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Tittel

Grong Gruber A/S Concentrator

Forfatter	Dato	År	Bedrift (Oppdragsgiver og/eller oppdragstaker)
Eerola Paavo	20.06	1988	Norsulfid Grong Gruber AS

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Oppredning		Jomafeltet Jomaforekomsten

Råstoffgruppe	Råstofftype
Malm/metall	Cu, Zn, Py

Sammendrag, innholdsfortegnelse eller innholdsbeskrivelse

Rapporten består av tre deler: 1) An evaluation of the operation and a development program 2) A preliminary proposal for the renovation of the zinc flotation 3) A preliminary for the development of process control.

Del 1) gir en vurdering av dagens situasjon i oppredningsverket og analyserer hvor de enkelte tiltak må settes inn og hvilke av disse er mest viktig.

Del 2) gjennomgår alternativer for Zn-flotasjonen der det påvises at cellevolumet er for lite, men at varmeflotasjonen må beholdes. Kostnader til renovering anslås til omlag 6MNOK. Vedlagt forslag til flytskjema.

I del 3) vises til at de ofte opptredende variasjonen i flotprosessen, gir behov for automatisk styring, blandt annet med on-lin analysering. En mulig slik prosesskontroll blir foreslått med aktuell instrumentereing og kostnader.

outokumpu MINING /TECHNICAL SERVICES

Paavo Eerola/PAL June 20, 1988

G R O N G   G R U B E R   A / S

CONCENTRATOR

Distribution:

Norsulfid A/S
Grong Gruber A/S (2)
NMG/Palviainen
Technical Services/Välttilä, Eerola

1 AN EVALUATION OF THE OPERATION AND A DEVELOPMENT PROGRAM

2 A PRELIMINARY PROPOSAL FOR THE RENOVATION OF ZINC FLOTATION

3 A PRELIMINARY PROPOSAL FOR THE DEVELOPMENT OF PROCESS CONTROL

outokumpu MINING
/TECHNICAL SERVICES
Paavo Eerola/PAL 20.6.1988 1 (19) 257/88 Ri

GRONG GRUBER A/S

CONCENTRATOR

AN EVALUATION OF THE OPERATION AND A DEVELOPMENT PROGRAM

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CONTENTS

APPENDICES

1	Planlegginsoppgaver i oppredningsverket, Arve Haugen, 11.3.1988.
2	Table 1, Flotasjonsresultater, Grong Gruber A/S.
3	Table 2, Annual production 1987, Grong Gruber A/S.
4	Concentrator flowsheet, Grong Gruber A/S.
5	Monthly metallurgical results, Grong Gruber A/S.
6	Daily ore and tailing assays, January-March, 1988.
7	List of mineralogical reports.
8	Provetaking av flotasjonskretser ved Grong Gruber A/S, 6/4-88.
9	Zinc flotation, concentrate and tailing assays along the rougher bank.
10	Proposal by Geoanalytical Laboratory of Outokumpu Oy.

SUMMARY

Grong Gruber A/S ordered in February 1988 mining and metallurgical consultation from Technical Services/ Outokumpu Oy, Mining Division. At the mine, 15 days were spent for fact finding. The earlier special reports and operation data were studied. A major sampling campaign was arranged.

It was found that:

- Grinding does not seem to be the most urgent problem today, but should, however, be studied more closely.
- Results of copper flotation are reasonable. Silver recovery, operation of cleaning and the optimal use of Flash Flotation call for attention.
- Results of zinc flotation vary widely. There seems to be possibilities to increase the revenue several percents by improving the recovery and the grade of concentrate.

As short term measures it is suggested:

- to investigate process mineralogy etc.,
- to develop operation practice,
- to arrange some plant tests.

For long term development, preliminary project proposals have been prepared for

- renovation of zinc flotation,
- development of process control.

1 INTRODUCTION

Grong Gruber A/S ordered in February, 1988, mining and metallurgical consultation from Technical Services / Outokumpu Oy Mining Division*). A reasonably long time was allocated for fact finding phase; 14.3.-24.3. and 13.4.-21.4. i.e. 15 working days were spent at the mine. Report on mining is to be prepared by Tauno Manunen. At the final discussion (I. Dybdahl, A. Haugen, P. Kerola, P. Eerola) it was agreed that the concentrator report (in English) should include three parts:

1) An evaluation of the operation and a proposal for improvement of the efficiency of existing process and equipment.

2) A project proposal for the renovation of zinc flotation.

3) A project proposal for the development of process control.

It was agreed that for the time being, pyrite production would be considered only for space reservations.

2 PRODUCTION

The annual production and flotation results from the start-up are shown in App. 1. It can be seen e.g. that:

- The tonnage treated has increased 30 % from 1981.

- Cu %/ore has slightly decreased, Zn % increased.

- The most noticeable change in the metallurgical results is the improvement of Zn-conc. grade after the introduction of the hot reverse cleaning 1982.

The ore mineralogy has become less favourable during years, e.g. chalcopyrite in more finely disseminated.

*) The task was outlined in writing by Arve Haugen, 11.3.1988 (App. 1).

The metallurgy of 1987 is shown in Table 2, App. 3.

To see the possibilities to increase the revenues, it can be roughly calculated that (1987 production and prices):

- Zn %/Cu-conc: 0,1 % corresponds 0,3 %; Zn-recovery (~70 000 NOK/a)
- Cu %/Zn-conc: 0,1 % corresponds 0,17 % in Cu-recovery (~85 000 NOK/a).
- Zn %/Zn-tailing: 0,01 % corresponds 0,55 % in Zn-recovery (~ 122 000 NOK/a).
- Cu %/ Zn-tailing: 0,01 % corresponds 0,6 % in Cu-recovery (~307 000 NOK/a).
- The influence of concentrate grade is great. In Cu-conc. one grade-% (Cu %) corresponds roughly two recovery-%, in Zn-conc. the value one grade-% is 1,7 recovery-%.

The calculations need checking and updating but should give an idea where exists possibilities to increase revenue.

3 BRIEF DESCRIPTION OF THE PROCESS

The flowsheet is shown in App. 4. The ore is crushed underground (set of the jaw crusher ca. 150 mm). The hoisted ore is stockpiled in a longish bin (6 000 tons ~ 3 days production). Under the bin there are 7 vibrating feeders which normally are all in use, if there is enough ore. The ore can be fed to the bin into several points so the bin and the feeders below it could very effectively homogenize the concentrator feed if properly operated.

The ore is ground in Ø 4,8 x 4,8 m autogenous mill which is in closed circuit with cyclones. From the cyclone overflow some final Cu-conc. (ca. 10 %) is floated in Unit Cell (Aker-2). Unit Cell tailing and product of secondary ball mill are pumped to cyclones. Underflow goes into Flash Flotation (Skim-Air 80) where perhaps 20 % of Cu and 25 % Ag are recovered. Flash Flotation concentrate is cleaned in the last Cu-cleaning. Tailing from Flash Flotation flows to secondary ball mill. Cu-middling is also cycloned and the underflow goes to ball mill, overflow to flotation. The froth product from Zn reverse cleaning is pumped to ball mill.

Cu-roughing and scavenging consists of one Aker-5/2 and four Boliden BFP 300, total cell volume 61 m^3. In Cu-cleaning there are 7 different flotation stages, total cell volume 26 m^3.

In Zn-roughing and scavenging there is one Aker-5/2, four Boliden BFP-300 and one OK-8/2, total cell volume 77 m^3. In cleaning there is 8 different stages, cell volume 30 m^3.

From Zn-circuit the concentrate is pumped to hot reverse cleaning. Sphalerite is there depressed using high temperature (~80-90 %) and sodium bisulphite. Chalcopyrite and pyrite are floated and returned to grinding.

A regrind ball mill is reserved for Zn-scavenger concentrate (?), but it has not been used for some time.

For Cu-conc. and Zn conc. there are thickeners and drum filters. For Cu conc. there is a rotary drier. There has been difficulties to reach the required shipping moisture of Zn-conc. Therefore the fineness of the concentrate has been critical. That is one reason for abandoning the regrind. A rotary drier will be installed for Zn-conc. and so the moisture problem will be overcome.

For process control the most important tool is Minexan on-stream analyzer (8 streams in use). Other instrumentation is quite sparse. It includes the conventional belt scales, mill power and pH-measurements. Most of reagents are fed through remote controlled diaphragm pumps.

4 DEVELOPMENTS IN THE PROCESS

The choice of autogenous grinding was a very modern decision at its time. The mill earlier tended to fill up and throughput was limited. A plan for implementation of so called Outokumpu-type grinding (large ports in the grates to eliminate the critical material) was prepared. However, the mill throughput could be increased using higher pulp density and higher power level. Today the mill seems not to be the first process bottleneck.

To Cu flotation an Aker -2/2 flotation machine was installed some years ago for Unit cell flotation and last cleaning. An Aker -5/2 was added for Cu roughing and Zn roughing.

The reverse (hot) Zn-cleaning was implemented in 1982. It has improved clearly the Zn-conc grade.

Skim Air was installed for secondary cyclone underflow in 1986. After some months operation a noticeable increase in Ag recovery could be shown.

The cell volume of Zn-flotation was increased in 1987 by installing on OK-8/2. Its effect cannot be seen in the monthly results (table 3, App. 5), at least, if the influence of the ore grade is taken into consideration.

Several changes in the flowsheet concerning e.g. the handling of different middling streams have been made but information on the results is not available.

5 VARIATIONS OF METALLURGICAL PERFORMANCE

5.1 Monthly results

In table 3 (App. 5), the annual figures 1984-87 and monthly figures January 1987 - March 1988 are shown. Some comments:

- The average throughput has been increased from 58 tph to 72 tph.
- Cu conc. grade is quite constant (~24 %).
- Cu-%/tailing seems to follow Cu %/ore to some extent, but anyhow the best recoveries are won from high-grade ore.
- Zn-conc grade varies 50-54 % Zn, no correlation to ore grade can be seen.
- Zn recovery varies widely 72-83 %. The lowest figures occur when Cu:Zn-ratio in the ore is high; the highest Zn %/tailing when Zn % ore is high.

5.2 Daily figures

Daily tailing assays January-March 1988 were studied dividing the days to classes after ore grade (Cu and Zn). The study was quite rough and not statistically valid but at least it shows that most of the variation in results cannot be explained by ore grades. The most obvious correlation was Cu %/tailing vs. Cu %/ore. It seems that Cu % /tailing increases ca. 0,006-0,008 when Cu %/ore increases 0,1 %. In general, variations in Cu %/ tailing varies much less inside the same feed class than Zn %/ tailing.

Comparing the lowest and average tailing assays (Zn %) inside "feed classes" the difference in the middle classes is roughly 0,10 % Zn. It can be speculated that his represents the maximum potential improvement in tailing assay.

For Cu %, the variations are smaller as can be expected because of the flowsheet.

Some of the daily data is represented in App. 6. It would be interesting to make a more through-out study of this kind.

The daily data from grinding and flotation, 22.2.-22.3.1986 was studied graphically. Some observations:

- The screen analysis (%-325 mesh, 0,044 mm) of the flotation feed varied very widely (70-40 %). It was found out (H. Mikkelsen) that the sampling did not work properly.
- The energy consumption in primary autogenous mill is quite constant (9-11 kWh/t). It seems to have some correlation to the Fe %/ tailing, i.e. pyrite content of the ore.
- Cu- and Zn-recoveries seem vary quite in the same way.

