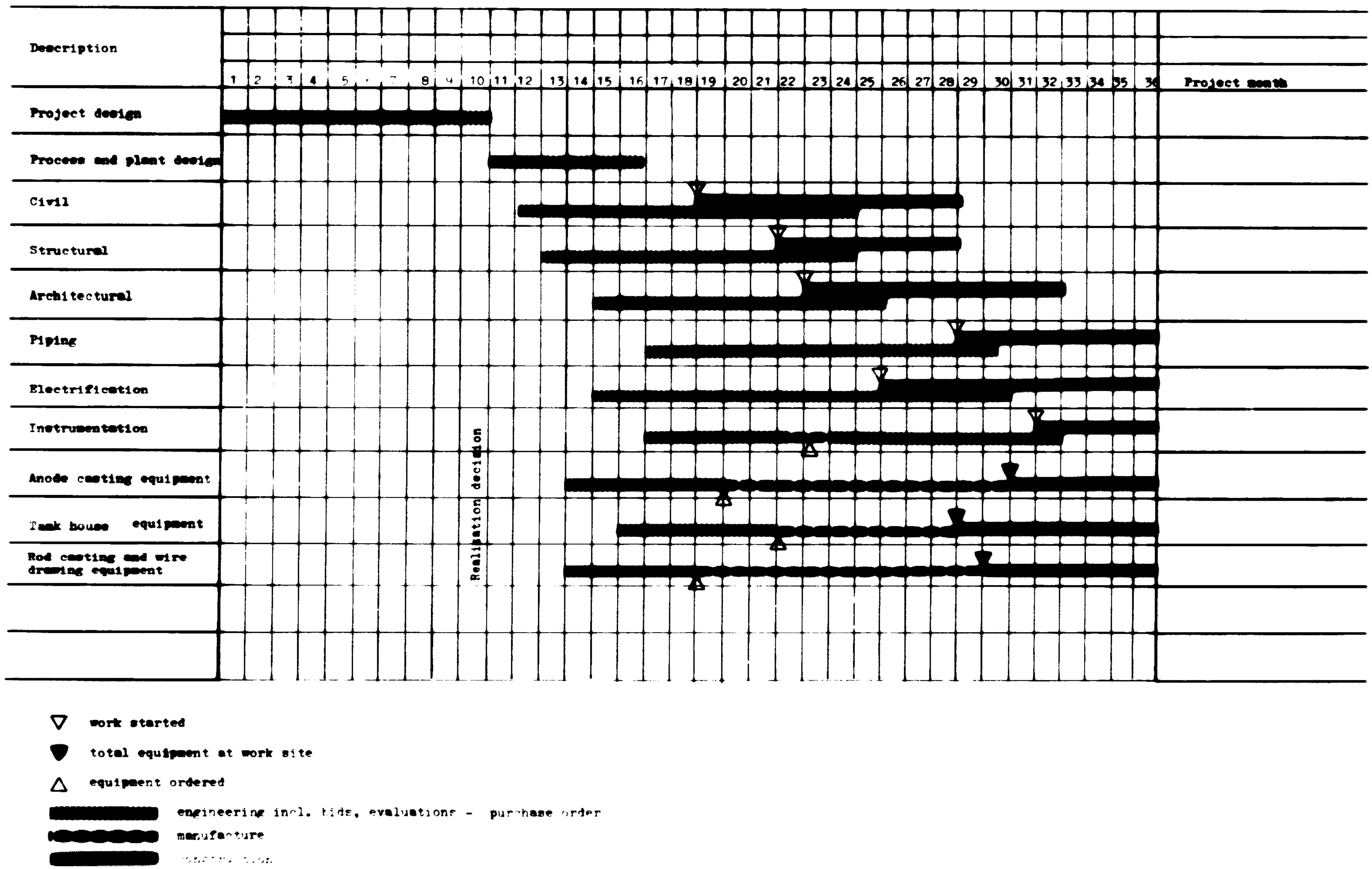
Preliminary project schedule



- equipment design, outline drawings with specifications, erection drawings
- piping design
- electrification and instrumentation design
- civil engineering

The necessary documents for purchasing will be provided.

Part of the basic engineering, as civil engineering, and almost all the detail design have been assumed to be carried out in Turkey.

The additional design hours in the second stage, when expanding the capacity to 50 000 MTPA, have been estimated at 20 000 h, including

- tank house 12 000 h
- wire production 8 000 h

5.5 Project management and procurement

As shown in the organization scheme 3-10 men will be needed for project management and procurement depending on the project phase. In the first stage 120 men months are estimated to be required and 72 men months in the second stage.

5.6 Erection

The erection stage requires an erection supervisior organization, 3-7 men depending on the erection phase. 60 men months have been estimated for the first erection stage and 45 for the second stage.

5.7 Recommendations

In general when the client designs and purchases the equipment himself, he will be held responsible for the operation of the plant. On the other hand, when delivering on turn-key basis, the supplier or main contractor of the plant will take the responsibility, transferring it to the equipment price.

We would suggest that Etibank forms an organization for the realization of this project in Turkey, in order to minimise costs. However, this organization will need internationtal know-how. This know-how could be gained on the basis on international offer competition, from organizations that have

- know-how on process operation
- experience in marketing of copper products
- possibility to supply major equipment
- possibility to provide training and start-up assistance.

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6. ECONOMICAL SURVEY

CONTENTS

6.1
Capital costs

6.1.1
General

The capital cost estimate for the copper electrolytic refinery has been made as an accuracy of ± 20 %. It covers necessary cost items to complete the plant for production inside the scope of this study.

The limits and basis of estimates and the essential investment cost are as follows:

6.1.2
Extent of estimates

Alternatives

According to item 3.2.6 capital cost estimates consist of four alternatives.

Alternative 1

- first stage, capacity for wire products 25 000 MTPA after 1980
- second stage, 3 years after first stage, additional capacity 25 000 MTPA after 1983
- based on imported blister to the end of 1982 and thereafter on Turkish blister
- the production is marketed abroad up to the end of 1982 and afterwards on domestic markets

Alternative 2

- capacity 50 000 MTPA after 1980
- based on import blister until the end of 1982 and thereafter on Turkish blister
- the production is marketed abroad to the end of 1982 and afterwards on domestic markets

Alternative 3
- capacity 50 000 MTPA after 1980
- based on Turkish blister
- the production is marketed on domestic markets

Alternative 4
- first stage, capacity 25 000 MTPA after 1982
- second stage, 2 years after the first stage, additional capacity 25 000 MTPA after 1984
- based on Turkish blister
- the production is marketed on domestic markets

In each one of the alternatives the construction times of the stages have been estimated for two years before commissioning.

The estimates cover anode casting, electro-refining and wire production plant in the first stage of the project and additional investment for the plant in the second stage to double the production.

The cost areas are as follows:

Fixed capital

Fixed capital comprises the following main parts:

Plant area:
- piping
- electrification
- civil engineering

Anode casting area:
- anode casting equipment
- piping
- instrumentation
- electrification
- spare parts
- civil engineering

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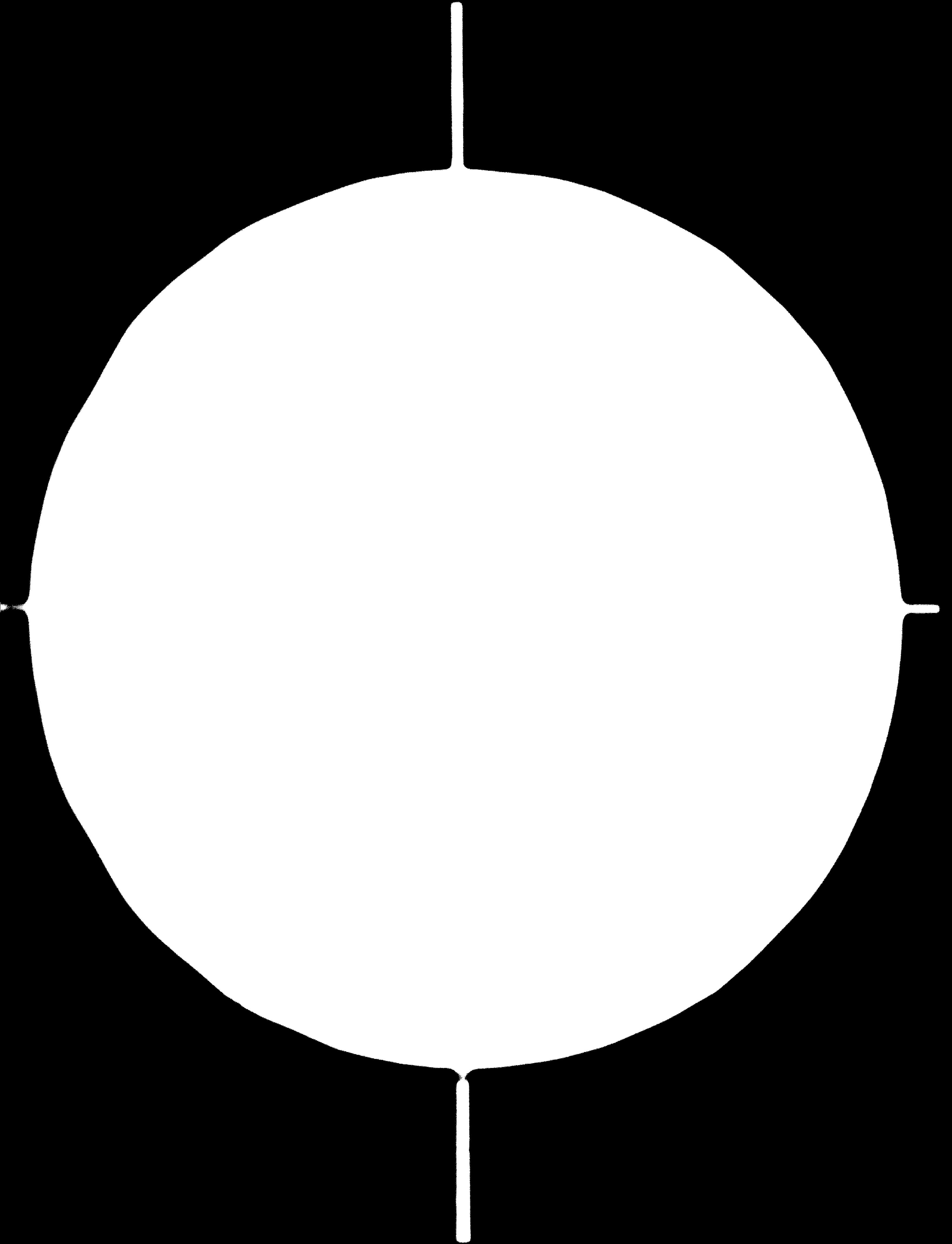
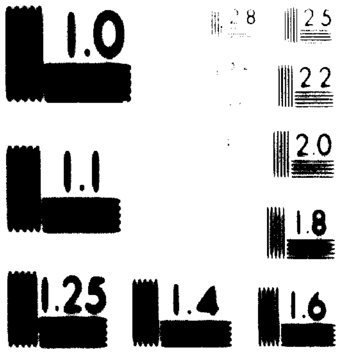


6-10



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Electrolytic tank house area:
- tank house equipment
- electrolyte purification equipment
- slime treatment equipment
- auxiliary equipment
- piping
- instrumentation
- electrification
- spare parts
- civil engineering

Wire production plant:
- rod casting equipment
- rod rolling equipment
- wire drawing equipment
- auxiliary equipment
- piping
- instrumentation
- electrification
- spare parts
- civil engineering

The cost items for process equipment and buildings consist of FOB-prices for material and equipment, freight and sea insurance, erection and taxes. Civil work and foundations for heavy equipment are included in the estimates for buildings.

Other fixed capital:
- engineering
- training
- erection supervision and start-up services
- project management and procurement
- contingencies

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Engineering, project management, training and other services for the project have been estimated to facilitate the good completition of the construction and performance of the plant.

Working capital

The working capital consists of the investment which keeps the plant comlex in continuous performance.

The cost items are:

- cash
- accounts receivable minus accounts payable
- process inventories
- product inventories

6.1.3
Basis for estimates

Monetary units

The estimates are based on prices and rates of exchange valid on September, 1976.

Rates of exchange:

1 TL = 0.2406 Finnish marks
= 0.0625 US$
= 0.0351 St.£
= 0.1552 DM

Building and equipment costs

The costs for buildings and equipment have been based on:

- quotations from material and equipment manufacturers for this project
- quotations from manufacturers for previous projects similar to this
- cost information and unit prices from Turkey

- the experience of Outokumpu Oy in previous investment projects in Finland and abroad

Regarding the quotations attention has been paid particularly to the reliability of manufacturers from Outokumpu Oy's experience. The advantages of offers have been considered from both economical and technical points of view.

Freights and sea insurance

The freight charges have been estimated on the basis of freight volume and weight taking into account both Turkish and foreign supply.

The mean sea freight charge from Europe has been assumed to be 1930 TL/m^3. The sea insurance has been calculated 0.37 % of the CIF-value + 10 %.

Erection

As a basis for erection costs unit price of wages and other cost items in Turkey have been used. Also previous cost information in erection and civil work has been used.

Unit proces

Average daily wage

- engineer	450 TL
- worker	250 TL

Material and equipment

- steel construction	13 TL/kg
- steel plate at factory	4 TL/kg
- reinforced concrete	400 TL/m^3
- concrete foundation	350 TL/m^3

- brick wall (1/1) 664 TL/m^3
- roofing 100 TL/m^3
- painting 45 TL/m^3
- panelling average 120 TL/m^2

Spare parts

A set of spare parts for two year's operation of the plant has been estimated to be 5 % of the value of process equipment.

Duties and taxes

Custom duties and taxes have been calculated on the basis of information from Turkey, for each one of the alternatives and equipment. To make this possible the equipment have been divided into Turkish and import supplies.

The following duties and taxes have been taken into account for import supplies:

- custom duty (CIF-value x % rate)
- municipal tax (custom duty x % rate)
- stamp duty (CIF-value x % rate)
- harbour tax (CIF-value + custom duty + municipal tax x % rate)
- production tax (CIF-value + custom duty + municipal tax + harbour tax x % rate)

The rates of taxes and import from privileged countries have been taken into account in the estimates.

The rates have been calculated so that foreign supplies are imported during the second year of the construction period.

No duties or taxes have been considered for engineering and other services, Turkish supplies, erection cost and for the alternatives where the production is exported.

Engineering

According to item 5.4 the engineering costs for the project have been calculated by using estimated 40 000 hours in the first stage and 20 000 hours more in the second stage.

Project management and services

Project management and procurement, erection supervision, training and start-up services have been estimated to be totally 180 men/month (see items 5.5 and 5.6) in the first stage and 117 men/month in the second stage.

Contingencies

Contingencies for fixed capital costs have been estimated to be 15 % of the fixed capital to cover miscellaneous costs of capital.

Working capital

To cover the cash requirement during the operation time of the plant a monthly value of supplies and wages has been reserved.

The delay which is due to the payments of the client is taken into account as the value of average monthly accounts receivable minus value of average monthly accounts payable which are due to supply of utilities.

For the supply of utilities the value for one month's operation has been estimated.

The average value of copper in process has been estimated to be 2400 tons, when the plant capacity is 25 000 MTPA.
To cover the fluctuations in the demand for wire, products have been considered to be kept for one month's production in the warehouse to facilitate the sudden need.

6.1.4
Fixed capital

The estimates for alternatives are shown in Table No. 6.1.

The detailed cost break-down for equipment costs have been indicated in Chapter 8.

6.1.5
Working capital

Working capital has been collected into Table No. 6.2.

6.1.6
Domestic and foreign supplies

The supply of capital has been estimated between Turkish and foreign supplies according to Table No. 6.3.

Freight and erection costs have been included in the Turkish supply.

TABLE No. 6.1

FIXED CAPITAL

The estimates for alternatives are as follows:
(Unit = 1000 TL)

	Alternative 1		Alternative 2	Alternative 3	Alternative 4	
	25 000 MTPA	+ 25 000 MTPA	50 000 MTPA	50 000 MTPA	25 000 MTPA	+ 25 000 MTPA
Plant Area						
- piping	2 750	250	3 000	3 000	2 750	250
- electrification	2 080	2 080	4 160	4 160	2 080	2 080
- civil engineering	899	-	899	899	899	-
Subtotal	TL 5 729	TL 2 330	TL 8 059	TL 8 059	TL 5 729	TL 2 330
Anode Casting Area						
- anode casting equipment	43 690	-	43 690	55 694	54 680	-
- piping	400	-	400	400	400	-
- instrumentation (included in casting eq.)	-	-	-	-	-	-
- electrification	10 390	-	10 390	10 390	10 390	-
- spare parts	3 350	-	3 350	3 350	3 350	-
- civil engineering	600	-	600	600	600	-
Subtotal	TL 58 430	TL -	TL 58 430	TL 70 434	TL 69 420	TL -
Electrolytic Tank House Area						
- copper refining equipment	23 215	19 909	41 600	45 669	25 706	19 919
- electrolyte purification equipment	1 128	269	1 322	1 377	1 236	263
- slime treatment equipment	2 312	669	2 910	3 721	3 026	657
- auxiliary equipment	3 456	1 470	4 912	4 912	3 440	1 470
- piping	2 909	2 909	5 818	5 818	2 909	2 909
- instrumentation	4 156	3 325	7 481	7 481	4 156	3 325
- electrification	37 404	33 664	71 068	71 068	37 404	33 664
- spare parts	357	268	625	625	357	268
- civil engineering	25 281	16 271	41 552	41 552	25 281	16 271
Subtotal	TL 100 218	TL 78 754	TL 177 263	TL 182 217	TL 103 515	TL 78 746
Wire Production Plant Area						
- rod casting equipment	38 669	25 984	58 037	84 709	52 338	25 212
- rod rolling equipment	14 396	18 099	28 870	40 751	19 074	18 407
- wire drawing equipment	21 051	25 808	42 140	56 698	27 762	24 458
- auxiliary equipment	8 654	7 676	16 378	16 309	8 635	7 670
- piping	499	499	998	998	499	499
- instrumentation	3 657	2 926	6 583	6 583	3 657	2 926
- electrification	18 983	15 154	34 097	34 097	18 983	15 154
- spare parts	6 961	5 221	12 182	12 182	6 961	5 221
- civil engineering	7 331	5 818	13 149	13 149	7 331	5 818
Subtotal	TL 120 161	TL 107 539	TL 212 434	TL 265 476	TL 145 200	TL 105 365
Others						
- engineering	19 950	9 975	24 940	24 940	19 950	9 975
- training	1 920	623	1 920	1 920	1 920	623
- erection supervision and start-up services	9 450	4 724	10 038	10 038	9 450	4 724
- project management and procurement	1 215	729	1 215	1 215	1 215	729
- contingencies 15 %	4 880	2 408	5 717	5 717	4 880	2 408
Subtotal	TL 37 415	TL 18 459	TL 43 830	TL 43 830	TL 37 415	TL 18 459
SUBTOTAL	TL 321 953	TL 207 122			TL 361 279	TL 204 900
TOTAL		TL 529 075	TL 500 001	TL 570 016		TL 566 179

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WORKING CAPITAL

TABLE No. 6.2

(Unit = 1000 TL)

	Alternative 1				Alternative 2				Alternative 3		Alternative 4			
	1st stage		2nd stage								1 st stage		2nd stage	
Liquid assets														
- cash		1895		923		2818		-		2818		1895		1895
- accounts receivable	52399		168955		104027		118068		218394		100683		100683	
./. accounts payable	1746	50653		167009	3492	100535	200	117868	3692	214702	1846	98837	1846	98837
Subtotal		52548		167932		103353		117868		217520		100732		100732
Inventories														
- supplies inventory		1746		1946		3492		200		3692		1846		1846
- process inventory		60039		154971		120078		94932		215010		107505		107505
- product inventory		26325		77450		52650		51125		103775		51887		51887
Subtotal		88110		234367		176220		146257		322477		161238		161238
SUBTOTAL		140658		402299		279573		264125				261970		261970
TOTAL			TL 542 957				TL 543 698		TL 539 997				TL 523 940	

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9.2
42.24
37.74
23.28
824.7
269.5
1980.34

226.5
67.5
44.1
338.1
0399.94

TURKISH AND FOREIGN SUPPLIES

Item	Alternative 1						Alternative 2		Alternative 3		Alternative 4					
	1.Stage		2.Stage		Total						1.Stage		2.Stage		Total	
	T	I	T	I	T	I	T	I	T	I	T	I	T	I	T	I
Plant area																
Piping	2750	-	250	-	3000	-	3000	-	3000	-	2750	-	250	-	3000	-
Electrification	2080	-	2080	-	4160	-	4160	-	4160	-	2080	-	2080	-	4160	-
Civil engineering	899	-	899	-	899	-	[illegible]	-	[illegible]	-	[illegible]	-	-	-	[illegible]	-
Subtotal	5729	-	2330	-	8059	-	8059	-	8059	-	5729	-	2330	-	8059	-
Anode casting plant	19630	24060	-	-	19630	24060	19630	24060	19630	36064	19630	35050	-	-	19630	35050
Anode casting equipment	19630	24060	-	-	19630	24060	19630	24060	19630	36064	19630	35050	-	-	19630	35050
Piping	400	-	-	-	400	-	400	-	400	-	400	-	-	-	400	-
Instrumentation incl.equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Electrification	10390	-	-	-	10390	-	10390	-	10390	-	10390	-	-	-	10390	-
Spare parts	1489	1861	-	-	1489	1861	1489	1861	1489	1861	1489	1861	-	-	1489	1861
Civil engineering	600	-	-	-	600	-	600	-	600	-	600	-	-	-	600	-
Subtotal	32509	25921	-	-	32509	25921	32509	25921	32509	37925	32509	36911	-	-	32509	36911
Electrolytic tank house area																
Copper refining equipment	14060	9132	13142	6777	27202	15909	27153	14447	27153	18425	14060	11616	13142	6777	27202	18393
Electrolytic purification equipment	765	340	54	214	819	554	674	647	674	696	765	467	54	208	819	675
Slime treatment	839	1400	503	165	1392	1565	1392	1586	1392	2336	889	2129	503	153	1392	2282
Auxiliary equipment	3432	-	1468	-	4900	-	4907	-	4907	-	3432	-	1499	-	4931	-
Piping	2909	-	2909	-	5818	-	5818	-	5818	-	2909	-	2909	-	5818	-
Instrumentation	1455	2701	1164	2161	2619	4862	2618	4863	2618	4863	1455	2701	1164	2161	2619	4862
Electrification	37404	-	33664	-	71068	-	71068	-	71068	-	37404	-	33664	-	71068	-
Spare parts	238	119	179	89	417	208	417	208	417	208	238	119	179	89	417	208
Civil engineering	25281	-	16271	-	41552	-	41552	-	41552	-	25281	-	16271	-	41552	-
Subtotal	86483	13692	69354	9406	155837	21533	155599	21681	155599	26518	86433	17032	69385	9388	155818	26420
Wire production plant																
Rod casting equipment	-	38669	-	25984	-	64653	-	58037	-	84709	-	52338	-	25212	-	77550
Rod rolling equipment	-	14396	-	18859	-	33255	-	28870	-	40751	-	19074	-	18407	-	37481
Wire drawing equipment	245	20806	245	25159	490	45965	490	41650	490	56208	245	27417	245	24213	490	51730
Auxiliary equipment	8654	-	7674	-	16328	-	16378	-	16309	-	8635	-	7670	-	16305	-
Piping	499	-	499	-	998	-	998	-	998	-	499	-	499	-	998	-
Instrumentation	1280	2377	1024	1902	2304	4279	2304	4279	2304	4279	1280	2377	1024	1902	2304	4279
Electrification	18943	-	15154	-	34097	-	24097	-	34097	-	18943	-	15154	-	34097	-
Spare parts	-	6961	-	5221	-	12182	-	12182	-	12182	-	6961	-	5221	-	12182
Civil engineering	7331	-	5818	-	13149	-	13149	-	13149	-	7331	-	5818	-	13149	-
Subtotal	36952	83209	30414	77125	67366	160334	67416	145018	67347	[illegible]	36933	108267	30410	74955	67343	183222
Others																
Engineering	11970	7980	5985	3990	17955	11970	9976	14964	9976	14964	11970	7980	5985	3990	17955	11970
Erection supervision and start-up	2370	7080	1181	3543	3551	10623	2359	7679	2359	7679	2370	7080	1181	3543	3551	10623
Training	-	1920	623	-	623	1920	-	1920	-	1920	-	1920	623	-	623	1920
Project management and procurement	1215	-	-	729	1215	729	1215	-	1215	-	1215	-	-	729	1215	729
Contingencies* 15 %																
Subtotal	15555	16980	7789	8262	23344	24242	13550	24563	13550	24563	15555	16980	7789	8262	23344	25242
Total	117228	[illegible]	109887	94793	227115	[illegible]	277133	217183	277064	287135	[illegible]	[illegible]	[illegible]	92605	287073	27179
					T = 49 %	I = 51 %	T = 56 %	I = 44 %	T = 49 %	I = 51 %					T = 51 %	I = 49 %

Unit = 1000 TL
T = Turkish supply
I = Foreign supply

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6.1.7
Annual capital costs

Annual capital costs have been estimated in each alternative according to the preliminary project schedule.

The main principles are:

- construction time in each stage and alternative is 2 years
- engineering completed during the first year
- the foreign supplies are delivered during the second year and the main share of payments are made then.
- working capital is invested at the beginning of the third year
- escalation for capital costs has been estimated to be average 12 % per year.

The distribution of annual costs has been presented in the Table No. 6.4.

Annuities for the capital costs for the alternatives have been calculated so that annual capital costs have been discounted to the beginning of the project and the annuities have been calculated according to the production time of 18 years. The rate of interest is 15 %.

Alternative 1	101 813 620 TL
Alternative 2	112 307 050 TL
Alternative 3	130 528 990 TL
Alternative 4	115 097 100 TL

The cost break-down for equipment and buildings in Alternative 1 is presented in Chapter 8.

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TABLE 6.4

ANNUAL CAPITAL COSTS
(UNIT = 1000 TL)

Item	1978	1979	1980	1981	1982	1983	1984
ALTERNATIVE 1							
Fixed capital							
-Plant area	171[illegible]	34[illegible]	573	699	1[illegible]98	[illegible]33	
-Anode casting plant	175[illegible]	35058	5843	-	-	-	
-Electrolytic tankhouse	3006[illegible]	601[illegible]	1002[illegible]	24638	47277	7879	
-Wire Production plant	36048	72097	12016	32262	645[illegible]	10754	
- Others	11225	22449	3741	5538	11075	1846	
Subtotal	96586	19317[illegible]	32195	62137	12473	20712	
Working capital			140658			402[illegible]99	
TOTAL	96586	193172	172853	62137	1247[illegible]	423011	
ALTERNATIVE 2							
Fixed capital							
- Plant areaa	2418	4835	806				
- Anode casting plant	17529	35058	5843				
- Electrolyte tankhouse	53184	106368	17728				
- Wire production plant	63730	127461	21243				
- Other	13149	26298	4383				
Subtotal	150010	300020	50003				
Working capital			279573			264125	
TOTAL	150010	300020	329576			264125	
ALTERNATIVE 3							
Fixed capital							
-Plant area	2418	4835	806				
-Anode casting plant	21130	42261	7043				
-Electrolyte tankhouse	54665	109330	18222				
-Wire production plant	79643	159286	26547				
- Other	13149	26298	4393				
Subtotal	17105	42010	57001				
Working capital			539997				
TOTAL	17105	342010	596998				

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Item	1979	1979	1980	1981	1982	1983	1984
ALTERNATIVE 4							
Fixed capital							
-Plant area			1719	3437	1272	1398	253
-Anode casting plant			20826	41652	6942	-	-
-Electrolyte tankhouse			31055	62109	33975	[illegible]	7874
-Wire production plant			43559	87120	46130	63219	10537
-Others			11225	22449	9279	11075	1846
Subtotal			108384	216767	97598	122940	20490
Working capital					261970		261970
TOTAL			108384	215767	359568	122940	282460

6.2 Operating costs

6.2.1 General

The operating costs estimate for the plant complex consists of estimates of variable and fixed operating costs. The price estimate for blister copper has been considered in this section.

6.2.2 Extent of estimates

The estimates have been calculated in each stage of the alternatives for the following items:

Raw material

- blister copper

Operating costs

Variable costs:

- power
- steam
- process water
- cooling water
- compressed air
- oil
- propane
- barytes
- sulphuric acid
- limestone
- graphite dies
- charcoal
- maintenance
- miscellaneous

Fixed costs:

- labour wages
- staff salaries
- marketing expenses
- miscellaneous

6.2.3
Basis for estimates
Blister copper

The amount of blister is based on process calculations. The price of import blister has been considered according to the LME quotation and Turkish blister is based on information from Turkey.

Utilities

The consumption of utilities is based on process calculations and unit prices on information from Turkey and in some cases on world market prices taking into account the Turkish import taxes.

Unit prices:

- electricity	0.4793	TL/Kwh
- oil	2	TL/kg
- sulphuric acid	1 200	TL/MT
- wood poles	2 600/1 900	TL/m^3
- propane	10	TL/kg
- lime (untreated)	0.50	TL/kg
- process water	1	TL/m^3
- cooling water	0.1	TL/m^3
- barytes	4	TL/kg
- compressed air	0.2	TL/m^3
- graphite dies	160	TL/pc
- graphite power	25.5	TL/kg
- charcoal	11.2	TL/kg

Maintenance costs

Maintenance materials for the plant complex have been estimated on the basis of Outokumpu Oy's experience for similar plants as follows:

- anode casting	10 %	of equipment prices
- electrolytic refining	5%	" " "
- rod casting	15 %	" " "
- wire rolling and drawing	10 %	" " "

Wages and salaries

Labour and staff costs have been based on the manning list of the plant (see Item 4.8.1) and on the average annual wages in Turkey.

Marketing expenses

The marketing expenses have been calculated according to sale incomes, taking 1.5 % from the sales and 1.5 % more for agents' fees if it is marketed abroad.

The marketing expenses include the salaries of sales personnel and sales promotion costs.

The expenses have been taken into account as a decrease in the sale price of Cu-wire. The sale prices have been considered on FOB-basis.

Miscellaneous

Variable miscellaneous costs include general laboratory costs, internal transportation costs and utilities with low consumption. These costs have been calculated on the basis of other variable costs taking 15 % from them.

- cost information and unit prices from Turkey

Fixed miscellaneous costs include consumption of office materials and contingencies of operating costs. 15 % for other fixed operating have been estimated to cover these costs.

6.2.4
Operating cost estimates

Raw materials

Price of blister

<u>Turkish blister price</u>

- 37 000 TL/t

<u>Import blister</u>

Cu-price for one ton of blister

- 1000 kg x 99 % Cu - loss 0.3 % = 987 kg
- price of LME quotation for Cu wire bars = 900 £/t = 25 641 TL/t
- 987 kg/t x 25 641 TL/t = 25 308 TL/t
- treatment charge 8.8 US¢/lbs = 3.10 TL/kg 987 kg x 3.10 TL/kg = 3 059.7 TL
- 25 308 - 3 059.7 = 22 248 TL

Au-price of one ton of blister

- average 20 g Au
- loss 1 g Au
- 20 g Au - 1 g Au = 19 g Au/t
- price of LME quotation for gold = 111 US$ /troy OZ = 177.6 TL/troy OZ = 1071.1 TL
- treatment charge 35 US$/kg = 560 TL/kg = 10.64 TL
- 1071.1 TL = 10.64 TL = 1060.43 TL

Ag-price for one ton of blister

- average 200 g
- loss 35 kg
- 200 g - 35 kg = 165 g Ag
- price of LME quotation for silver = 2.75 $/troy OZ = 78.35 TL/troy OZ = 410.35 TL
- treatment charge 4 US$/kg = 64 TL/kg= 10.56 TL
- 410.34 TL - 10.56 TL = 399.78 TL

Total price for one ton of blister

- price of Cu + Au + Ag = 22 248 TL + 1060.43 TL + 399.78 TL = 23 798.21 TL/t blister

Total costs for raw materials per year in the various cases at the capacity of 25 000 MTPA

Turkish blister

- 37 700 TL/t x 25 253 t/a = 952 038 100 TL/a

Import blister withour taxes

- 23 708.31 TL/t x 25 253 t/a = 598 703 430 TL/a

If the production of the plant is marketed on domestic markets it will have to increase import duties and taxes by 128.7 % (see item 3.8 of the marketing study).

- 2.287 X 23 708.21 = 54 220.68 TL/t blister
- 25 253 t/a x 54 220.68 = 1 369 234 830 TL/a

Variable costs

Capacity 25 000 MTPA

- Electricity		
29960 MWh x 0.4793 TL/kWh	=	14 359 828 TL/a
- Steam		
20000 t No costs		-
- Process water		
3500 m^3 x 1 TL/m^3	=	3 500 TL/a
- Cooling water		
1160000 m^3 0.10 TL/m^3	=	116 000 TL/a
- Compressed air		
1313000 m^3 x 0.2 TL/m^3	=	262 600 TL/a
- Oil		
1240 t x 2 TL/kg	=	2 480 000 TL/a
- Propane		
124 t x 10 TL/kg	=	1 240 000 TL/a
- Barytes		
50 t x 4 TL/kg	=	200 000 TL/a
- Sulphuric acid		
400 t x 1200 TL/t	=	480 000 TL/a
- Lime stone		
460 t x 0.5 TL/kg	=	230 000 TL/a
- Graphite dies		
3300 pcs x 160 TL/pc	=	580 000 TL/a

of average monthly accounts payable which are due to supply of utilities.

- Graphite powder
  18.5 t x 25.50 TL/kg = 471 750 TL/a

- Charcoal
  130 m^3 x 11.2 TL/kg = 582 000 TL/a

- Maintenance = 20 617 500 TL/a

- Miscellaneous
  15 % x other variable costs = 6 235 677 TL/a

Total for variable costs	47 806 855 TL/a

When the capacity of the plant is increased by 25 000 MTPA the variable costs will be doubled.

Fixed Costs

Capacity 25 000 MTPA

- Labour
  94 x 75000 TL/person = 7 050 000 TL/a

- Staff
  21 x 135 000 TL/person = 2 835 000 TL/a

- Miscellaneous
  15 % other fixed costs = 1 483 000 TL/a

Total	11 368 000 TL/a

Capacity 50 000 MTPA

- Labour
  151 x 75 000 TL/person = 11 325 000 TL/a

- Staff
  25 x 135 000 TL/person = 3 375 000 TL/a

- Miscellaneous
  15 % x other fixed costs = 2 205 000 TL/a

Total	16 905 000 TL/a

Total operating costs

Alternative 1

First stage 25 000 MTPA

Variable costs	1912.27	TL/t Cu-wire	47 806 855 TL/a
Fixed costs	454.72	TL/t Cu-wire	11 368 000 "
Total	2366.99	TL/t Cu-wire	59 174 855 TL/a

Second stage; additional capacity 25 000 MTPA

Variable costs	2048.41	TL/t Cu-wire	51 210 281 TL/a
Fixed costs	221.48	TL/t Cu-wire	5 537 000 "
Total	2269.89	TL/t Cu-wire	56 747 281 TL/a

Alternative 2

Export marketing to the end of 1982

Variable costs	1912.27	TL/t Cu-wire	95 613 710 TL/a
Fixed costs	338.10	TL/t Cu-wire	16 905 000 TL/a
Total	2250.37	TL/t Cu-wire	112 518 710 TL/a

Domestic marketing from 1983

Variable costs (additional)	68.07	TL/t Cu-wire	3 403 426 TL/a
Fixed costs (additional)			-
Total	68.07	TL/t Cu-wire	3 403 426 TL/a

Alternative 3

Capacity 50 000 MTPA

Variable costs	1980.34	TL/t Cu-wire	99 017 136 TL/a
Fixed costs	338.10	TL/t Cu-wire	16 905 000 TL/a
Total	2218.44	TL/t Cu-wire	115 922 136 TL/a

Alternative 4

First stage 25 000 MTPA

Variable costs	1980.34 TL/t Cu-wire	49 508 568 TL/a
Fixed costs	454.72 TL/t Cu-wire	11 368 000 TL/a
Total	2435.06 TL/t Cu-wire	60 876 568 TL/a

Second stage; additional capacity 25 000 MTPA

Variable costs	1980.34 TL/t Cu-wire	49 508 568 TL/a
Fixed costs	221.48 TL/t Cu-wire	5 537 000 TL/a
Total	2201.82 TL/t Cu-wire	55 045 568 TL/a

6.2.5
Domestic and foreign supplies

As import supplies barytes, graphite dies and graphite powder have been considered.
In the alternatives where the production is sold to domestic consumers the import taxes have been estimated to be 100 %.

6.2.6
Annual operating costs during the production years

Raw Materials

The increases in blister prices per year have been estimated to be 11 % for Turkish and import blister.

Operating Costs

Annual operating costs for each stage and alternatives have been estimated according to the rate of escalation 15 % per year.

The distribution of annual operating costs and blister prices without escalation has been presented in the Table No. 6.5.

THE PRICE OF BLISTER AND OPERATING COSTS (WITHOUT ESCALATION)
(UNIT = TL)

TABLE No. 6.5

ITEM	Alternative 1 25000	50000	Alternative 2 25000	50000	Alternative 3 50000	Alternative 4 50000	50000
	Import	Turkish	Import	Turkish	Turkish	Turkish	Turkish
Raw Materials/t Cu-wire							
Blister	23948.1	38081.52	23948.1	38081.52	38081.52	38081.52	38081.52
	1.stage	2.stage				1.stage	2.stage
	Export	Domestic	Export	Domestic	Domestic	Domestic	Domestic
Operating costs/t Cu-wire							
Variable Costs							
Power	574.4	574.4	574.4	574.4	574.4	574.4	574.4
Steam	-	-	-	-	-	-	-
Process water	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Cooling water	4.64	4.64	4.64	4.64	4.64	4.64	4.64
Compressed air	10.50	10.50	10.50	10.50	10.50	10.50	10.50
Oil	99.2	99.2	99.2	99.2	99.2	99.2	99.2
Propane	49.6	49.6	49.6	49.6	49.6	49.6	49.6
Barytes	8	16	8	16	16	16	16
Sulphuric acid	19.2	19.2	19.2	19.2	19.2	19.2	19.2
Lime stone	9.2	9.2	9.2	9.2	9.2	9.2	9.2
Graphite dies	21.12	42.24	21.12	42.24	42.24	42.24	42.24
Graphite powder	18.87	37.74	18.87	37.74	37.74	37.74	37.74
Charcoal	23.28	23.28	23.28	23.28	23.28	23.28	23.28
Maintenance	824.7	824.7	824.7	824.7	824.7	824.7	824.7
Miscellaneous 15 %	249.43	269.5	249.43	269.5	269.5	269.5	269.5
Subtotal	1912.28	1980.34	1912.28	1980.34	1980.34	1980.34	1980.34
Fixed costs/t Cu-wire							
Labour	282	226.5	226.5	226.5	226.5	282	226.5
Staff	113.4	67.5	67.5	67.5	67.5	113.4	67.5
Miscellaneous	59.3	44.1	44.1	44.1	44.1	59.3	44.1
Subtotal	454.7	338.1	338.1	338.1	338.1	454.7	338.1
Total operating costs/t Cu-wire	26315.08	40399.94	26198.48	40399.94	40399.94	40516.34	40399.94

6.3 Incomes

6.3.1 General

The income estimation for the electrolytic refinery plant consists of the sale incomes from several qualities of copper wire products, gold and silver.

6.3.2 Basis for Estimates

According to the definition of alternatives in item 6.1.2 and process calculations the productions are as follows:

- 25 000 MTPA Cu-wire products

ø 0.4 mm	834 t/a
ø 0.6 mm	833 "
ø 0.8 mm	833 "
ø 1.0 - 1.4 mm	3750 "
ø 1.4 - 3.5 mm	6250 "
ø 4 mm	6250 "
ø 8 mm	6250 "
	25000 t/a

- 490 kg/a Gold in anode slimes
- 4900 kg/a Silver in anode slimes

When the capacity is increased to 50 000 MTPA the afore mentioned quantities will be doubled.

The prices and incomes are as follows:

Wire products

In Turkey

ø 0.4 mm, ø 0.6 mm, ø 0.8 mm	55.15 TL/kg
ø 1.0 - 1.4 mm	53.50 TL/kg

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∅ 1.4 - 3.5 mm ∅ 4 mm	52.55 TL/kg
∅ 8 mm	51.45 TL/kg

Weighted mean 52 677.5 TL/kg x 25 000 t

= 1 316 937 500 TL/a

(marketing costs are included)

Abroad

The average price of Cu-wire products abroad is:

LME quotation for wire bars	880 £/t	
+ price difference between wire bars and wires	44 £/t	
	924 £/t =	
		26 324.79 TL/t
+ sale organization and agent fee 3 %		
1.03093 x 26 324.79	=	27 139.02 TL/t
25000 t x 27 139,02 TL/t	=	678 475 500 TL/

Gold

The selling price of gold is LME quotation

111 US$/troy OZ	=	56 941.33 TL/kg
./. 45 £/kg	=	1 282.05 "
		55 659.28 TL/kg
./. bulk treatment 50 US$/t	=	0.80 TL/kg
		55 658.48 TL/kg
490 kg x 55 658.48 TL/kg	=	27 272 655 TL/a

Silver

The selling price of silver is LME quotation

2.75 £/troy OZ = 78.35 TL/troy OZ	2 512.02	TL/kg
./. 30 £/kg =	854.70	TL/kg
	1 657.28	TL/kg

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	1 657.28	TL/kg
./. bulk treatment 50 US$/t =	0.80	TL/kg
	1 656.48	TL/kg
490 kg x 1 656.48 TL/kg =	8 116 752	TL/a

6.3.3

Estimate of incomes

The estimate for incomes for each alternative without escalations is(18 years' production life):

<u>Alternative 1</u>

First stage 25 000 MTPA production from 1980

Cu-wire	first year 18 000 MTPA	488 502 360 TL
	2 x 678 475 500	1 356 951 000 "
Gold	first year 353 kg/a	19 647 443 "
	2 x 27 272 655	54 545 310 "
Silver	first year 3530 kg/a	5 847 374 "
	2 x 8 116 752	16 233 504 "
./. marketing costs		55 363 600 "

First stage + second stage = 50 000 MTPA, prod. from 1983

Cu-wire	first year 47 500 MTPA	2 502 181 250 TL
	14 x 2 633 875 000	36 874 250 000 "
Gold	first year 931 kg/a	51 818 045 "
	14 x 54 545 310	763 634 340 "
Silver	first year 9310 kg/a	15 421 829 "
	14 x 16 233 504	227 269 056 "
./. marketing costs		590 646 469 "
TOTAL		41 730 291 442 TL

Outokumpu Oy

Alternative 2

Capacity 50 000 MTPA, production from 1980

Cu-wire	first year 35 000 MTPA	949 865 700 TL
	2 x 1 356 951 000	2 713 902 000 "
	15 x 2 633 875 000	39 508 125 000 "
Gold	first year 686 kg/a	38 181 717 "
	17 x 54 545 310	927 270 270 "
Silver	first year 6860 kg/a	11 363 453 "
	17 x 16 233 504	275 969 568 "
./. marketing costs		702 534 906 "
TOTAL		43 723 142 802 TL

Alternative 3

Capacity 50 000 MTPA, production from 1980

Cu-wire	first year 35 000 MTPA	1 843 712 500 TL
	17 x 2 633 875 000	44 775 875 000 "
Gold	first year 686 kg/a	38 181 717 "
	17 x 54 545 310	927 270 270 "
Silver	first year 6860 kg/a	11 363 453 "
	17 x 16 233 504	275 969 568 "
./. marketing costs		699 293 812 "
TOTAL		47 173 078 696 TL

Alternative 4

First stage 25 000 MTPA, production from 1982

Cu-wire	first year 18 000 MTPA	948 195 000 TL
	second year	1 316 937 000 "
Gold	first year 353 kg/a	19 647 443 "
	second year	27 272 655 "
Silver	first year 3530 kg/a	5 847 374 "
	second year	8 116 752 "
./. marketing costs		67 953 975 "

Percentage change of Estimated

First stage + second stage = 50 000 MTPA, prod. from 1984

Cu-wire	first year 47 500 MTPA	2 502 181 250 TL
	15 x 2 633 875 000	39 508 125 000 "
Gold	first year 931 kg/a	51 818 045 "
	15 x 54 545 310	818 179 650 "
Silver	first year 9310 kg/a	15 421 829 "
	15 x 16 233 504	243 502 560 "
./. marketing costs		630 154 594 "
TOTAL		44 767 136 489 TL

6.3.4
Annual incomes

The escalation for the products of plant has been estimated for

- Cu-wire products average 10 % per year
- Gold average 1976-1980 3 % per year
  1981-2000 5 % per year
- Silver average 4 % per year

6.4 Profitability calculations

6.4.1 General

The comparison between the alternatives will be made by calculating the rate of return and pay-back period of each alternative without escalation.

On the basis of these and other factors a basic alternative will be chosen on which the escalation is calculated, taking the following into account:

- rate of return and pay-back period
- sensitivity analysis
- risk analysis
- cash flow

6.4.2 Annual proceeds

The annual proceeds of the investment alternative without escalation before income taxes have been indicated in the Table No. 6.6.

These average annual proceeds have been calculated on the basis of 18 years' production time.

The annual capital costs have been discounted to the beginning of the project and the annuities have been calculated according to 18 years' production.

The rate of interest 15 % has been used.

Investment costs are according to item 6.1.7. Operating and raw material costs are according to items 6.2.4 and 6.2.6.

Incomes are according to item 6.3.4.

ANNUAL PROCEEDS

(Unit = 1000 TL)

TABLE No. 6.6

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Incomes				
- cu-wires	2 290 105 TL/a	2 398 438 TL/a	2 589 977 TL/a	2 459 747 TL/a
- gold	49 425 "	53 636 "	53 636 "	50 940 "
- silver	14 710 "	15 963 "	15 963 "	15 160 "
Subtotal	2 354 240 TL/a	2 468 037 TL/a	2 659 576 TL/a	2 525 847 TL/a
./. sale expenses	35 889 "	39 030 "	38 850 "	38 784 "
TOTAL	2 318 351 TL/a	2 429 007 TL/a	2 620 726 TL/a	2 487 063 TL/a
Operating costs				
- blister	1 671 911 TL/a	1 766 341 TL/a	1 872 341 TL/a	1 778 196 TL/a
- variable costs	89 463 "	96 856 "	97 367 "	92 471 "
- fixed costs	15 982 "	16 905 "	16 905 "	16 290 "
TOTAL	1 777 356 TL/a	1 880 102 TL/a	1 986 613 TL/a	1 886 957 TL/a
Capital costs				
- fixed capital	58 338 TL/a	63 673 TL/a	72 585 TL/a	65 734 TL/a
- working capital	43 476 "	48 634 "	57 944 "	49 363 "
TOTAL	101 814 TL/a	112 307 TL/a	130 529 TL/a	115 097 TL/a
Average annual proceed BEFORE TAXES	439 181 TL/a	436 598 TL/a	503 584 TL/a	485 009 TL/a
PRODUCTION TAX	174 689	177 918	203 634	193 394
AVERAGE ANNUAL PROCEED BEFORE INCOME TAXES	264 492	258 680	299 950	291 615

6.4.2
Return on investment and pay back period

When making profitability calculations to find out to return on investment and pay back period the following principles have been used:

- The lift of investment is 20 years and the construction time for each stage of the alternatives have been considered to be 2 years.

- The depreciated value for the alternatives is

  alternative 1 562 925 000 TL
  alternative 2 565 743 000 TL
  alternative 3 562 614 000 TL
  alternative 4 545 743 000 TL

- The pay-back period has been calculated using the rate of interest 15 %, depending on the rate of interest of loans in Turkey.
  - short period loans 2-5 years, 14 %
  - longperiod loans, over 5 years, 17 %

- 30 % production tax of the increased value of products has been taken into account but no incomes taxes

The result of calculations are shown in the following.

Outokumpu Oy

<u>Alternative 1</u> (without escalation)
(Unit = 1000 TL)

Year	Capital costs	Net incomes	Blister Prices Operating costs Production Tax	Net before income taxes
1978	96 586			
1979	193 172			
1980	172 853	449 341.4	489 687.2	9 654.2
1981	62 137	693 511.9	675 702.3	17 809.6
1982	124 273	693 511.9	675 702.3	17 809.6
1983	423 011	2 531 886.6	2 116 573.3	415 313.3
1984		2 665 143.8	2 227 082.1	483 061.7
1985		2 665 143.8	2 227 082.1	438 061.7
1986		2 665 143.8	2 227 082.1	438 061.7
1987		2 665 143.8	2 227 082.1	438 061.7
1988		2 665 143.8	2 227 082.1	438 061.7
1989		2 665 143.8	2 227 082.1	438 061.7
1990		2 665 143.8	2 227 082.1	438 061.7
1991		2 665 143.8	2 227 082.1	438 061.7
1992		2 665 143.8	2 227 082.1	438 061.7
1994		2 665 143.8	2 227 082.1	438 061.7
1995		2 665 143.8	2 227 082.1	438 061.7
1996		2 665 143.8	2 227 082.1	438 061.7
1997		3 228 068.8	2 227 082.1	1 000 986.7
Total	1 072 032	42 293 190	35 136 814.5	7 156 375.5

Rate of return: 25.8%
Pay-back period: 10 years

Alternative 2 (without escalation)
(Unit = 1000 TL)

Year	Capital costs	Net incomes	Blister Prices Operating costs Production Tax	Net before income taxes
1978	167 569			
1979	335 137			
1980	335 429	970 914.9	946 971.6	23 943.3
1981		1 387 023.8	1 345 573.7	41 450.1
1982		1 387 023.8	1 345 573.7	41 450.1
1983	264 125	2 665 143.8	2 227 082.1	438 061.7
1984		2 665 143.8	2 227 082.1	438 061.7
1985		2 665 143.8	2 227 082.1	438 061.7
1986		2 665 143.8	2 227 082.1	438 061.7
1987		2 665 143.8	2 227 082.1	438 061.7
1988		2 665 143.8	2 227 082.1	438 061.7
1989		2 665 143.8	2 227 082.1	438 061.7
1990		2 665 143.8	2 227 082.1	438 061.7
1991		2 665 143.8	2 227 082.1	438 061.7
1992		2 665 143.8	2 227 082.1	438 061.7
1993		2 665 143.8	2 227 082.1	438 061.7
1994		2 665 143.8	2 227 082.1	438 061.7
1995		2 665 143.8	2 227 082.1	438 061.7
1996		2 665 143.8	2 227 082.1	438 061.7
1997		3 230 886.8	2 227 082.1	1 003 804.7
Total	1 102 260	44 287 862.5	37 044 350.5	7 243 512

Rate of return: 22.7%
Pay-back period: 10 years

-Miscellaneous

15 % x other fixed costs = 2 205 000 TL/a

Total 16 905 000 TL/a

Alternative 3 (without escalation)

(Unit = 1000 TL)

Year	Capital costs	Net incomes	Blister Prices Operating costs Production Tax	Net before income taxes
1978	171 005			
1979	342 010			
1980	596 999	1 865 598.4	1 564 027.3	301 571.1
1981		2 665 143.8	2 227 082.1	438 061.7
1982		2 665 143.8	2 227 082.1	438 061.7
1983		2 665 143.8	2 227 082.1	438 061.7
1984		2 665 143.8	2 227 082.1	438 061.7
1985		2 665 143.8	2 227 082.1	438 061.7
1986		2 665 143.8	2 227 082.1	438 061.7
1987		2 665 143.8	2 227 082.1	438 061.7
1988		2 665 143.8	2 227 082.1	438 061.7
1989		2 665 143.8	2 227 082.1	438 061.7
1990		2 665 143.8	2 227 082.1	438 061.7
1991		2 665 143.8	2 227 082.1	438 061.7
1992		2 665 143.8	2 227 082.1	438 061.7
1993		2 665 143.8	2 227 082.1	438 061.7
1994		2 665 143.8	2 227 082.1	438 061.7
1995		2 665 143.8	2 227 082.1	438 061.7
1996		2 665 143.8	2 227 082.1	438 061.7
1997		3 227 757.8	2 227 082.1	1 000 675.7
Total	1 110 014	47 735 657	39 424 423	8 311 234

Rate of return: 33.4%

Pay-back period: 6 years

Alternative 4 (without escalation)
(Unit = 1000 TL)

Year	Capital costs	Net incomes	Blister Prices Operating costs Production Tax	Net before income taxes
1980	108 384			
1981	216 767			
1982	359 568	959 464.4	807 030.1	152 434.3
1983	122 940	1 332 571.9	1 116 456.5	261 115.4
1984	282 460	2 531 886.6	2 116 573.3	415 313.3
1985		2 665 143.8	2 227 082.1	438 061.7
1986		2 665 143.8	2 227 082.1	438 061.7
1987		2 665 143.8	2 227 082.1	438 061.7
1988		2 665 143.8	2 227 082.1	438 061.7
1989		2 665 143.8	2 227 082.1	438 061.7
1990		2 665 143.8	2 227 082.1	438 061.7
1991		2 665 143.8	2 227 082.1	438 061.7
1992		2 665 143.8	2 227 082.1	438 061.7
1993		2 665 143.8	2 227 082.1	438 061.7
1994		2 665 143.8	2 227 082.1	438 061.7
1995		2 665 143.8	2 227 082.1	438 061.7
1996		2 665 143.8	2 227 082.1	438 061.7
1997		2 665 143.8	2 227 082.1	438 061.7
1998		2 665 143.8	2 227 082.1	438 061.7
1999		3 210 906.8	2 227 082.1	983 824.7
Total	1 090 119	45 346 842.9	37 446 291.4	7 900 551.5

Rate of return: 32.9%
Pay-back period: 7 years

presented in the Table No. 6.5.

Selection of alternative

The rates of return and pay-back periods calculated for the alternatives have proved that Alternative No. 3 would be the best. This alternative is based on domestic blister, capacity 50 000 tons of copper wire per year, and marketing of the products in Turkey.

The result of Alternatives Nos. 1 and 2 shows that the profitability of the plant would be weakened on present world markets, when the production is started with import blister and foreign markets. Alternative No. 1 is the most favourable of these alternatives. The production would then be started with the capacity 25 000 tons per year; expansion to 50 000 tons per year as soon as possible and domestic production.
If this period for expansion is three years, the rate of return would fall from 32.9% to 25.8%. A shorter period would improve the result and a longer period would worsen it.

Alternative No. 1 has, however, the following advantages compared with Alternative No. 3:

- the investment of the plant will be divided over several years

- it will be easier to start the operation in two stages

- experience on export markets will be gained as early as possible before EEC custom barriers are removed

Turkish custom walls. The new plant must be

- it will be easier to turn to domestic markets when the demand has grown, as the products and sales organization are ready.

On the basis of these factors, Alternative No. 1 can as a whole (apparently) be selected as the most favourable.

An investment calculation, in which the evaluated escalation factors for different components of investment have been taken into account, has been calculated for Alternative No. 1.

Moreover the calculations show that if the plant

ø 0.4 mm
ø 0.6 mm } 55.15 TL/kg
ø 0.8 mm
ø 1.0 - 1.4 mm 53.50 TL/kg

Outokumpu Oy

6.4.3 Sensitivity analysis

Alternative 1

To investigate the influence of different investment parameters on the rate of return on investment a sensitivity analysis has been made.

The following parameters have been studied by the sensitivity analysis: how much the rate of return depends on the unit price of Cu-wire products, variable costs, price of blister and the sum of fixed capital costs.

The limits of alternation of the estimated value are:

	Lowest value	Highest value
Unit price of Cu-wire	- 20%	+ 20%
Blister price	- 20%	+ 20%
Variable costs	- 20%	+ 20%
Fixed costs	- 20%	+ 20%
Fixed capital costs	- 20%	+ 20%

The sensitivity analysis indicated that the return on investment to a great extent depends on the price of wire products and blister, but changes in amounts of fixed capital and operating costs have a very small effect on it.

The results of the sensitivity analysis have been presented graphically on the next pages.

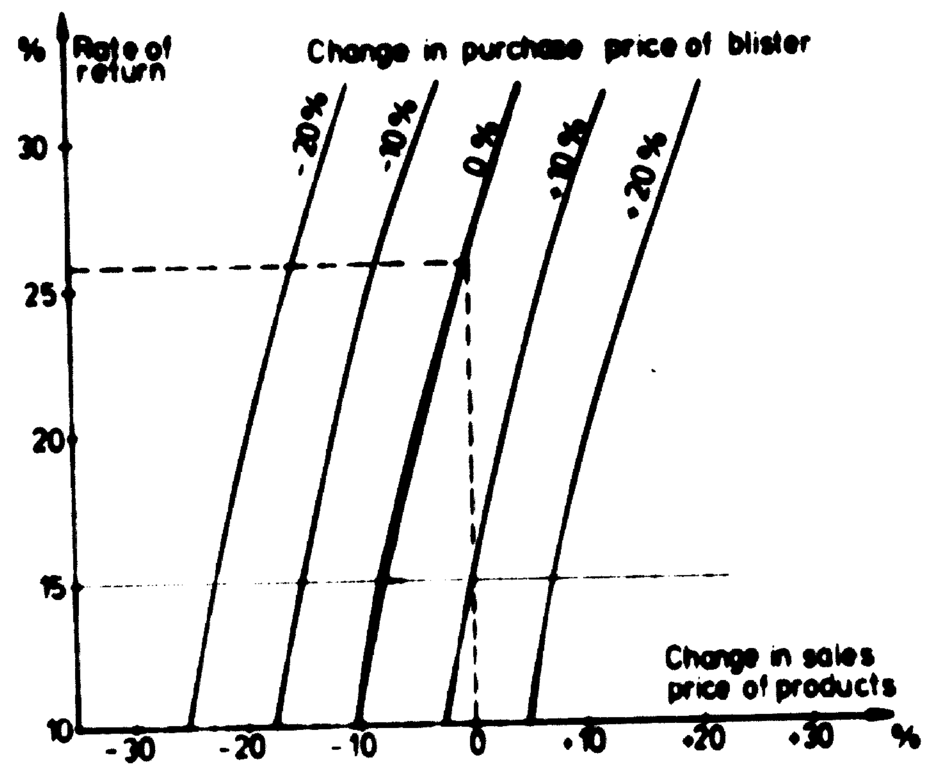
Outokumpu Oy

Unnecessary automatization has been avoided in

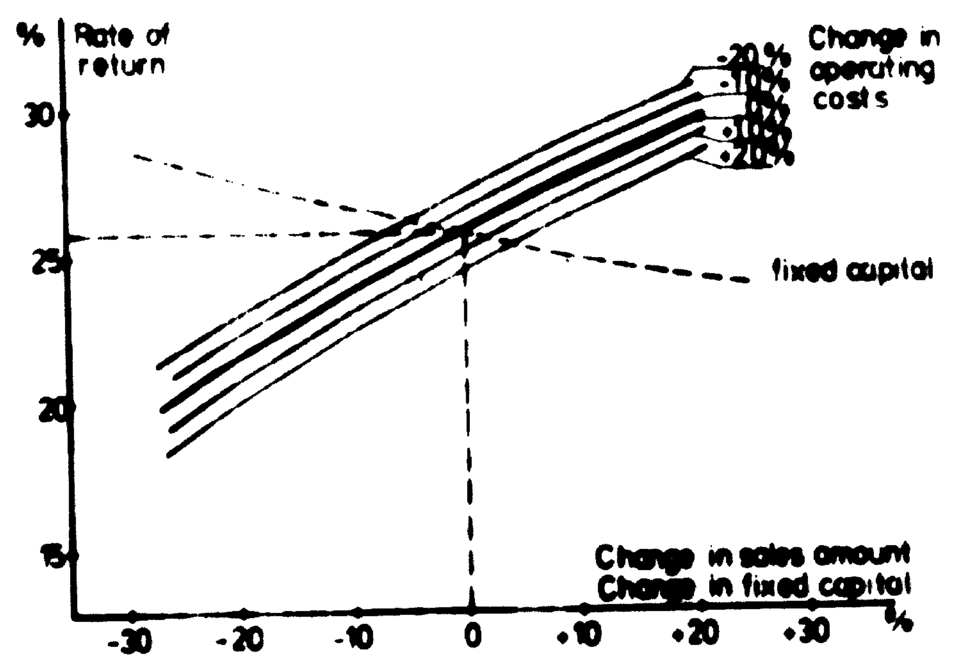
./. 30 £/kg = 854.70 TL/kg

1 657.28 TL/kg

CURVES OF SENSITIVITY



CURVES OF SENSITIVITY



6.4.4
Risk analysis

Alternative 1

To find out in which limits the rate of return on the investment probably well be, the risk analysis has been made using the "Monte Carlo" method.

As the bases of analysis the estimated probabilities of the changes in price and production of Cu-wires, blister price, variable costs and fixed costs have been given.

Percentage change of production of Cu-wires from the estimated value	Estimated probability of the change
- 20% - - 10%	29%
- 10% - 0%	55%
0% - 10%	15%
10% - 20%	1%
20% - 30%	-%

Percentage change of price for Cu-wires from the estimated value	Estimated probability of the change
- 20% - - 10%	5%
- 10% - 0%	25%
0% - 10%	40%
10% - 20%	20%
20% - 30%	10%

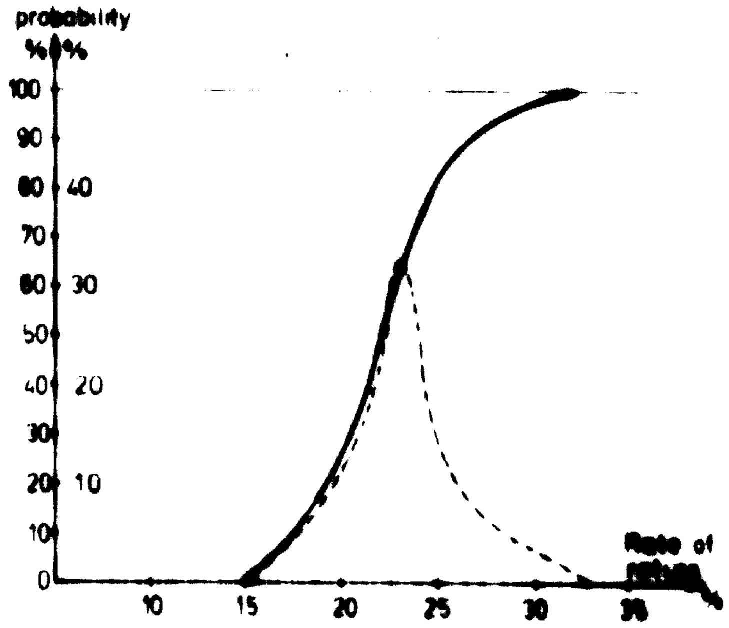
Percentage change of price for blister from the estimated value	Estimated probability of the change
- 20% - - 10%	4%
- 10% - 0%	5%
0% - 10%	45%
10% - 20%	30%
20% - 30%	16%

Percentage change of variable costs from the estimated value	Estimated probability of the change
- 20% - - 10%	2%
- 10% - 0%	17%
0% - 10%	38%
10% - 20%	25%
20% - 30%	18%

Percentage change of fixed costs from the estimated value	Estimated probability of the change
- 20% - - 10%	2%
- 10% - 0%	14%
0% - 10%	45%
10% - 20%	26 %
20% - 30%	13%

The risk analysis shows that on the basis of estimated probabilities for different components of investment calculation the return on investment is between 20 and 27% at a probability of 65%.

The cumulative probability curves of the rate of return are presented below.



6.4.5

Cash flow calculation and financing

Alternative 1

The annual cash flows have been discounted according to the rate of interest 15% to the end of the first year.

Financing

The method of financing is not known. In order to get an idea of the influence of financing on the pay-back period, the financing has been examined according to the following excample:
In this estimate the financing of investment is divided into

- loan 60%, 643 219 000 TL, rate of interest 15%, pay-back period 8 years
- own financing 40%, 462 611 000 TL + interest of loan untila the end of 1983, 52 491 250 TL

The financing requirement is:

	1978	1979	1980	1981	1982	1983
			(unit = 1000 TL)			
Own financing	96586	193172	139055	5069.7	14390.25	33031.2
Loan			33798	62137	124273	423011

The repayment period for the loan has been calculated to begin after the last share of the loan has been taken.

Interest on borrowed capital

Year	Debt at the beginning of the year	Interest at 15%	Amount paid back
1981	33798000	5069700	Own financing
1982	95935000	14390250	Own financing
1983	220208000	33031200	Own financing

Year	Dept at the beginning of the year	Interest at 15%	Amount paid back
1984	643219000	96482850	80402375
1985	562816625	84422494	80402375
1986	482414250	72362137	80402375
1987	402011875	60301781	80402375
1988	321609500	48241425	80402375
1989	241207125	36181069	80402375
1990	160804750	24120712	80402375
1991	80402375	12060356	80402375

Annual cash flows

The annual net cash flows with financing have been presented in the Table No. 6.7.

Escalated annual net cash flows without financing and discounting have been presented in the Table No. 6.8.

Cumulative cash flow curves for various cases have been presented in the Fig. No. 6.9. The curves show that financing according to the example will extend the pay-back period from 10 to 11 years. In addition it can be proved that the operation of the plant will bring losses after 16 project years, if the escalation is according to estimates.

On the estimated terms of financing and escalation the investment does not pay itself back, but small improvements in the terms of financing or not so pessimistic cost development have such an effect that the pay-back period might be 15-16 years.

TABLE No. 6.7

ANNUAL DISCOUNTED CASH FLOW WITHOUT ESCALATION

(The financing has been taken into account)

Unit 1000 TL

Year	Inflows	Outflows			Net
	Net incomes	Capital costs	Blister prices, operating costs, production tax	Interest of loan	cashflow
1(1978)		96586			-96586
2(1979)		167963			-167963
3(1980)	339747	130694	370252		-161199
4(1981)	455984	40855	447274	3333	- 32478
5(1982)	396481	71047	386299	8227	- 69092
6(1983)	1258601	210279	1052149	16420	- 20247
7(1984)	1152143		962768	41710	147665
8(1985)	1001828		837160	31734	132934
9(1986)	851236		728033	23655	119548
10(1987)	757434		632937	17138	107359
11(1988)	658557		550312	11920	96325
12(1989)	572739		478600	7775	86364
13(1990)	498115		416242	4508	77365
14(1991)	433086		361901	1960	69225
15(1992)	376585		314687		61898
16(1993)	327280		273486		53794
17(1994)	284637		237852		46785
18(1995)	247592		206896		40696
19(1996)	215344		179948		35396
20(1997)	226610		156341		70269
Total	10073999	717424	8590137	168380	598058

TABLE No. 6.8

ESCALATED ANNUAL NET CASH FLOW (UNDISCOUNTED)

UNIT 1000 000 TL

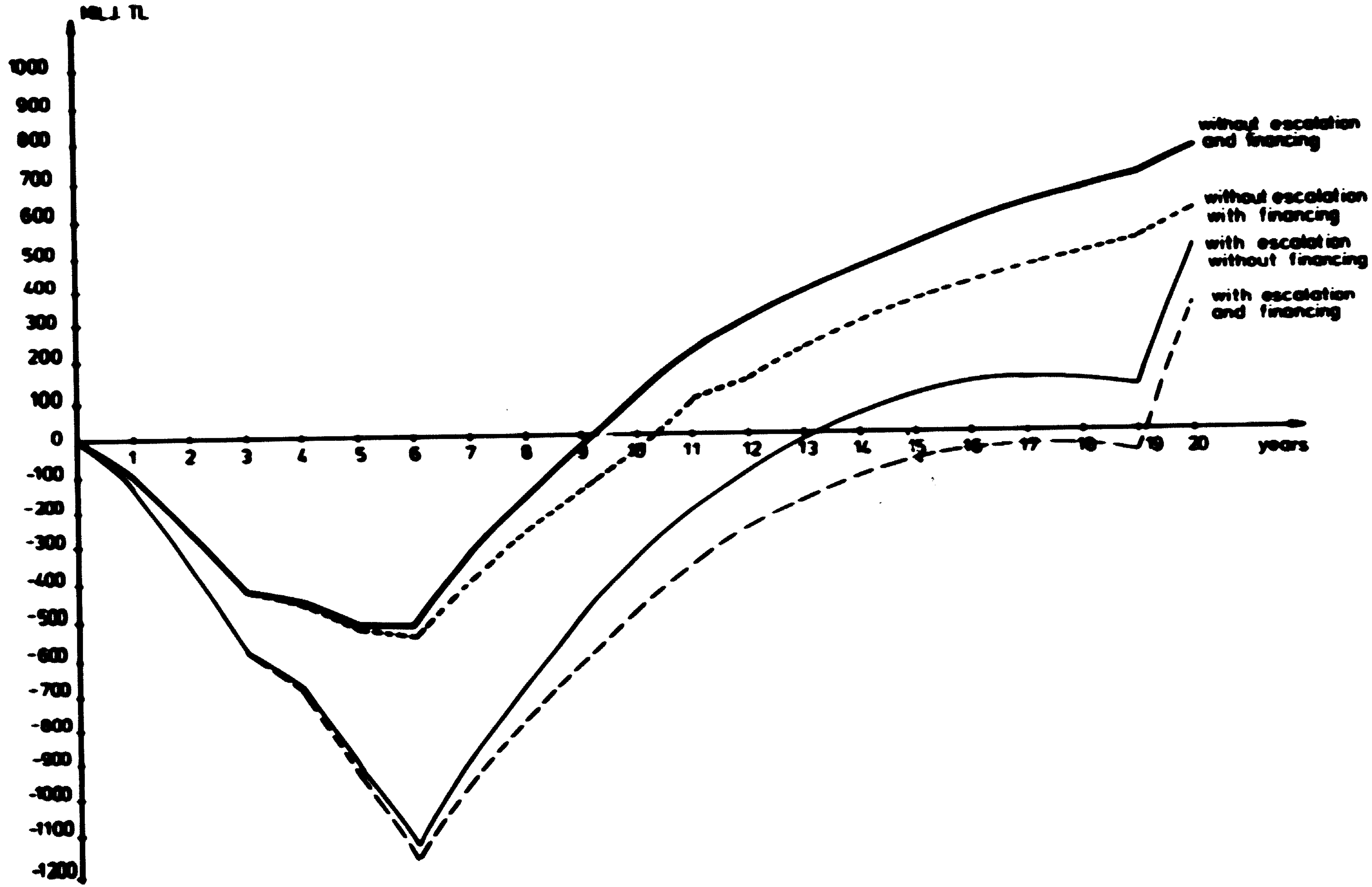
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Incomes (NET)										
Cu-wire	-	-	693.8	1059.9	1165.9	4802.	5560.8	6116.9	6728.6	7401.4
Gold	-	-	22.1	32.2	33.8	67.	74.6	78.4	82.3	86.4
Silver			6.8	9.9	10.3	20.	22.2	23.1	24.0	25.0
Depreciated value of capital										
TOTAL			722.7	1102.0	1209.6	4890.[illegible]	5657.6	6218.4	6834.9	7512.8
Raw Material										
Blister	-	-	654.4	1008.8	1119.8	3755.5	4388.0	4870.7	5406.5	6001.2
Subtotal			654.4	1008.8	1119.8	3755.5	4388.0	4870.7	5406.5	6001.2
Operating costs										
Variable costs			60.2	96.2	217.6	263.4	302.9	348.3	400.6	460.7
Fixed Costs			19.9	22.9	39.1	45.0	51.7	59.5	68.4	78.6
Subtotal			80.1	119.1	256.7	308.4	354.6	407.8	469.0	539.3
Capital costs										
Fixed capital	121.2	271.4	50.7	109.5	245.3	45.8	-	-	-	-
Working capital	-	-	221.3	-	-	889.4	-	-	-	-
Subtotal	121.1	271.4	272.0	109.5	245.3	935.2	-	-	-	-
Production tax			11.8	15.3	13.8	314.1	351.8	373.9	393.6	420.0
TOTAL	121.1	271.4	1018.3	1252.7	1635.6	5313.2	5094.4	5652.4	6269.1	6360.5
ANNUAL NET CASH FLOW	-121.2	-271.4	-295.6	-150.7	-426.0	-422.9	563.2	566.0	565.8	552.5

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Incomes (NET)										
Cu-wire	8141.6	8955.7	9851.3	10836.4	11920.0	13112.1	14423.3	15865.6	17452.1	19197.4
Gold	90.7	85.2	100.0	105.0	110.2	115.8	121.6	127.6	134.0	140.7
Silver	26.0	27.0	28.1	29.2	30.4	31.6	32.9	34.2	35.6	37.0
Depreciated value of capital										6079.[illegible]
TOTAL	8258.3	9077.9	9979.4	10970.6	12060.6	13259.5	14577.8	16027.4	17621.7	25454.7
Raw Material										
Blister	6661.3	7394.1	8207.4	9110.2	10112.3	11224.7	12459.4	13830.0	15351.2	17039.9
Subtotal	6661.3	7394.1	8207.4	9110.2	10112.3	11224.7	12459.4	13830.0	15351.2	17039.9
Operating costs										
Variable costs	529.8	609.2	700.6	805.7	926.6	1065.5	1225.4	1409.2	1620.6	1863.7
Fixed Costs	90.4	104.0	119.6	137.6	158.2	181.9	209.2	240.6	276.7	318.2
Subtotal	620.2	713.2	820.2	943.3	1084.8	1247.5	1434.6	1649.8	1997.3	2181.9
Capital costs										
Fixed capital	-	-	-	-	-	-	-	-	-	-
Working capital	-	-	-	-	-	-	-	-	-	-
Subtotal	-	-	-	-	-	-	-	-	-	-
Production tax	444.1	505.1	531.6	558.1	584.5	610.4	635.5	659.2	681.1	700.6
TOTAL	7725.6	8612.4	9559.2	10611.6	11781.6	13082.6	14529.5	16139	17869.6	19922.9
ANNUAL NET CASH FLOW	532.7	465.5	420.2	359	279	176.9	48.3	-111.6	-247.9	5532.3

ESCALATION FOR capital costs 12 %/a
Cu-wire 10 %/a
Au 3 %/a (-76-80), 5 % -81-97)
Ag 4 %/a
Blister 11 %/a
Operating costs 15 %/a

figure no 6.9

CUMULATIVE CASH FLOW CURVES



Outokumpu Oy

7. CONCLUSIONS

CONTENTS

7. CONCLUSIONS

7.1 General

The aim of surveys made in Turkey during the study work and plans and calculations made after that has been to form an illustration, as wide as possible, on the situation in Turkey of today and on future possibilities to refine copper to various products.