5.3 Hourly variations

As an example Minexan assays (6 per hour) 17.3.-21.3. (Thu-Mon) were studied shift by shift. It was tried to find the occurrence and wideness of the variations of ore grades and process results during one shift. This study also was very rough and a proper statistical analysis would be worthwhile.

Observations:

- Ore grades were during most of the shifts reasonably constant.
- Cu-conc: Grade (Cu %) varies during most of the shifts 2 %, Zn % varies ca. 0,5 %.

- Zn-conc: Zn % varies 3-8 % during a shift, also Cu % varies Ca. 0,4 %. Obviously the hot reverse cleaning is not in control.

- Tailing: Zn % varied during almost every shift so that the average is ca. 0,1 % higher than the lowest value. It may be that Zn-circuit is overloaded at times and Zn escapes to the tailing. Also here (see 4.2) the variations of Cu % were smaller.

6 EARLIER REPORTS

6.1 Mineralogy

Several mineralogical reports have been prepared in Trondheim (NTF/Sintef) mostly by Terje Malvik. In App. 7 they are listed. Some excerpts:

- Zn-avgang 1984, week 2: Quite a lot liberated grains (chalcopyrite and sphalerite). It was estimated that if all liberated particles would have been floated, the tailing assays, Cu %/Zn % would have decreased from 0,25/0,34 to 0,16/0,17.

- Zn-avgang årsprove 1984: 30 % of Cu and 50 % of Zn is in liberated particles. Most of Zn is in -10 µm fraction. The most common locked particle is pyrite with chalcopyrite inclusions. If production of clean pyrite conc. and improvement of Cu-recovery are looked for, then finer grind is needed.

- Cu-conc. 6.11.1984: 90 % of sphalerite appears in liberated particles. Sample: Cu % 25,4, Zn % 4,6 (!).

- The occurrence of silver in ore and Zn conc. has been studied. However, it does not help much to understand the silver recovery to Cu conc.

- Pågang 1984 og 1985. In 1985 there is more pyrite and chalcopyrite occurs more frequently as fine grained disseminations in pyrite (in 1985 Cu recovery had dropped).

More mineralogical work on actual mineral processing problems is needed.

6.2 Other reports

There are several reports about metallurgical problems etc. Some excerpts:

- Arvid Rein (NTH) 1985: The problems in maintenance and low operating time were noted. The cell volume in Zn-flotation was deemed too small. - Measures have been later taken to overcome these problems.

- Faste Strómmevåld, Kåre Tamnes (Folldal) 1985: Large variations and other problems in grinding. Great and variable circulating loads in flotation (it still is a problem). The high consumption of $CuSO_4$ and lack of air feed measurements were noted.

- B.A. Dybdahl (NTH) 1986: Based on lab. test results the change of collector was proposed to improve Cu, Zn and Ag recoveries (carried out later). The use of $CuSO_4$ is excessive and the use of air too low. A proposal for operation instructions was enclosed.

7 SAMPLING SURVEYS

In general very little data of this kind was available.

7.1 Sampling 28.9.1979

Samples and screen fraction assays from grinding. Circulating load in primary grinding 270 % and in secondary grinding 53 %.

7.2 Sampling 1985

It was organized by Strómmevåld and Tamnes. 20 streams were sampled on three days. Because pulp flow measurements (manual) gave unreliable results mass balances were not calculated. Observations:

- High circulating loads.

- Reverse zinc cleaning seemed to operate satisfactorily. Feed to the circuit was 41,1 - 48,4 % Zn, final Zn conc 51,4 -54,8

% Zn and froth product (returned to grinding) 24,5 - 38,9 % Zn. Only 40 % of the feed was floated, so sphalerite was reasonably well depressed, still 30-40 % (calculated from ore Zn content) was returned from reverse cleaning.

7.3
Sampling 19.1.1987

The operation of Unit Cell, Flash Flotation and Cu-flotation (partly) was studied. In Flash Fl. relatively more Ag and Zn was floated than in Unit Cell and Cu-flotation. The tonnage of Flash conc. was low and Ag recovery only 3,5 %. The tonnage of Unit Cell conc. was 5-fold.

7.4
Sampling 6.4.1988

This was the most comprehensive sampling campaign until now (App. 8). 35 streams were sampled. In the results there are some inconsequences but in general the sampling was quite successful.
Some remarks:

- The ore was quite low in Zn, 1,02 %, Cu 1,52 %.

- This time Unit Cell produced only 1,0 % (of ore) conc, Cu recovery 15 %, Ag 8 %.

- Flash conc. was 2,3 % of ore (it was pumped to final Cu cleaning). Cu recovery was 26 % as well as Ag recovery. Relatively the Zn-content was double as high as in Unit cell conc. It has been considered to direct Flash conc. to final Cu conc. but calculations (taking into consideration Zn and Ag recovered per Cu kg and Cu %/conc) seem to show this unjustified.

- Silver floats very poorly in Cu-cleaning. Ag/final Cu conc. was 159 ppm and Ag/cleaner tailing 199 ppm. The occurrence of silver should be investigated more closely.

- Cleaner tailing is high also in Cu, 12,1 %, which causes quite high Cu circulation (210 % calculated as metal content).

- Cell volume in rougher-scavenger bank seems to be reasonable. Tailing in the last cell drops from 0,45 % Cu -> 0,22 %.

- In Zn-flotation the circulating load is much higher than in Cu flotation, 80 % as solids, 800 % as Zn-metal.

- Because of low Zn %/ore the cell volume seemed to be quite sufficient. In the last cell the tailing went from 0,39 % Zn to 0,22 % Zn. The operation of rougher-scavenger is illustrated by the assay graph (App. 9).

- If the assays are correct, Zn-cleaning works very poorly. The cleaned Zn conc. (before reverse cleaning) had 26 % Zn, the first rougher conc. 25 % and cleaner tailing 14 %.

- The reverse cleaning operated well, again presuming that figures are correct. In cleaned Zn conc. was 50,2 % Zn and froth product returned to grinding only 1,9 %. 78 % of material was floated, still only 6,7 % of Zn (metal content calculated from the ore content) was circulated. Looks almost too good.

8 CONCLUSIONS

The large and fast variations in ore grades obviously deteriorate the metallurgical results, but it was not possible to evaluate this effect numerically. On the other hand, during visits variations were not as strong as some times earlier.

Concerning the grinding the impression was that it is not the most urgent problem. Through day-to-day observation, special sampling and mineralogical studies and size fraction assays the situation should be studied.

The results of Cu-flotation are reasonable good. The behaviour of silver is not known well enough. The assaying of silver should be improved. In cleaning silver seems to float very poorly. There is a short-term variation in the Cu-% of conc., which shows possibilities to some improvements. Zn content of Cu-conc. could sometimes be lower.

In Zn flotation there seems to be more space for improvements. The hourly and daily variations seem to show that it should be possible to increase the recovery by several (3 ?) percents. Also the concentrate grade could be improved if variations can be decreased. The hot reverse cleaning seems to operate basically well, but it is not effectively controlled. The tonnage and grade of its feed (Zn conc.) varies controlled. The tonnage and grade of its feed (Zn conc.) varies very much and this creates disturbance in reverse cleaning. Anyhow, it seems that reverse cleaning is a necessity also in future.

The cost analysis was not included in the scope. It might be, however, relevant to note that the variations in metallurgical results can easily cost more than what is possible to save in i.e. reagent costs.

9 PROPOSAL FOR SHORT TERM DEVELOPMENT PROGRAM

9.1 Investigations

9.1.1 Mineralogical studies

- A basic investigation should be carried out, e.g. by Geoanalytical Laboratory (Outokumpu) (App. 10). The cost estimate is 63 000 FIM.
- The effect of ore type variations and reasons for extremely poor or good metallurgy should be studied investigating properly timed samples (tailing, concentrates).

9.1.2 Grinding

- As has been discussed at Joma, at first grinding circuit should be sampled in a typical condition and samples assayed by size fractions. This information could be used i.e. to consider the optimal location of Skim-Air.

9.1.3 Sampling of Cu-cleaning, Zn-cleaning and Zn-reverse cleaning

The general sampling showed that cleaning circuits do not operate properly or the sampling assays were not all reliable. To keep the number of samples reasonable it is better sample the circuits at separate times.

9.1.4 Investigation of grade/recovery correlations and calculation of optimal combination

It might prove difficult to show the correlations from the raw operation data. In that case, test periods could be run trying to keep e.g. 3 different concentrate grade levels.

9.1.5
OK-PCF

The use of potential control in flotation could be tentatively considered and investigated.

9.2 General actions

9.2.1
Training

The program prepared at the concentrator should be fulfilled. If not done yet, a time table should be fixed for the program.

9.2.2
Laboratory, assays

- For process development and tuning special sampling and assays are needed. Therefore laboratory should have reasonable resources. The process metallurgist and other process personnel should not be tied to laboratory work.
- There seemed to exist some unreliability especially in the silver assays. Checking could be arranged e.g. with Geoanalytical Laboratory.
- The Minexan analyzer has not been properly calibrated (at least for years). If it will be used in the future this should be done. This again will give extra work for laboratory.

9.2.3
Reports etc.

- A reasonably comprehensive daily report should be produced. It could show production, metallurgy, process variables (reagents etc.), and comments on disturbances and irregularities.
- Monthly report. Like daily report plus a brief verbal part reporting also changes in personnel and process and the most important investigations and tests. Of course costs & revenue information should be included.

- A program for research and development activities with time table should be prepared and the progress reported by 2-3 months intervals. All tests and investigations should be reported.

9.2.4 Development of the operational practice

The operation instructions were included in the training program. They should be completed. Instructions should not be complicated i.e. rules for reagent addition ought to be kept straightforward. On the other hand instructions should cover all essential aspects of the operation control. The occasions when instructions cannot be observed ought to be reported.

To stabilize the operation three main objects could be chosen in the beginning:

1) Control of the circulating loads in Cu-and Zn-flotation.

   The earlier rule that grade in the flotation circuit feed should not exceed the ore grade more than by 100 % could be suitable or for Cu flotation it could be 80 % and for Zn flotation 120 %. During high ore grades percentages should be lower.

2) $CuSO_4$ dosage in Zn-flotation

   The problem has been recognized in several earlier reports. The Zn-flotation from high-pyrite ores seems to be problematic: $CuSO_4$ consumption is high and the froth tends to become thick or heavy. Combination $CuSO_4$, frother and xanthate is difficult to optimize. The quite complex computer control of Pyhäsalmi is a good example. At Joma the problem could be tackled at first by two means:

   - Setting absolute upper limit for $CuSO_4$ feed.

   - Testing a froth-height gauge (Pyhäsalmi can provide).

3) Control of hot reverse cleaning

   Three aspects could be focused:

- The feed to reverse is kept reasonable i.e. the grade and the pulp density of cleaned and the pulp density Zn-conc. is controlled.
- The temperature in the hot conditioning is kept in the planned range. This might mean that the feed flow has to be decreased in some occasions.
- The grade of final Zn conc is kept in certain range, dependant of the ore grade.

It is obvious that without added instrumentation and assays the satisfactory result is difficult to obtain. At least some indication should be received on the reverse feed and froth product; for Zn conc. there is already a Minexan assay.