The aim of the study is to give the bases for possible further actions within the limits of accuracy and to emphasize those factors on which it will be profitable to pay special attention.

7.2 Field survey in Turkey

Our aim during the field survey was to gather needed basic information from as many sources as possible in order to get an objective result.

In our opinion the bases connected with the plant design, like

- products and markets
- location and capacity
- available raw materials and utilities
- equipment supplies from Turkey

were sufficiently cleared up.

On the other hand, matters regarding financing, like

- loans, their pay back periods and interests
- import taxes and duties for equipment
- taxes and duties of raw materials
- product taxes
- taxation on profits, depreciations etc. and possible allowances and liberations in various situations would need clearer explanations in connection with the further actions.

7.3 Markets

As shown in the marketing study the most favourable products within the investment period would be copper wires the demand for which now is growing by 15-20% per year due to Turkey's strong industrialization degree. The growth rate of demand will, however, decrease in a longer period.

The calculations showed that it will be considerably more profitable to start the plant on the basis of domestic blister and markets than foreign blister and markets.

Part of the capacity of the plant should, however, be directed towards exportation for the following reasons: Regarding Turkey's balance of trade it is necessary that the new plants produce export articles and replace imports. Secondly, Turkish plants must get experience on exports and be prepared for the hardened international competition caused by EEC. Regarding marketing the best time for investments is just now, because the plant will get a good start-up protected by

Turkish custom walls. The new plant must be prepared for the new situation after 10-20 years, when customs between Turkey and EEC will be removed according to their agreement.

7.4 Site selection

On the basis of surveys the economically most favourable site was found out to be the K.B.I. smelter area in Samsun. The calculations are based on and valid only for this site selection.

If any other factors than these mentioned in the study will require the site to be chosen elsewhere, new calculations must be made.

7.5 Capacity

Based on the plans for expansion regarding production of Turkish blister, on the present electrolysis capacity and growth rate of demand, the capacity of the plant has been chosen to 25 000 tons of copper wires per year in the first building stage. This production will be based on import blister and marketing abroad for the part which exceeds the demand on domestic markets.

The profitability calculations show that it will be profitable to start using domestic blister and markets as soon as possible in the production. Three years have been used in calculations. When the demand for domestic blister production and copper products grows, it will be profitable to expand the production in the second stage to 50 000 tons per year.

Moreover the calculations show that if the plant would be based only on import blister and foreign markets, the capacity should be considerably bigger, about 100 000 tons per year, before the unit would be economically profitable. Considering national economic views such a big investment would not be the best possible, also because of the big risks of it.

7.6
Process

The process selection and design of the plant have been based on typical domestic blister.

The plant in this case is new and the process is new for its users, so that the aim in the process selection has been to select a reliable final result avoiding risks.

A lower quality of import blister could make the recovery of by-products, like Ni, profitable, but, on the other hand it is likely that harmful impurities should be eliminated.

The selected processes and equipment will give possibilities for these mentioned additions.

7.7
Plant

The capacity 25 000 tons per year has been chosen as the basis for the designed plant. The possibilities of expansions and their influences have been examined separately.

Unnecessary automatization has been avoided in the plans, but it will be possible to include this in the layout.

The following characteristic features describe the designed plant:

- equipment and building investment per annual production of copper from blister to wire = 9 464 TL/ton of Cu-wire

- equipment and building investment for electrolytic refinery per annual production = 3 580 TL/ton of cathode

- man hours without supervision and maintenance per cathode ton in refinery (25 000/ 50 000) = 2.1/3.0

- operating costs per ton of production from blister to wires = 2.3 TL/kg.

The mentioned characters are according to international practice.

The total investment costs of the plant are as follows:

- 1st stage 462 611 000 TL
- 2nd stage 609 421 000 TL

Normal import duties and taxes, 30-40%, have been imposed on those foreign equipment supplies which are marketed on a domestic basis. Possible allowances for taxes and duties will decrease investment costs correspondigly.

Outokumpu Oy

7.8 Profitability

The profitability calculations show that the rate of return of the selected alternative will be 25,8% and the pay-back period without interests of loans 10 years and 11 years, provided that 60% of the investments will be taken as loans with 15% interest and 8 years' pay-back period.

The sensitivity analysis showed that the profitability of the investment will be very sensitive to the purchase price of blister and sales price of the product. Special attention should be paid on these matters in further research. On the other hand the influences of investment and operating costs and changes in sales amounts are smaller.

The profitability will improve with the transition to domestic blister and real markets instead of purchased blister and foreign markets.

Taking the before mentioned into consideration, the capacity of the plant, the expansion of capacity and the profitability will mainly be dependent on the supply of domestic blister, on the development of the Turkish blister production.

The price development of blister will also influence on the export possibilities.

7.9 National economic effect

Foreign trade

In the formulation of the consumption and production targets, a forecast and examination of the probable export and import figures is considered essential. According to the Third Five Year Development Plan 1973-1977 Turkey's aim is to get a zero current account deficit by the year 1982. The average annual growth rate of exports must then be maintained at 10% up to the year 1987. In Fig. No. 7.1 foreign trade and balance of trade during the last ten years are shown.

Copper exports

The development of copper exports is shown in Fig. No. 7.2. About 20-30% of the production of the electrolytic refinery to be built can be estimated to be exported. This means exportation of about 5 000 - 8 000 tons of copper wire per year, which corresponds to an addition of about US$ 12-18 million in exports.

Income target

The growth rate of the Gross National Product is estimated to be recently 8.6% per year, and 9.6% for the future (Fig. No. 7.3).

Foreign Trade

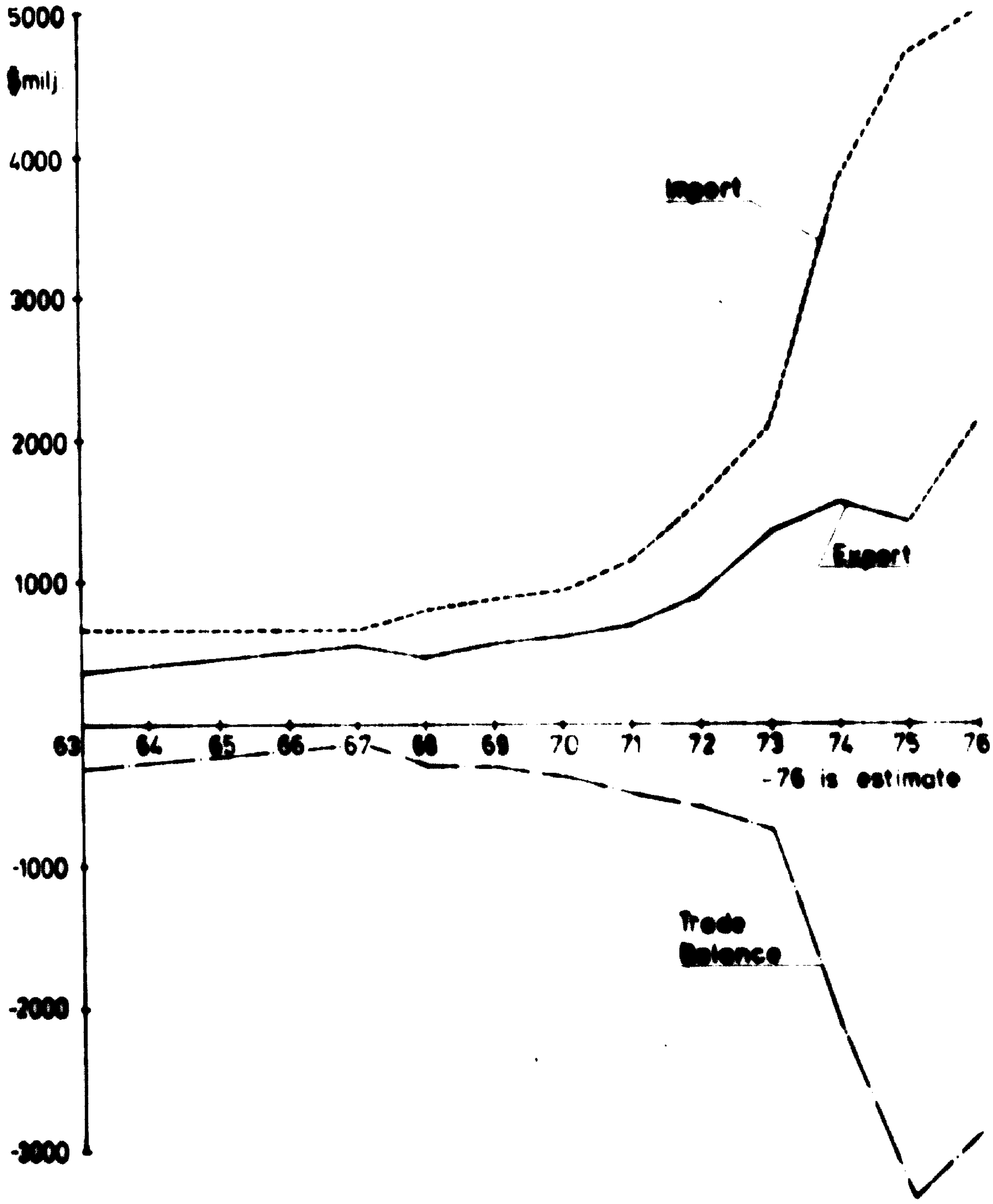


FIG. NO 7.1

Copper export (thousand tons)

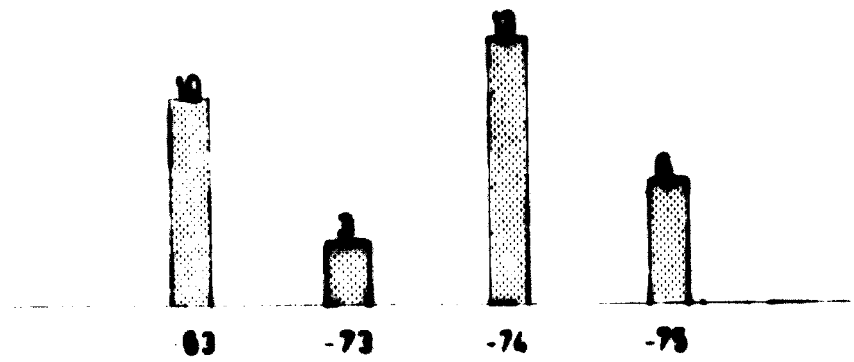


FIG. NO 7.2

GNP at constant -68 producer's prices

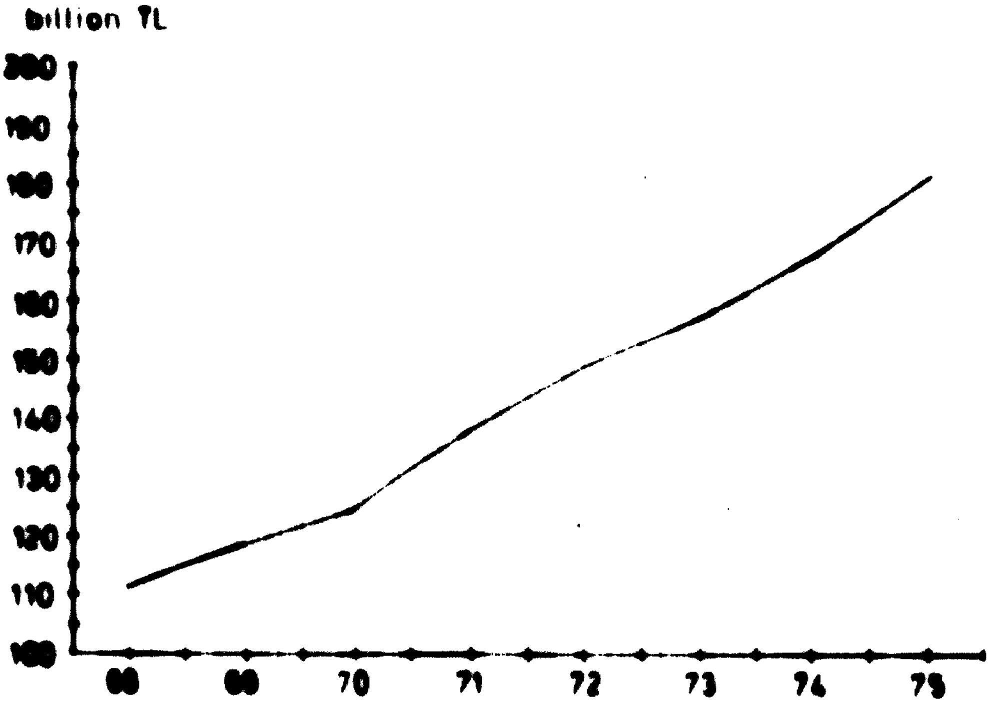


FIG. NO 7.3

Investment for mining

The domestic demand for mining products is expected to grow by an average annual rate of 13%. In order to keep pace with the growing demand it is anticipated that the output of the mining sector will increase by 15.3% per year on an average. During the last ten years investments of about 10 billion TL have been made in the mining. And for the next five year period it will be about 15 billion TL. About 40% of these investments should be allocated to prospecting, exploration and research.

Employment

In the following table the development of unemployment in Turkey during the last few years is shown.

LABOUR (million people)

	1962	1967	1972	1973	1974	1975	1976
Labour force supply	12.2	13.4	14.3	14.7	15.1	15.6	16.0
Labour force surplus	1.1	1.4	1.6	1.6	1.9	2.0	2.1
Unemployment rate %	9.0	10.4	11.1	10.8	12.6	12.8	13.1

Considering the development of unemployment the effect of the copper electrolytic refinery will be considerable. The plant will directly employ about 170 persons, but indirectly, including families and public services, about 600-800 persons will be employed.

8.

APPENDIX No. 1

CONTENTS

OUTOKUMPU OY
Engineering Division
02100 ESPOO 10
Finland

I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1 FIRST STAGE
FO FLASH SMELTER AREA

Project: UNIDO
Mon.unit: 1000TL Sheet 1 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
F9	Anode Casting Eq.									
F9.01	Anode Furnace	T	3.6x6.7	m		12 676		-	2 423	15 099
F9.01.01	Steel Work		70	MT	incl. F9.01		-	-	-	-
F9.01.02	Refractories	I	110	MT		2 103	187	-	inc.	2 290
F9.01.03	Drive		4 45	kW	incl.F9.01		-	-	-	-
F9.02	Incinerator				incl.F9.01		-	-	-	-
F9.02.01	Steel Work		20	MT	incl.F9.02		-	-	-	-
F9.02.02	Refractories	I	65	MT		1 247	112	-	incl.	1 359
F9.03	Fuel Oil System									
F9.03.01	Oil Tank	T	60	m^3		407		-	incl.	407
F9.03.02/ 1-2	2 Oil Pumps	T	1000	kg/h		17		-	4	21
F9.03.03	Oil Burner	I	150-1000	kg/h		287	4	-	54	345
F9.03.04	Valves	T						-		
F9.03.05	Oil Piping	T						-		
F9.04	Propane System	I				1 434	104	-	274	1 812
F9.04.01	Propane Tank		50	m^3	incl. F9.04		-	-	-	-
F9.04.02/ 1-2	2 Propane Pumps		1000	kg/h	incl. F9.04		-	-	-	-
F9.04.03	Electr.Evaporator		1000	kg/h	incl. F9.04		-	-	-	-
F9.04.03/ 1-4	4 Oxidation/Reduction Nozzles	I			incl. F9.01		-	-	-	-

OUTOKUMPU OY
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Finland

I = import
T = Turkish

ESTIMATE OF COSTS

ALTERNATIVE 1 FIRST STAGE
FO FLASH SMELTING AREA

Project: UNIDO

Mon.unit: 1000 TL Sheet 2 of 26

Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
F9.04.06	Valves	T						-		
F9.05	Comb.Air System									
F9.05.01/ 1-2	2 Combustion Air Fans	T	12000	m^3/h		345		-	66	411
F9.05.02	Combustion Air Piping	T						-		
F9.05.03	Valves	T						-		
F9.06	Cooling Air System									
F9.06.01/ 1-2	2 Cooling Air Fans	T	3000	m^3/h		287		-	58	345
F9.06.02	Cooling Air Piping	T						-		
F9.06.03	Valves	T						-		
F9.07	Offgas System									
F9.07.01/ 1-2	Offgas Fans	T	50000	m^3/h		1 101		-	212	1 313
F9.07.02	Offgas Ducts	T						-		
F9.07.03	Valves	T						-		
F9.07.04	Stack	T				623		-	incl.	623

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I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1 FIRST STAGE
FO FLASH SMELTER AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 3 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
F9.08	Launder for An.Copper	T				382		-	incl.	382
F9.08.01	Steel Work				incl. F9.08		-	-	-	-
F9.08.02	Lining		refr.lined		incl. F9.08		-	-	-	-
F9.08.03/ 1-4	4 Propane Burners	I	15	m^3/h		2 631	17	-	254	2 902
F9.09	Automatic Casting and Weighing Equipment	I				2 207	42	-	320	2 569
F9.09.01	Casting and Weighing Mechanism	I			incl. F9.09		-	-	-	-
F9.10	Anode Cast.Wheel Eq.	I								
F9.10.01	Casting Wheel		∅ 9500 6 moulds	mm	incl. F9.10		-	-	-	-
F9.10.02	Mould Cool.Spray Syst.				incl. F9.10		-	-	-	-
F9.11	Automatic Lifting Device for Anodes	I				6 263	170	-	1 197	7 630
F9.12	Cooling Tank for An.	I	10	m^3						
F9.13	Control Room for Casting Operations	T				287		-	incl.	287
F9.14	Electronics for Casting Operations	I				4 301	29	-	823	5 153

f 26
:±20 %

otal
2 080
2 750
100
50
333
416
5 729

of 26	
ur: ±20 %	
Total	
6 234	
4 427	
5 908	
478	
591	
1 313	
189	
266	
241	
89	

OUTOKUMPU OY
Engineering Division
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I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1 FIRST STAGE
FO FLASH SMELTER AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 4 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
F9.15	Hydraulic Power Unit for Casting Oper.	I			incl. F9.14		-	-	-	-
F9.16	Auxiliary Equipment									
F9.16.01	Overhead Travelling Crane	T	2 x 5 span 17	MT		478		-	46	524
F9.16.02/ 1-10	10 Tracks for Anode Storing	T	each for 40	pieces		96		-	12	108
			Total freight of equipment in Turkey							110
	Subtotal									43 690

of 26	
cur: ±20 %	
Total	
183	
54	
85	
129	
312	
191	
165	

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I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
FO FLASH SMELTER AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 5 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
	Instrumentation	I	incl.	equipment						-
	Electrification	T	transformer, switchgear							10 390
	Piping	T	oil, propane and utility piping							400
	Spare Parts	T/I								3 350
	Subtotal									14 140
	Foundations of Eq.	T								600
	Subtotal									14 740

OUTOKUMPU OY
Engineering Division
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Finland

I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 6 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R1	<u>Copper Ref.Equipment</u>									
R1.01/1-144	144 Commercial Cells									
R1.01.01	Busbars	T						-	incl.	6 234
	Concrete Work	T				3 238		-	989	4 427
R1.01.02/1-144	144 Lead Linings with Overflow Eq.	I				2 410	166	-	2 302	4 878
<u>R1.02</u>	Electrolyte Circul. Equipment									
R1.02.01/1-2	2 Circulation Tanks for Electrolyte	T	50	m^3		478		-	incl.	478
R1.02.02/1-5	5 Circulation Pumps	I	1,5 20	m^3/min mWG		420	33	-	42	495
R1.02.03/1-2	2 Polish Filter for Starting Sheet Electr.	I	1,5	m^3/min		806	16	-	170	992
R1.02.04/1-5	5 Heat Exhangers for Electrolyte	T	55-65 1,5	°C m^3/min		1 434		-	208	1 642
R1.02.05	Storage Tank for H_2SO_4	T	10	m^3		145		-	incl.	145
R1.02.06	Pump for H_2SO_4	I	200 15	l/min mWG		54	4	-	4	62

of 26
Accur: ±20 %

Total
280
-
1 180
8
-
-
35
22 358

of	26
Accur:	±20%

Total
3 325
33 664
2 909
268
40 166
16 271
56 437

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Finland

I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 7 of 26
Date: 75-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R1.02.07	Storage Tank for El.	T	60	m^3		407		-	inc.	407
R1.02.08/ 1-3	3 Pumps for Electro-lyte	I	400 20	1/m mWG		158	12	-	17	187
<u>R1.03</u>	Stripping and Start. Sheet Prod.Equipment									
R1.03.01	Wash Tank for Blanks	T	7,5	m^3		133		-	incl.	133
R1.03.02/ 1-2	2 Racks for Stripping	T				96		-	incl.	96
R1.03.03	Starting Sheet Prepairing Machine	F	cutting unit straghtening unit punching unit			1 912	37	-	503	2 452
<u>R1.04</u>	Cathode and Scrap Anode Washing Eq.									
R1.04.01/ 1-2	2 Wash Tanks for Cathodes	T	7,5	m^3		266		-	incl.	266
R1.04.02	Scrap Anode Wash Eq.	T				8		-	incl.	8
<u>R1.05</u>	Condensate Collecting and Wearing Equipment									
R1.05.01	Collecting Tank for Condensate	T	30	m^3		241		-	incl.	241
R1.05.02	Pump for Condensate	I	300 60	1/min mWG		58	4	-	4	66
R1.05.03	Feeding Tank for Condensate	T	20	m^3		183		-	incl.	183
										25 192

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I = import
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ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 8 of 26
Date: 76-09-25 Estim: MH Accur: $\pm$20 %

Account No.	Description	I/T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R2	Electrolyte Purification Equipment									
R2.01	Circulation Eq. for Decopperizing Electrol.									
R2.01.01/1-2	2 Collecting and Circul.Tanks for D.E.	T	20	m^3		362		-	incl.	362
R2.01.02/1-2	2 Circulation Pumps	I	400 20	l/min mWG		104	8	-	8	120
R2.02/1-2	2 Decopperizing Cells									
R2.02.01	Concrete Work	T				42		-	12	54
R2.02.02/1-2	2 Lead Linings with Overflow Equipment	I				33	4	-	33	70
R2.02.03/1-2	2 Gas Hoods	I				75	17	-	incl.	92
R2.02.03	Demister	I	6000	m^3/h		50		-	8	58
R2.02.04/1-2	2 Ventilation Fans	T	6000	m^3/h		133		-	21	154
R2.03	Neutralizing Equipm. for Decopp. Electol.									
R2.03.01	Neutralation Reactor	T	5	m^3		145		-	incl.	145
R2.03.02	Transport Tank for Neutralisation Residue	T	5	m^3		50		-	incl.	50
										1 105

of 26
Accur: $\pm$20 %
Total
25 882
-
-

OUTOKUMPU OY
Engineering Division
02100 ESPOO 10
Finland

I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 9 of 26
Date: 76-09-25 Estim: MH Accur: +20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R3	Slime Treatment Eq.									
R3.01	Slime Collecting Eq.									
R3.01.01	Launders for Slime Coll.	T				312		-	incl.	312
R3.01.02/ 1-2	2 Floor Sumps for Slime Collection	T	3	m^3		191		-	incl.	191
R3.01.03/ 1-2	2 Vertical Pumps for Slime	I	200 20	1/m mWG		104	4	-	8	116
R3.01.04	Storage Tank for Slime Slurry	T	30	m^3		241		-	incl.	241
R3.02	Treatment Equipment for Slime Slurry									
R3.02.01/ 1-2	2 Pumps for Slime Filtering	I	400 50	1/min mWG		115	4	-	12	132
R3.02.02	Polishing Filter	I	400	1/min		229	8	-	46	283
R3.02.03	Filter Press	I	15	m^2		719	13	-	137	869
R3.02.04	Leaching Reactor	T	10	m^3		145		-	incl.	145
										2 289

of 26
Accur: +20 %

Total
-
18 788
12 311
5 257
5 257
245
1 241
732
259

of 26	
cur: ±20 %	
Total	
586	
121	
4 779	
1 434	
719	
300	
10	
77 921	

OUTOKUMPU OY
Engineering Division
02100 ESPOO 10
Finland

I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO

Mon.unit: 1000 TL Sheet 10 of 26

Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R4	Auxiliary Equipment									
R4.01	Racks for Tank H.A.	T				287		-	incl.	287
R4.01.01	Spacing Rack for An.									
R4.01.02/ 1-10	10 Racks for Anodes									
R4.01.03/ 1-6	6 Racks for Starting Sheets									
R4.01.04/ 1-12	12 Racks for Cathodes									
R4.01.05/ 1-4	4 Racks for Lead An.				incl. R4.01			-	-	-
R4.01.06/ 1-2	2 Lifting Racks for Anodes and Cathodes									
R4.01.07/ 1-2	2 Lifting Racks fo Starting Sheets									
R4.02	Cranes and Transp.Eq.									
R4.02.01	Overhead Crane	T	2 x 7.5 span 27	MT m		1 076		-	104	1 180
R4.02.02	Overhead Crane for Site Isle	T	2 x 3 span 9	MT m		403		-	37	440
R4.02.03	Fork Lift	I	15	MT		1 197		-	-	1 197
R4.02.04	Transfer Wagon	T				241		-	-	241
R4.02.05/	2 Transfer Jacks	T				17		-	-	17

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Engineering Division
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Finland

I = import
T = Turkish

ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 11 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R4.03	Hand Tools	T				8		-	-	8
R4.03.01	Stripping Tools				incl. R4.03			-	-	-
R4.03.02	Short Circuit									
	Defection Meter				incl. R4.03					
	Scale for									
	cathode Weighing	I	2	t		54		-	8	62
										3 432
			Total freight of equipment in Turkey							70
	SUBTOTAL									30 088

of 26
Accur: ±20 %
Total
2 926
5 154
499
5 221
23 800
5 818
29 618

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I = Import
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ESTIMATE OF COSTS

ALTERNATIVE 1, FIRST STAGE

RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO

Mon.unit: 1000 TL Sheet 12 of 26

Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
	Instrumentation	I								4 156
	Electrification	T	transformers, switches (excl. busbars)							37 404
	Piping	T	process and utility piping							2 909
	Spare Parts	T/I								357
	Subtotal									44 826
	Buildings	T						26100 m^3		25 281
	Subtotal									70 107

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I = import
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ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
WO WIRE CASTING, ROLLING AND DRAWING AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 13 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
W1	Rod Casting Equipment					35 326		-	3 017	38 343
W1.01			8	MT						
W1.02/1-2	2 Smelting Furnaces	I	cap 15000	MTPA						
W1.03/1-2	2 Launders between Smelt.and Hold.Furn.	I								
W1.04/1-2	2 Handling Furnaces	I	3 150	MT kW						
W1.05	Cooling System for Inductors	I								
W1.06	Production Gas Generating System	I								
W1.02	Casting and Coiling Eq.				incl. W1		-	-	-	-
W1.02.01/1-2	2 Withdrawal Machine	I	16 stards							
W1.02.02/1-16	16 Pairs of Coiling Machines	I								
W1.03	Control Desk for Sm. Cast. and Coil.Operat.	I			incl. W1		-	-	-	-
W1.04	Vacuum Generation Eq.for Withdawal Machine	I			incl. W1		-	-	-	-

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ESTIMATE OF COSTS

ALTERNATIVE 1, FIRST STAGE
WO WIRE CASTING, ROLLING AND DRAWING AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 14 of 26
Date: 76-09-25 Estim: MH Accur: +20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
W1.05	Hydraulic Power System				incl. W1		-	-	-	-
	for S,C.and C.Oper.	I								
W2	Rod Rolling Equipment									
W2.01	Wire Cold Rolling		ø 20 to 8 square wire							
	Machine	I	6	m/sec		12 011		-	2 294	14 305
W3	Wire Drawing Eq.									
W3.01	Wire Drawing Line	I	ø 4 to 1.4	mm		7 871		-	1 509	9 380
W3.02	Wire Drawing Line	I	ø 1.4 to 1	mm		4 019			769	4 788
W3.03	Wire Drawing Line	I	ø 0.8 to 0.4	mm		4 019		-	769	4 788
W3/1-3	Scales	T				212		-	33	245
W3.04	Emulsion Line									
	for Drawing	I				790		-	150	940
	Machine									
W3.05	Thinning and									
	Threading Equipment	I				465		-	87	552
W3.06	But-Welding Equipment	I				162		-	33	195

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ESTIMATE OF COSTS

Project: UNIDO

Mon.unit: 1000 TL Sheet 15 of 26

Date: 76-09-25 Estim: MH Accur± 20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
W4	<u>Auxiliary Equipment</u>									
W4.01	Overhead Crane	T	5 span 20	MT m		536		-	50	586
W4.02	Overhead Crane	T	10 span 20	MT m		860		-	83	943
	Unloading racks for reels	T	5	ps		121		-	incl.	121
	Steel reels	T	500	ps		4 779		-	incl.	4 779
	Wood reels	T	1500	ps		1 434		-	incl.	1 434
	Truck	T	5	t		719		-	-	719
			Total freight of WO							632
			Total freight of equipment in Turkey							20
										82 575

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ESTIMATE OF COSTS
ALTERNATIVE 1, FIRST STAGE
WO WIRE CASTING, ROLLING AND DRAWING AREA

Project: UNIDO

Mon.unit: 1000 TL Sheet 16 of 26

Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
										3 657
	Instrumentation	I								18 943
	Electrification	I	transformers, laboratory							499
	Piping	I	hydraulic, emulsio and utility piping							6 961
	Spare Parts	T/I	5299 (cast.) + 1662 (draw.)							
	Subtotal									30 060
	Buildings	T	1400	m^3						7 331
	Subtotal									37 391

OUTOKUMPU OY Engineering Division 02100 ESPOO 10 Finland	I = import T = Turkish	ESTIMATE OF COSTS ALTERNATIVE 1, FIRST STAGE PLANT AREA	Project: UNIDO Mon.unit: 1000 TL Sheet 17 of 26 Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I / T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
PO.H	Instrumentation									-
PO.R	Electrification	T							incl.	2 080
PO.E	Piping	T	4 x 550	m	+		(total 1247 TL/m)		incl.	2 750
PO.C	Civil Engineering	T								
PO.C.01	Building of main switchgear		160	m^3					incl.	100
PO.C.02	Heating Ventilation		incl.	PO.C.01					incl.	50
PO.C.03	Foundations								incl.	333
PO.C.04	Roads and yeards		1038	TL/m					incl.	416
PO.C.05	Sewage work									
	Subtotal									5 729

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ESTIMATE OF COSTS
ALTERNATIVE 1, SECOND STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 18 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R1	Copper Ref.Equipment									
R1.01/1-	144 Commercial Cells									
144	Busbars	T						-	incl.	6 234
R1.01.01	Concrete Work	T						-	incl.	4 427
R1.01.02/	144 Lead Lining									
1-144	with Overflow Eq.	I					incl.	1 030	incl.	5 908
R1.02	Electrolyte Circul.									
R1.02.01/	2 Circulation Tanks									
1-2	for Electrolyte	T	50	m^3						478
R1.02.02/	4 Circulation Pumps	I	1.5	m^3/min						
1-5			20	mWG			incl.	149	incl.	591
R1.02.04/	4 Heat Exhangers		55-65	°C						
1-5	for Electrolyte	T	1,5	m^3/min					incl.	1 313
R1.02.08/	2 Pumps for		400	l/min						
1-3	Electrolyte	I	20	mWG			incl.	47	incl.	189
R1.04.01/	2 Wash Tanks for									
1-2	Cathodes	T	7,5	m^3					incl.	266
R1.05.01	Collecting Tank									
	for Condensate	T	30	m^3					incl.	241
R1.05.02	Pump for Condensate	I	300	l/min						
			60	mWG			incl.	23	incl.	89

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ESTIMATE OF COSTS
ALTERNATIVE 1, SECOND STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 19 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R1.05.03	Feeding Tank for Condensate	T	20	m^3					incl.	183
R2.	<u>Electolyte Purification Equipment</u>									
<u>R2.02./</u> 1-2	2 Decopperizing Cells									
R2.02.01	Concrete Work	T							incl.	54
R2.02.02/ 1-2	2 Lead Lining with Overflow Equipment	I					incl.	15	incl.	85
R2.02.03/ 1-2	2 Gas Hoods	I					incl.	37	incl.	129
R3.	<u>Slime Treatment Eq.</u>									
<u>R3.01</u>	Slime Collecting Equipment									
R3.01.01	Launders for Slime Collection	T							incl.	312
R3.01.02/ 1-2	2 Floor Sumps for Slime Collection	T	3	m^3					incl.	191
R3.01.03/ 1-2	2 Vertical Pumps for	I	200 20	l/min mWG			incl.	41	incl.	165

PRELIMINARY
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ESTIMATE OF COSTS
ALTERNATIVE 1, SECOND STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 20 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
R4	Auxiliary Equipment									
R4.01	Racks for Tank H.A.	T							incl.	280
R4.01.02/ 1-10	10 Racks for Anodes									
R4.01.03/ 1-6	6 Racks for Starting Sheets									
R4.01.04/ 1-12	12 Racks for Cathodes									
R4.01.05/ 1-4	4 Racks for Lead Anodes				incl. R4.01		-	-	-	-
R4.02	Cranes and Transp.Eq.									
R4.02.01	Overhead Crane	T	2 x 7.5 span 27	MT m					incl.	1 180
R4.03	Hand Tools	T							-	8
R4.03.01	Stripping Tools				incl. R4.03		-	-	-	-
R4.03.02	Short Circuit									
	Defection Meter				incl. R4.03		-	-	-	-
							Freight in Turkey			35
	Subtotal									22 358

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ESTIMATE OF COSTS

ALTERNATIVE 1, SECOND STAGE
RO ELECTROLYTE TANK HOUSE AREA

Project: UNIDO

Mon.unit: 1000 TL Sheet 21 of 26

Date: 76-09-25 Estim: MH Accur: ±20%

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
	Instrumentation	I								3 325
	Electrification	T	transformer, switches, (excl. busbars)							33 664
	Piping	T	process and utility piping							2 909
	Spare Parts	T/I								268
	Subtotal									40 166
	Buildings	T								16 271
	Subtotal									56 437

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ESTIMATE OF COSTS

ALTERNATIVE 1, SECOND STAGE
WO WIRE CASTING, ROLLING AND DRAWING AREA

Project: UNIDO

Mon.unit: 1000 TL Sheet 22 of 26

Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
W1	Rod Casting Equipment						incl.	6 611	incl.	25 882
W1.02/1-2	1 Smelting Furnace	I	8	MT						
			cap 15000	MTPA						
W1.03/1-2	1 Launder between Smelt. and Hold Furn.	I								
W1.04/1-2	1 Holding Furnace	I	3	MT						
			150	kW						
W1.05	Cooling System for Inductors	I			incl. W1.02/1-2		-	-	-	-
W1.02	Casting Coiling Eq.									
W1.02.01/1-2	1 Withdrawal Machine	I	16 strands		incl. W1.02		-	-	-	-
W1.02.02/1-16	16 Pairs of Coiling M.	I								
W1.03	Control Desk for Sm. Casting and Coiling Operations	I			incl. W1					

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ESTIMATE OF COSTS
ALTERNATIVE 1, SECOND STAGE
WO WIRE CASTING, ROLLING AND DRAWING AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 23 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
W1.05	Hydr.Power System for S.C and C.Oper.	I			incl. W1		-	-	-	-
W2	Rod Rolling Equipm.									
W2.01	Wire Cold Rolling Machine	I	ø 20 to 8 square wire 6	m/sec			incl.	4 483	incl.	18 788
W3.	Wire Drawing Eq.									
W3.01	Wire Drawing Line	I	ø 4 to 1.4	mm			incl.	2 391	incl.	12 311
W3.02	Wire Drawing Line	I	ø 1.4 to 1	mm			incl.	469	incl.	5 257
W3.03	Wire Drawing Line	I	ø 0.8 to 0.4	mm			incl.	469	incl.	5 257
W3/1-3	Scales	T							incl.	245
W3.04	Emulsion Line for Drawing Machines	I					incl.	301	incl.	1 241
W3.05	Thinning and Threading Equipment	I					incl.	175	incl.	732
W3.06	But-Welding Equipment	I					incl.	61	incl.	259

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Engineering Division
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I = import
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ESTIMATE OF COSTS
ALTERNATIVE 1, SECOND STAGE
WO WIRE CASTING, ROLLING AND DRAWING AREA

Project: UNIDO
Mon.unit: 1000 TL Sheet 24 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
W4	Auxiliary Equipment									
W4.01	Overhead Crane	T	5 span 20	MT m					incl.	586
	Unloading racks for reels	T	5	ps					incl.	121
	Steel reels	T	500	ps					incl.	4 779
	Wood reels	T	1500	ps					incl.	1 434
	Truck	T	5	T					-	719
							Total freight of WO			300
							Freight in Turkey			10
	Subtotal									77 921

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I = import
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ESTIMATE OF COSTS
ALTERNATIVE 1, SECOND STAGE
WO WIRE CASTING, ROLLING AND DRAWING AREA

Project: UNIDO

Mon.unit: 1000 TL Sheet 25 of 26
Date: 76-09-25 Estim: MH Accur: ±20 %

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
	Instrumentation	I								2 926
	Electrification	T	transformers, laboratory							15 154
	Piping	T	hydraulic, emulsio and utility piping							499
	Spare Parts	T/I								5 221
	Subtotal									23 800
	Buildings	T								5 818
	Subtotal									29 618

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I = import
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ESTIMATE OF COSTS
ALTERNATIVE 1, SECOND STAGE
PLANT AREA

Project: UNIDO

Mon.unit: 1000 TL Sheet 26 of 26
Date: 76-09-25 Estim: MH Accur: ±20%

Account No.	Description	I T	Quantity	Unit	Unit cost	Cost	Freight	Duties and taxes	Erection	Total
PO.H	Instrumentation	I								-
PO.R	Electrification	T							incl.	2 080
PO.E	Piping	T							incl.	250
	Subtotal									2 330

9.

APPENDIX No. 2

CONTENTS

1. Drawings

1.1	Flow sheet	Dwg No. 738132-1/0
1.2	Equipment diagram	Dwg No. 738133-1/0
1.3	Plot plan	Dwg No. 738134-1/0
1.4	Blister refining and anode casting, lay-out	Dwg No. 738137-2/0
1.5	Electrolytic tank house, lay-out	Dwg No. 738135-1/0
1.6	Wire production plant, lay-out	Dwg No. 738136-1/0
1.7	Electrolysis and wire production plant, perspective	Dwg No. 738138
1.8	Single line diagram	Dwg No. 738139-2/0

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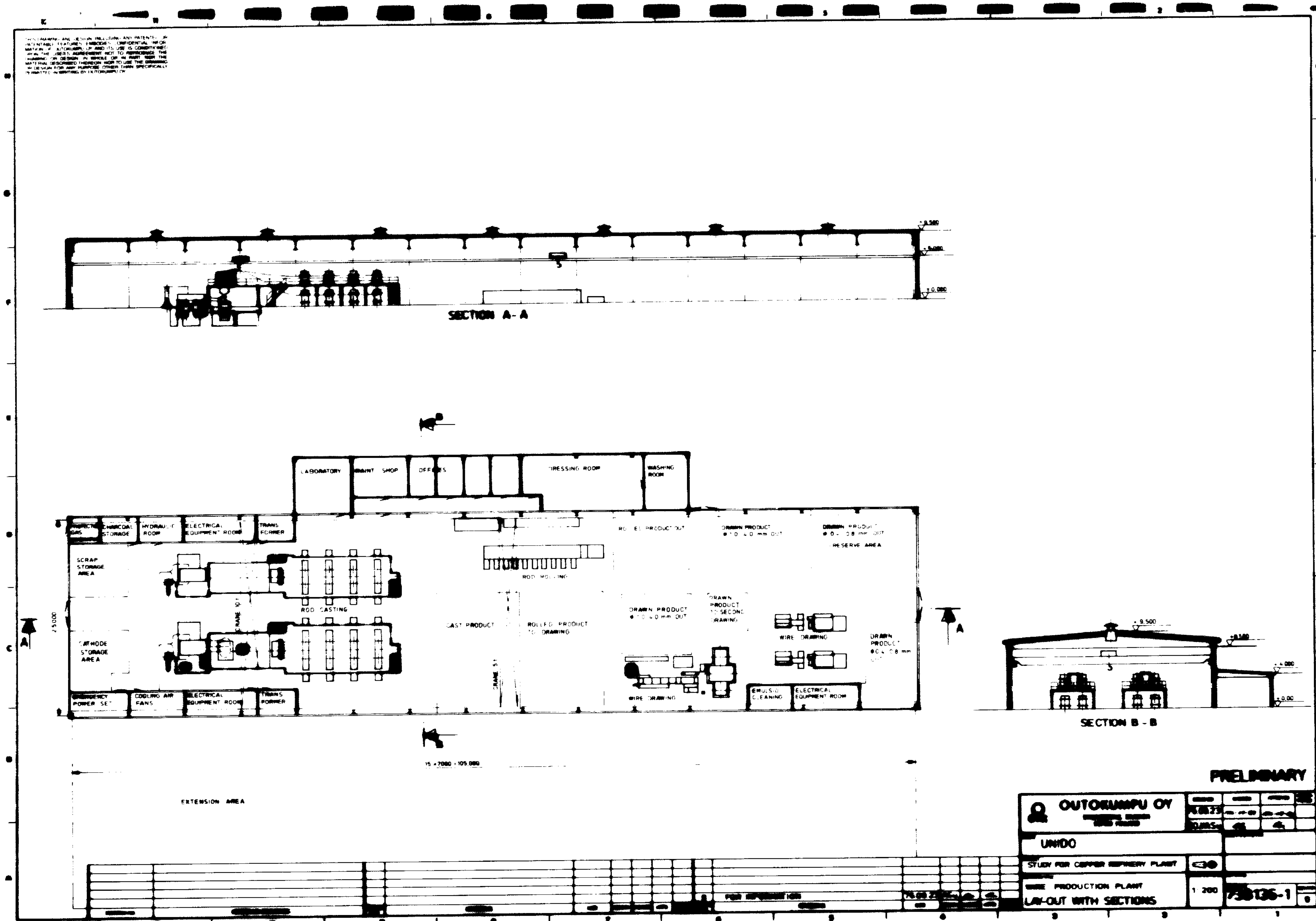
APPENDIX No. 2

CONTENTS



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Account No.	
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W4.01	Ove
W4.02	Ove
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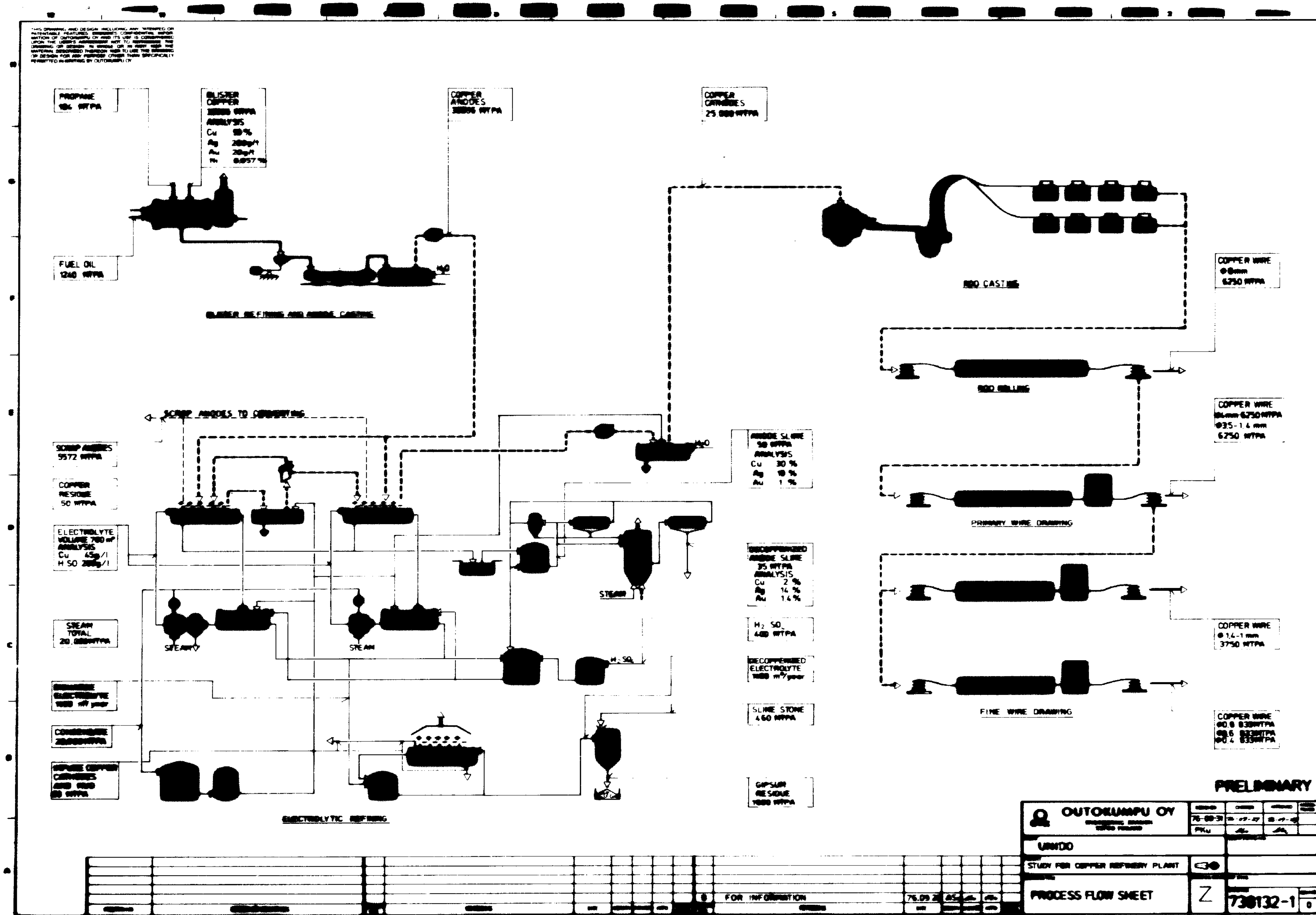

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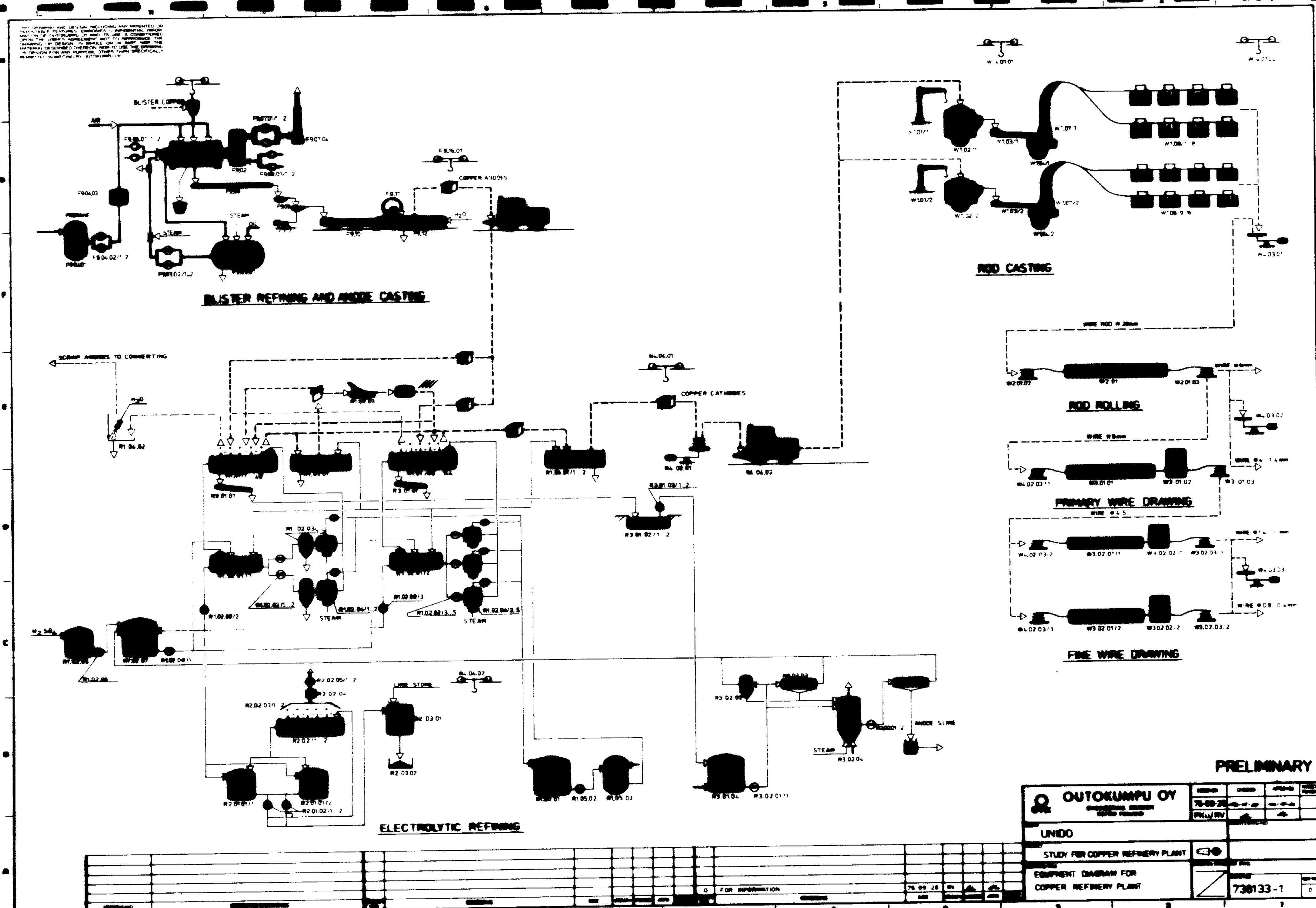

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Account No.	
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PO.R	El
PO.E	Pi
PO.C	Ci
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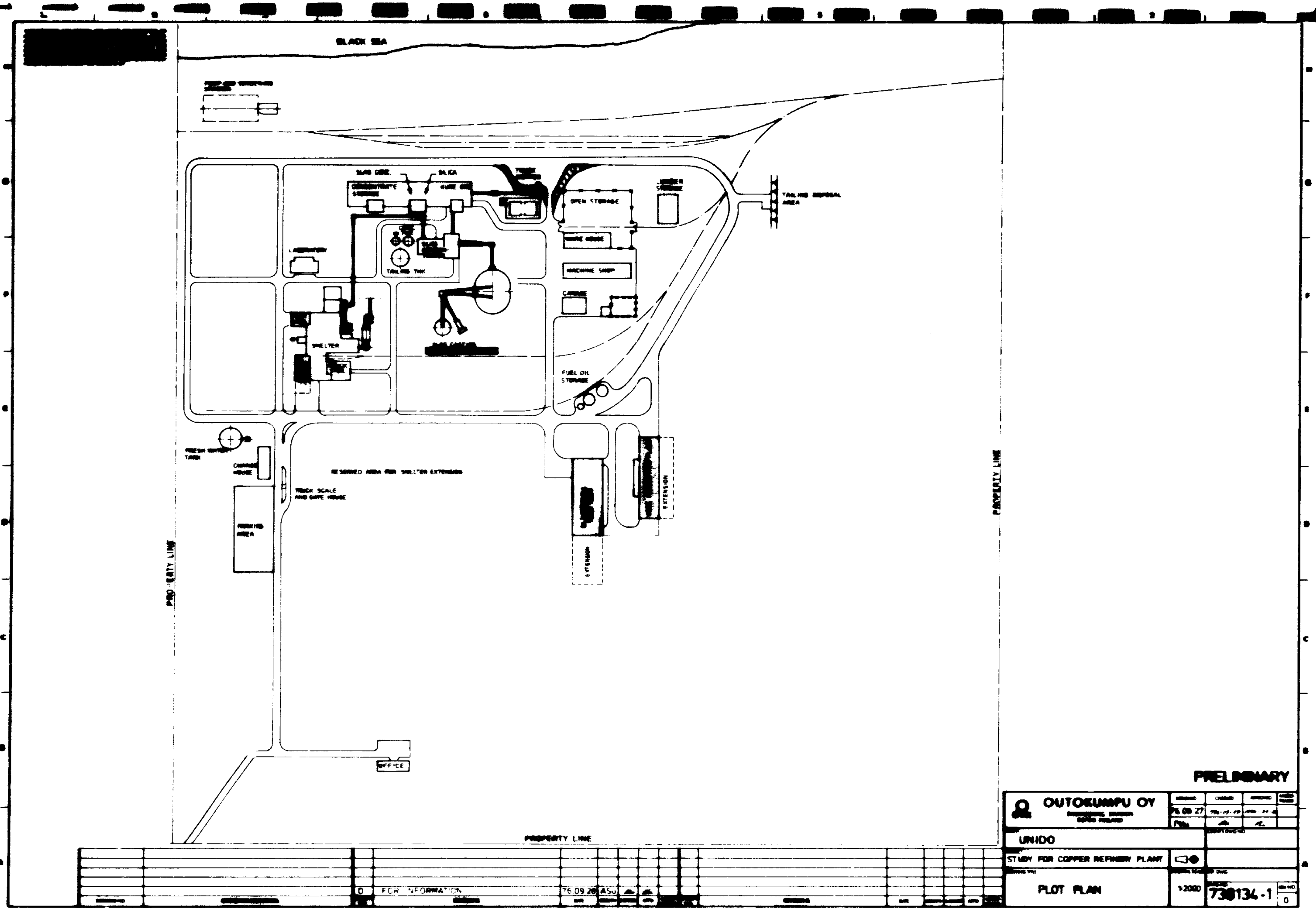
PO.C.02	He
PO.C.03	Fo
PO.C.04	Re
PO.C.05	Se
	Su



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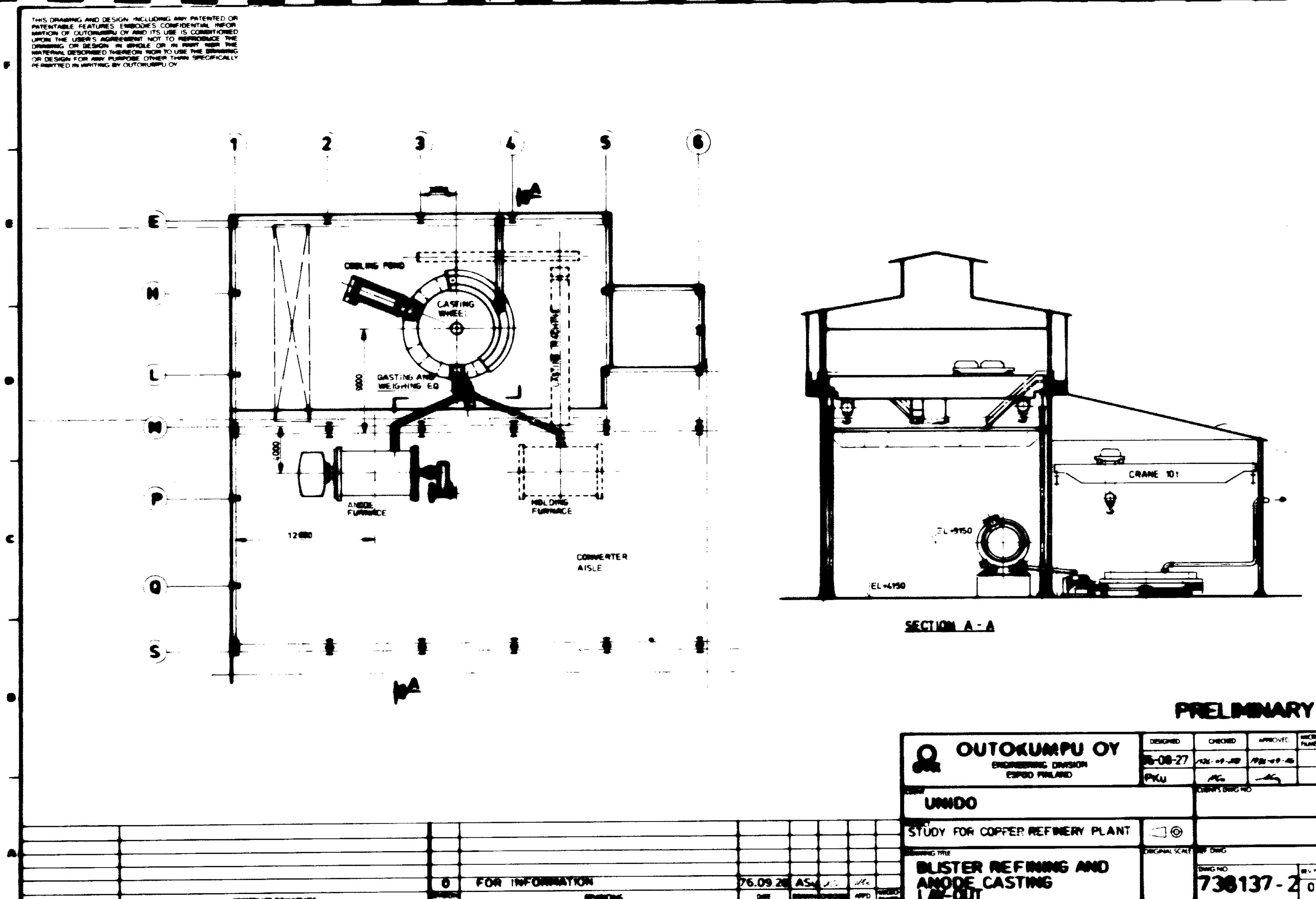
Account No.
R1
R1.01/1-144
R1.01.01
R1.01.02/1-144
R1.02
R1.02.01/1-2
R1.02.02/1-5
R1.02.04/1-5
R1.02.08/1-3
R1.04.01/1-2
R1.05.01
R1.05.02



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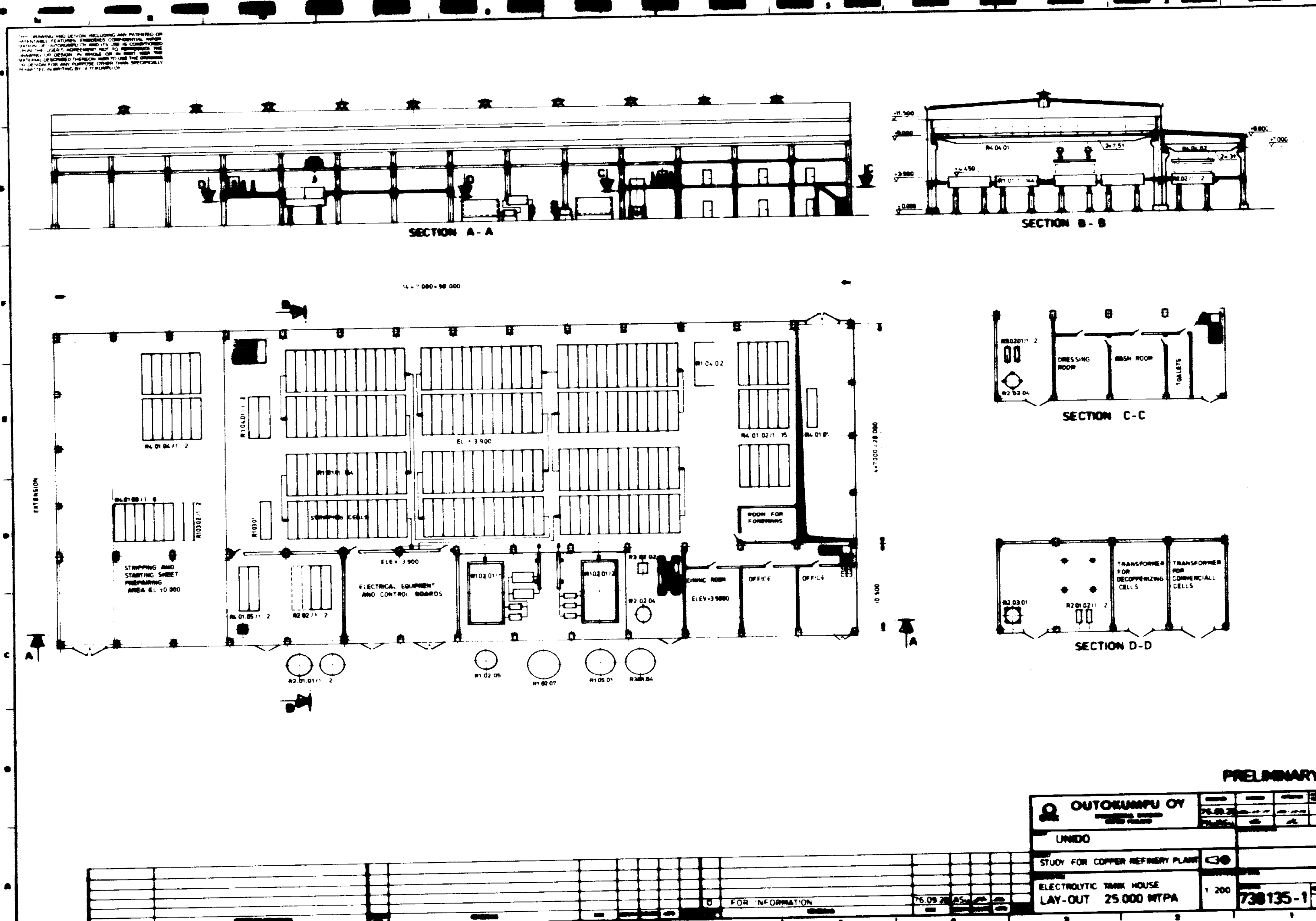
Account No.
R1.05.03
R2.
R2.02./ 1-2
R2.02.01
R2.02.02/ 1-2
R2.02.03/ 1-2
R3.
R3.01
R3.01.01
R3.01.02/ 1-2
R3.01.03/ 1-2



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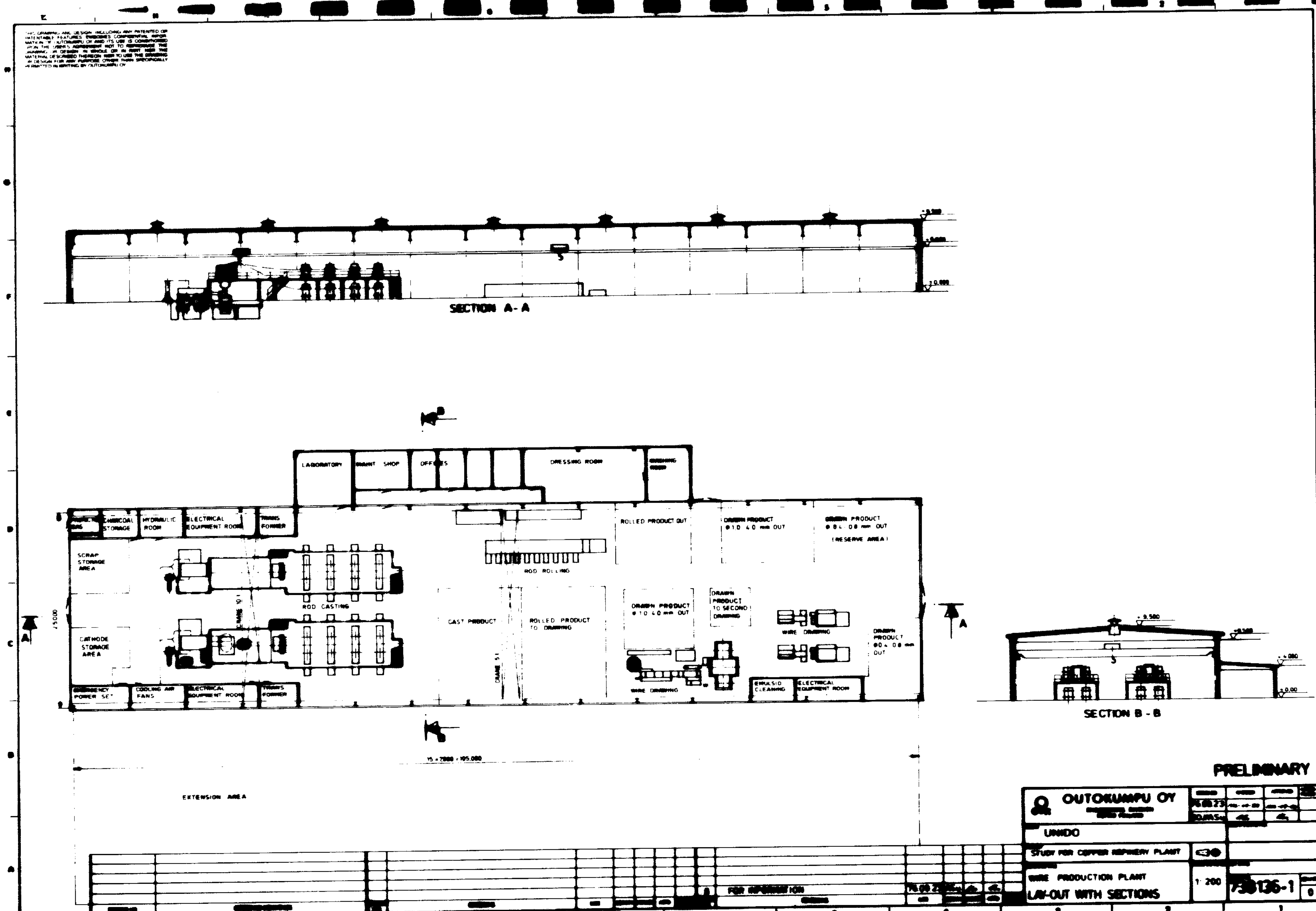
Finland

Account No.
R4
R4.01
R4.01.02/ 1-10
R4.01.03/ 1-6
R4.01.04/ 1-12
R4.01.05/ 1-4
R4.02
R4.02.01
R4.03
R4.03.01
R4.03.02



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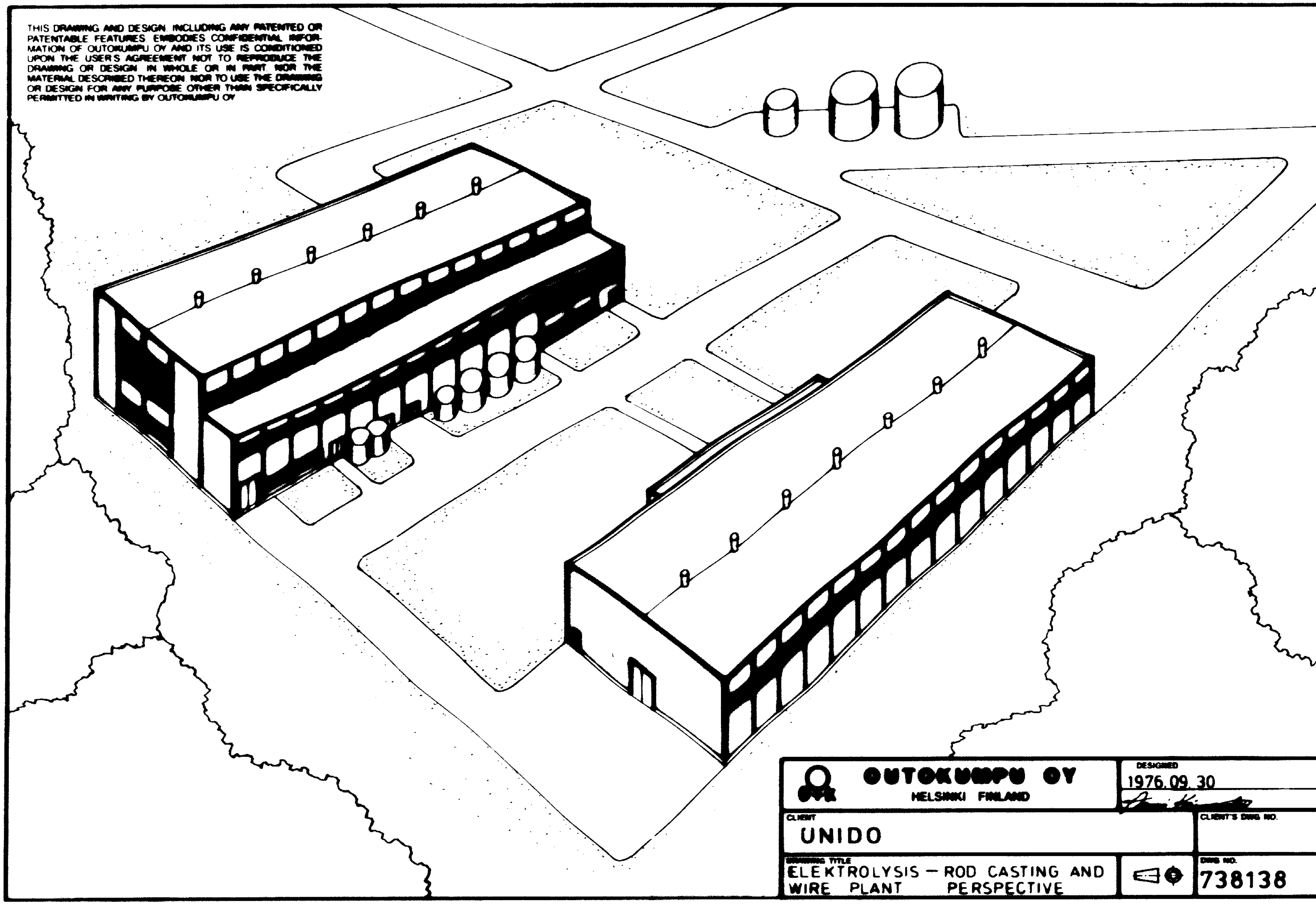
Account
No.