9.3 Reagent and flowsheet tests

9.3.1 Flash flotation

If the grinding circuit sampling does not prove it useless, flash flotation should be tried for primary cyclone underflow. It could be expected that more silver could be recovered from there than from secondary cyclone underflow. Possibly the grade of flash concentrate would there be high enough to justify direction to final concentrate.

9.3.2 Collector reagent to Cu-cleaning

The sampling 6.4.1988 showed that silver floats very poorly in Cu-cleaning. Also Cu-content of cleaner tailing was high. A small addition of selective collector e.g. Aerophine 3418 A or Aerofloat 242 might prove useful. It should also be checked that too much lime is not used.

9.3.3 Optimization of reagent feed rates

It is not known how the present reagent consumption rates and pH values were decided. At any case the ore and the conditions have changed. Therefore it would be worthwhile to start a program to test reagent feed rates e.g. on three levels.

9.3.4 Regrinding

Zn regrinding has not been in use for some time. Its effect on Zn-flotation results is not known. When the Zn concentrate moisture problem is over, regrinding should be tested. Various middling products (scavenger concentrates, cleaner tailing) could be tested or possibly mineralogical studies could show which needs regrinding most.

Regrinding of some Cu-middling product could also be considered if mineralogical studies show liberation problems.

GRONG GRUBER A/S
Oppredn.avd.
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afoppr.ram

PLANLEGGINGSOPPGAVER I OPPREDNINGSVERKET.

Rammen omkring P.Eerola's opphold og oppgaver som det er aktuelt han ser på.

I. S T A T U S.

Dagens oppredningsverk kjører etter en takt på 525.000 tonn pr år. Verket ble i sin tid bygget for en kapasitet på 250-300.000 tonn pr år. Selv om mange og betydelige utbygginger er gjennomført siden 1972 lider mange deler av prosessen under at det kjøres på en sprengt kapasitet. Noe av vanskene skyldes måten prosessen må håndteres på, men det vesentlige ligger i en til stadighet topp utnyttelse av alle volum (sanding i celler etc). Belastningen på el-kraftnettet er maksimal.

Videre planlegging av produksjonen vil måtte ta hensyn til
- øking av påsatt tonnasje
- optimalisering av utvinninger
- optimalisering av konsentrat-gehalter

II. H O V E D A R B E I D S M Å L.

De hovedtanker som må bearbeides nå, er:
- Hva/hvilke forandringer må gjennomføres for å få et effektivt oppredningsverk med en kapasitet på 600.000-650.000 tonn/år?
- Hvilke forbedringer må introduseres for at dagens produksjon skal bli mer effektiv?
- Hvilke generelle forandringer må gjennomføres dersom S-kis flotasjon blir aktuell?

III. D E T A L J P R O B L E M E R.

- Mølleavd: Hvordan bedre møllekapasiteten? Prim.møller kjører idag med en fyllingsgrad på 35%.
  : Jevnere mating
  : Forbedring av sykloniseringen.
- Flot.avd: Innføring av større celler?
  : Rensekretsene må utvides. For Zn er dette en absolutt nødvendighet.
  : Hva med nye flot.konsepter (Kolonne-flot)?
- Tanking/avvann : Hva med avvanning på sikt? Senere innføring av pressefilter?
- Reagens-system : Idag er mye avhengig av skjønn hos operatør.
- Prosess-kontroll: Innføring av regulerings-teknikk. Utnyttelse av Courir 30 fra Løkken + ny datamaskin. Kontrollrom-instrumentering for jevnere kontroll

av forbruk av reagenser.

- Generelt: Dagens belastningsproblemer på el-nettet må bort. El-forsyningen må oppdimensjoneres.

IV. K O N K L U S J O N.

Oppsummering av overforstående, gir følgende prioriterte ramme for det som skal bearbeides.

A. Se på forhold som gir en bedre håndtering av dagens produksjon og overlater mindre til prosess-operatørens skjønn.

B. Hva vil en utvidelse av produksjonskapasiteten bety for prosess, utstyr og areal.

JOMA 11.03.88
Arve Haugen

Table 1. Flotasjonsresultater Grong Gruber A.S.

År	Tonn påg	Påg % Cu	Påg % Zn	Kons.		Kons. % Zn	Utv. % Cu	Utv. % Zn
				% Cu	Ag g/t			
1972	73.109	1,43	0,96	22,75		38,75	84,80	40,90
1973	289.113	1,61	0,87	21,95		46,37	90,50	63,00
1974	278.018	1,56	0,99	24,27		48,21	92,70	72,40
1975	329,964	1,95	1,14	23,61		47,56	93,90	73,70
1977	347.103	1,51	1,16	24,52		48,87	92,71	70,63
1978	352.034	1,54	1,13	24,60		50,99	90,50	71,18
1979	367.838	1,37	1,08	23,81		51,51	87,84	76,66
1980	395.847	1,62	1,00	24,10		50,36	90,13	78,79
1981	402.158	1,60	1,08	23,75		50,81	87,93	77,63
1982	424.831	1,58	1,15	23,59		52,58	87,09	80,36
1983	482.738	1,48	1,15	24,71		53,88	86,61	80,86
1984	395.711	1,38	1,46	25,04	138	53,13	84,35	81,98
1985	442.261	1,30	1,51	25,25	159	53,42	81,14	80,03
1986	489.406	1,53	1,47	24,81	168	51,99	87,93	80,51
1987	519.803	1,53	1,67	24,05	177	52,20	85,38	80,10

Table 2. Grong Gruber A/S / Annual production 1987

	Tonnasje		Gehalter % (g/t)			Metall, t (kg)			Distribusjon, %		
	t	%	Cu	Zn	Ag	Cu	Zn	Ag	Cu	Zn	Ag
Pågang	519 802,6	100,00	1,530	1,672	23	7953	8691	11955	100,00	100,00	
Cu-kons.	28 236	5,43	24,05	1,29	177	6791	364	4998	85,4	4,2	41,8
Zn-kons.	13 340	2,57	0,51	52,20		68	6963		0,8	80,1	
Avgang	478 226,6	92,00	0,229	0,285		1095	1363		13,8	15,7	

App. 3

App. 4

FLOWSHEET GRONG GRUBER A/S

Mars-88.   22 3 88

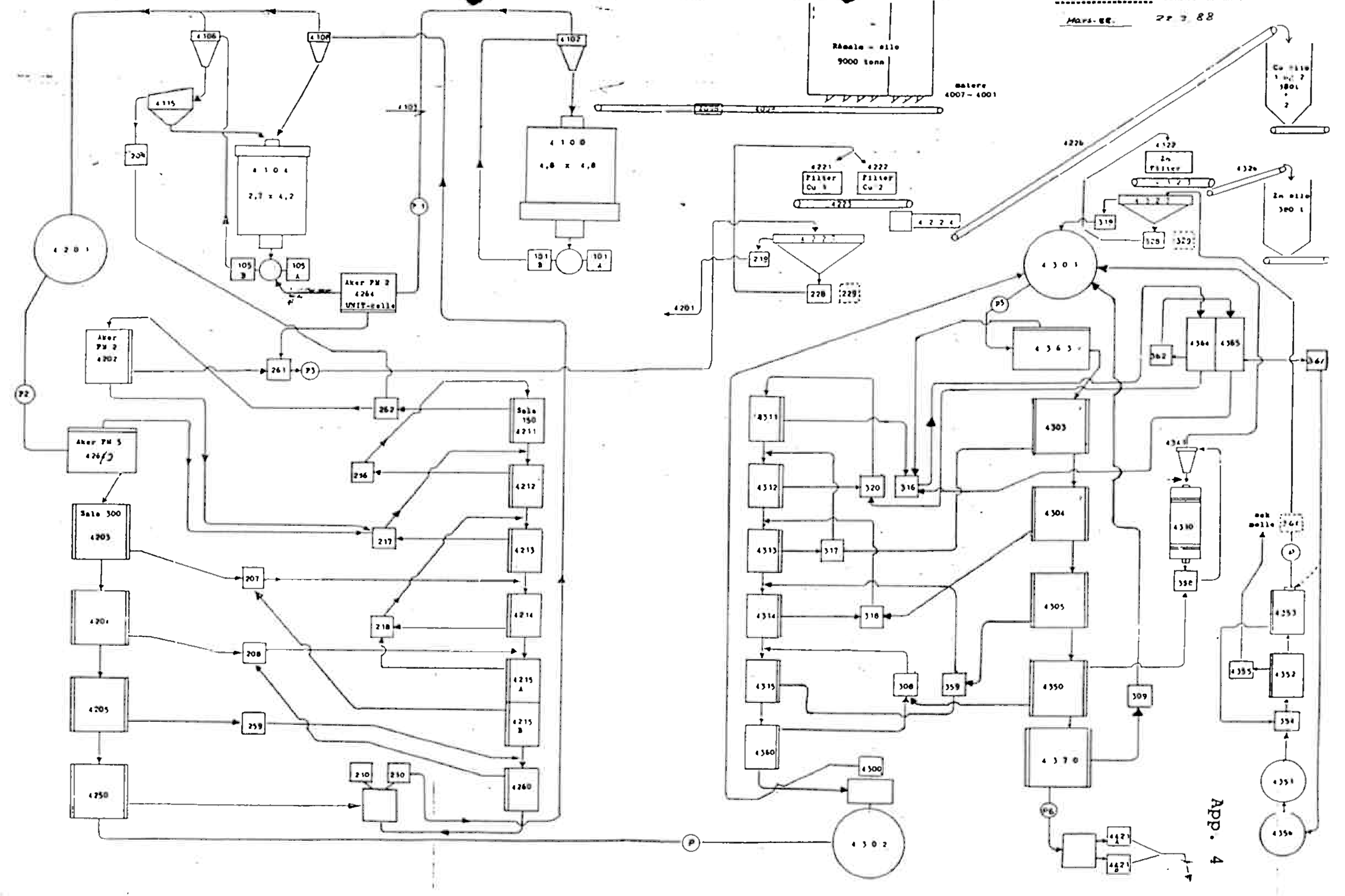

Table 3. Grong Gruber A/S
Monthly metallurgical results

År / måned	Pågang t/h	Pågang Cu %	Pågang Zn %	Cu-kons. Cu %	Zn-kons. Zn %	Avgang Cu %	Avgang Zn %	Utvinn. Cu %	Utvinn. Zn %
1984	58,75	1,38	1,46	25,04	53,13	0,22	0,22	84,35	81,98
1985	59,99	1,32	1,55	25,25	53,42	0,25	0,26	81,49	80,88
1986	62,88	1,52	1,48	24,83	52,95	0,20	0,22	87,38	81,27
1987	70,58	1,53	1,67	24,05	52,17	0,23	0,29	85,38	80,10
1987/1	64,90	1,06	1,76	23,72	51,95	0,18	0,27	83,04	83,40
" /2	70,39	1,47	1,79	23,94	53,09	0,23	0,28	84,47	82,20
" /3	69,58	1,62	1,87	23,58	52,13	0,22	0,285	86,50	82,51
" /4	73,55	1,657	1,634	23,69	50,17	0,191	0,244	88,68	81,33
" /5	71,71	1,795	1,371	24,09	52,36	0,237	0,225	86,37	81,93
" /6	73,58	1,801	1,255	24,30	53,59	0,276	0,224	85,47	76,14
" /7	66,73	1,816	1,319	24,10	55,74	0,277	0,215	85,62	75,84
" /8	66,58	1,557	1,719	24,56	53,44	0,214	0,243	86,32	82,49
" /9	70,65	1,566	1,532	24,75	52,34	0,232	0,286	85,12	78,62
" /10	68,53	1,709	1,441	24,15	51,79	0,284	0,366	83,90	71,59
" /11	71,72	1,277	2,137	24,07	51,86	0,218	0,342	83,18	82,10
" /12	71,75	1,121	2,028	23,12	52,09	0,21	0,395	80,90	79,08
1988/1	72,53	1,29	1,55	23,48	51,27	0,18	0,22	86,36	81,77
" /2	71,99	1,41	1,68	24,81	53,14	0,19	0,28	87,01	77,82
" /3	70,86	1,33	1,67	23,91	53.49	0,20	0.27	85,29	79,89
1987 (2-6)	71,76	1,669	1,584	23,92	52,27	0,231	0,252	86,30	80,82
1987(9)-88(3))	71,15	1,386	1,720	24,04	52,28	0,217	0,308	84,54	78,70
1987(9-10) + 1988(1-3)	70,92	1,461	1,575	24,22	52,40	0,217	0,284	85,54	77,94