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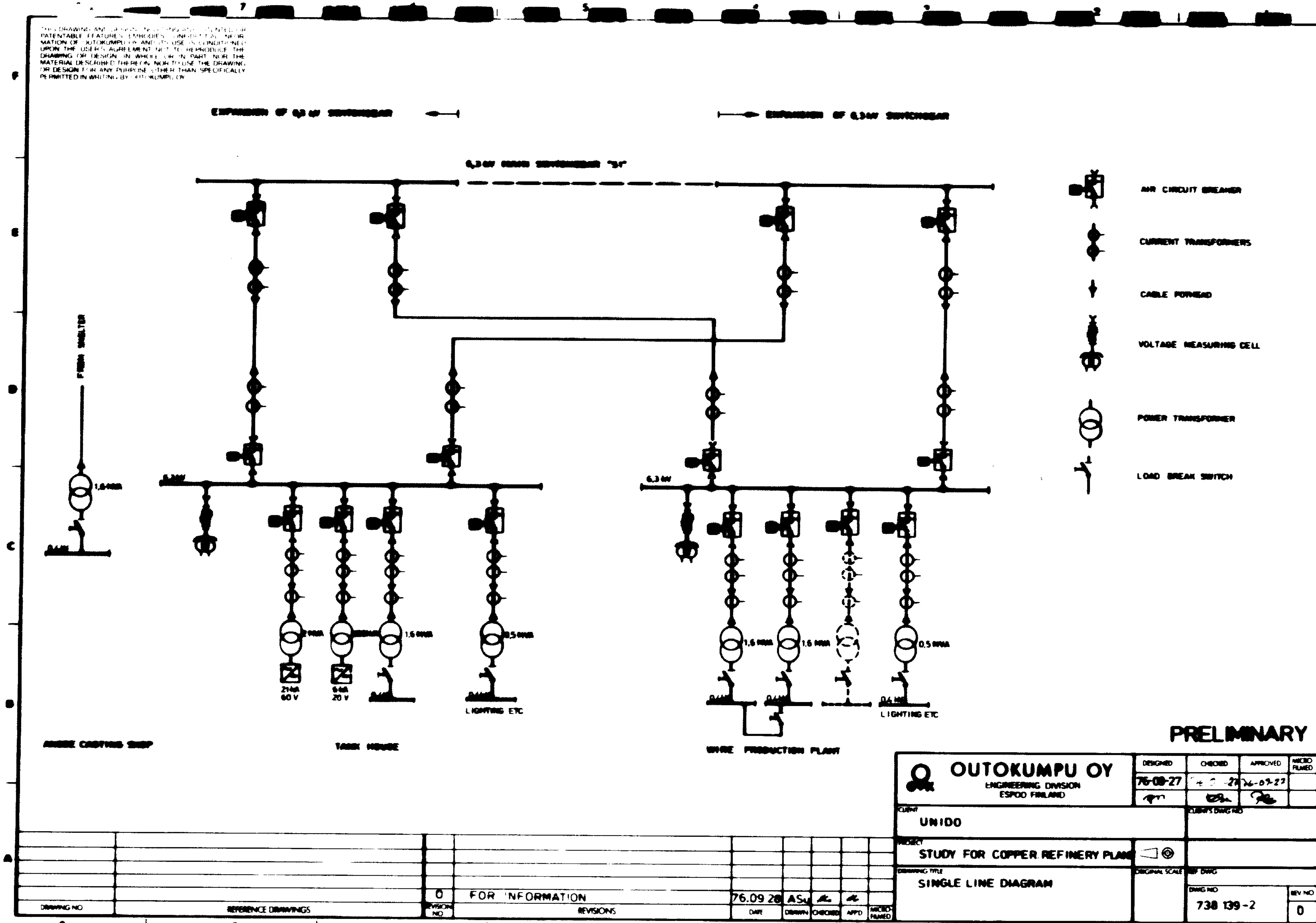
Account No.

W1
W1.02/1-2
W1.03/1-2
W1.04/1-2
W1.05
W1.02
W1.02.01/
1-2
W1.02.02/
1-16
W1.03



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Account No.
W1.05
W2
W2.01
W3.
W3.01
W3.02
W3.03
W3/1-3
W3.04
W3.05
W3.06

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10.

APPENDIX No. 3

CONTENTS

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Account No.

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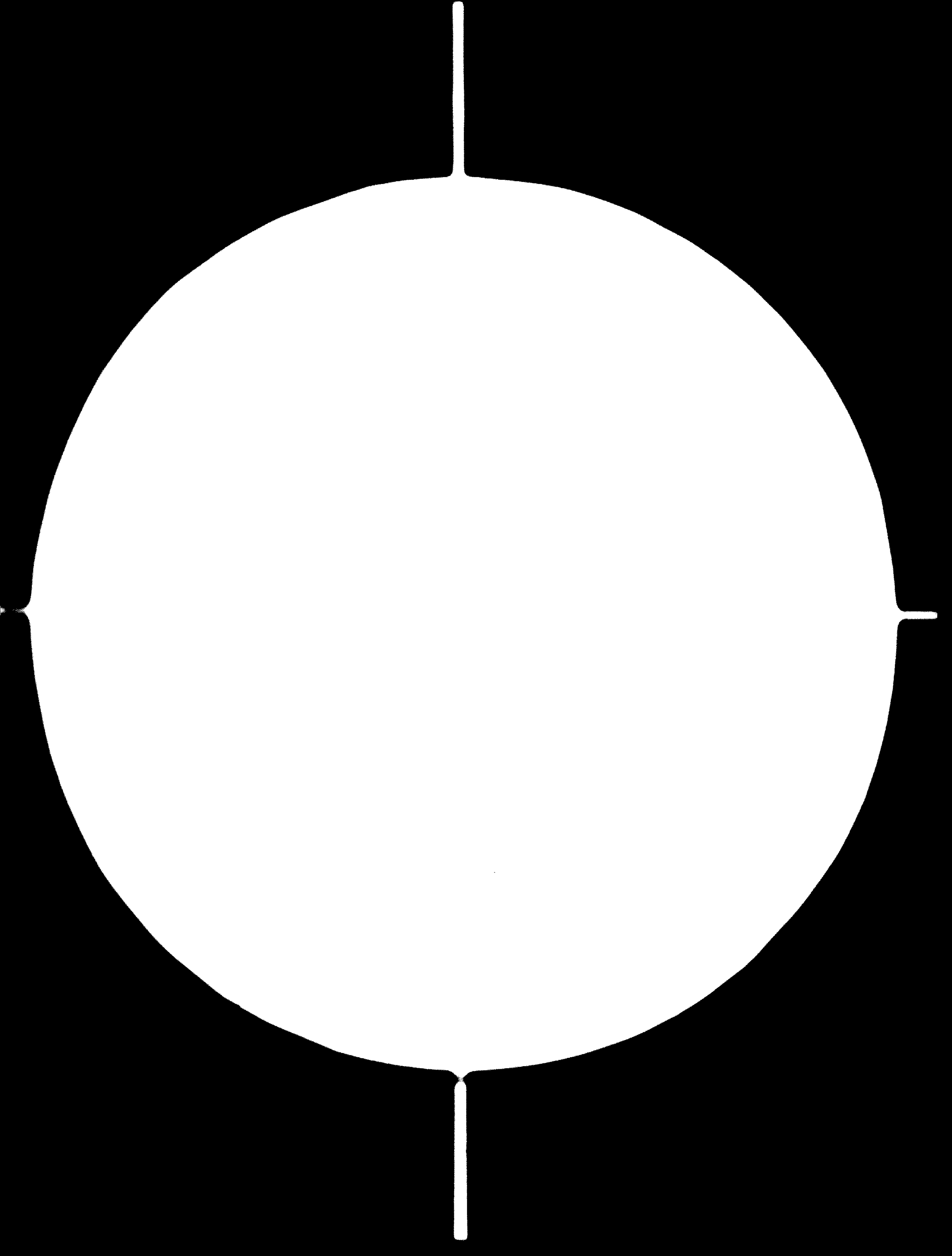
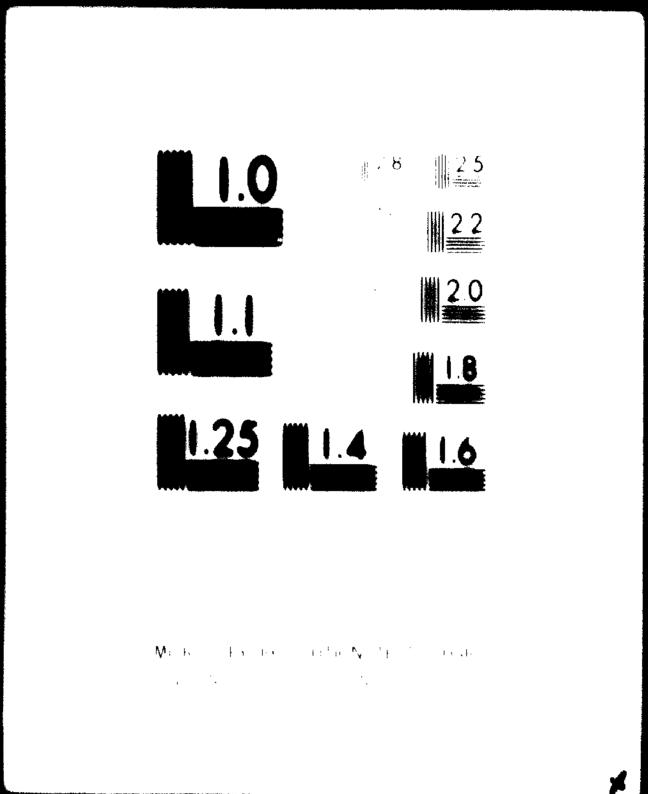
82.09.22



3 OF 4



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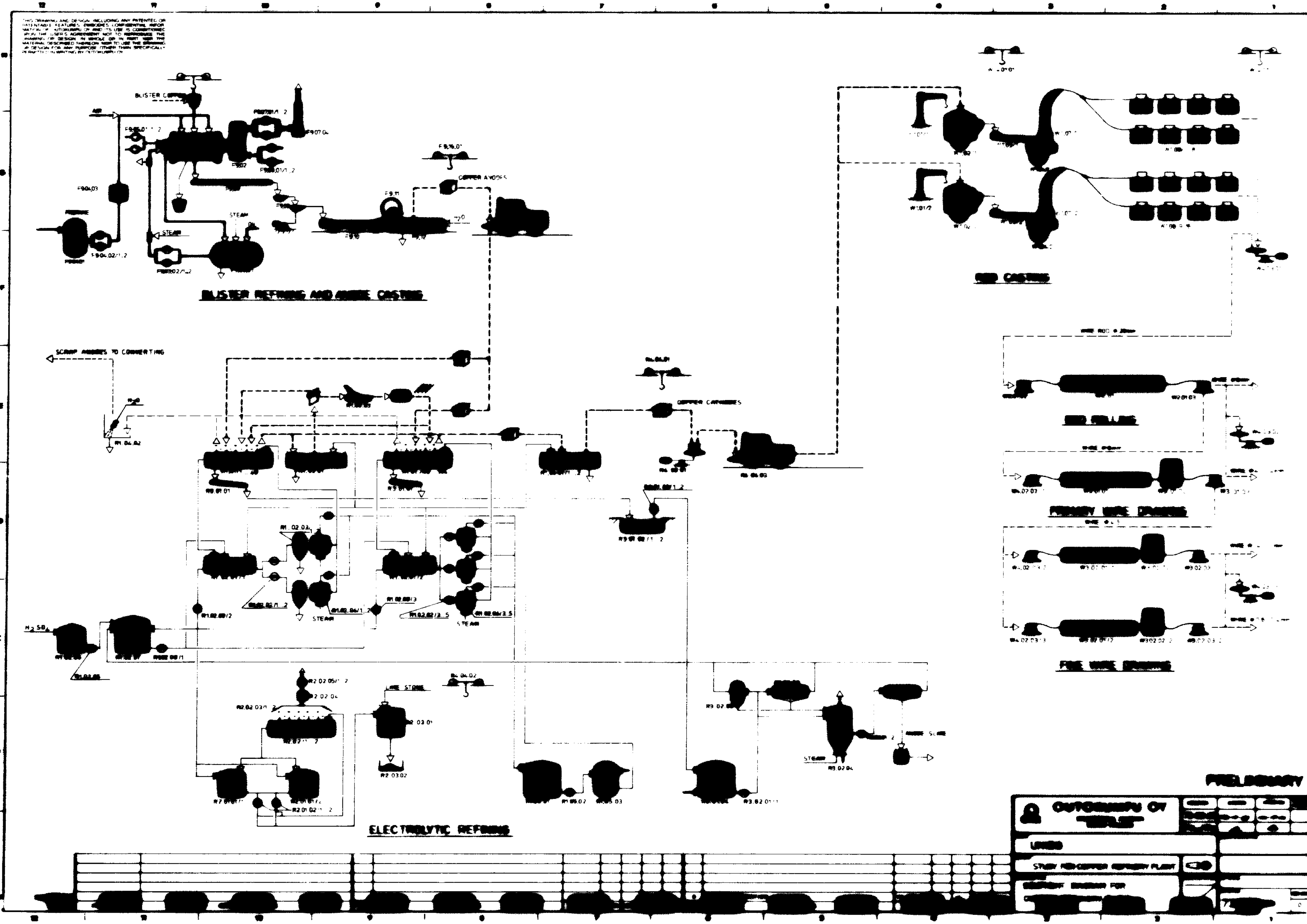
BLISTER REFINING AND ANODE CASTING
BLISTER COPPER
AIR
STEAM
COPPER ANODES
SCRAP ANODES TO CONVERTING
COPPER CATHODES
ROD CASTING
ROD ROLLING
PRIMARY WIRE DRAWING
FINE WIRE DRAWING
ELECTROLYTIC REFINING
H_2SO_4
ANODE SLIME
PRELIMINARY
OUTOKUMPU OY
STUDY FOR COPPER REFINERY PLANT

1.1

EQUIPMENT LIST FOR THE CAPACITY 25 000 MTPA

Contents

H — Instrumentation

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C — Civil Engineering

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F9.C Civil Engineering for Anode Casting Area
R0.C Civil Engineering for Tank House Area
W0.C Civil Engineering for Wire Production Area

10.

EQUIPMENT LIST FOR THE CAPACITY 25 000 MTPA

P0	**Copper Refinery Plant**
F0	**Flash Smelter Area**
F9	**Anode Casting Equipment**
F9.01	**Anode Furnace** - capacity 120 MT Cu - size ∅ 3 600 x 6 700 mm
F9.01.01	**Steel Work** - material mild steel - weight 40 MT
F9.01.02	**Refractories** - weight 110 MT
F9.01.03	**Drive Equipment** - fast drive 45 kW - slow drive 4 kW - pneumatic emergency drive 4 kW
F9.02	**Incinerator** - temperature at inlet +1400°C - temperature at outlet +350°C
F9.02.01	**Steel Work** - material mild steel - weight appr. 20 MT
F9.02.02	**Refractories** - weight 65 MT

F9.03 Fuel Oil System

F9.03.01 Oil Tank
- material mild steel
- volume 60 m^3

F9.03.02/1...2 Two (2) Oil Pumps
- capacity max. 1 000 kg/h
- head 20 m WG
- drive 0.5 kW

F9.03.03 Oil Burner
- capacity 150-1 000 kg/h

F9.04 Propane System
F9.04.01 Propane Tank
- material mild steel
- volume appr. 50 m^3

F9.04.02/1...2 Two (2) Propane Pumps
- capacity max. 1 000 kg/h
- head 20 m WG
- drive 0,5 kW

F9.04.03 Electrical Evaporator
- capacity max. 1 000 kg/h

F9.04.04/1...4 Four (4) Oxidation/Reduction Nozzles

F9.05 Combustion Air System

F9.05.01/1...2 Two (2) Combustion Air Fans
- material mild steel
- capacity 12 000 (NTP) m^3/h
- pressure 600 mm WG
- drive 45 kW
- multivane radial damper

F9.05.02	Combustion Air Piping - material mild steel - diameter 500 mm - total length 50 m
F9.05.03/1...2	Two (2) Butterfly Valves - diameter 500 mm
F9.06	Cooling Air System
F9.06.01/1...2	Two (2) Cooling Air Fans - material mild steel - capacity 30 000 (NTP) m^3/h - pressure 200 mm WG - drive 35 kW - multivane radial damper
F9.06.02	Cooling Air Piping - material mild steel - diameter 800 mm - total length 50 m
F9.06.03/1...2	Two (2) Butterfly Valves - diameter 800 mm
F9.07	Offgas System
F9.07.01/1...2	Two (2) Offgas Fans - material acid proof steel - capacity 50 000 (NTP) m^3/h - pressure 250 mm WG - temperature $+350^{\circ}C$ - drive 160 kW

F9.07.02	**Offgas ducts**
	- material carbon steel
	- diameter 1 000 mm
	- total length 70 m
F9.07.03/1...4	**Four (4) Slide Gate Dampers**
	- diameter 1 000 mm
F9.07.04	**Stack**
	- height 30 m
	- material carbon steel
	- heat insulated
F9.08	**Launder for Anode Copper**
F9.08.01	**Steel Work**
	- material mild steel plate, welded construction
	- total length 9 m
F9.08.02	**Linings**
	- refractory lined
F9.09	**Automatic Casting and Weighing Equipment**
F9.09.01	**Casting and Weighing Mechanism**
	- one intermediate ladle
	- one casting ladle
	- hydraulic operations
F9.10	**Anode Casting Wheel Equipment**
F9.10.01	**Casting Wheel**
	- diameter 9 500 mm
	- 16 moulds made of copper
	- hydraulic driving mechanism

F9.10.02	Mould Cooling Spray System - spray piping - hood above cooling area - steam exhaust canal above the hood - steam exhaust fan
F9.11	Automatic Lifting Device for Anodes - frame of welded steel construction - hydraulic and pneumatic operations
F9.12	Cooling Tank for Anodes - water tank, volume 10 m^3 made of mild steel plate - chain conveyor with electrical drive - spacing device with pneumatic operation - platforms and stairways
F9.13	Control Room for Casting Operations
F9.14	Electronics for Casting Operations
F9.15	Hydraulic Power Unit for Casting Operations - drives 15 kW and 37 kW
F9.16	Auxiliary Equipment
F9.16.01	Overhead Travelling Crane - capacity 2 x 5 MT - span 17 m - drive 20 kW
F9.16.02/1...10	Ten (10) Tracks for Anode Storing - material mild steel - each track for 40 anodes

R0 Electrolytic Tank House Area

R1.01 Copper Refining Equipment

R1.01/1...144 One Hundred and Forty Four (144) Commercial Cells
- inside dimensions 1 100 x 1 330 x 4 775
- volume 7 m^3

R1.01.01 Concrete Work of Cells
- metal forms
- material reinforced concrete panels

R1.01.02/1...144 One Hundred and Forty Four (144) Lead Linings with Overflow Equipment for Commercial Cells
- material antimonial lead

R1.01.03/1...450 Four Hundred and Fifty (450) Starter Blanks
- material of special grade titanium
- copper hanger bars

R1.01.04/1...7000 Seven Thousand (7000) Rectangular Cathode Rods
- material copper

R1.02 Electrolyte Circulating Equipment

R1.02.01/1...2 Two (2) Circulating Tanks for Electrolyte
- material concrete
- volume 50 m^3
- lead linings

R1.02.02/1...5 Five (5) Circulating Pumps for Electrolyte
- capacity 1.5 m^3/min
- total head 20 m WG
- material AISI 316 or equal
- electric drive 20 kW

R1.02.03/1...2 Two (2) Polish Filters for Starting Sheet Electrolyte
- flow rate 1.5 m^3/min
- material AISI 316 or rubberlined mild steel

R1.02.04/1...5 **Five (5) Heat Exchangers for Electrolyte**
- temperature range 55-65°C
- flow rate of electrolyte 1.5 m^3/min
- steam consumption 1.0 MTPH
- material graphite

R1.02.05 **Storage Tank for H_2SO_4**
- volume 10 m^3
- material, mild steel plate

R1.02.06 **Pump for H_2SO_4**
- capacity 200 l/min
- total head 15 m WG
- material AISI 316 or equal
- electric drive 3 kW

R1.02.07 **Storage Tank for Electrolyte**
- volume 60 m^3
- material AISI 316 or equal

R1.02.08/1...3 **Three (3) Pumps for Electrolyte**
- capacity 400 l/min
- total head 20 m WG
- material AISI 316 or equal
- electric drive 4 kW

R1.03 **Stripping and Starting Sheet Preparation Equipment**

R1.03.01 **Wash Tank for Blanks**
- volume 7.5 m^3
- material AISI 316 or equal
- direct steam heating

R1.03.02/1...2 **Two (2) Racks for Stripping**
- material mild steel

R1.03.03 **Starting Sheet Preparation Machines**

- cutting unit for sheets and loops
- straightening unit
- punching unit

R1.04 **Cathode and Scrap Anode Washing Equipment**

R1.04.01/1...2 **Two (2) Wash Tanks for Cathodes**

- volume 7.5 m^3
- material AISI 316 or equal
- direct steam heating

R1.04.02 **Scrap Anode Washing Equipment**

- washing by water hose
- plate surrounded washing area

R1.05 **Condensate Collecting and Distribution Equipment**

R1.05.01 **Collecting Tank for Condensate**

- volume 3 m^3
- material AISI 316 or equal

R1.05.02 **Pump for Condensate**

- capacity 300 l/min
- total head 60 m WG
- material AISI 316 or equal
- electric drive 11 kW

R1.05.03 **Feeding Tank for Condensate**

- volume 2 m^3
- material AISI 316 or equal
- compressed air connection

R2 **Electrolyte Purification Equipment**

R2.01 **Circulating Equipment for Decopperising Electrolyte**

R2.01.01/1...2	Two (2) Collecting and Circulating Tanks for Decopperising Electrolyte - volume 20 m^3 - material AISI 316 or equal
R2.01.02/1...2	Two (2) Circulating Pumps for Decopperising Electrolyte - capacity 400 l/min - total head 200 m WG - material AISI 316 or equal - electric drive 4 kW
R2.02./1...2	Two (2) Decopperising Cells - inside dimensions 1 100 x 1 330 x 4 775 - volume 7 m^3 - sloping bottom
R2.02.01	Concrete Work of Cells - metal forms - material reinforced concrete panels
R2.02.02/1...2	Two (2) Lead Linings with Overflow Equipment for Decopperising Cells
R2.02.03/1...2	Two (2) Gas Hoods for Decopperising Cells - material plastic or fiber glass
R2.02.04	Demister - capacity 6 000 (NTP) m^3/h - material AISI 316 or equal
R2.02.05/1...2	Two (2) Ventilation Fans - capacity 6 000 (NTP) m^3/h - pressure 100 mm WG - material AISI 316 or equal - electric drive 4 kW

R2.02.06/1...220	Two Hundred and Twenty (220) Lead Anodes - copper hanger bars
R2.03	Neutralizing Equipment for Decopperized Electrolyte
R2.03.01	Neutralizing Reactor - volume 5 m^3 - material AISI 316 or equal - equipped with agitator and vent tube - feed funnel for slime stone
R2.03.02	Transport Tank for Neutralisation Residue - volume 5 m^3 - material mild steel
R3	<u>Slime Treatment Equipment</u>
R3.01	Slime Collecting Equipment
R3.01.01	Launders for Slime Collecting - material plastic
R3.01.02/1...2	Two (2) Floor Sumps for Slime Collecting - volume 3 m^3 - material AISI 316 or equal
R3.01.03/1...2	Two (2) Vertical Pumps for Slime - capacity 200 l/min - total head 20 m WG - material AISI 316 or equal - electric drive 3 kW
R3.01.04	Storage Tank for Slime Slurry - volume 30 m^3 - material AISI 316 or equal - air agitator

R3.02 **Treatment Equipment for Slime Slurry**

R3.02.01/1...2 **Two (2) Pumps for Slime Filtering**
- capacity 400 l/min
- total head 50 m WG
- material AISI 316 or equal
- electric drive 11 kW

R3.02.02 **Polishing Filter**
- flow rate 400 l/min
- material AISI 316 or rubber lined mild steel

R3.02.03 **Filter Press**
- cake volume 300 l
- filtering area 15 m^2

R3.02.04 **Leaching Reactor**
- volume 10 m^3
- material AISI 316 or equal
- direct steam heating

R4 **Auxiliary Equipment**

R4.01 **Racks for Tank House Area**

R4.01.01 **Spacing Rack for Anodes**
- material mild steel
- manually operated spacing

R4.01.02/1...15 **Fifteen (15) Racks for Anodes and Scrap Anodes**
- material mild steel

R4.01.03/1...6 **Six (6) Racks for Starting Sheets**
- material mild steel

R4.01.04/1...12	Twelve (12) Racks for Cathodes - material mild steel
R4.01.05/1...2	Two (2) Racks for Lead Anodes - material mild steel
R4.02	Auxiliary Lifting Equipment
R4.02.01/1...2	Two (2) Bundle Lifting Devices for Anodes and Cathodes - material mild steel
R4.02.02	Bundle Lifting Device for Starting Sheets - material mild steel
R4.02.03	Bundle Lifting Device for Lead Anodes - material mild steel
R4.03	Weighing Equipment
R4.03.01	Scale for Cathode Weighing - capacity 2 MT max
R4.04	Cranes and Transportation Equipment
R4.04.01	Overhead Travelling Crane - capacity 2 x 7.5 MT - span 27 m - drive 30 kW
R4.04.02	Overhead Travelling Crane for Side Aisle - capacity 2 x 3 MT - span 9 m - drive 20 kW

R4.04.03	Fork Lift - capacity 15 MT
R4.04.04	Transfer Wagon for Electrode - capacity 5 MT
R4.04.05/1...2	Two (2) Transfer Jacks - lifting capacity 2 MT
R4.05	Hand Tools
R4.05.01	Stripping Tools
R4.05.02	Short Circuit Defection Meter - gauss meter

W0	**Wire Production Area**
W1	**Rod Casting Equipment**

W1.01/1...2 Two (2) Automatic Charging Devices for Smelting Furnace

W1.02/1...2 Two (2) Smelting Furnaces
- channel type induction furnace
- capacity 8 MT
- smelting capacity 15 000 MTPA
- two inductors
- furnace rating 600 kW
- hydraulic tilting mechanism

W1.03/1...2 Two (2) Launders between Smelting and Holding Furnaces
- gas tight
- electrical heated
- rating 11 kW

W1.04/1...2 Two (2) Holding Furnaces
- channel type induction furnace
- capacity 3 MT
- one inductor
- furnace rating 150 kW

W1.05 Cooling System for Inductors
- cooling air ducting, Ø 400, L = 30 m
- three (3) fans, capacity appr. 10 000 (NTP) m^3/h

W1.06 Production Gas Generating System
- capacity 400 (NTP) m^3/h max
- pressure 2 mm WG
- CO content 20%
- raw material charcoal

W1.07/1...2 Two (2) Withdrawal Machines
- 16 strands
- casted rod diameter 20 mm

W1.08/1...16 Sixteen (16) Pairs of Coiling Machines
- hydraulic drive equipment, 1.1 kW/pair
- speed and coil diameter control

W1.09 Control Desk for Smelting and Casting Operations

W1.10 Vacuum Generating Equipment for Withdrawal Machines
- fan, capacity 6-10 m^3/min, p = 900 mm WG, drive 7.5 kW
- vacuum piping

W1.11/1...2 Two (2) Hydraulic Power Systems for Smelting Furnaces
- oil tank 250 l
- oil pump, capacity 57 l/min, p = 70 kg/cm^2, drive 11 kW

W1.12/1...2 Two (2) Hydraulic Power Systems for Withdrawal Machines
- oil tank 250 l
- oil pump, capacity 45 l/min, p = 50 kg/cm^2, drive 5.5 kW

W2 <u>Rod Rolling Equipment</u>

W2.01 Rod Rolling Machine
- from Ø 20 mm rod to 8 mm square wire
- running out speed max. 6 m/sec
- rating 570 kW

W2.01.01 Straightening Device

W2.01.02 Pay-off Table
- two coil barrels

W2.01.03	Self-winding Device
W2.01.04	Emulsion Treatment and Cooling Line
W3	<u>Wire Drawing Equipment</u>
W3.01	Primary Wire Drawing Line
W3.01.01	Medium Wire Drawing Machine - inlet diameter max 8 mm - outlet diameter min 1 mm - number of drafts 13 - drawing speed max 38 m/sec - connection rating 286 kW
W3.01.02	Slipless Continuous Resistance Annealer - annealing diameter range ø 4.52 - ø 1 mm - connection rating 300 kVA - annealing voltage max 65 V
W3.01.03	Bundle Packer - coiler with stationary wire carrier - coiling diameter range ø 5 - ø 1 mm - coiling speed max 30 m/sec - flange diameter max 1250 mm - barrel diameter min 600 m - total width 400-900 mm - wire capacity max 5 MT - connection rating 30 kW
W3.02	Fine Wire Drawing Line
W3.02.01/1...2	Two (2) Fine Wire Drawing Machines - inlet diameter max 4.5 mm - outlet diameter min 0.4 mm - number of drafts 17 - drawing speed max 60 m/sec - connection rating 132 kW

W3.02.02/1...2	Two (2) Slipless Continuous Resistance Annealers - annealing diameter range ∅ 1.8 - ∅ 0.4 mm - connecting rating 100 kVA - annealing voltage max 65 V
W3.02.03/1...2	Two (2) Bundle Packers - coiler with stationary wire carrier - coiling diameter range ∅ 1.8 - 0.4 mm - flange diameter max ∅ 1000 mm - barrel diameter min ∅ 645 mm - total width 1000 mm - wire capacity max 2 250 kg
W3.02.04	Emulsion Line for Drawing Machines
W3.02.05	Steam Generating Line for Drawing Lines
W4	<u>Auxiliary Equipment</u>
W4.01	Cranes and Transportation Equipment
W4.01.01	Overhead Travelling Crane for Rod Casting - capacity 10 MT - span 24 m - drive 15 kW
W4.01.02	Overhead Travelling Crane for Wire Drawing - capacity 5 MT - span 24 m - drive 11 kW
W4.01.03	Fork Lift - capacity 5 MT

W4.02	Auxiliary Machines and Reels	
W4.02.01/1...3	Three (3) Pointing Machines	
	- diameter range ∅ 8 - 1.2 mm	
W4.02.02/1...3	Three (3) But-welding Machines	
	- one for diameters ∅ 8-4 mm	
	- one for diameters ∅ 4-1 mm	
	- one for diameters ∅ 1 - 0.15 mm	
W4.02.03/1...3	Three (3) Pay-off Devices for Drawing Machines	
	- one for primary wire drawing line	
	- two for fine wire drawing lines	
W4.02.04	Cutting Device for Scrap Wires	
W4.02.05	Reels for Drawing Machines	
	- 500 metal reels	
	- 1500 wooden reels	
W4.03	Weighing Equipment	
W4.03.01	Scale for Wire Rods	
	- capacity 4 MT	
W4.03.02	Scale for Wires from ∅ 8 mm to ∅ 1.4 mm	
	- capacity 4 MT	
W4.03.03	Scale for Wires from ∅ 1.4 mm to ∅ 0.4 mm	
	- capacity 1 MT	

E	Piping
P0.E	Piping for Plant Area
P0.E.1	Steam piping
P0.E.02	Process water piping
P0.E.03	Cooling water piping
P0.E.04	Compressed air piping
F9.E	Piping for Anode Casting Shop Area
F9.E.01	Fuel oi piping
F9.E.02	Propane piping
F9.E.03	Utility piping
R0.E	Piping for Tank House Area
R0.E.01	Process piping
R0.E.02	Utility piping
W0.E	Piping for Wire Production Plant Area
W0.E.01	Hydraulic piping
W0.E.02	Emulsio piping
W0.E.03	Utility piping

R	Electrification
P0.R	Electrification for Plant Area
P0.R.01	Extension of main switchgear
P0.R.02	Power supply for tank house and wire production
F9.R	Electrification for Anode Casting Shop Area
F9.R.01	Expansion of smelter high voltage switchgear
F9.R.02	Process transformer
F9.R.03	Cabling and control
F9.R.04	Lighting

R0.R	**Electrification for Tank House Area**
R0.R.01	Rectifier transformer for commercial cells - current 21 kA - voltage 60 V
R0.R.02	Rectifier transformer for decopperizing cells - current 6 kA - voltage 20 V
R0.R.03	6.3 kV switchgear
R0.R.04	Process transformer
R0.R.05	Main busbars - area 16 000 mm2 - total length 77 m
R0.R.06	Distribution busbars - area 20 000 mm^2 - total length 123 m
R0.R.07	Cell busbars - area 1 000 mm^2 - total length 657 m
R0.R.08	Short circuit switches sections - quantity 6
R0.R.09	Main busbar for decopperizing cells - area 4 600 mm^2 - total length 14 m
R0.R.10	Cell busbars - area 1 000 mm^2 - total length 19 m
R0.R.11	Cabling and control
R0.R.12	Lighting

W0.R		**Electrification for Wire Production Plant Area**
W0.R.01		High voltage switchgear
W0.R.02		Process transformers
W0.R.03		Cabling and control
W0.R.04		Lighting
W0.R.05		Emergency power for tank house and wire production

H Instrumentation

F9.H	Instrumentation for anode casting shop area
R0.H	Instrumentation for tank house area
W0.H	Instrumentation for wire production area

C Civil Engineering

P0.C	**Civil Engineering for Plant Area**
P0.C.01	Building of main switchgear - volume 160 m^3
P0.C.02	Heating and ventilating of the building
P0.C.03	Foundations of equipment
P0.C.04	Roads and yards - length 300 m
P0.C.05	Sewage work
F9.C	**Civil Engineering for Anode Casting Area**
F9.C.01	Foundations of equipment
F9.C.02	Trail for overhead crane
F9.C.03	Auxiliary building works

R0.C	<u>Civil Engineering for Tank House</u>
R0.C.01	Foundation for equipment
R0.C.02	Building
	- dimensions 38.5 x 98 m
	- volume 40 600 m^3
R0.C.03	Heating and ventilating
R0.C.04	Furniture
R0.C.05	Sanitary plumbing
W0.C	<u>Civil Engineering for Wire Production Area</u>
W0.C.01	Foundation of equipment
W0.C.02	Building
	- dimensions 25 x 105 m
	- volume 23 350 m^3
W0.C.03	Heating and ventilating
W0.C.04	Furniture
W0.C.05	Sanitary plumbing

1.2

EQUIPMENT LIST FOR COPPER REFINERY PLANT EXTENSION

(total capacity 50 000 MTPA)

Contents

C Civil Engineering

P0.C Civil Engineering for Plant Area

H0.C Civil Engineering for Tank House Area

W0.C Civil Engineering for Wire Production Area

EQUIPMENT LIST FOR COPPER REFINERY PLANT EXTENSION

(total capacity 50 000 MTPA)

R0	Electrolytic Tank House Area
R1	Copper Refining Equipment
R1.02/145...288	One Hundred and Forty Four (144) Commercial Cells - inside dimensions 1 100 x 1 330 x 4 775 - volume 7 m^3
R1.01.01	Concrete Work of Cells - metal forms - material reinforced concrete panels
R1.01.02/145...288	One Hundred and Forty Four (144) Lead Linings with Overflow Equipment for Commercial Cells - material antimonial lead
R1.01.03/451...900	Four Hundred and Fifty (450) Started Blanks - material of special grade titanium - copper hanger bars
R1.01.04/7001... 14000	Seven Thousand (7000) Rectangular Cathode Rods - material copper
R1.02	Electrolyte Circulating Equipment
R1.02.01/3...4	Two (2) Circulating Tanks for Electrolyte - material concrete - volume 50 m^3 - lead lining
R1.02.02/6...9	Four (4) Circulating Pumps for Electrolyte - capacity 1.5 m^3/min. - total head 20 m WG - material AISI 316 or equal - electric drive 20 kW

R1.02.04/6...9 Four (4) Heat Exchangers for Electrolyte
- temperature range 55-65 °C
- flow rate of electrolyte 1.5 m^3/min
- steam consumption 1.0 MTPH
- material graphite

R1.02.08/4...5 Two (2) Pumps for Electrolyte
- capacity 400 l/min
- total head 20 m WG
- material AISI 316 or equal
- electric drive 4 kW

R1.04 Cathode and Scrap Anode Washing Equipment

R1.04.01/3...4 Two (2) Wash Tanks for Cathodes
- volume 7.5 m^3
- material AISI 316 or equal
- direct steam heating

R1.05 Condensate Collecting and Distribution Equipment

R1.05.01 Collecting Tank for Condensate
- volume 30 m^3
- material AISI 316 or equal

R1.05.02 Pump for Condensate
- capacity 300 l/min
- total head 60 m WG
- material AISI 316 or equal
- electric drive 11 kW

R1.05.03 Feeding Tank for Condensate
- volume 2 m^3
- material AISI 316 or equal
- compressed air connection

R2	**Electrolyte Purification Equipment**	
R2.02/3...4	Two (2) Decopperizing Cells	
	-	inside dimensions 1 100 x 1 330 x 4 775
	-	volume 7 m^3
	-	sloping bottom
R2.02.01	Concrete Work of Cells	
	-	metal forms
	-	material reinforced concrete panels
R2.02.02/3...4	Two (2) Lead Linings with Overflow Equipment for Decopperizing Cells	
R2.02.03/3...4	Two (2) Gas Hoods for Decopperizing Cells	
	-	material plastic or fiber glass
R2.02.06/221...440	Two Hundred and Twenty (220) Lead Anodes	
	-	copper hanger bars
R3	**Slime Treatment Equipment**	
R3.01	Slime Collecting Equipment	
R3.01.01	Launders for Slime Collecting	
	-	material plastic
R3.01.02/3...4	Two (2) Floor Sumps for Slime Collecting	
	-	volume 3 m^3
	-	material AISI 316 or equal
R3.01.03/3...4	Two (2) Vertical Pumps for Slime	
	-	capacity 200 l/min
	-	total head 20 m WG
	-	material AISI 316 or equal
	-	electric drive 3 kW

R4	**Auxiliary Equipment**	
R4.01	Racks for Tank House Area	
R4.01.02/16...30	Fifteen (15) Racks for Anodes and Scrap Anodes - material mild steel	
R4.01.03/7...12	Six (6) Racks for Starting Sheets - material mild steel	
R4.01.04/13...24	Twelve (12) Racks for Cathodes - material mild steel	
R4.01.05/3...4	Two (2) Racks for Lead Anodes - material mild steel	
R4.04	Cranes and Transportation Equipment	
R4.04.01/2	Overhead Travelling Crane - capacity 2 x 7.5 MT - span 27 m - drive 30 kW	
R4.05	Hand Tools	
R4.05.01	Stripping Tools	

W0	**Wire Production Area**
W1	**Rod Casting Equipment**
W1.01/3	Automatic Charging Device for Smelting Furnace
W1.02/3	Smelting Furnace - channel type induction furnace - capacity 8 MT - smelting capacity 15 000 MTPA - two inductors - furnace rating 600 kW - hydraulic tilting mechanism
W1.03/3	Launder between Smelting and Holding Furnace - gas tight - electrical heated - rating 11 kW
W1.04/3	Holding Furnace - channel type induction furnace - capacity 3 MT - one inductor - furnace rating 150 kW
W1.05	Cooling system for inductors - cooling air ducting, Ø 400 - one fan, capacity appr. 10 000 (NTP) m^3/h
W1.07/3	Withdrawal Machine - 16 strands - casted rod diameter 20 mm
W1.08/17...24	Eight (8) Pairs of Coiling Machines - hydraulic drive equipment, 1.1 kW/pair - speed and coil diameter control

W1.09	Control Desk for Smelting and Casting Operations
W1.11/3	Hydraulic Power System for Smelting Furnace - oil tank 250 l - oil pump, capacity 57 l/min, $p = 70\ kg/cm^2$, drive 11 kW
W1.12/3	Hydraulic Power System for Withdrawal Machine - oil tank 250 l - oil pump, capacity 45 l/min, $p = 50\ kg/cm^2$, drive 5.5 kW
W2	<u>Rod Rolling Equipment</u>
W2.01/2	Rod Rolling Machine - from Ø 20 mm, rod to 8 mm square wire - running out speed max 6 m/sec - rating 570 kW
W2.01.01/2	Straightening Device
W2.01.02/2	Pay-off Table - two coil barrels
W2.01.03/2	Self-winding Device
W2.01.04/2	Emulsion Treatment and Cooling Line
W3	<u>Wire Drawing Equipment</u>
W3.01	Primary Wire Drawing Line

W3.01.01/2	**Medium Wire Drawing Machine** - inlet diameter max 8 mm - outlet diameter min 1 mm - number of drafts 13 - drawing speed max 38 m/sec - connection rating 286 kW
W3.01.02/2	**Slipless Continuous Resistance Annealer** - annealing diameter range ø 4.52 - ø 1 mm - connection rating 300 kVA - annealing voltage max 65 V
W3.01.03/2	**Bundle Packer** - coiler with stationary wire carrier - coiling diameter range ø 5 - ø 1 mm - coiling speed max 30 m/sec - flange diameter max 1 250 mm - barrel diameter min 600 mm - total width 400 - 900 mm - wire capacity max 5 MT - connection rating 30 kW
W3.02	**Fine Wire Drawing Line**
W3.02.01/3...4	**Two (2) Fine Wire Drawing Machines** - inlet diameter max 4.5 mm - outlet diameter min 0.4 mm - number of drafts 17 - drawing speed max 60 m/sec - connection rating 132 kW
W3.02.02/3...4	**Two (2) Slipless Continuous Resistance Annealers** - annealing diameter range ø 1.8 - ø 0.4 mm - connecting rating 100 kVA - annealing voltage max 65 V

W3.02.03/3...4 **Two (2) Bundle Packers**

- coiler with stationary wire carrier
- coiling diameter range ∅ 1.8 - 0.4 mm
- flange diameter max ∅ 1000 mm
- barrel diameter min ∅ 645 mm
- total width 1000 mm
- wire capacity max 2 250 kg

W3.02.04/2 **Emulsion Line for Drawing Machines**

W3.02.05/2 **Steam Generating Line for Drawing Lines**

W4 **Auxiliary Equipment**

W4.01 **Cranes and Transportation Equipment**

W4.01.01/2 **Overhead Travelling Crane for Rod Casting**

- capacity 10 MT
- span 24 m
- drive 15 kW

W4.01.02/2 **Overhead Travelling Crane for Wire Drawing**

- capacity 5 MT
- span 24 m
- drive 11 kW

W4.02 **Auxiliary Machines and Reels**

W4.02.01/4...6 **Three (3) Pointing Machines**

- diameter range ∅ 8 - 1.2 mm

W4.02.02/4...6 **Three (3) But-welding Machines**

- one for diameters ∅ 8 - 4 mm
- one for diameters ∅ 4 - 1 mm
- one for diameters ∅ 1 - 0.15 mm

W4.02.04/4...6	Three (3) Pay-off Devices for Drawing Machines - one for primary wire drawing line - two for fine wire drawing lines
W4.02.05	Reels for Drawing Machines - 500 metal reels - 1500 wooden reels
W4.03	Weighing Equipment
W4.03.01/2	Scale for Wire Rods - capacity 4 MT
W4.03.02/2	Scale for Wires from Ø to 1.4 mm - capacity 4 MT
W4.03.03/2	Scale for Wires from Ø 1.4 to 0.4 mm - capacity 1 MT

E	**Piping**
RO.E	Piping for Tank House Area
RO.E.01	Process piping
RO.E.02	Utility piping
WO.E	Piping for Wire Production Plant Area
WO.E.01	Hydraulic piping
WO.E.02	Emulsio piping
WO.E.03	Utility piping
R	**Electrification**
PO.R	Electrification for Plant Area
PO.R.01	Extension of main switchgear
PO.R.02	Power supply for tank house and wire production
RO.R	Electrification for Tank House Area
RO.R.01	Rectifier transformer for commercial cells - current 21 kA - voltage 60 V
RO.R.02	Rectifier transformer for decopperizing cells - current 6 kA - voltage 20 V
RO.R.03	6.3 kV switchgear
RO.R.04	Process transformer
RO.R.05	Main busbars - area 16 000 mm^3 - total length 77 m
RO.R.06	Distribution busbars - area 20 000 mm^2 - total length 123 m

RO.R.07	Cell busbars
	- area 1 000 mm^2
	- total length 657 m
RO.R.08	Short circuit switcher sections
	- quantity 6
RO.R.09	Main busbars for decopperizing cells
	- area 4 600 mm^2
	- total length 20 m
RO.R.10	Cell busbars
	- area 6 000 mm^2
	- total length 19 m
RO.R.11	Cabling and control
RO.R.12	Lighting
WO.R	<u>Electrification for Wire Production Plant Area</u>
WO.R.01	High voltage switchgear
WO.R.02	Process transformers
WO.R.03	Cabling and control
EO.R.04	Lighting
WO.R.05	Emergency power for tank house and wire production
H	<u>Instrumentation</u>
RO.H	<u>Instrumentation for Tank House Area</u>
WO	Instrumentation for wire production area
C	<u>Civil Engineering</u>
PO.C	<u>Civil Engineering for Plant Area</u>
PO.C.01	Building of main switchgear
	- volume 160 m^3

PO.C.02 Heating and ventilating of the building

PO.C.03 Foundations of equipment

PO.C.04 Roads and yards

- length 100 m

RO.C <u>Civil Engineering for Tank House</u>

RO.C.01 Foundation for equipment

RO.C.02 Building

- dimensions 38.5 x 64 m
- volume 26 522 m^3

RO.C.03 Heating and ventilating

RO.C.04 Furniture

RO.C.05 Sanitary plumbing

WO.C <u>Civil Engineering for Wire Production Area</u>

WO.C.01 Foundation of equipment

WO.C.02 Building

- dimensions 18 x 105 m
- volume 16 065 m^3

WO.C.03 Heating and ventilating

WO.C.04 Furniture

WO.C.05 Sanitary plumbing

PO.C.02 Heating and ventilating of the building

PO.C.03 Foundations of equipment

PO.C.04 Roads and yards

- length 100 m

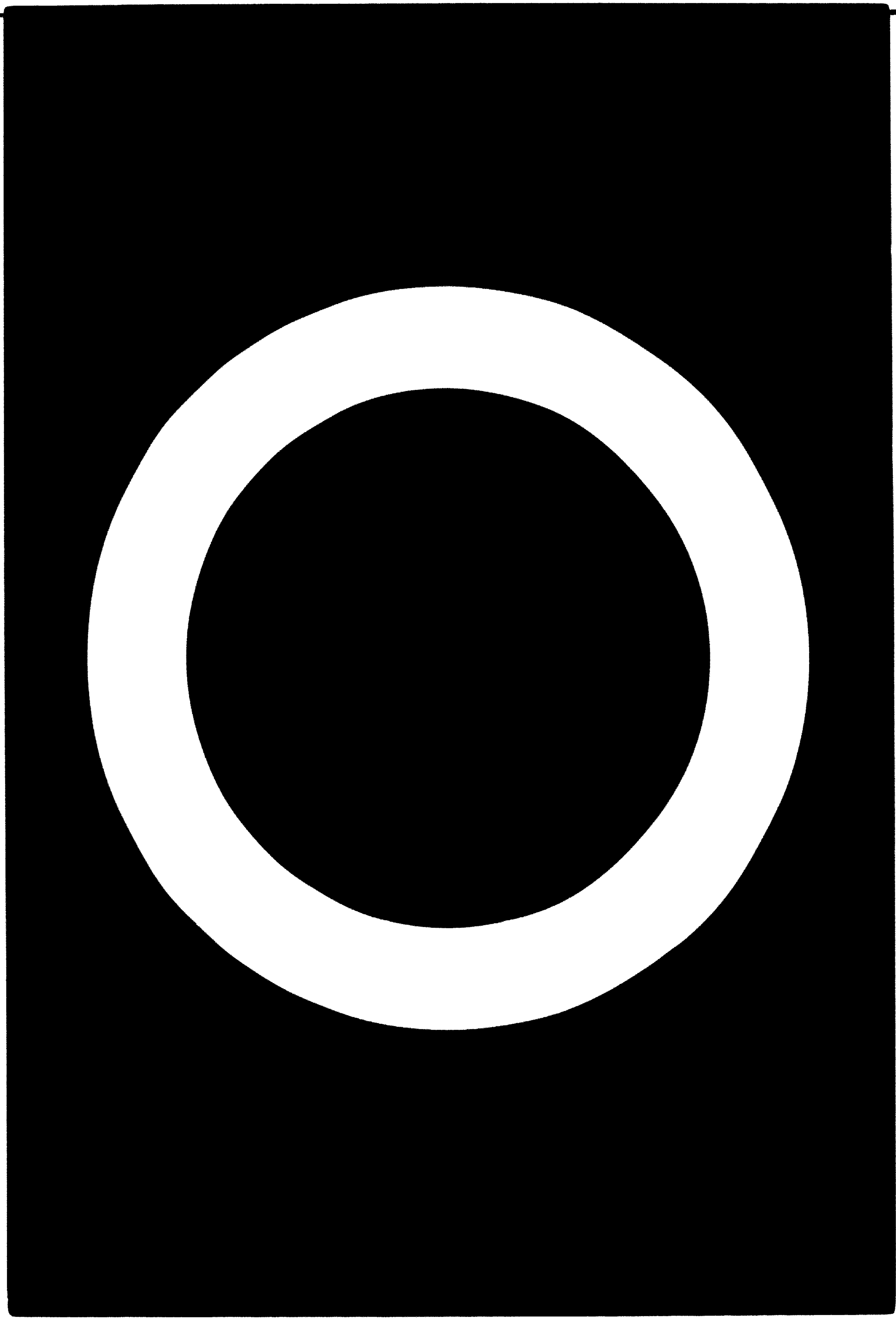
RO.C <u>Civil Engineering for Tank House</u>

RO.C.01 Foundation for equipment

RO.C.02 Building

- dimensions 38.5 x 64 m
- volume 26 522 m^3

R0.C.03	Heating and ventilating
R0.C.04	Furniture
R0.C.05	Sanitary plumbing
W0.C	<u>Civil Engineering for Wire Production Area</u>
W0.C.01	Foundation of equipment
W0.C.02	Building - dimensions 18 x 105 m - volume 16 065 m^3
W0.C.03	Heating and ventilating
W0.C.04	Furniture
W0.C.05	Sanitary plumbing



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(2 of 2)

Study of Electrolytic Copper Production at Etibank in Turkey

The United Nations Industrial Development Organisation

Volume II
Marketing Study

20th December, 1976.

Outokumpu Oy

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SUMMARY

1.1 Purpose of the study
1.2 Blister markets
1.3 Products
1.4 Demand
1.5 Price
1.6 Consumers
1.7 Competition
1.8 Sales effort

1. SUMMARY

1.1 Purpose of the study

The purpose of this market research has been to examine the market possibilities in Turkey for the products from the new electrolytic refinery. The research includes a literature study and a field survey in Turkey. Since supply of blister copper, the raw material to the new plant, is an essential part of the wire production plant's operation, the blister markets have been examined.

1.2 Blister markets

Blister can be purchased on international markets, either by direct purchase or toll agreements. Part of the capacity of the refinery could be satisfied by toll agreements.

1.3 Products

It is evident that copper wire will be the most suitable product form the electrolytic refinery to be built in Turkey. Copper cakes, billets, wire bars and wire rods have not sufficient demand on the Turkish market, and it would not be profitable to produce them for export.

Demand for copper sheet is growing in Turkey, but at this stage it would not be profitable to install rolling mill capacity. There is enough production capacity for copper sulphate in Turkey, and the demand for it is growing very slowly. Also an anode slime treatment plant with sufficient capacity for Turkey is under construction.

From the marketing aspect the most profitable products for a new plant would be:

- copper wire
- anode slime

1.4 Demand

The demand for copper wire has so far been in excess of production capacity. In future the demand will grow by 15-20 % per year. Although the wire plants now operating in Turkey have programs for expansion and one new plant is being built, there will be adequate demand for a new wire production plant on the Turkish market. A plant suitable for the markets would have an initial capacity of 25 000 tons per year with a later expansion to 50 000 tons per year. The new plant should be prepared to develop markets and also to export. The demand for copper wire in Turkey is at present 35 000 - 40 000 tons per year.

Anode slime can be treated in Istanbul at the anode slime plant which is being built there. Slime could also be processed in foreign plants on toll basis.

1.5 Price

The price of copper wire in Turkey is at present approximately 54-56 TL/kg. The price can be estimated to grow by 7-10 % per year. On international markets the price of copper wire is about 990-1010 £/ton. The price is expected to rise by about 10-15 % per year.

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1.6
Consumers

The largest consumers are the cable industry and the industry of electrical equipment. This industry is situated mainly in the Istanbul area.

1.7
Competition

At present there are two manufacturers of wire; Rabak A.S. and Sarkuysan A.S., but next year Bakirsan will also start its production. All these are situated in the Istanbul area.

1.8
Sales effort

The new plant should form an effective sales organization at an early stage of planning. It should also be prepared for marketing abroad. Regarding marketing the most important factor would be the commissioning of the new electrolytic copper refinery before Turkey becomes a full member of EEC and the custom barriers are removed. At present the protective duties effectively protect a new industry and give the possibility of a profitable start-up.

2.
STUDY PROCEDURE

2. STUDY PROCEDURE

The market study was made by the following Outokumpu Oy's engineers:

Mr. Jouko Sinisalo, Chief of Project Appraisal Department, Engineering Division

Mr. Raimo Rantanen, Manager of Pori Refinery

Dr. Olli Hyvärinen, Metallurgist of Pori Refinery

Mr. Heikki Savolainen, Project Engineer, Engineering Division

The field work was performed from 17th May to 18th June, 1976.

2.1 Sources of information

Before the proper marketing research in Turkey was carried out a literature survey was made at the following libraries:

- The Library of the University of Helsinki, Finland
- The Library of UNIDO, Vienna, Austria
- The Library of Outokumpu Oy's Metallurgical Research Institute
- The Library of Finland's Export Association

During the field survey the following blister copper producers in Turkey were visited: Etibank and Karadeniz Bakir Isletmeleri A.S. and their smelters in Samsun, Murgul and Ergani. The main blister copper consumers in Turkey

- Rabak Elektrolitik Bakir ve Mamülleri A.S.
- Sarkuysan Elektrolitik Bakir Sanayii ve Ticaret A.S.
- Bakirsan A.S.

were visited. One of the Turkish copper wire users, Türkkablo A.O., was interviewed.

The Turkish economical development was discussed with Mr. Emre Gönensay, Professor of Economics, Boğazici University, Istanbul. Export taxation was discussed with the Ministry of Commerce, Ankara, and import taxation with the Ministry of Monopolies, Ankara.

The availability of power was discussed with Türkiye Elektrik Kurumu (TEK).

Statistics was collected from the following sources:

- State Planning Organization
- State Institute of Statistics
- Turkish Industrialists' and Businessmen's Association

Because Outokumpu Oy has exported copper and copper products since 1935 and annual sales of copper outside Finland is 30 000 tons, we have used Outokumpu Oy's own experience for the estimation of international copper markets.

2.2 Persons interviewed

During the field work we collected information from the following persons:

Mr. Suat Yasa, Manager	Etibank, Ankara
Mr. Muammer Senkart, R&D Manager	Etibank, Ankara
Mr. Turaon Ardali, Sales Manager	Etibank, Ankara
Mr. Enerem Cüler, Sales Department	Etibank, Ankara
Mr. Osman Vesal, Manager of Credits	Etibank, Ankara
Mr. Enver Eke, President	KBI, Ankara
Mr. Ugur Bilkin, Vice President	KBI, Ankara
Mr. Aykut Akis, Chief of Designing	KBI, Ankara
Mrs. Ozmur Yalcinkaya, Economist	KBI, Ankara

Mr. Attila Celik, Engineer	Etibank, Ankara
Mr. Naki Akpinar, Plant Manager	KBI, Samsun
Mr. Ali Yavuz, Plant Manager	Etibank, Murgul
Mr. Suleiman Akbai, Chem. Engineer	Etibank, Murgul
Mr. Sabri Altin, Economist	Etibank, Murgul
Mr. S. Soylemezoglu, Metallurgist	Etibank, Murgul
Mr. Taskin Akdeniz, Plant Manager	Etibank, Ergani
Mr. Abdullah Camli, Technical Manager	Etibank, Ergani
Mr. Belent Gökberg, Chemical Engineer	Etibank, Ergani
Mr. Erol Erden, Plant Manager	Alarko A.S., Istanbul
Mr. Cahit Kütükoğlu, Chief of Design	Alarko A.S., Istanbul
Mr. Magbool Siddigui, Project Manager	Alarko A.S., Istanbul
Mr. Tarhan Günay, Marketing Engineer	Alarko A.S., Istanbul
Mr. Mahmut Erdin, Manager	Türkiye Zirai Donation Kurumu
Mr. Erdal Kabatepe	State Planning Organization, Ankara
Mr. Nahit Eruz, Assistant of General Manager	Ministry of Monopolies and Customs, Ankara
Mr. Suat Ocum, Chief of Dept.	"
Mr. Dineer Asena, Manager	Ministry of Commerce, Ankara
Mr. Ismet Bacerdem, Chief of Dept.	State Institute of Statistics
Mr. Orhan Yildirim, Manager	TEK, Ankara
Mr. Vural Akin, Engineer	TEK, Ankara
Mr. Orhan Tarkan, Engineer	TEK, Ankara
Mr. Olli Kokkonen, Manager	Türkkablo, Istanbul
Mr. Bahri Ersöz, President	Rabak A.S., Istanbul
Mr. Sezai Cankut, General Manager	Rabak A.S., Istanbul

Mr. Fehmi Kavurga, Plant Manager	Rabak A.S., Istanbul
Mr. Metin Güngörmüs, Techn. Director	Rabak A.S., Istanbul
Mr. Basar Ergun, Techn. Director	Rabak A.S., Istanbul
Mr. Yusuf Ay, Manager	Bakirsan, Istanbul
Mr. Sami Onursal, Lawyer	Bakirsan, Istanbul
Mr. Ekrem Askin, Chief of Dept.	Bakirsan, Istanbul
Mr. Cavit Akcay, President	Sarkuysan, Istanbul
Mr. Hayrettin Cayci, Manager	Sarkuysan, Istanbul
Mr. Dogan Cakir, Chief of Refinery	Sarkuysan, Istanbul
Mr. Ishok Alaton, President	Alarko Holding A.S., Istanbul
Mr. Güner Kocel, Manager	"
Mr. Emre Gönensay, Professor	Boğazici University, Istanbul
Mr. Teoman Yurdunol, Manager	Metkon Müsavir Mühendislik Firmasi

2.3 Literature

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State Institute of Statistics, Turkey

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3.

INTERNATIONAL ELECTROLYTIC COPPER MARKET

3. INTERNATIONAL ELECTROLYTIC COPPER MARKET

3.1 General considerations

During the last thirty years, the technical progress has brought forth new structural materials. Some of them, particularly light alloys, plastic materials and stainless steels have been widely used in those fields of application which had been reserved by tradition to copper and its alloys. The copper consumption in the world is steadily increasing owing to the rising living standard and to development of new applications brought about by the physical, chemical and mechanical characteristics of copper.

Copper and its alloys possess a range of properties which no other material for industrial use can present. The main properties of copper are:

- high electrical and thermal conductivity; among the other metals, only silver presents a higher conductivity than copper, while aluminium has an electrical conductivity amounting to 55 % of the copper figure
- good castability and hot and cold workability; these characteristics are also displayed by the main alloys, such as brasses, bronzes, aluminium bronzes, cupro-nickel, nickel silver
- the ability of forming alloys with many other metals to make a large number of materials presenting a very wide range of properties
- the excellent mechanical characteristics existing to the lowest temperatures
- the good corrosion resistance in many atmospheres

- easy electrodeposition permitting the production of semi-products directly by the electrolytical method
- easy jointing by welding and soldering

3.2 Geographical distribution

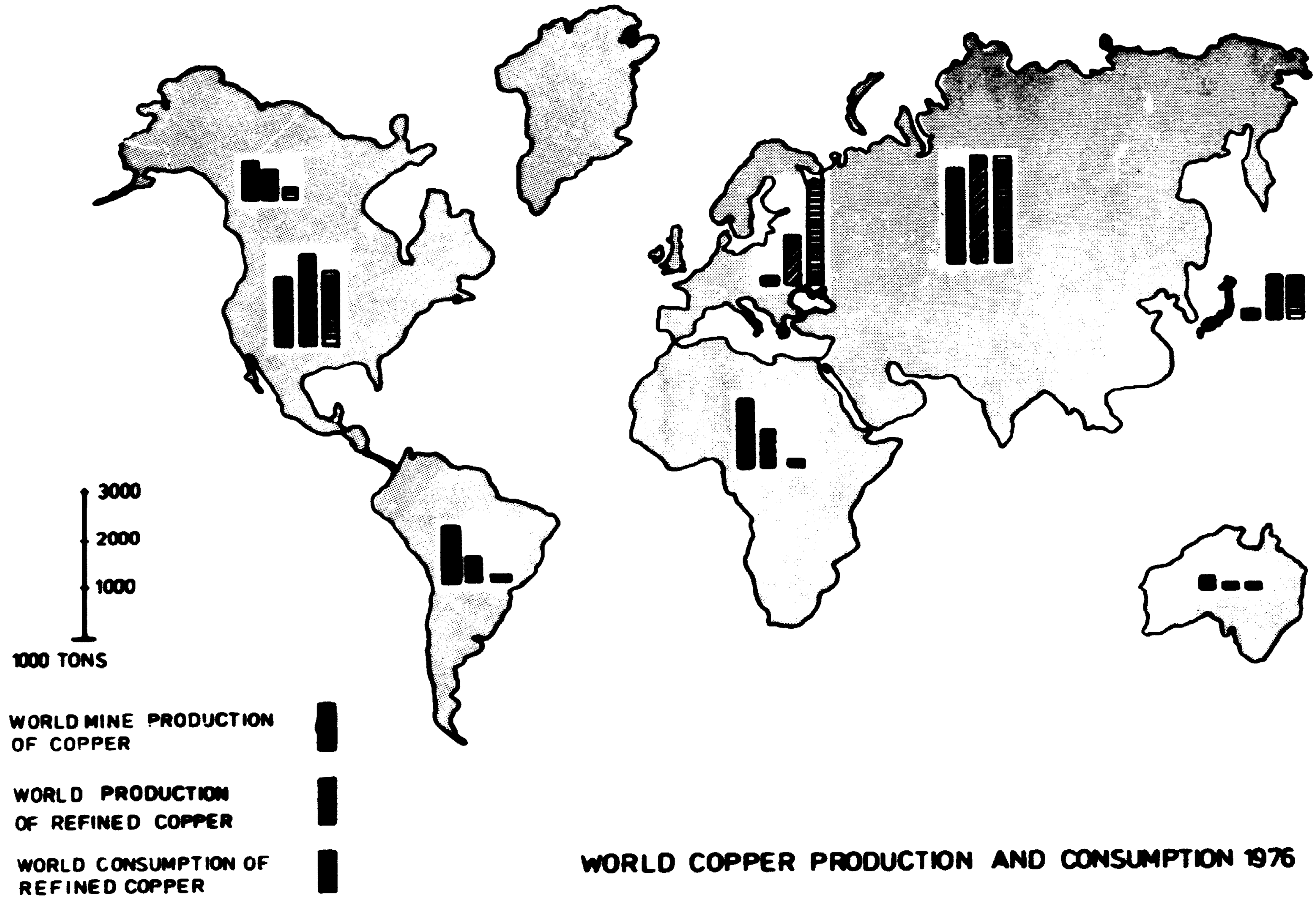
To a great extent copper reserves are to be found in different continents and countries than where copper is consumed. The main production areas of copper are South America, Africa and also Australia. Copper is mainly consumed in Europe, North America and Japan. Figure 3-1 shows the production and consumption in various continents.

For the above mentioned reasons copper is in value one of the most important materials in the world.

3.3 Copper consumption and production

The relative share of copper consumption on a world wide basis is as follows:

Material	%
Iron and steel	49
Cement	45
Plastics	3
Aluminium	1
Copper	1
Zinc	0.5
Lead	0.5
TOTAL	100 %



WORLD COPPER PRODUCTION AND CONSUMPTION 1976

Fig. 3-1

Copper is the fifth in this table.

In addition to virgin copper a considerable amount of copper is being refined in the world by using either copper scrap from the industries or scrap from old products, e.g. old cables, machine parts, household articles, as raw materials. About 37-40 % of all the copper consumption in the world, including alloys, is taken form scrap. It has been estimated that about 75 % of the total world copper consumption could be recycled. The circulating time is on an average 30-35 years.

The world production and consumption of copper are shown in figure 3-2. At present world consumption of copper is about 7-9 million tons per year and production is marginally greater than consumption.

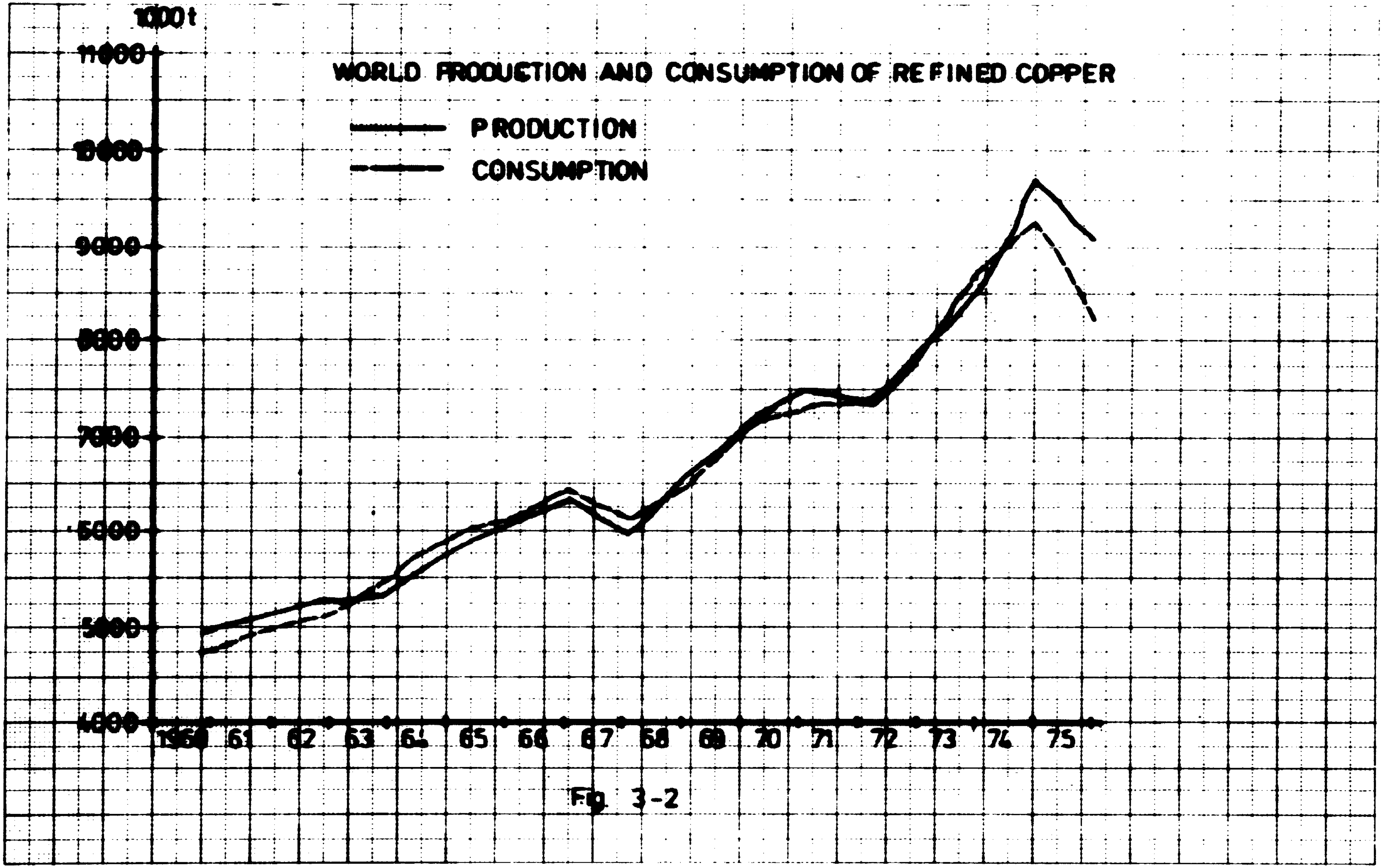

WORLD PRODUCTION AND CONSUMPTION OF REFINED COPPER
PRODUCTION
CONSUMPTION
1000t
11000
10000
9000
8000
7000
6000
5000
4000
1960
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75

Fig 3-2

3.4
Copper prices on European markets

3.4.1
The London Metal Exchange and Commodity Markets

In Europe the London Metal Exchange (LME) mainly determines the price of copper. It was founded as early as in 1881 and it has become a significant pricing factor of copper in the whole world. However, only a fraction of the world copper goes through the London Metal Exchange, perhaps about 5 %. A majority of the copper trading is done by mutual contracts.