APP. 5

DAILY ORE AND TAILING ASSAYS

F

Januar 1988

På gang % Cu	Avgang % Cu x100	Gjennomsnitt % Cu
< 1.0	0.16 15 14 13	0.145
1.0-1.2	0.18 26 14 12 15 14 15 11 19	0.160
1.2-1.4	0.19 19 27 18 16 16 19	0.191
1.4-1.6	0.20 21 29 23 13 22 19	0.209
1.6-1.8	20	0.20
1.8-2.0	21 24	0.225
Gj.snitt 1,294		0,18[illegible]

Februar 1988

På gang % Cu	Avgang % Cu x100	
1,0-1,2	16 19 17 17 17	0,172
1.2-1,4	21 14 14 14 19 21 22 19 17 17 23	0,183
1,4-1,6	19 15 25 25 22 23 24 20	0,216
1,6-1,8	17 22 23	0,206
1,8-2,0		
> 2,0	21 20	0,205
Gjennomsnitt 1,408		0,193

Mars 1988

På gang % Cu	Avgang % Cu x 100	
< 1,0	16	0.16
1,0-1,2	18 28 21 20 17 18 18 19	0,201
1.2-1,4	19 17 18 17 16 17 24 15 20 20 22	0,186
1,4-1.6	24 17 19 22 26	0,216
1.6-1.8	23 20 27 26 22	0,236
1,8-2,0		
Gjennomsnitt 1,327		0,202

DAILY ORE AND TAILING ASSAYS

Pågang % Zn | Avgang % Zn x 100 | Avgang % Zn gjennomsnitt

JANUAR 1988

Pågang % Zn	Avgang % Zn x 100									Avgang % Zn gjennomsnitt
< 1.2	24	22	17	10	18					0.182
1.2 - 1.4	20	20	16							0.187
1.4 - 1.6	17	32	86	32	11	13	27	20	20	0.298 (0.228)
1.6 - 1.8	16	17	16	15	25	12				0.168
1.8 - 2.0	21	14	25							0.200
> 2.0	36	28	17	45						0.315
Gj. snitt 1.555										0.212

FEBRUAR 1988

Pågang % Zn	Avgang % Zn x 100								Avgang % Zn gjennomsnitt
< 1.2	25	17	21	27					0.225
1.2 - 1.4	~~36~~	20	18	23					0.203
1.4 - 1.6	0.16	35	30	32	21	30	92	32	0.36 (0.269)
1.6 - 1.8	20	32	36	37	24	22	22		0.275
1.8 - 2.0	0.57	19	20	30	28				0.308 (0.243)
> 2.0 - ~~2.0~~	0.34	36							0.35
Gj. snitt 1.677									0.272

MARS 1988

Pågang % Zn	Avgang % Zn x 100									Avgang % Zn gjennomsnitt
< 1.2	0.22	0.36	0.34							0.307
1.2 - 1.4	0.19	0.25	0.19	0.12	0.26	0.42	0.40		7	0.261
1.4 - 1.6	0.30	0.21	0.21	0.45	0.16	0.19	0.29	0.36	8	0.274 (0.13)
1.6 - 1.8	0.28	0.26	0.24	0.38						0.293
1.8 - 2.0	0.23	0.30								0.265
> 2.0	0.23	0.23	0.29	0.33	0.24	0.36				0.27
Gj. snitt 1.666										0.274

GRONG GRUBER A/S

LIST OF MINERALOGICAL REPORTS

Solv-undersøkelse på materiale fra Grong Gruber A/S, NTH, Geologisk Institutt 28/81.
Terje Malvik, Gleny Foslie, 27.10.81.

Korntelling av Zn-avgang, uke 2, 1984. NTH, Geologisk Institutt 11/84.
Terje Malvik 26.4.84.

Sink i kobberkonsentrat. SINTEF 84015.
Terje Malvik 4.12.84.

Mineralundersøkelse av Zn-avgang. Årsprove 1984. SINTEF F 85080.
Terje Malvik 5.11.85.

Mineralundersøkelse av pågang 1984 og 1985. SINTEF STF 36 F 85086.
Terje Malvik 27.11.85.

Opptreden av sølv i Zn-konsentrat. September 1985. SINTEF F 86047.
Terje Malvik 2.6.86.

P. Eerola 21.6.1981

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PRØVETAKING AV FLOTASJONSKRETSER

VED GRONG GRUBER A/S

6/4 - 88

Joma 2/5 -88

S. Christensen

H. T. Mikkelsen

SAMMENDRAG:

Produksjonstakten ved Grong Gruber A/S har økt de siste årene. Likeens har det skjedd en del forandringer i prosessen. Forandringene har gjordt det nødvendig å skaffe nye detaljerte opplysninger mht. massefordelingen i Cu- og Zn-kretsen. En serie med prøvetaking av begge kretser ble derfor gjennomført den 6/4 88.

Resultatene viser at sirkulerende last i Zn-kretsen er langt større enn tilsvarende for Cu-kretsen. Forholdet er illustriert i tabell 1 under.

	Cu-krets	Zn-krets
Pågang råkrets	82.4 t/h (125.5 %)	118.4 t/h (180.3 %)
Pågang rens.	13.3 t/h	53.5 t/h

Tabell 1: Massefordelingen i pågang råkrets og rensekrets for hhv. Cu- og Zn-kretsene. Påsetningen til oppredningsverket var 65.67 t/h.

MÅLSETTING:

Produksjonstakten ved Grong Gruber A/S har økt raskt de siste årene. For 1988 er det budsjettert med en påsetning på 525.000 tonn råmalm (72 t/h) til oppredningsverket. Alle tidligere data for massefordeling i male- og flotasjonskretsene baserer seg på en langt lavere tonnasje (55-60 t/h). Videre har det skjedd en del forandringer mht flytskjema. Vedlegg 1 viser en oppdatert versjon av eksisterende flytskjema.

Det var derfor nødvendig å skaffe seg opplysninger om hvordan flotasjonskretsene arbeider ut fra dagens forutsetninger. En større serie med prøvetaking av begge flotasjonskretser (Cu- og Zn-krets), ble derfor gjennomført den 6/4 - 1988.

UTFØRELSE:

Det var bestemt at prøveserien skulle utføres ved pågangsgehalter tilsvarende budsjetterte pågangsgehalter, og budsjettert tonnasje.

Det ble tatt prøver av alle konsentrater, avganger og returer i begge flotasjonskretsene, med unntak av rensekretsene som ble betraktet som en celle. Noen steder ble det i tillegg tatt mengdeprøver.

Tidsrommet for prøvetakingen strakk seg fra kl. 09.50 til kl. 12.30. Det ble tatt tre kutt av hver enkelt godsstrøm. Kuttene ble tatt med en times mellomrom. Hvert enkelt prøvepunkt er anmerket i vedlegg 2. Nummereringen av prøvepunktene samsvarer med nummereringen i vedlegg 3 (analyseresultater).

RESULTATER:

Analyseskjemaene vedlegg 3 gir grunnlagsdata for beregningene av massefordelingen gitt på side 4 og 5.

Mengdemålinger ble foretatt på følgende steder:

Påsetning primærmølle:	65.67 t/time
Flash-konsentrat (4115):	1.50 t/time
Pågang 4352 (varmeflot.):	4.50 t/time
Zn-konsentrat (Avg. 4353):	1.01 t/time

Massefordelingene i Cu-kretsen er beregnet ut fra påsetningene ovenfor, og gehalt av Cu i de ulike produktene i kretsen. For Zn-kretsen er gehalt av Zn i produktene benyttet, kombinert med mengdemålinger.

Diagrammet på side 4 gir massefordelingen i kobberkretsen. Man ser at pågang Cu-råkrets utgjør 126 % av påsetningen på verket, og at avgangen fra skrapflotasjonen (4250) utgjør 100.2 % av påsetningen. Dette skyldes at mengden Cu-konsentrat som ble tatt ut var noe mindre enn returen fra varmeflotasjonen. Forholdet skyldes dels naturlige feil i forbindelse med prøvetakingen, men kan også skyldes midlertidig ustabilitet i prosessen. Ellers er det verdt å merke seg at Akercella (4263) bidrar lite til den totale utvinningen av Cu.

Påsetningen til Zn-råkrets utgjør 180.3 % av opprinnelig påsetning. Akercella (4363) bidrar lite til utvinningen av Zn i kretsen. Pågang Cu-rensekrets utgjør 13.3 t/time, mens pågang Zn-rensekrets utgjør 53.5 t/time.

Generelt viser diagrammene at sirkulerende last er langt større i Zn-kretsen enn i Cu-kretsen, jfr. forøvrig tabell 1.