Copper transactions on the London Metal Exchange are done in lots of 25 tons and only authorized members belonging to the so-called "ring" take part in the actual trading. The trading is done in periods of 10 minutes - the quotations of the first session will be the basis for information given to the press.

It is alleged that the price of copper exactly follows the law of supply and demand.

The main purpose of the LME is nowadays for both producers and buyers to use it for so-called hedging. The trading is done either in cash or in three months' futures in accordance with standard contracts. The principle in so-called hedging is that the physical transaction is always opposite to the transaction made on the LME. Therefore, because of this function of the LME the physical exchange of copper is approximately 10 % of the transactions made.

Only three copper qualities are traded:

a) wire bars: electrolytic or high conductivity fire refined copper

b) electrolytic copper cathodes: Cu minimum 99.90 %

c) fire refined bars: Cu minimum 99.70 %

Only copper from approved suppliers can be bought or sold on the London Metal Exchange. It is the buyer's duty to receive the copper from any warehouse of the LME in England, Hamburg, Rotterdam or Antwerpen.

The hedging can be described by the following example: the refiner of copper buys his copper at the price of the shipping day from some corner of the world, but he receives it only after about three months. The refiner has to take the risk of copper price fall during these three months, after which he can resell the copper. In hedging the refiner sells through a broker the same amount as he actually bought. After three months if the price of copper has decreased the refiner can buy from the LME the quantity of copper he sold. In this way he makes good almost totally those losses that were caused by the decrease in price of copper to be refined.

Another function of the LME is to be a speculative market. On the other hand, this is alleged to make the rise and the fall steeper, but on the other hand speculators stabilize the markets, because they act contrarily to those making hedging transactions.

3.4.2 Producers' price

In the beginning of 1960's so-called producers' price was valid for some time. The purpose of this price was to balance changes on copper price and to check an excess increase in copper price. There were fears that an excess increase in copper price would cause replacement of copper by aluminium.

Gradually the cooperation became impaired and the producers' price was given up. Altogether this stage lasted from 16th January 1964 to 24th April 1966.

3.5 Copper price on American markets

In USA the pricing bases of copper differ completely from the European ones. There are three different pricing bases and in addition to these so-called COMEX-price which is used for speculation trading in futures.

The most important one is domestic producer price. It is, at least in principle, determined by each big firm independently. The difference between the highest and the lowest price valid at a time is approximately 2 c/lb or about £ 16/t.

The second most important one probably is the weighted average published by Engineering and Mining Journal (E&MJ). Daily transactions are registered and the above-mentioned average is calculated from them. Domestic and international prices are calculated separately.

The third price is consumer smelting price. This price fluctuates considerably, because the smelters try, with the help of pricing, to keep their plants operating with an even capacity. Another reason for the great fluctuation is the large use of scrap as raw material, the price of which fluctuates considerably according to demand and supply.

The fourth price in the US copper markets is the COMEX-price (Commodity Exchange Price). This price is used, however, mainly for hedging transactions of speculative type. COMEX is a clearing house of its members.

3.6
Copper price trend

The copper price depends on very many factors and it is sensitive to changes, however small, both in supply and demand. The figure 3-3 shows the development of copper price from 1960. In the following we give some factors that have affected the copper price. In the autumn 1962 during the Cuban crisis the Rhodesians sold copper to the LME thus preventing prices from rising. There were fears that aluminium would be introduced as substitute to copper.

A heavy increase in demand in 1964 caused a sharp rise in copper price.

At the end of 1964 it was thought that copper price was coming back to its "normal" price level when it decreased strongly.

In the latter part of the year 1965 there were large strikes in the US mines. This resulted in severe disturbances in the copper deliveries from Chile to USA. Because of the Vietnam war a stipulation was

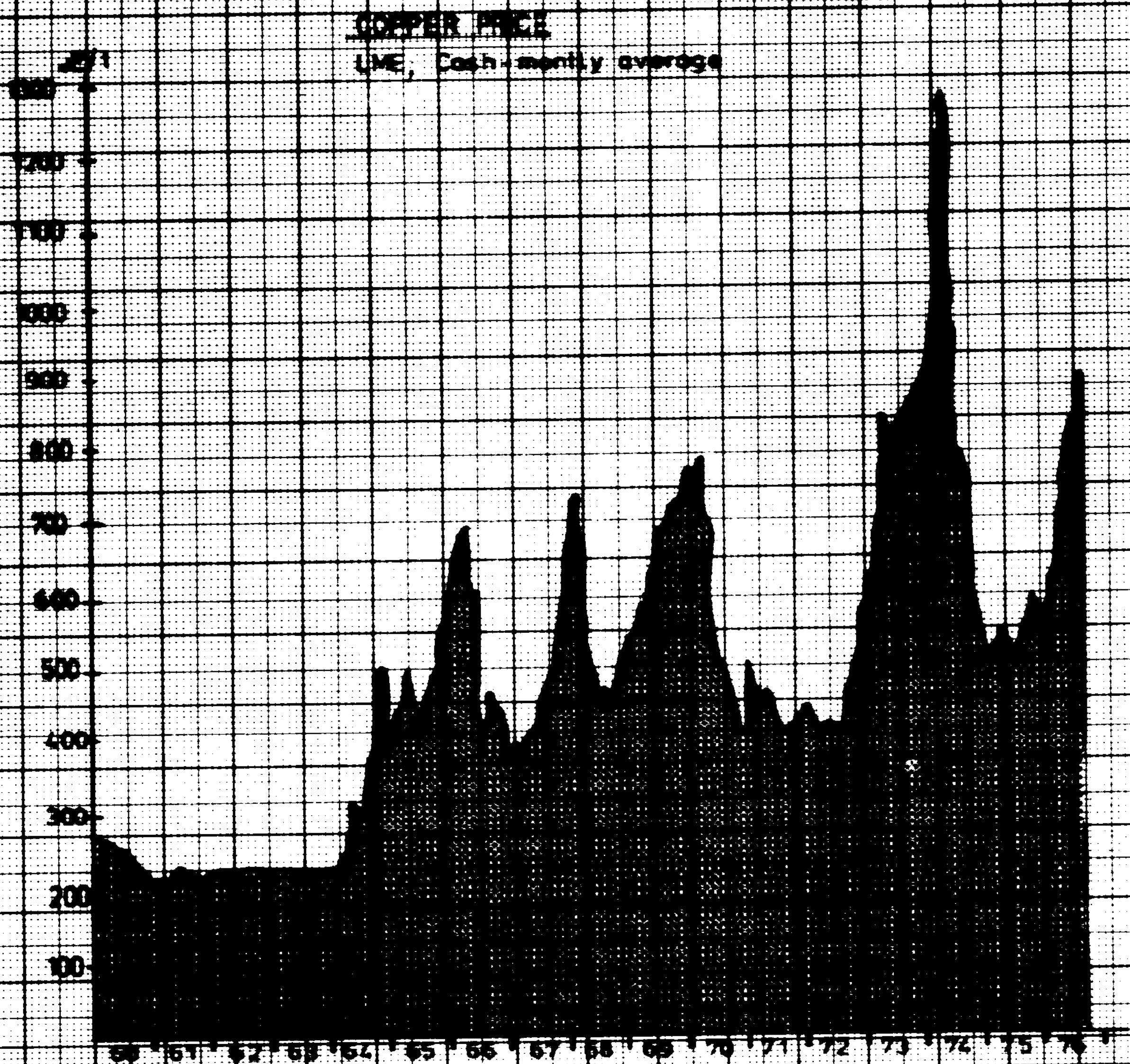

COPPER PRICE
LME, Cash-monthly average
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76

Fig. 8-3

given in USA that 20 % of copper had to be reserved for military requirements. The consequence of all this was that the copper price on the London Metal Exchange approached £ 500/t.

In the beginning of 1966 strikes in Chile continued for which reason USA declared an import prohibition on refined copper. The Vietnam crisis still limited the US copper production.

In the production the situation relaxed when the strike at the mines of El Teniente in Chile was called off. This and another significant factor - transport of copper from Zambia became easier - had an effect on the sharp fall of the LME price of copper. When the strike in Zambia was solved at the end of 1966, the decline of copper price continued.

At the end of 1967 the former Congo, nowadays Zaire, nationalized all its mines. In the same year four significant copper producers formed an organization called CIPEC (Conceil Intergouvernemental des Pays Exportateurs de Cuivre). These countries were Chile, Peru, Zaire and Zambia. In the summer of 1967 a lengthy strike started in the US mines.

Strikes were prevalent in 1968 which included the lengthy strike in USA, which started as early as in the middle of 1967. The end of strike in March caused a sharp fall in copper price on the London Metal Exchange.

In 1969 Zambia took over 51 % i.e. the majority of shares of mines in the country. Chile partially nationalized her mines and the extent of nationalization varied between various mines.

At first the demand increased and on the other hand the disturbances associated with nationalisation of mines decreased the production. Large strikes occured both in the Chilean mines and in the Falconbridge mine in Canada. Exceptionally large purchases by China and the Vietnam war increased the demand.

The copper prices continued to rise up to 1974 when it fell sharply. One reason for this was the commissioning of the further production capacity in various parts of the world and stocks were filled with copper.

During the present economic depression copper stocks grew to a record size. Voluntary decreases in production and closing of some small mines were not enough to stabilise the situation.

The low copper price, large stocks and sluggish demand have caused that resources invested in copper production have been few and therefore there is a risk that in the future changes in demand and supply will be considerable. It has been suggested that a protective stock should be created to stabilise copper markets, but its realisation in the near future is unlikely because of amount of necessary capital (approximately 3 to 4 billion dollars).

At this moment it is estimated that only about 60 % of the western copper producers in the world can continue to operate on the present price level. If the price level does not rise the rest of the producers run into difficulties and it may cause a downward swing in the copper production.

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With the economic recovery coming up also in Europe it is to be expected that also the consumer goods industry needing copper will become more active. However, the large stocks may have a restraining effect on the price development of copper at the beginning of the boom despite of the increasing demand. The price peak has been estimated to be during years 1979 and 1980.

Economic development forecast

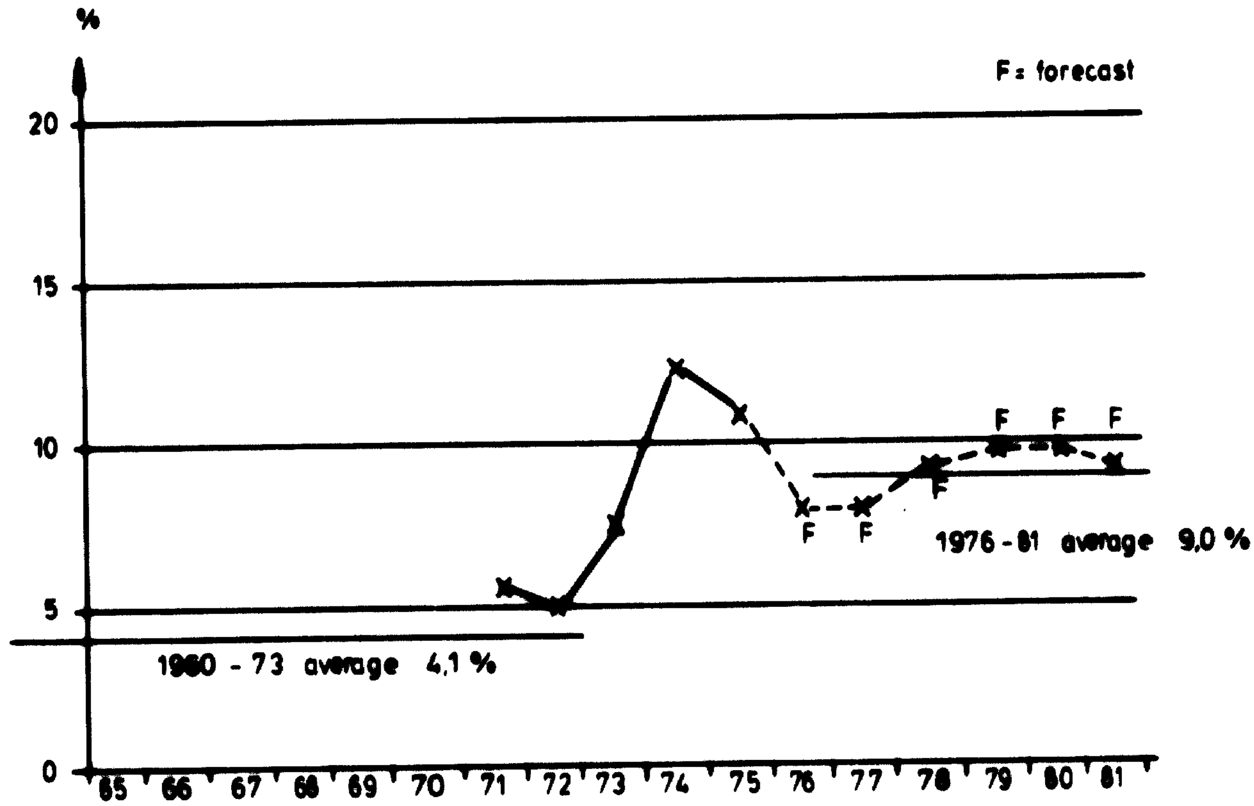
The slowing down in economic activity, which started at the end of 1973, deepened to the worst depression in the industrial countries since the second World War. The gross national product of the OECD countries decreased by 0.1 % in 1974 and by 2 % in 1975. In the middle of 1975 the economic conditions indicated a rise in recovery in USA and Japan. Recently some signs of the recovery have been seen also in West Europe. Economic conditions are estimated to improve rather slowly, because so far the great industrial countries have increased the demand only slowly to avoid reacceleration of inflation. This year the gross national product of OECD countries is estimated, however, to grow by at least 4 %, which is partly caused by the low comparison level.

The growth rate of the total yield in industrial countries is assumed to grow slowly from the level in 1976 and to reach its peak at the end of 70's.

The gross national product of OECD countries is estimated to grow in 1976-81 by an average of 4 to 5 % a year, while the corresponding average in 1960-73 was 5.5 % a year. A slower growth than during previous recoveries can be explained by high inflation level, change in the structure of business life in favour of services i.e. a move from the producing industry, and large share of energy investments of the productional investments in the near future.

Figure 3-4 presents the achieved gross national product volume and price increase of OECD countries.

GROSS NATIONAL PRODUCT PRICE IN OECD COUNTRIES



GROSS NATIONAL PRODUCT VOLUME IN OECD COUNTRIES

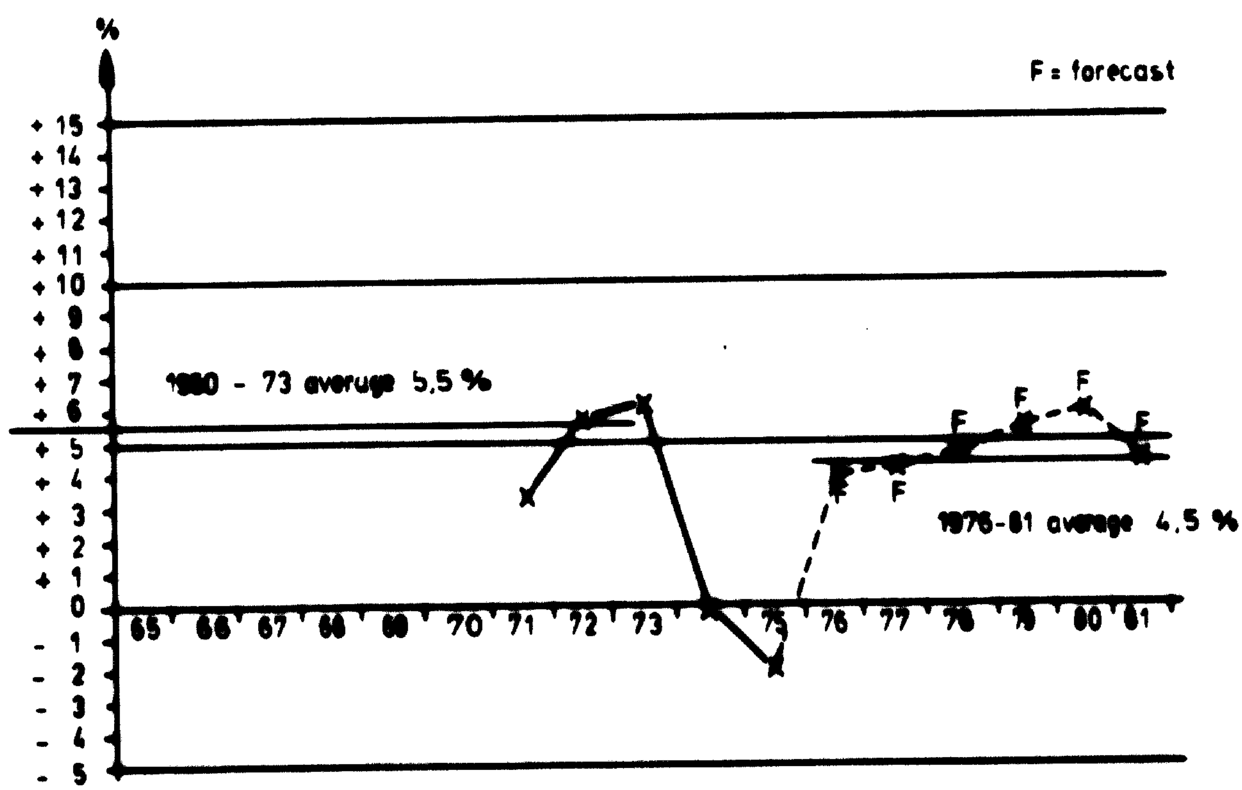


Fig. 3-4

3.7
Copper substitutes

Aluminium has always been the worst threat as a substitute for copper. The electrical conductivity of aluminium is 63 % of copper, but as the specific weight of aluminium is only 30 % of copper, aluminium requirements are only half as much as copper.

Use of aluminium and copper in various areas is divided as follows:

	Copper	Aluminium
Electrical industry	55 %	10 %
Building industry	14 %	20 %
Workshop industry	14 %	9 %
Motor industry	9 %	30 %
Consumer goods	4 %	7 %
Packing products	-	15 %
Others	4 %	9 %
	100 %	100 %

Figure 3-4 shows the growth of aluminium and copper besides some other metals. The areas where aluminium has replaced copper are the electrical industry (open-wire circuits, electric cables, bus bars) and the building industry (profiles, facade materials).

The world production of major metals and their relative growth is presented in figure 3-5.

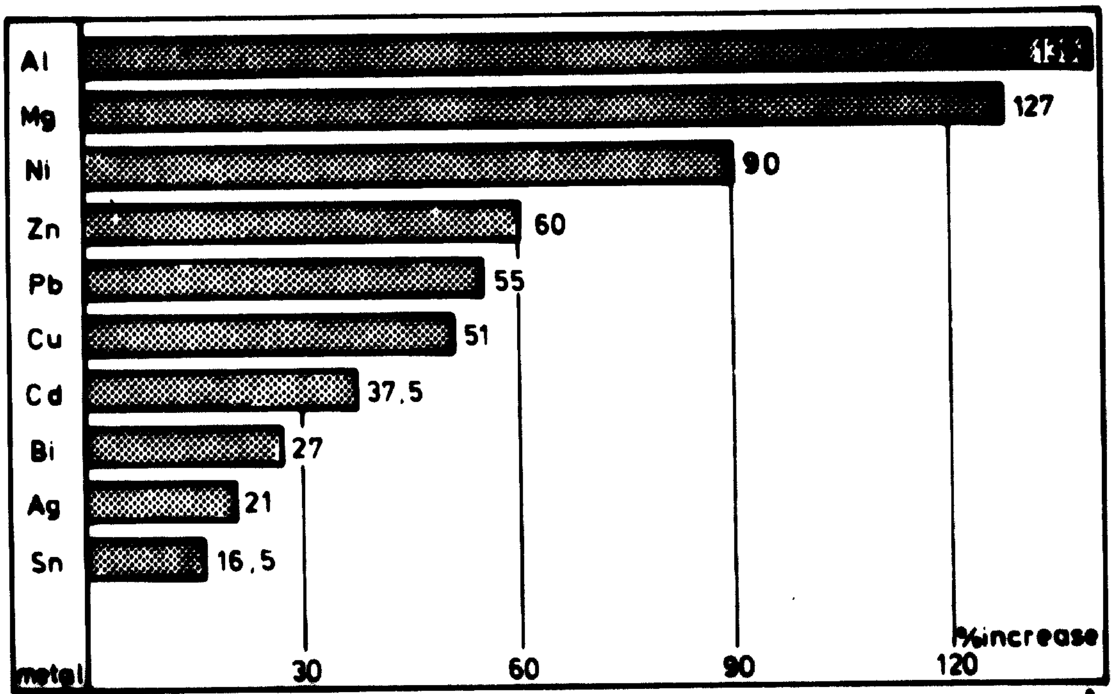


Fig. 3-4 Growth of world production and consumption (tonnes×10³) of major non ferrous metals over the period 1960 - 1970

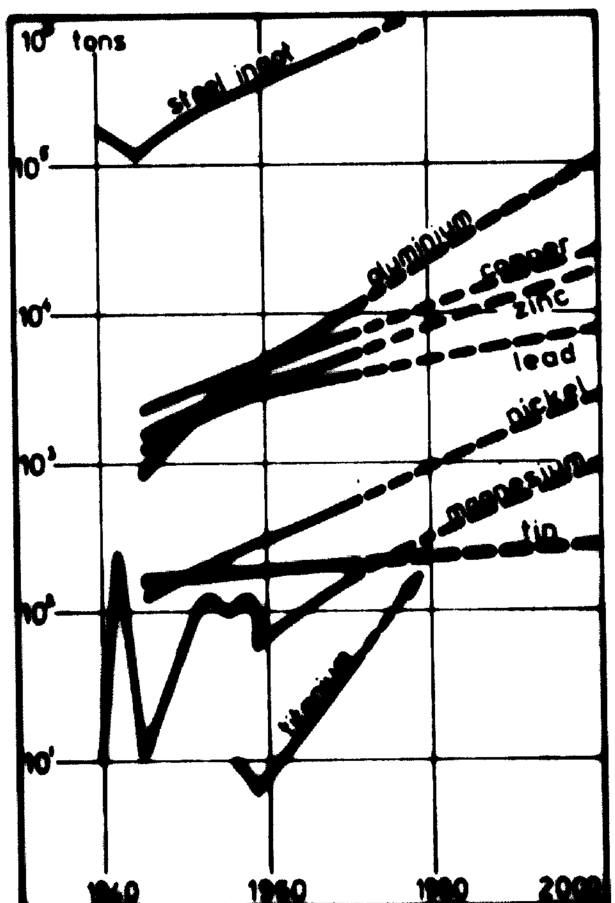


Fig. 3-5 World production of major metals (tons)

Plastic and stainless steel

Plastic has won markets from copper pipes in special areas like instrumentation and in some sections of the chemical industry. The biggest threat was however - and is still - with the hot water pipes in the building industry. So far plastic pipes have not been approved for various reasons.

The threat coming from stainless steel has not been as great, except regarding building facade and roofing materials.

3.8 Custom duties in Turkey

Import

Customs for blister import is zero, if the blister is refined in Turkey and is then reexported. If the imported blister is refined and used in Turkey, its customs value will be 128.7 % of its cif value.

The custom is composed as follows:

Legal custom duty	30 %
Production tax	30 %
Import duty	24 %
Stamp duty	9 %
Harbour tax	5 %
Municipal tax	15 %

- Legal custom duty
  cif value x 30 % = 30 %
- Import duty
  cif value x 24 % = 24 %
- Stamp duty
  cif value x 9 % = 9 %

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- Municipal tax
  custom duty x 15 % = 4.5 %
- Harbour tax
  cif value + custom duty + import duty + municipal tax x 5 % = 8.4 %
- Production tax
  cif value + custom duty + import duty + municipal tax + harbour tax x 30 % = 52.8 %

TOTAL 128.7 %

Export

According to information from the Ministry of Customs no custom duties have to be paid for goods which are exported from Turkey.

3.9
International associations of Turkey

Turkey is a member of OECD and GATT and associated member of the European Economic Community. According to the time schedule Turkey will be a full member in 1995. Turkey also belongs to the Regional Cooperation for Development (RCD) organization consisting of Iran, Pakistan and Turkey.

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4.
INTERNATIONAL BLISTER MARKETS

4. INTERNATIONAL BLISTER MARKETS

4.1 Dealing methods

At present about 1.0 million tons of blister is dealt with per year, either through agent firms or by direct buyers. About 20 % of blister goes through agents and the rest to direct buyers. The most important of the direct buyers are purchasers from subsidiary companies in developing countries.

The following agent firms can be mentioned:

- Ametalco
- Amalgamated
- Philips Brothers
- Marc Rich

4.2 Sources

In figures 4-1 and 4-2 the blister production in Turkey is shown.

On international markets blister is sold by

- South Africa
- Chile
- Peru
- Southwest Africa

Peru is, however, reducing its sales, because they will refine blister in their own country.

Zaire also markets blister, but most of the refining is carried out in Belgium.

Blister copper production (thousand tons) in Turkey

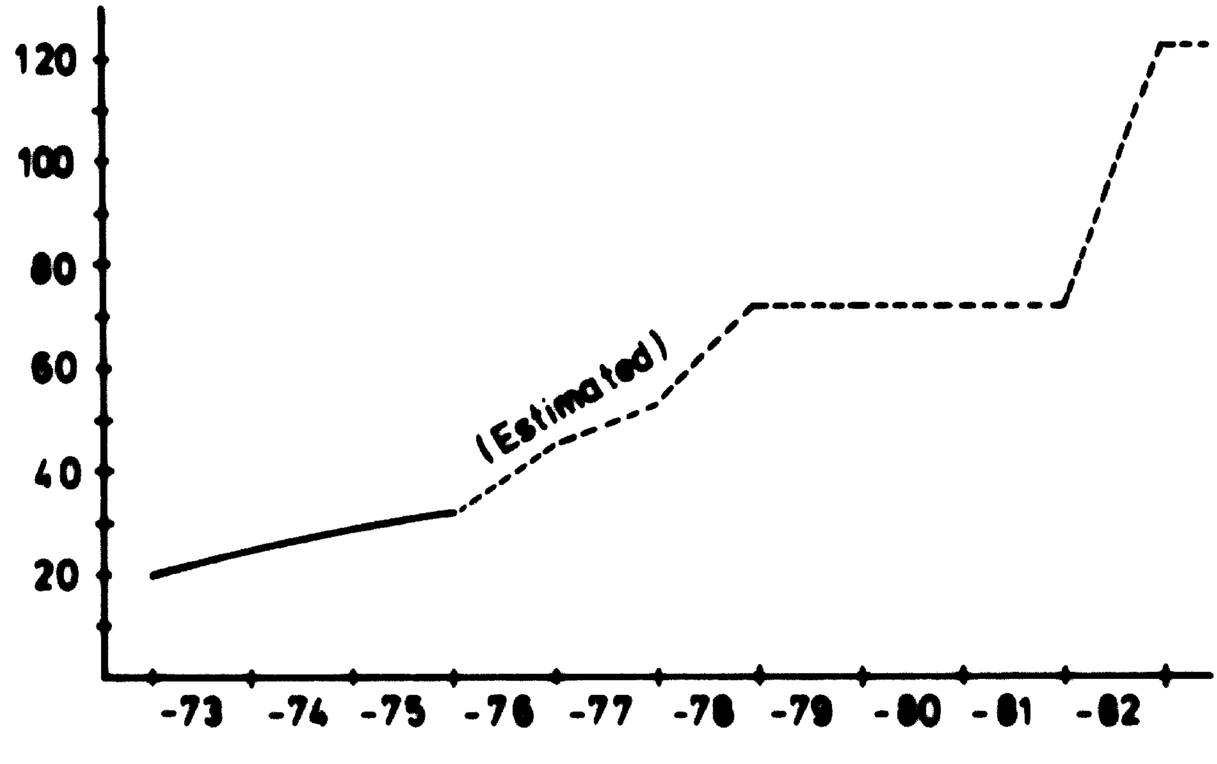
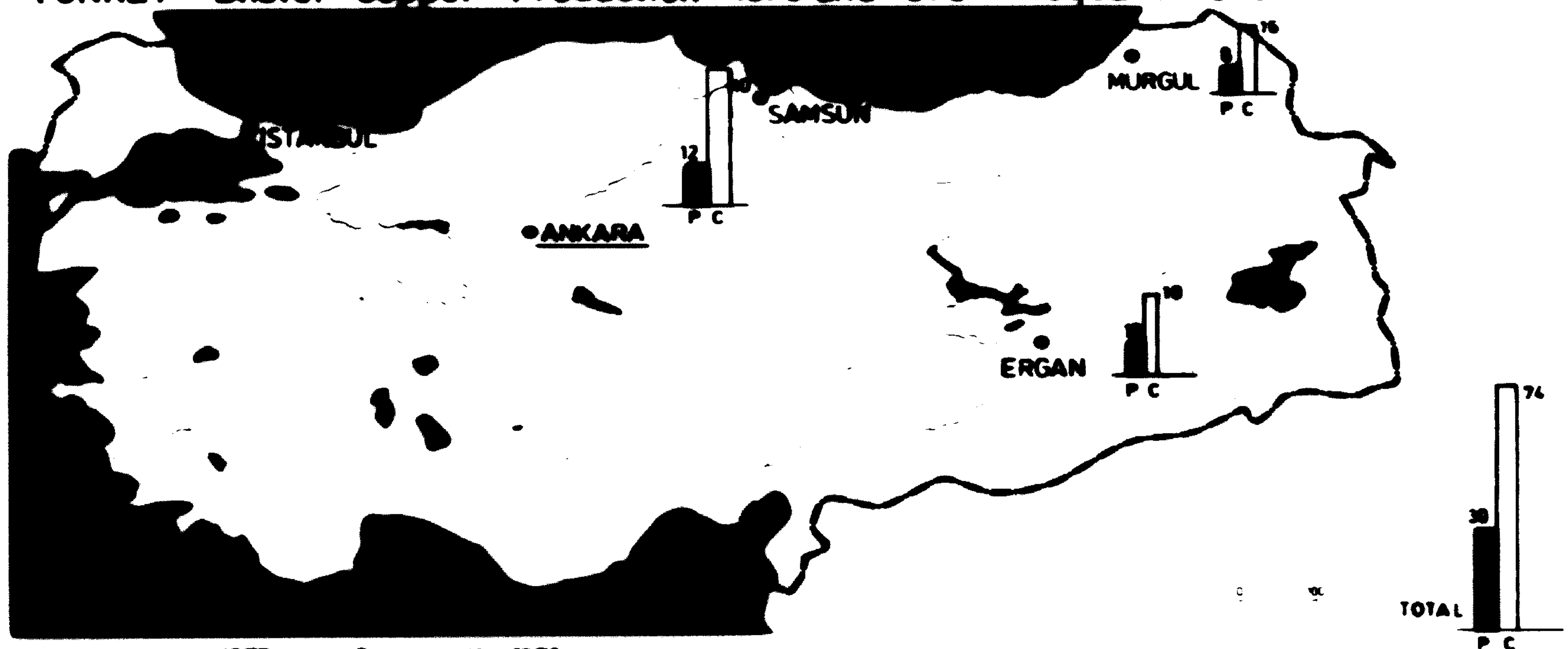


Fig. 4-1

TURKEY Blister Copper Production 1975 and 1976 thousand tons



P = productivity 1975 C = capacity 1976

Fig. 4-2

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4.3 Sales agreements

The blister quality is defined in the agreement.

The price is usually determined as follows:

- from the Cu-content of blister 0.3 % is deducted to cover losses and for the rest of the copper 100 % or 99 % of some LME quotation is paid
- from the silver content 30-35 g Ag/ton of blister is deducted and for the rest 99 % of the LME quotation is paid
- from the gold content 1 g Au/ton of blister is deducted and for the rest 99 % of the lowest LME quotation is paid

The price is normally based on the average of the month of arrival. Treatment charge will be reduced from the value of blister calculated as above. At present the treatment charge has been about 7 - 8.5 US¢/lb, but the charge has been falling lately because there is shortage of blister and copper scrap.

Penalty for the blister seller is also defined in the agreement, if the Cu-content is lower than the predefined analysis.

Gold and silver treatment charges are generally determined separately, e.g.:

- gold treatment charge US$ 30-35 /kg
- silver treatment charge US$ 3.5 - 4.0 /kg

Penalties for the contents of arsenic, antimony and nickel are also normally defined in the agreement.

4.4 Toll agreements

Toll agreements are in principle similar to sales agreements.

An exception is the fact that in the agreement defined amounts of refined copper will be returned. Thus the refineer will get:

- treatment charge
- if the yield is better than estimated in the agreement, the difference will be a profit for the refiner, correspondingly losses for the refiner with lower yield.

4.5 Conclusions

The production of blister has been sufficient on international markets. Developing countries are beginning to electrorefine blister in their own countries. In addition to new refining capacity, mines and smelters are being commissioned. Thus part of the capacity of the copper electrolytic refinery to be built in Turkey can be based either on purchase or toll blister.

5. DEMAND FOR ELECTROLYTIC COPPER IN TURKEY

5.1 Cathode copper
5.2 Billets, cakes and wire bars
5.3 Sheets
5.4 Rod
5.5 Wire
5.6 Copper sulphate
5.7 Gold and silver

5. DEMAND FOR ELECTROLYTIC COPPER IN TURKEY

5.1 Cathode copper

The demand for cathode copper in Turkey is at present very low. The companies with equipment for melting of cathode copper have adequate refining capacity, so they do not need to buy it. Only occasionally demand for cathode copper might be found.

5.2 Billets, cakes and wire bars

At present there are no plants in Turkey which use copper billets, cakes or wire bars as raw materials. Thus it would not be logical to build a plant producing copper billets, cakes and wire bars for Turkish markets. On international markets the plants using billets, cakes and wire bars as raw materials usually have long-term agreements with their suppliers, and it could be difficult for a new producer to break into these markets.

5.3 Sheets

In Turkey copper sheets are produced only by Makina Kimina, a plant near Ankara with a yearly production of about 2000 tons. The import of copper sheets to Turkey has been insignificant, below 100 tons per year. The import of sheet has been about 200 - 400 tons per year, including bronzes, brasses and other copper alloys, which does not justify investment in this sector at the moment.

5.4
Rod

Plants that might buy copper rods in Turkey are:

- Rabak A.S.
- Sarkuysan A.S.
- Bakirsan A.S. in 1978

All these plants are placed in the Istanbul area. These firms have sufficient production capacity for wire rods.

5.5
Wire

Copper wire seems to be the most promising product. There is a rapidly growing demand for copper wire in Turkey.

Copper wire is at present produced by

- Rabak A.S.
- Sarkuysan A.S.
- Makina Kimiya
- and in the nearest future Bakirsan A.S.

All these plants have plans for expansion.

The copper consumption and demand trends are presented in figure 5-1. The demand is predicted to increase by about 15-25 % per year. The bases for this are the following:

- the latest trend
- plans in the cable industry
- plans in the industry of electric motors
- plans in the transformer plants
- Turkey's growing development as industrialised country

The development has occurred very rapidly, but is not expected to be maintained. The latent demand has now been filled by the production.

Demand for copper wire

Because all the wire will be used in manufacturing plants, the thickness of consumed wire depends on its end use and the manufacturers' equipment.

Most of the produced copper wire is used in cable plants. In European cable factories there has generally been a tendency to purchase drawing machines and use rolled wire as raw material. The same tendency has been noticed in Turkey. Some cable plants have already bought drawing machines and in many plants there are plans for installation of drawing capacity. Thus it seems that the demand will be distributed differently after a few years (see the following table).

Wire thickness mm	Present situation	Estimate after 2-4 years
8	2 %	10 %
4	23 %	30 %
1.4 - 3.5	35 %	30 %
1.0 - 1.4	25 %	20 %
below 1.0	15 %	10 %
	100 %	100 %

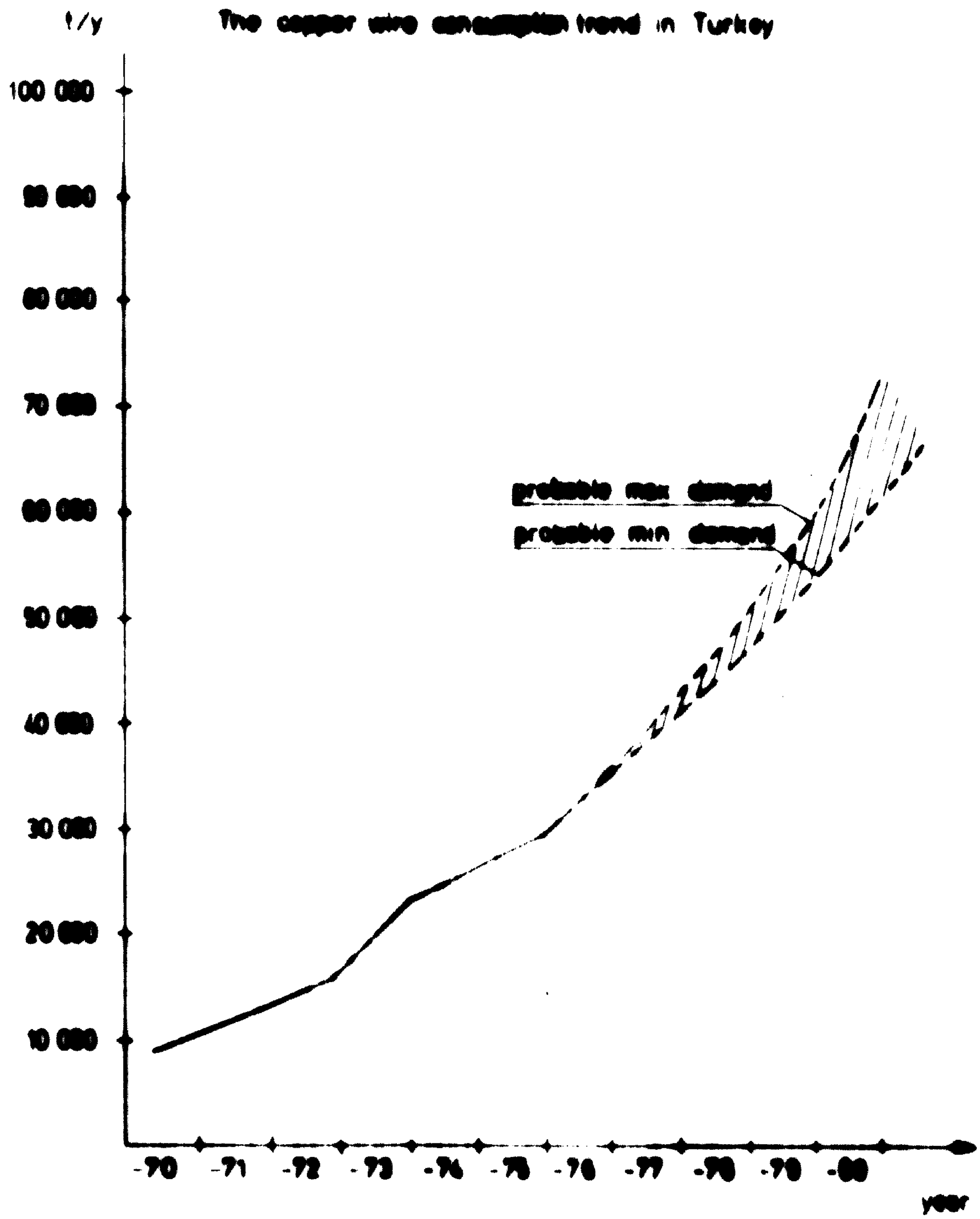
t/y
The copper wire consumption trend in Turkey
100 000
90 000
80 000
70 000
60 000
50 000
40 000
30 000
20 000
10 000
probable max demand
probable min demand
-70
-71
-72
-73
-74
-75
-76
-77
-78
-79
-80
year

Fig 5 -1

5.6
Copper sulphate

Rabak A.S. now produces about 3000 tons of copper sulphate per year. It is produced from dirty electrolyte and blister copper. The capacity of this plant satisfies the present demand in Turkey, which is mainly by the wine industry.

5.7
Gold and silver

The demand for gold and silver follows the international demand. Blister copper produced in Turkey contains gold and silver as follows:

Samsun	yearly average	latest months
gold	26.5 g/t	20 g/t
silver	151 g/t	130 g/t

Ergani	yearly average	latest months
gold	14 g/t	13 g/t
silver	77 g/t	48 g/t

Rabak A.S. is just building an anode slime treatment plant in Istanbul in which gold and silver will be recovered. As the capacity of this plant will be considerably in excess of their own requirements, it would be advisable to co-operate with them on the question of anode slime treatment instead of building an additional plant.

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6.

PRICE

6.1 Blister price

6.2 Copper wire

6.3 Cathode copper

6.4 Gold and silver, anode slime

6. PRICE

6.1 Blister copper

The price of blister copper in Turkey has developed according to the curve presented in figure 6-1. The price has not followed international fluctuations in the copper price, but stayed firm. The present price of blister delivered to Istanbul is 37 700 TL/t.

The price of blister on international markets follows the fluctuation of copper prices in the LME quotations. Calculation of the blister price has been presented in item 4.3 and duties to be paid in Turkey in item 3.8.

6.2 Copper wire

The price of copper wire has followed the price of blister copper on Turkish markets. The clear price leader has, however, so far been Rabak A.S. whose pricing the other producers have followed. The price of wire was in June 1976 as follows:

	annealed	hard
0.20 mm	57.00 TL/kg	56.50 TL/kg
0.25 mm	56.70 "	56.20 "
0.30 mm	56.40 "	55.90 "
0.35 - 0.40 mm	56.10 "	55.60 "
0.45 - 0.50 mm	54.80 "	54.30 "
0.55 - 0.60 mm	54.50 "	54.00 "
0.65 - 0.90 mm	54.20 "	53.70 "
0.95 - 1.35 mm	53.90 "	53.40 "
1.40 - 2.00 mm	53.10 "	52.60 "
2.05 - 2.90 mm	52.85 "	52.35 "
2.95 - 8.00 mm	51.95 "	51.45 "

Blister copper price in Turkey

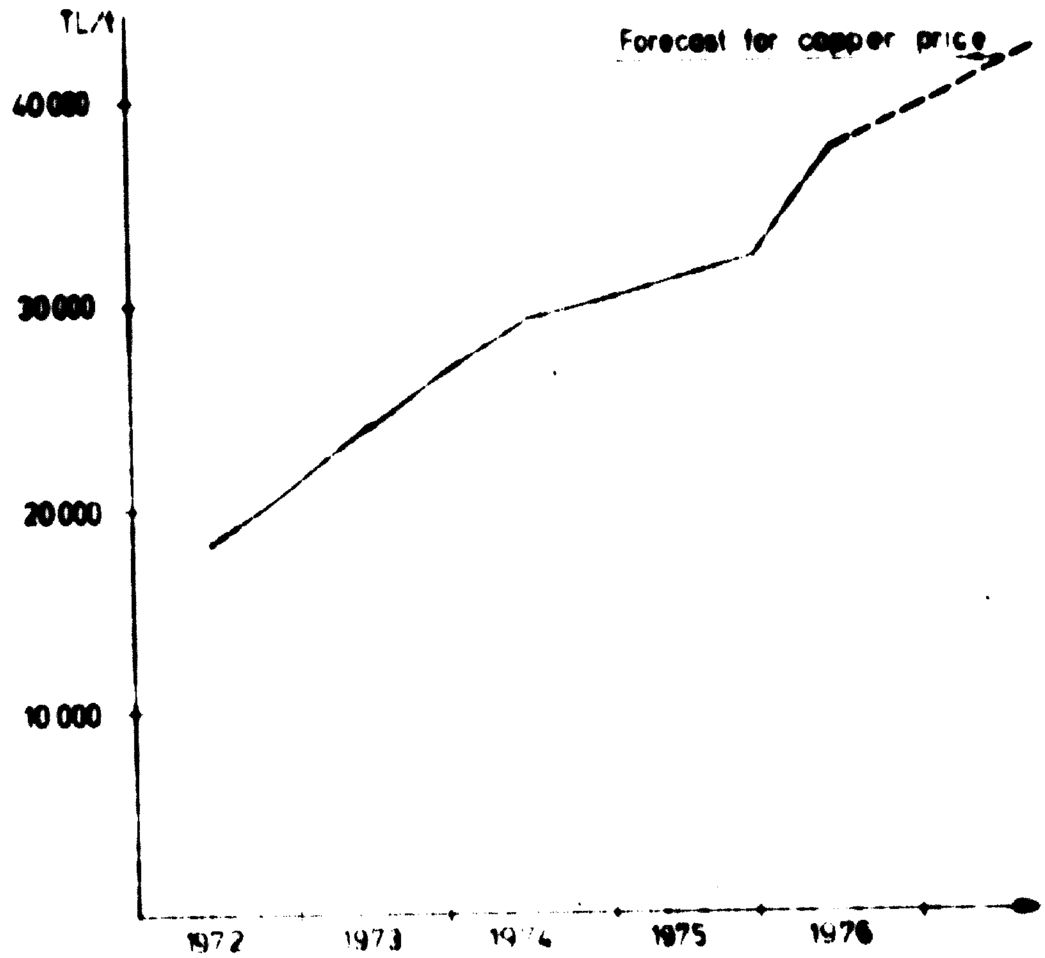

Fig 6-1

The increase in wire price is shown in figure 6-2.

On international markets the wire price follows closely the price quotations of LME copper. In figure 6-3 the yearly averages and development trends of copper wire bar LME cash quotations have been presented. The wire price is generally about St £ 44/ ton more expensive than the wire bar. The growth trend of wire price has been estimated to 7-10 % per year in the near future.

6.3 Cathode copper

Cathode copper is generally not dealt with in Turkey. But if there was a trade, the price would apparently be as much cheaper than the wire price as the costs of wire production. On international markets the price of cathode copper follows LME quotations (figure 6-3). Cathodes are generally about St £ 10/ ton cheaper than wire bars.

6.4 Gold and silver, anode slime

In figure 6-4 the latest development of the gold and silver price is shown.

Usually the price of anode slime is determined as follows:

- gold: quotation minus 40-45 £/kg
- silver: quotation minus 28-30 £/kg

The amounts of gold and silver to be paid are generally 98 % of their actual contents. The handling cost of bulk, about 50 US$/ton, is also reduced from the price.

Trend of copper wire price

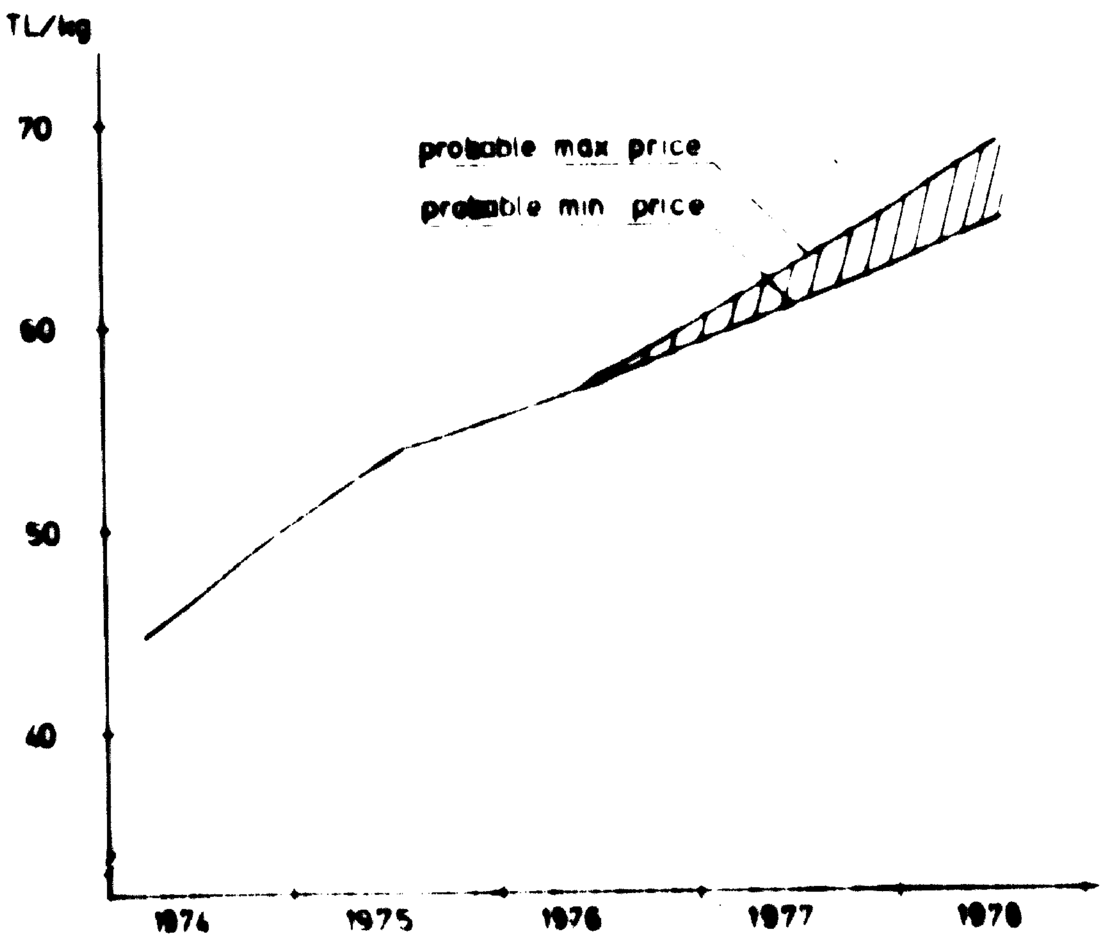

Fig. 6.2

COPPER WIRE BAR PRICE LME CASH YEARLY AVERAGE

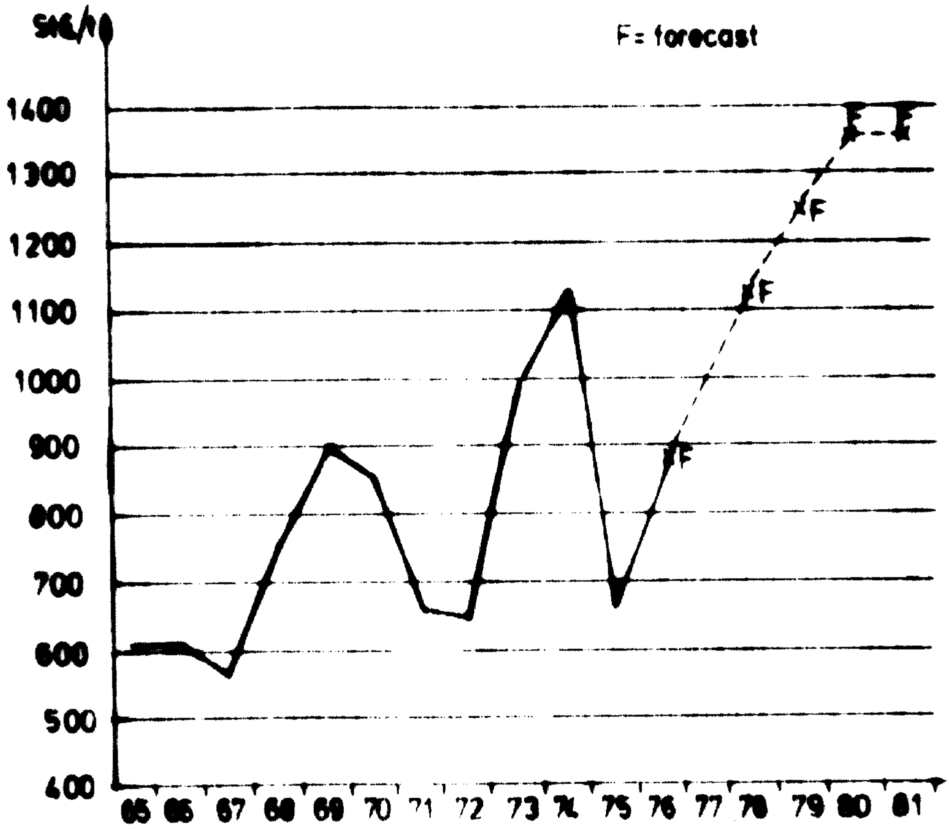

Fig 6 -3

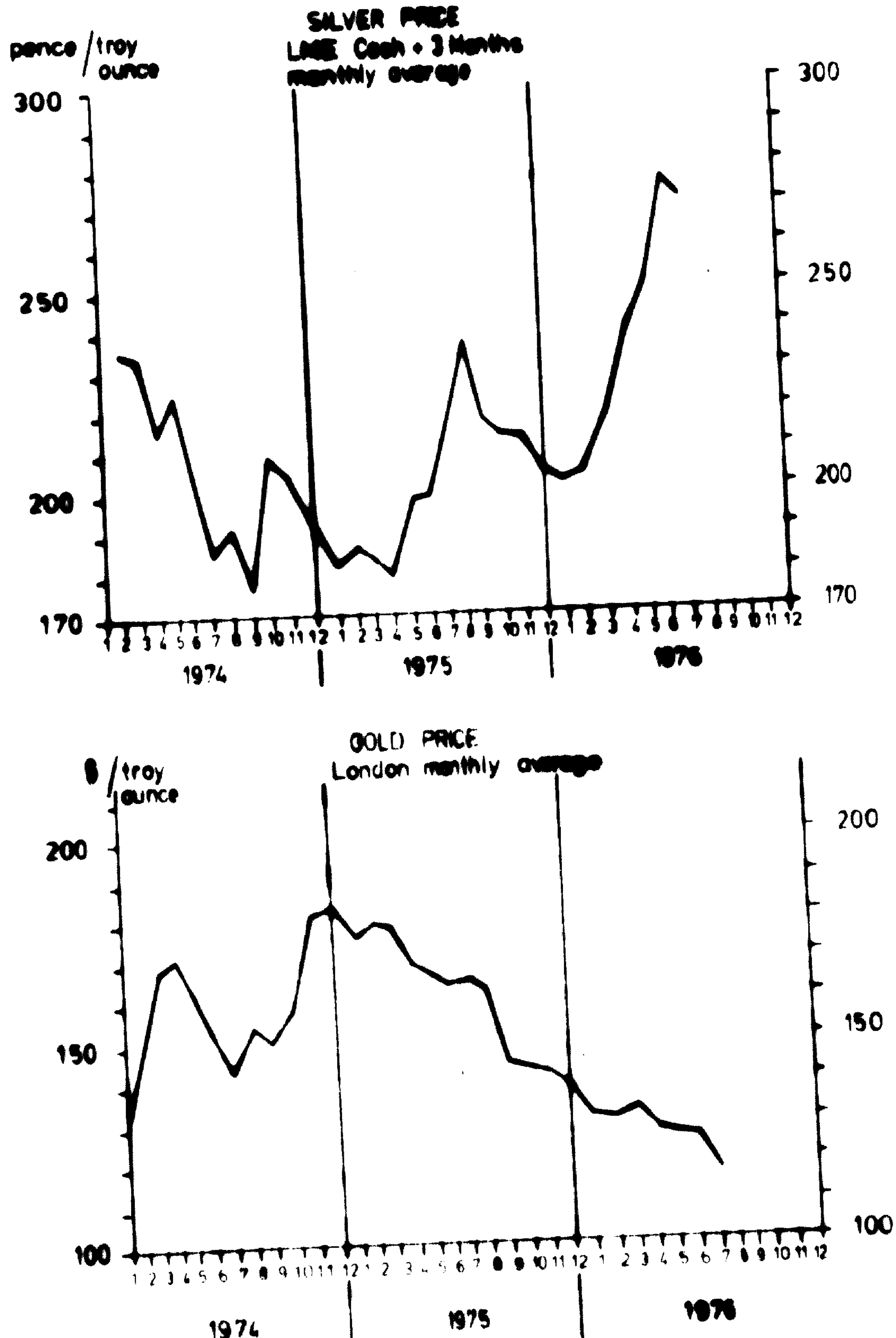
SILVER PRICE
LME Cash + 3 Months
monthly average
pence / troy ounce
300
250
200
170
1974
1975
1976
GOLD PRICE
London monthly average
$ / troy ounce
200
150
100
1974
1975
1976

Fig 6 - 4

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7.
CONSUMERS

7.1 Copper wire

7.2 Location of consumers

7.3 Copper sulphate

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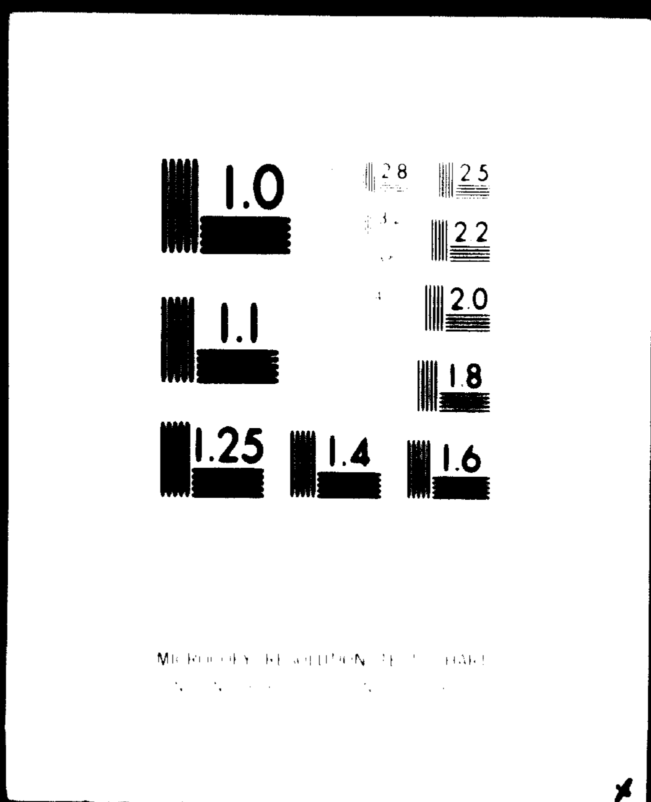

24x

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7. CONSUMERS

7.1 Copper wire

The main consumers of copper wire are:

- cable plants
- transformer plants
- plants for electrical machinery

The demand for copper wire in cable plants will decrease as copper is replaced by aluminium in power cables. In telephone cables copper will remain as the main material.

According to the Third Five Year Developement Plan 1972 - 1977 the target for average annual increase in the production of the electrical machinery industry has been set at 19.9 %. The apparent annual increase will be 15-25 % in the future, having been 10.8 % during the last five year period. The growth of demand expected in item 5.5 will be justified in spite of the fact that aluminium will be substituted for copper in the production of cables.

Most of the consumers of copper wire are located in the Istanbul area.

Potential consumers

Cable manufacturers

Siemens	5 500 t/year	Istanbul
Kavel	4 000 "	Istanbul
Surtel	2 000 "	Istanbul
Anka	1 500 "	Istanbul
Türkkablo	1 500 "	Istanbul

In addition there are about 50 small cable plants that are consuming about 800 tons of copper per year. Two new cable plants are now being built in Turkey and the previous ones are being expanded.

Transformer manufacturers

AEG	Istanbul
ESAS	Istanbul
Etitas	Izmir

The transformer plants need bus bars in addition to electrolytic copper.

Electric motor manufacturers

AEG
General Electric
Gemag

7.2 Location of consumers

The demand for copper wire has been mainly in the Istanbul area. The principal locations are shown in figure 7-1. It is, however, assumed that cable plants for electrical machinery will be placed also elsewhere in the country in future.

7.3 Copper sulphate

Copper sulphate is mainly used by small vinyards, of which the largest consumer is

Türkiye Zirai Donatim Kurumu

in Ankara.

TURKEY Areas of wire demand 1976

Fig. 7-1

8.

ELECTROLYTIC COPPER PRODUCERS

8.1 Rabak A.S.
8.2 Sarkuysan A.S.
8.3 Bakirsan A.S.
8.4 Makina Kimiya Kurumu A.S.
8.5 Location

8. ELECTROLYTIC COPPER PRODUCERS

8.1 Rabak A.S.

Rabak A.S.'s plant and head office are situated in Istanbul. Rabak started its operation in the beginning of 1960. At present their production is 18 000 tons per year which now is being expanded so that their production will be 40 000 tons per year in 1977. Rabak is the 19th biggest company in Turkey according to turn-over (1974).

turn-over	816 million TL
capital	338 million TL
profit	117 million TL
employees	924

Rabak A.S. is at present building an anode slime treatment plant. Its capacity will be enough to treat all anode slime produced in Turkey. This plant will be in operation in the end of this year. In addition Rabak produces about 3000 tons of copper sulphate per year. Rabak also produces small amounts of bronze and other copper alloys.

The Rabak plants include:

- anode casting plant
- copper tankhouse
- wire rod casting plant
- wire rolling and drawing plant
- copper sulphate plant
- anode slime treatment plant under construction

8.2
Sarkuysan A.S.

Sarkuysan started its production in 1975. The plant has had a good start-up and at present 10 000 tons of copper wire per year is produced. Sarkuysan has plans for expansion so their production capacity will probably be 20 000 tons per year within a few years.

The plant includes:

- anode casting plant
- copper electrolysis
- wire rod casting plant
- wire rolling and drawing plant

The plant is situated about 30 km from Istanbul on the Ankara road.

8.3
Bakirsan A.S.

Bakirsan is at present building a wire plant which should be started in 1977. The capacity of the plant will be 10 000 tons per year initially, but there are plans to expand the capacity immediately to 20 000 tons per year.

The plant is located in Istanbul.

8.4
Makina Kimiya Kurumu A.S.

The Makina Kimiya plant is situated near Ankara. The production of the plant is mainly used for military purposes. The plant produces about 2000 tons of copper sheets annually and about 600 tons of copper pipes annually.

8.5
Location

Figure 8-1 shows the location of electrolytic copper production in Turkey.

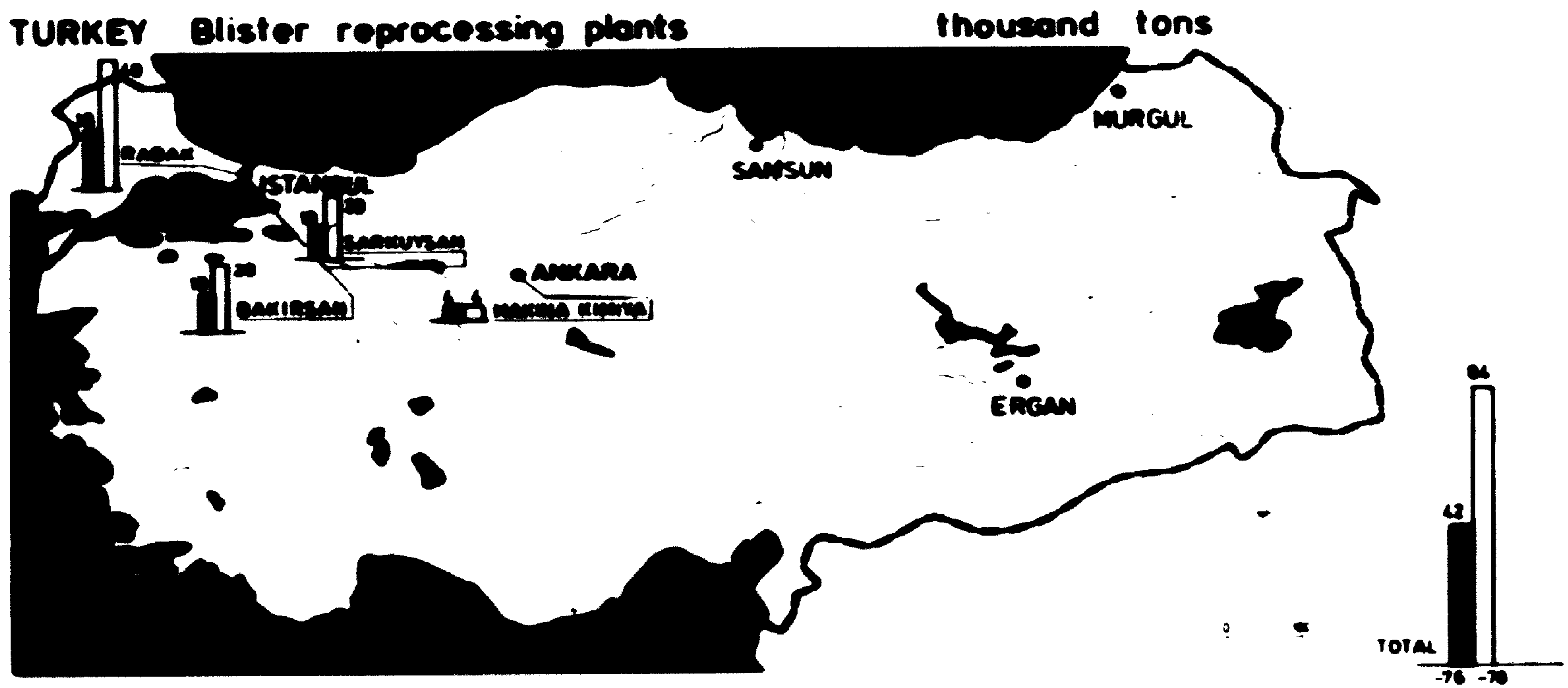

TURKEY Blister reprocessing plants
thousand tons
ISTANBUL
SAMSUN
MURGUL
ANKARA
ERGAN
TOTAL
42
84
-76
-78

Fig. 8-1

9.

SALES

9.1 Sales on domestic markets

9.2 Sales organisation

9.3 International markets

9.4 Marketing initiation

9.5 Marketing costs

9.6 Deliveries

9. SALES

9.1 Sales on domestic markets

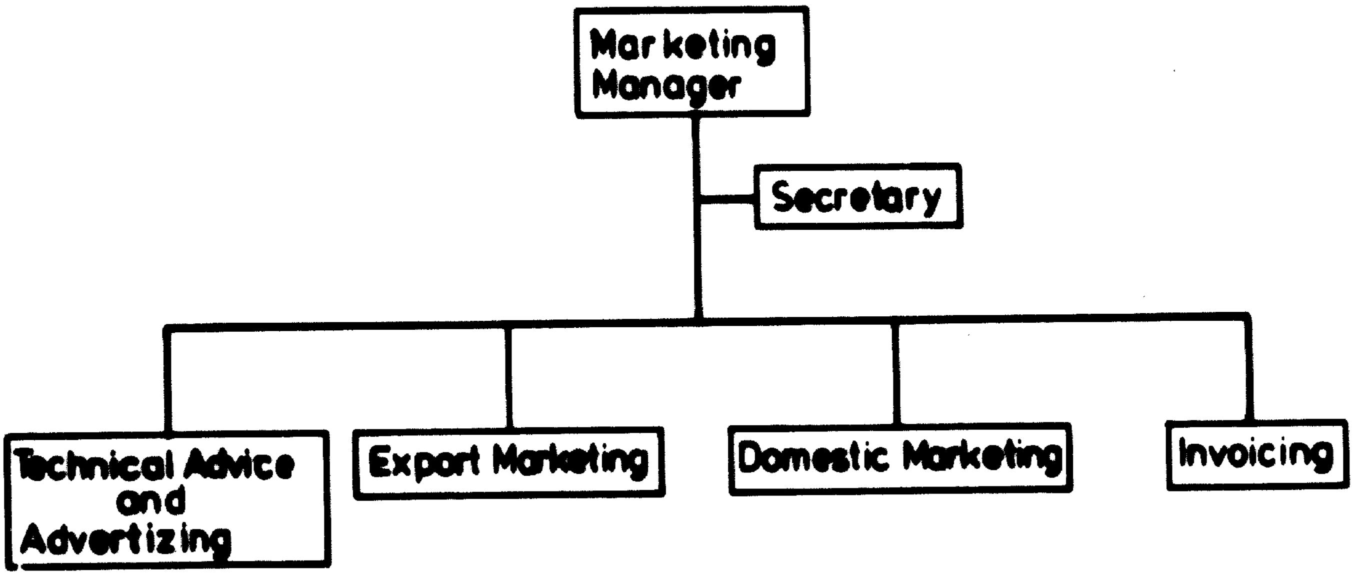
The plants now producing copper wire do not have to make considerable sales efforts, as the consumers buy it themselves from the producer. There is no significant price competition, but the others follow the pricing of Rabak A.S. This is due to the fact that a seller's market exists at present, however, when all the plans for expansion have been realized and the plant discussed in this research has been built, attention will have to be paid to marketing.

The new firm in particular should start effective marketing efforts before production has commenced. On domestic markets sales efforts should primarily be directed towards larger consumers, for this reason they should be made familiarized early with the new wire plant and its products. It would also be useful to make longer supply agreements with them after samples have been sent.

9.2 Sales organisation

Typical for the sale of copper is the fact that the volume per salesman is big, however, an effective marketing organisation is essential. Figure 9-1 shows a draft of sales organisation.

SALES ORGANIZATION FOR COPPER WIRE PLANT



1 Engineer	3 Sales representative 3 Secretaries	1 Sales representative 1 Secretaries	2 Clerks

Fig. 9 - 1

9.3 International markets

Several alternative routes are possible for starting copper wire exports:

1. direct sales to consumers
2. sales through agents
3. sales offices

A direct sale to consumers is the most favourable when steady contacts have been made. When making these contacts it is possible to call in consultation help from small producers of copper wire in Europe.

When selling through agents the agents' fees will of course have to be paid. At first it would be best to find an agent firm which has experience of selling copper wire, but not a major organization.

It would be advisable to set up a sales office, if marketing is not contracted to an agent, in Central Europe from where the European markets could be handled. In addition suitable agents should be found for all the other continents.

Turkey's favourable location in the Middle East should also be taken into consideration regarding potential markets. It could be easier to come into these markets than the very competitive markets in Europe.

9.4 Marketing initiation

The sales manager should be employed about two years before the plant is started. His first task would be to make an organization of domestic and export marketing. The sales organization should be formed about one year before the start-up of the plant.

Then an active information campaign and visits to the new plant will be arranged for potential consumers.

The new production plant should make a well organized advertising campaign, with brochures and advertisements. During the advertising campaign advertisements and articles on the new plant should be published in professional magazines. Advertisements should be made in professional advertising bureaus.

9.5
Marketing costs

Generally marketing costs are about 2 - 2.5 % of the sales. In addition there are the agents' fees, about 0.5 - 1.5 %.

9.6
Deliveries

The normal terms of payment are cash against documents. On domestic markets the consumer usually transports the copper wire with immediate payment. In exports longer periods of payment have to be given; 30 days, 60 days, 90 days. The longest is normally 180 days. The size of lots varies from 1 ton to 100 tons. The terms of delivery on Turkish markets is usually free on factory, but in exports it can be fob or cif.

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