MASSEBEREGNING FLOTASJON GRONG GRUBER A/S

	t.tørt	% Cu	t.Cu	% Zn	t.Zn	Utv.
Pågang	65.670	1.52	.998	1.02	.670	
Cukons	3.401	26.16	.890	.82	.028	89.14
Znkons	1.009	.42	.004	50.24	.507	75.72
Znavg	61.259	.17	.104	.22	.135	

Sted	% Cu	% ford.	tonn/t	utv	Ag g/t
Pågang	1.52	100.000	65.67		18.9
Kons 202 (UN-kons)	23.09	1.010	.66		155.0
Avg. 202	1.30	98.99	65.01		
Kons 264	26.56	4.170	2.74		157.0
Cu-kons (202 + 264)	26.16	5.180	3.40		159.0
Cu-avg	.22	100.150	65.77		
Påg. Flash	1.04				34.4
Kons. Flash	17.62		1.50		214.0
Ret. kons fra 4352	2.14	5.33	3.50		

```
Påg 263     I<--- ----   3.20  125.471  82.40
           __I___                                       PÅG. RENSEKRETS Cu
          I      I                                        13.293 t/time
          I      I                                        16.61 % Cu
Kons 263  I 263  I ---->  19.38    1.661   1.09  1.34 >I      __•___
          I______I                                     I    I  R  I
             I                                         I    I  E  I
Avg 263     I<--------   2.98  123.810  81.31          I    I  N  I
           __I___                                      I    I  S  I Cu-kons
          I      I                                     I ------>I  E  I  3.401
          I      I                                     I    I  K  I  26.16
Kons 203  I 203  I ---->  26.56    5.848   3.84  4.96 >I    I  R  I    .82
          I______I                                     I    I  E  I
             I                                         I    I  T  I
Avg 203     I<---------  1.75  117.962  77.47          I    I  S  I
           __I___                                      I    ------
          I      I                                     I   AVG. RENSEKRETS
          I      I                                     I      9.892 t/time
Kons 204  I 204  I ---->  13.50    6.913   4.54  6.23 >I      12.14 % Cu
          I______I                                     I        .99 % Zn
             I                                         I      199 g/t Ag
Avg 204     I<--------    .97  111.049  72.93          I         I
           __I___                                      I         I
          I      I                                     I
          I      I                                     I     SEK. MØLLE
Kons 205  I 205  I ---->   9.51    5.820   3.82  5.53 >I
          I______I                                               I
             I                                                   I
Avg 205     I<--- -----   .47  105.229  69.10                    I
           __I___                                                I
          I      I                                               I
          I      I                                               I
Kons 250  I 250  I ---->   5.15    5.079   3.34  5.07   ----------
          I______I
             I
Avg 250     I<--------    .22  100.150  65.77
```

	% Zn	ford.	t/t	utv.
Påg. 301	1.54	100.150	65.77	(- avg 4250)
Påg. 363	7.84	180.275	118.39	
Kons 363	25.80	2.251	1.48	1.26
	7.61	178.024	116.91	
Kons 303	22.84	18.147	11.92	11.35
Avg. 303	5.66	159.877	104.99	
Kons 304	19.86	15.369	10.09	10.64
Avg. 304	3.97	144.508	94.90	
Kons 305	12.50	25.170	16.53	21.09
Avg. 305	1.69	119.338	78.37	
Kons 350	6.64	20.548	13.49	20.80
Avg. 350	.39	98.790	65.67	
Kons 370	3.10	5.506	3.62	5.90 (→ 301)
Avg. 370	.22	93.28	61.26	

PÅG. RENSKRETS Zn
53.51 t/time
15.08 % Zn

RENSEKRETS

Zn-Retur ---> 301
49.01 t/t
1.13 % Cu
14.42 % Zn

--> Påg. varmflot
4.50 t/t
1.56 % Cu
26.35 % Zn

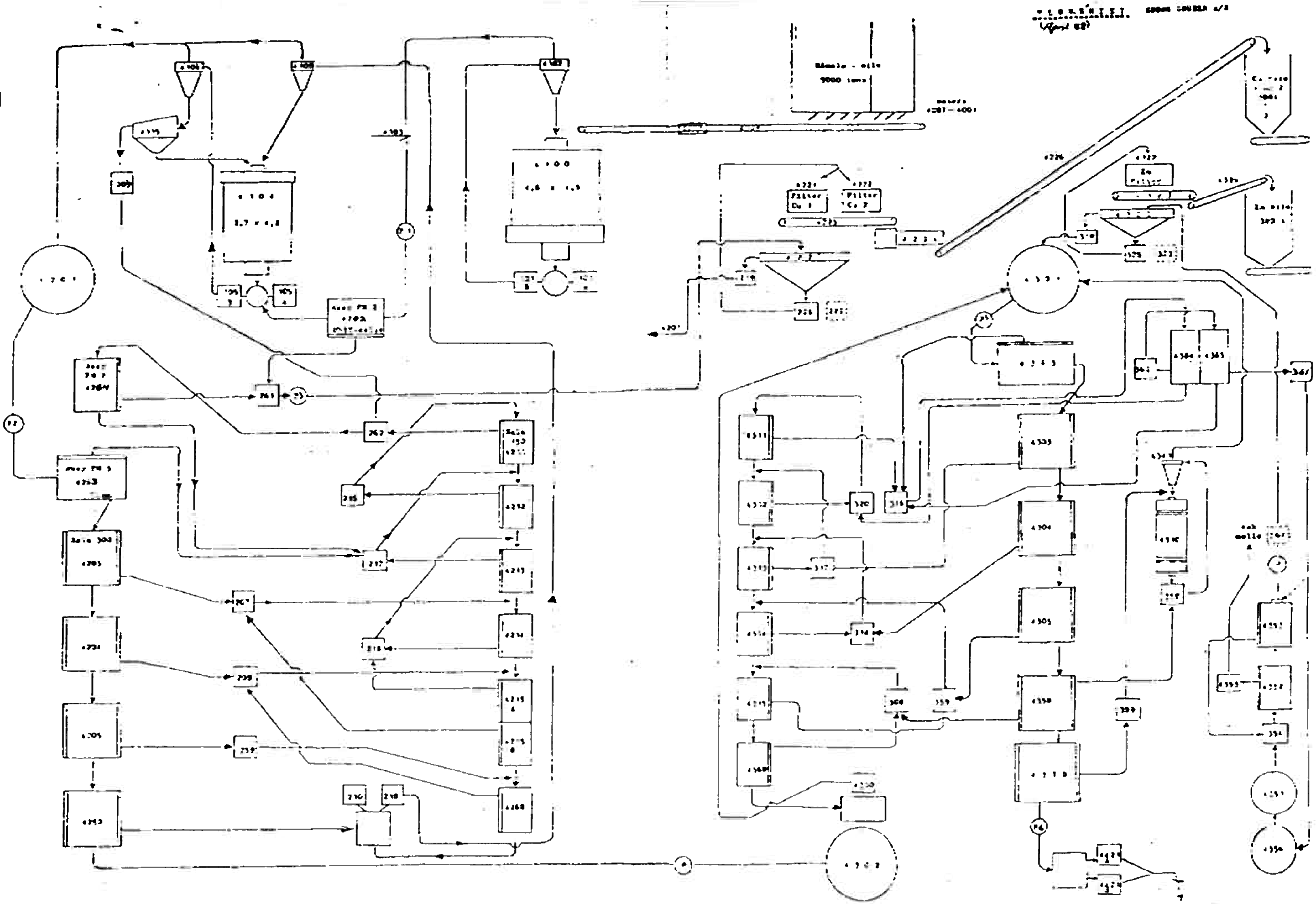
VARMFL

Ret. kons
3.50 t/t
2.14 % Cu
1.88 % Zn

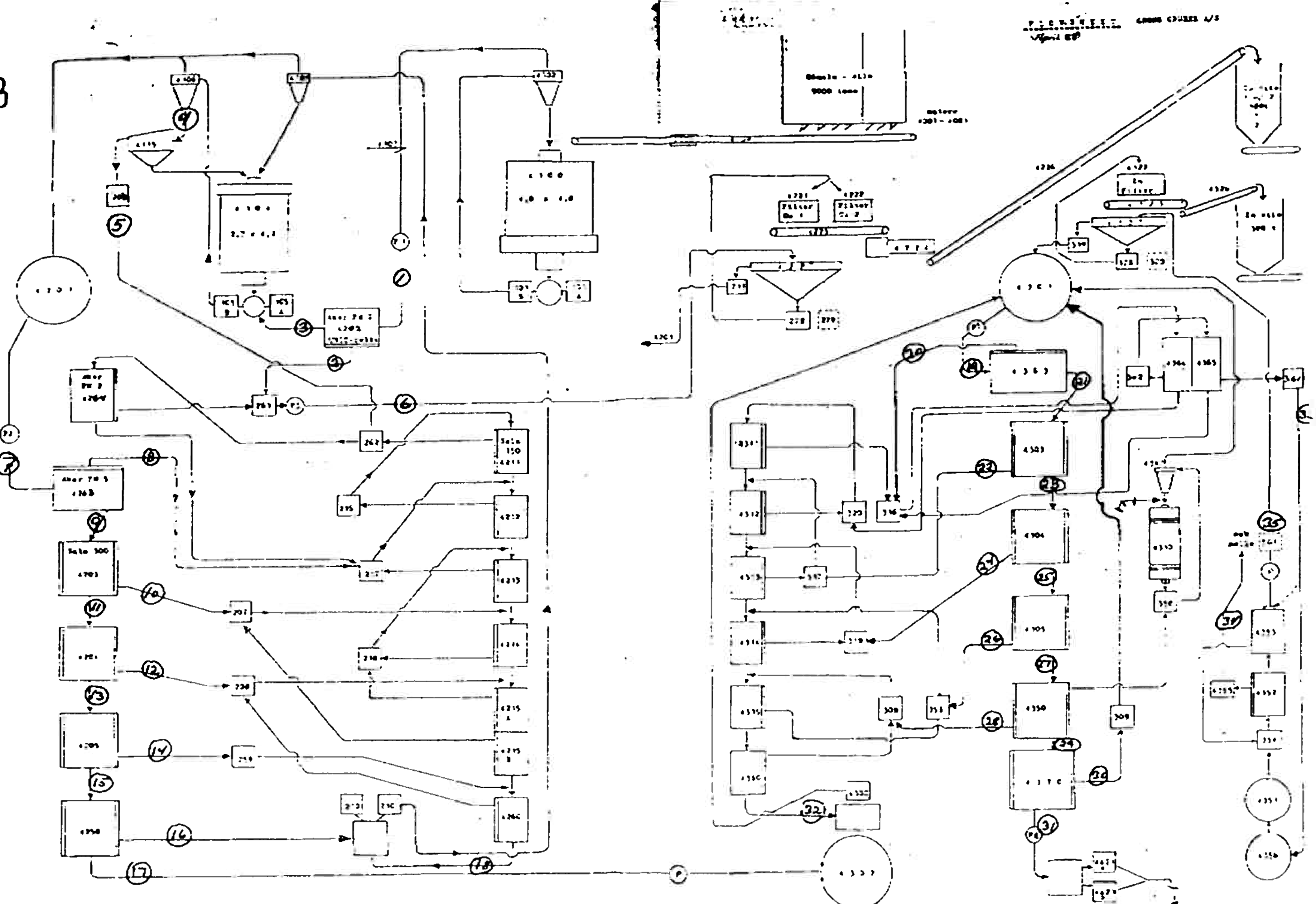
Zn-kons
1.01 t/t
.42 % Cu
50.24 % Zn

29.04.88 H.T.M S.CH

Vedlegg 1



Vedlegg 2



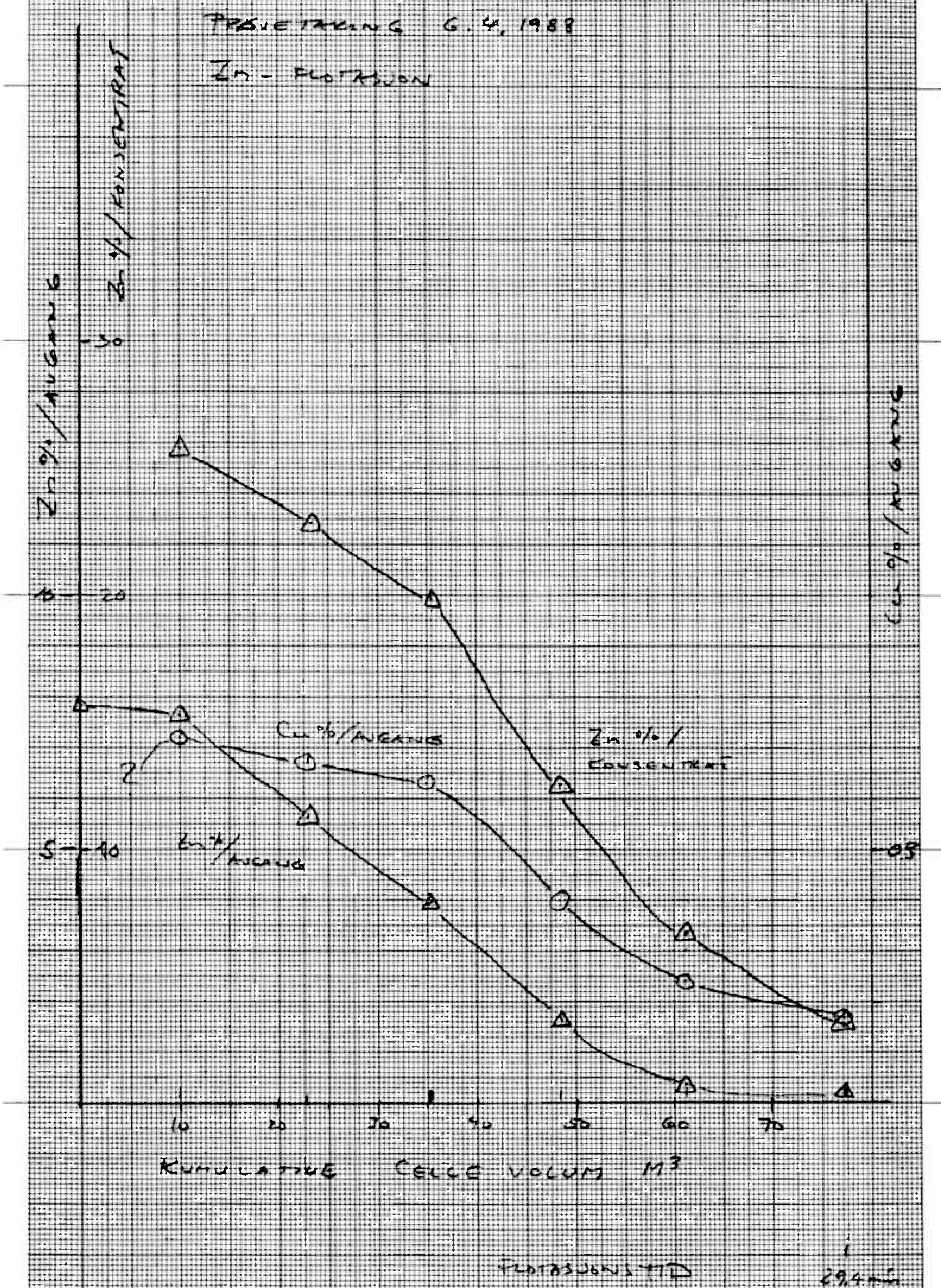
VEDLEGG 3

Prøvetakningen er tatt 06.04.88 fra kl.0930 1230 fordelt på 3 kutt

Analyse skjema for prøver tatt 06.04.88

Pr.nr		% Cu	% Zn	Ag	
1	Pågang 4202	1.52	1.02	18.9	
2	Kons 4202	23.09	.75		
3	Avgang 4202	1.30	1.07		
4	Påg.Flash 4115	1.04	.54	34.4	
5	Kons flash 4115	17.62	1.32	214.0	
6	Kons 4264 (slutt kons)	26.16	.82	159.0	
7	Påg. Cu-råkrets 4263	3.20	2.99	11.2	
8	Kons 4263	19.38	1.55	191.0	
9	Avg 4263	2.98	.39		
10	Kons 4203	26.56	.72	157.0	
11	Avg 4203	1.75	1.64		
12	Kons 4204	13.40	1.72	55.0	
13	Avg 4204	.97	1.68		
14	Kons 4205	9.51	2.16	90.5	
15	Avg 4205	.47	1.64		
16	Kons 4250	5.15	1.56	11.1	
17	Avg 4250 (Cu-avgang)	.22	1.54		(= Zn - pågang)
18	Avg 4260(Cu-ret)	12.14	.99	199.0	
					% Fe
19	Påg 4363	.43	7.84	19.8	
20	Kons 4363	.72	25.80	49.7	
21	Avg 4363	.72	7.61		34.60
22	Kons 4303	.86	22.84		
23	Avg 4303	.67	5.66		34.80
24	Kons 4304	1.05	19.86		
25	Avg 4304	.63	3.97		35.50
26	Kons 4305	1.20	12.50		
27	Avg 4305	.40	1.69		
28	Kons 4350	1.20	6.64		
29	Avg 4350	.24	.39		33.30
30	Kons 4370	1.16	3.10		
31	Avg 4370 (Zn- avg)	.17	.22		32.10
32	Avg 4360 (Zn-ret)	1.13	14.42		35.70
33	Kons 4365 (For-kons)	1.56	26.35		26.90
34	Kons 4352 (Ret-kons)	2.14	1.88		
35	Kons 4353 (Zn-kons)	.42	50.24		10.10

23.5.88
P6
App. 9



OUTOKUMPU OY
Geoanalytical Laboratory
P Hautala

PROPOSAL

23.6.1988

PROPOSAL FOR THE CHEMICAL AND MINERALOGICAL STUDY OF THE GRONG GRUBER'S CONCENTRATION CIRCUIT.

1. GENERAL

The proposal was made by the Technical Services of Outokumpu Mining to carry out the chemical and mineralogical study on the Grong Gruber's concentrator and its subcircuits for the performance and efficiency. The study would be done by Outokumpu's Geoanalytical Laboratory.

2. AIM OF THE STUDY

The aim of the study is to estimate the significant elemental (major and trace elements) and mineralogical mass flows and the liberation degrees of the subcircuits: milling (including flash flotation unit), Cu-flotation and Zn-flotation (including "inverse cleaning" unit).

3. SAMPLE STUDIES

The sample studies will include

- assays of major elements: Cu,Zn,Fe,S
- assays of trace elements: Ag,Au,Pb,As,Sb,Cd,Hg
- microscopy (minerals, textures, grain size, liberation, middling particles, photomicrographs)
- electron microprobe analyses of significant minerals
- sieve analyses (fractions -20,+20,+37,+53,+74,+105,+149, and +297 µm)
- assays and microscpy of the sieve fractions
- estimates of the weight fractions and liberation of sulfides in the samples and their sieve fractions
- reporting

4. SAMPLING

The sampling (i.e. mass flows to be sampled) for the study is shown in the flow sheet (Appendix 1). The sampling scheme (16 samples) is the minimum one for the given aim and is based on the checking of the mass conservations $\Sigma in = \Sigma out$.

The sampling should be done "consistent in time" (a necessary condition for mass balances). Daily samples of an "average day" will be recommended.

5. SAMPLES

Process samples (nos. 2 - 16 in Appendix 1) should be in process fineness and dried (T ≤ 70°C) shortly after sampling. Minimum sample weight required is about 2 kg per sample.

Crushed feed (ore) sample (no. 1 in Appendix 1) should be prepared with certain care. "Sufficiently large" quantity of crushed, unsorted feed (corresponding to the process samples in time) before primary milling should be collected , crushed to the fineness of 100% -2 mm, homogenized and split to "identical" subsamples. Required sample weight for the laboratory is about 0.5 kg. The sample will be suitable for assaying and microscopy of unmilled ore (after additional preparations in the laboratory).

The samples should be supplied with sufficient identifications, sample list and up-to-date process flow sheet showing sampling points.

6. ESTIMATED COSTS

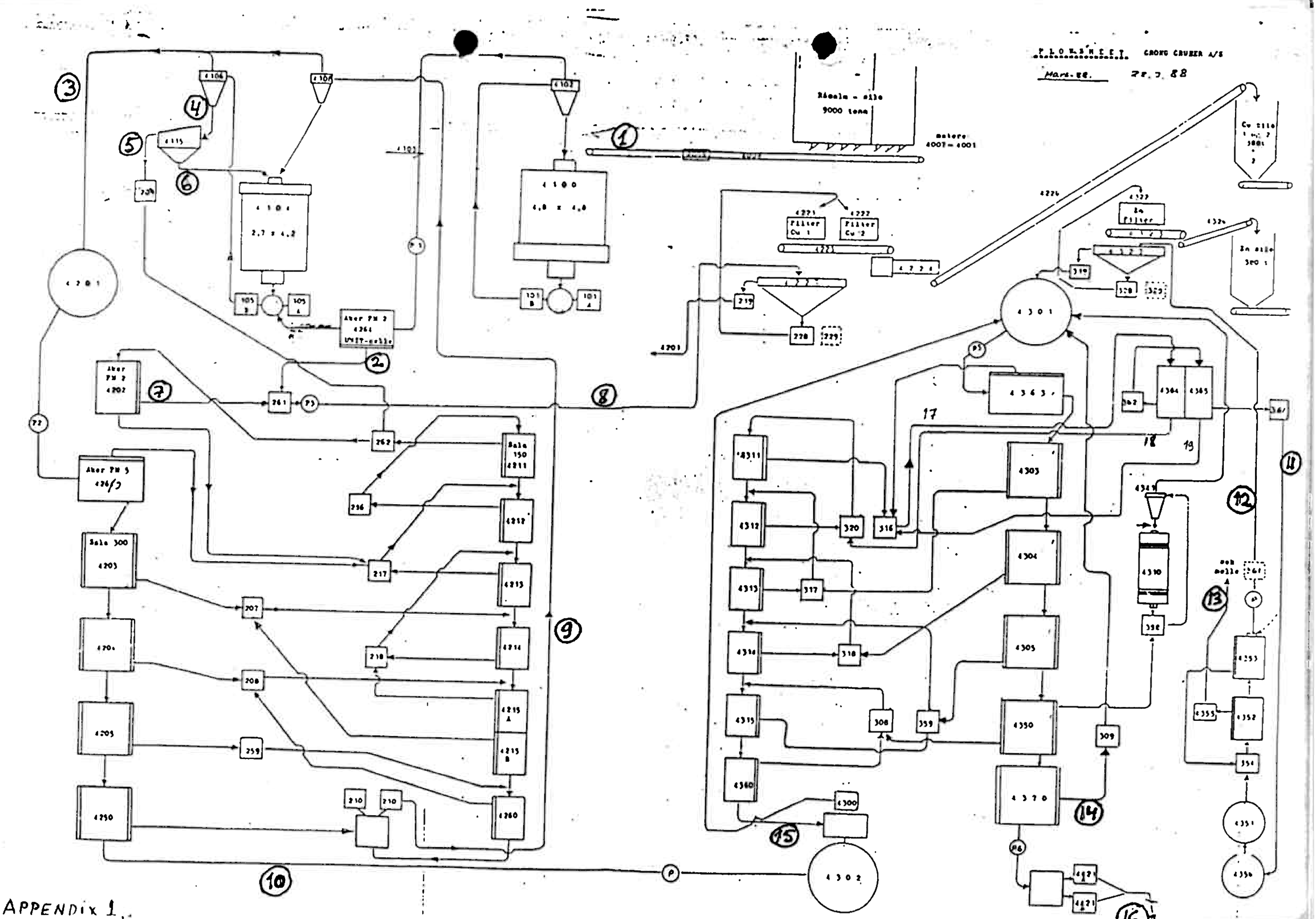
The cost estimates of the study (according to the sample studies given above) will be approximately in Finnish marks:

- major element assays	12200	Fmk
- trace element assays	6240	
- sieving	4275	
- polished sections	5520	
- photomicrographs	3000	
- electron probe analyses	5000?	
- research and reporting	27000	
Σ	63235	Fmk

7. SCHEDULE

The study will be completed in 3 to 4 months after receiving the samples.

Pertti Hautala
Geoanalytical Laboratory


FLOWSHEET GRONG GRUBER A/S
Mars. 88.
28.7.88
Råmalm - silo
9000 tonn
4100
4,8 x 4,8
4104
2,7 x 4,2
4201
4301
4302
Aker FM 2
4202
Aker FM 5
4267
Sala 300
4203
4204
4205
4250
Sala
150
4211
4212
4213
4214
4215
A
4215
B
4260
4303
4304
4305
4350
4370
4311
4312
4313
4314
4315
4360
4310
4353
4352
4355
4351
4356
Filter
Cu 1
Filter
Cu 2
Cu silo
Zn silo
1
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APPENDIX 1.

OUTOKUMPU OY'S GEOANALYTICAL LABORATORY.

Geoanalytical Laboratory of Outokumpu Exploration was formed during the summer 1986 when the Geological Laboratory of Exploration in Espoo and the Laboratory of Keretti Mine in Outokumpu were brought together. The Laboratory moved into the new facility in Outokumpu in September 1986.

In the laboratory plan, which was accomplished in 1984 to 1986, the priorities were given to necessary and sufficient geoanalytical services within the Outokumpu Group. With the reorganization some new personnel was hired and the instrumentation was updated.

The Geoanalytical Laboratory is a part of the Exploration within Outokumpu Mining. The basic functions are to supply analytical services and mineralogical, petrological and geochemical studies for Outokumpu's exploration, evaluation, mining and mineral processing activities, joint ventures, projects, and operations in Finland and in foreign countries. Ore dressing studies are supplied jointly with the Technical Services of Outokumpu Mining.

The Laboratory is organized into analytical and geological sections with an ore dressing laboratory and a library.
The number of personnel is thirty.

Analytical Section

The main function of the Analytical Section is to carry out chemical analyses of samples from various sources (rock, ore, mineral and process samples and their derivatives) with necessary and sufficient accuracy and precision applying variable sample preparation procedures and analysis methods.

The sample preparation consists of mechanical disintegrations of samples (crushing, grinding, splitting), ashing, sieving, briquette pressing and total and various selective dissolution and fusion techniques.

Analysis methods with instrumentation include
- conventional flame atomic absorption for common elements (Perkin Elmer 5000),
- flameless atomic absorption with graphite furnace for precious metals and trace elements (Perkin Elmer 5000, HGA 50 Z),
- sulphur and carbon determinations (Leco SC-32 and CR-12, respectively),
- inductively coupled plasma for common and trace elements (Jarrell-Ash 1100),
- X-ray fluorescence for bulk sample analyses (Philips PW 1400 with Rautaruukki Fundamental Parameter program RRFPO),
- fire assay for precious metals,

- classical gravimetric and titrimetric methods,and
- inorganic water analytics for the control of mine effluents, their environmental effects and for the process water circulation and purification studies.

The personnel consists of three chemists, a research assistant and eighteen laboratory technicians. The total annual analysis capacity will be about 50000 samples. The capacity of the fire assay laboratory is close to 10000 samples per year.

Geological Section

Geological Section carries out chemical and mineralogical studies on samples from various geological sources, ore deposits and metallurgical processes. The Section utilizes the services of the Analytical Section and has necessary facilities and instrumentation for mineralogical and petrological research.

The instrumentation includes
- reflected light (metallographic) polarizing microscope (Leitz MM6) and transmitted light polarizing microscopes for optical mineralogy,
- camera/photoautomat system for photomicrography (Wild MPS 51/45)
- X-ray diffraction for mineral identifications, crystallographic studies and quantitative mineralogy (Philips PW 1700 on-line to MicroVax II computer with Philips APD 1700 software and JCPDS data file)
- electron microprobe for electron microscopy, qualitative and quantitative wavelength and energy dispersive analyses of minerals and electron and X-ray image analyses of microtextures (Camebax SX-50 equipped with three wavelength dispersive spectrometers, secondary and backscattered electron detectors, PDP 11/73 computer with Cameca's software and Princeton Gamma Tech's System 4plus, i.e. energy dispersive Si(Li) detector, PDP 11/73 computer with PGT's Microanalysis and ImageCraft software).

Sample preparation includes conventional and polished thin sections, polished sections and resin mounted sections. Vacuum coating is applied for microprobe samples. Magnetic, gravity and flotation separations of mineral fractions can be done in the ore dressing laboratory.

The personnel consists of two geologists, a physicist, research assistant, microprobe operator and a technician for sample preparation.

The Section includes a photolaboratory for the development, enlargement and printing of films of photomicrography and of the digital image processing for remote sensing, geophysical and other data. The laboratory is equipped to produce high quality, large-size (max width 66 cm) color and black/white prints.

Ore dressing

Ore dressing laboratory is operated jointly with the Technical Services of Outokumpu Mining. The facility is equipped for flotation tests by batch cells and a continuous laboratory pilot system.

Information management

The laboratory is installing a Laboratory Information Management System (LIMS), modified MaVeLab 2B software by Soil and Water Ltd., jointly with Tietokumpu Oy, a subsidiary of Outokumpu Group. The system consists of a communication network integrating analytical instruments to MicroVax II, the central computer of the laboratory.

The LIMS includes the dating, information and follow-up of samples, collection and storage of data from the instruments into MicroVax II and analysis, file and customer reports. Two modem lines connect the MicroVax II to Tietokumpu's computers, where sample analyses are stored into proper files and subfiles of Outokumpu Mining for the use in exploration, evaluation, mine planning, feasibility studies, and economic analyses, etc.

Research staff is equipped with personal computers and software for reporting, graphics, numerical mathematics and statistics. The system allows the utilization of data files in MicroVax II and in the computers of Tietokumpu.

Research

A significant function of the Laboratory is to carry out (geo)chemical, mineralogical, petrological and process mineralogical studies with reports and consultations on clients' samples and sample sets. Determination of the sample variables, i.e. elemental concentrations (sample or system composition), mineralogy (phases), compositions of minerals (phase compositions), and crystallization textures allows a wide range of application studies in geology, exploration, mining, process engineering, and material sciences.

The clients within Outokumpu Group are Mining (Exploration, Technical Services, mines in Finland and abroad), Stainless Steel Industry (Kemi Mine), Engineering and Electronics. Other clients include the Technical Research Center of Finland, Geological Survey of Finland and a few Finnish and foreign exploration and mineral processing companies.

Current research is carried on nickel, gold and platinum-group element deposits in Finland, ore deposits in Sweden, Norway, Canada and Australia and on the concentrators of Tara, Bidjovagge Viscaria and Trout Lake mines.

Outokumpu's expanding world-wide operations and recent advances of applied mineralogy in science and industry are a challenge also to the Geoanalytical Laboratory. Reliability of analyses, quality of study reports and prices of services should be competetive and stand the criticism.

Boundaries of different areas of research and business are becoming less distinct. Outokumpu Group has research activities from exploration through metallurgy to advanced applications of physics. Integration of the laboratories with their know-how into team work will be a great benefit. The support of research and development is required to be competetive, to take advantage of emerging opportunities and to respond to changes in the technology and market.

Studies carried out by professional skill in right time will
- serve and support current operations
- give better understanding of geological and ore-forming processes for exploration,
- optimize process testing and planning (flow sheet),
- give "limits of possibilities" within the premises avoiding an attempt to fight against the nature,
- forecast products and yields,
- back up decision making, and
- explore and prepare the way for further advances and new possibilities.

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Telefax +358 73 56 610

GRONG GRUBER A/S

A PRELIMINARY PROPOSAL FOR THE RENOVATION OF ZINC FLOTATION

Distribution:

Norsulfid A/S
Grong Gruber A/S (2)
NMG/Mikko Palviainen
Technical Services/Välttilä, Eerola

SUMMARY

The evaluation of the process performance of Grong concentrator showed that the renovation of zinc flotation should be studied.

At first two basic changes - abandoning of hot reverse zinc cleaning and implementation of column flotation - were considered. However, it was decided to continue with the existing basic flowsheet.

The existing equipment is old and the flowsheet is complex. Manual and automatic control of the process is difficult. Circulating load tends to be very high. The cell volume is already at times too small both in roughing-scavenging and in cleaning and in future the feed rate and the zinc grade in the ore will increase.

The plan is based on using 16 m^3 OK-flotation machines in roughing-scavenging and (8 m^3, 5 m^3 and 3 m^3 (mostly existing units) in cleaning. Only three cleaning stages would be used. Thus the number of pumping steps is decreased and circuit will be easier to control.

The preliminary estimate for the investment is 6.1 or 5.6 MNOK depending on the choice of cleaning equipment. The estimated increase of operating profit is 1,0 MNOK/a.

It is suggested that possibilities to decrease the investment should be studied.

INTRODUCTION

In discussions at Joma (22.4.1988) it was agreed that a proposal for the renovation of zinc flotation would be prepared. The evaluation of the process performance showed that in the zinc circuit there was the greatest potential to improve the flotation results.

In this paper the renovation has been proposed only for the conventional zinc circuit. Also the zinc reverse cleaning needs some improvements but it is not discussed in this report. The first task is to get the conventional circuit to operate properly.

Grong Gruber has announced that the plant design should be based on 600 000 - 650 000 tpa production.

AIM OF THE PROJECT

There are several reasons to investigate possibilities to renovate the zinc circuit:

1) The flotation capacity is at times insufficient in rougher-scavenger bank and in cleaning.

2) The control of process is difficult and great variations appear in the results. The existing circuit is very complicated and difficult to equip for automatic control. A new circuit could be simpler with only few flotation machines and thus more favourable for manual and automatic control.

3) The existing equipment is quite old and would require major overhaul in near future.

4) Some savings in power and maintenance costs could be expected.

Two basic changes in flowsheet were considered. The hot reverse cleaning is quite expensive to run and makes the process very complex because of the return flow to grinding. On the other hand, it facilitates production of relatively high grade concentrate. It can be estimated that without reverse cleaning Zn grade would hardly be 50 %, with reverse cleaning 52 % can be guaranteed (in average) and 53-54 % is possible with good process control. This more than covers the costs of reverse cleaning. It can also be thought that the existing process increases Cu-recovery, but the final result may be opposite because of the extra circulation.

It has been suggested that the "conventional cleaning" should be replaced by column flotation. Column cell has won reputation as a very selective unit which could replace several conventional cleaning steps. When, however, it was obvious that the hot reverse cleaning would be kept then there was no need for utmost selectivity in the conventional cleaning. Reasonably high and constant grade was enough. Column flotation is still quite a new development in complex sulphide flotation and to implement it at Grong would have required a lot of testing, development and training. Thus this proposal is based on conventional cleaner flotation.

CIRCUIT DESCRIPTION

The annual tonnage of 650 000 and operating time 8 000 h (91,3 %) would make an average feed rate of 81 tph.

The basic flowsheet is shown in app. 1. It consists of four cell OK-16 in roughing, two cell OK-16 in scavenging. There are three cleaning steps: 1) three cell OK-8, 2) two cell OK-8, 3) 2 cell Aker-5/2. 2 and 3 are existing units. The number of cells, volumes and flotation times are shown in Table 1.

Table 1. Zinc flotation.
Volumes and flotation times.

Existing circuit		Flotation machines			
		Alternative A		Alternative B	
	No. of cells		No. of cells		No. of cells
Roughing:					
- AK 5/2	2	OK-16	6	see alternative A	
- BFP 300	16				
- OK-8	2				
Total volume	77 m^3		96 m^3		
Flotation time	29 min*)		33 min**)	"	
Cleaning:					
- BFP 150	12	OK-8	5	OK-8	2
- BFP 300	4	Aker-2/5	2	Aker -8/5	2
Total volume	30 m^3		50 m^3		32 m^3
*) feed rate 66 tph		**) feed rate 81 tph			

In app. 3 and 4 the lay-out and one section are shown.

There has been discussion on pyrite production. In App. 5 a preliminary plot plan including pyrite production is shown.

Because cleaning volume might be too large considering the hopefully decreased circulation, alternative B (app. 2) has smaller capacity. The cell sizes used might seem incoherent. The reasoning is that existing relatively new equipment is utilized.

There are only three cleaning steps, the existing circuit has eight. It is thought that simple circuit is easier to control and under proper control it is possible to produce 45 % Zn feed to reverse cleaning. It has been seen that 8 cleaning steps can produce only 26 % Zn concentrate if out of control.

Open circuit cleaning was considered but at least for the beginning, conventional closed circuit was chosen, because it is less unprotected against disturbances.

The proposed flowsheet has four pumping stages compared to 9 in the existing flowsheet (Cu- and Zn-tailing pumps are not included in these figures).

PROJECT SCHEDULE

Some more detailed work is needed before a reliable cost estimate can be presented. It would take about two months. The installation can be started four months after the decision. The production shutdown would be three weeks.

INVESTMENT

Equipment list including costs is shown in app. 6. It must be emphasized that cost estimate is based on Finnish conditions and on very preliminary planning. The grand total 6,1 MFIM is a lot higher than the first guess was.

The alternative B is 0,5 MNOK less expensive than alternative A.

The possibility to reduce the investment using second hand equipment from Finland will be studied.

INCREASE OF REVENUE AND COST SAVINGS

It is difficult to estimate savings in existing operation. Based on the "Evaluation report", following can be suggested, calculated on 525 000 tpa production, ore grades Cu 1,35 % and Zn 1,70 % and metal prices Cu NOK 9,69/kg, Zn USD 900/t (medium term plan, March 1988).

	NOK/a
- Zn %/Zn-tailing, decrease 0,05 % ~2,7 % recovery	550 000
- Cu-%/Zn-tailing 0,01 % ~0,7 % recovery	290 000
	840 000
Savings in maintenance costs (based on 1987 costs)	200 000
Savings in energy negligible	
Total	1 040 000

CONCLUSION

The project proposal presented here is quite preliminary. It shows, however, that the investment will be relatively high and quite long payback time is needed. However, the planned increase of feed rate and the mechanical condition of equipment make the project necessary. It might be advisable to study some new alternatives e.g. to renovate at first only the cleaner flotation.

APPENDICES:

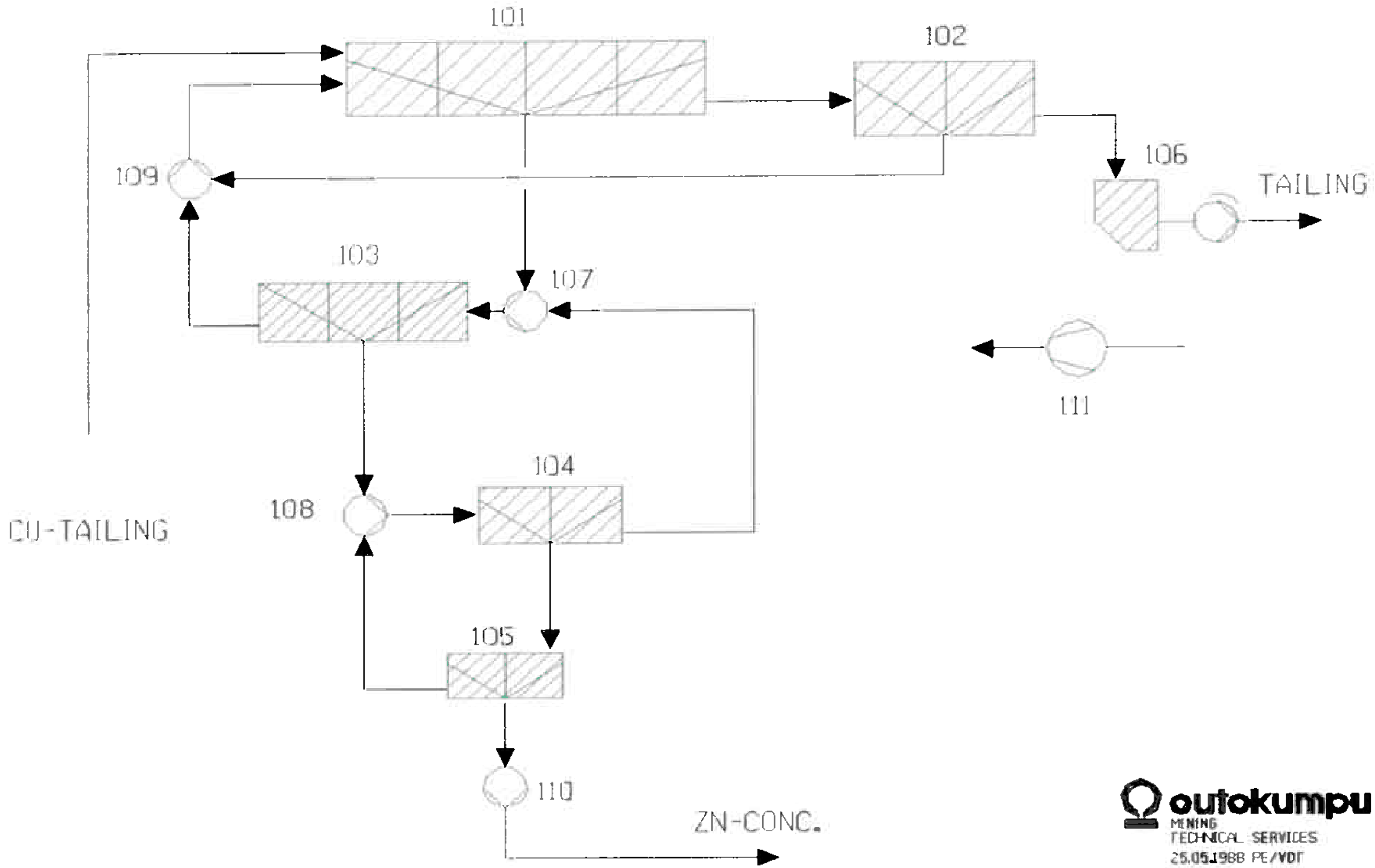
1	flowsheet, alternative	A
2	" "	B
3	Lay-out, alternative	A and B
4	Section	
5	Plot plan, including pyrite production	
6	Equipment list and investment cost estimate	

GRONG GRUBER A/S

ZN-FLOTATION FLOWSHEET

PROPOSAL FOR CIRCUIT RENOVATION

ALTERNATIVE A



outokumpu
MINING
TECHNICAL SERVICES
25.05.1988 PE/VDT

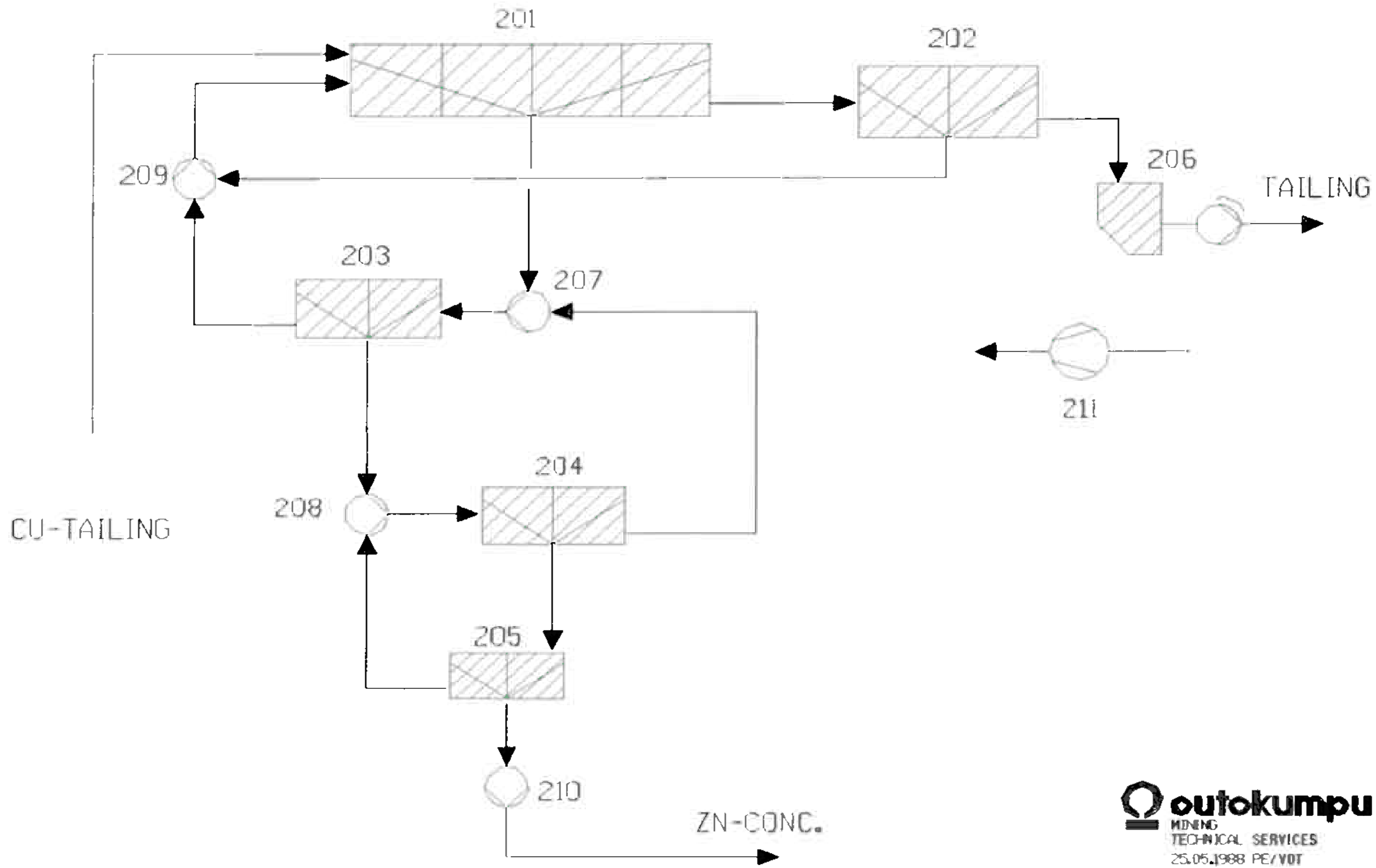
APP. 1

GRONG GRUBER A/S

ZN-FLOTATION FLOWSHEET

PROPOSAL FOR CIRCUIT RENOVATION

ALTERNATIVE B



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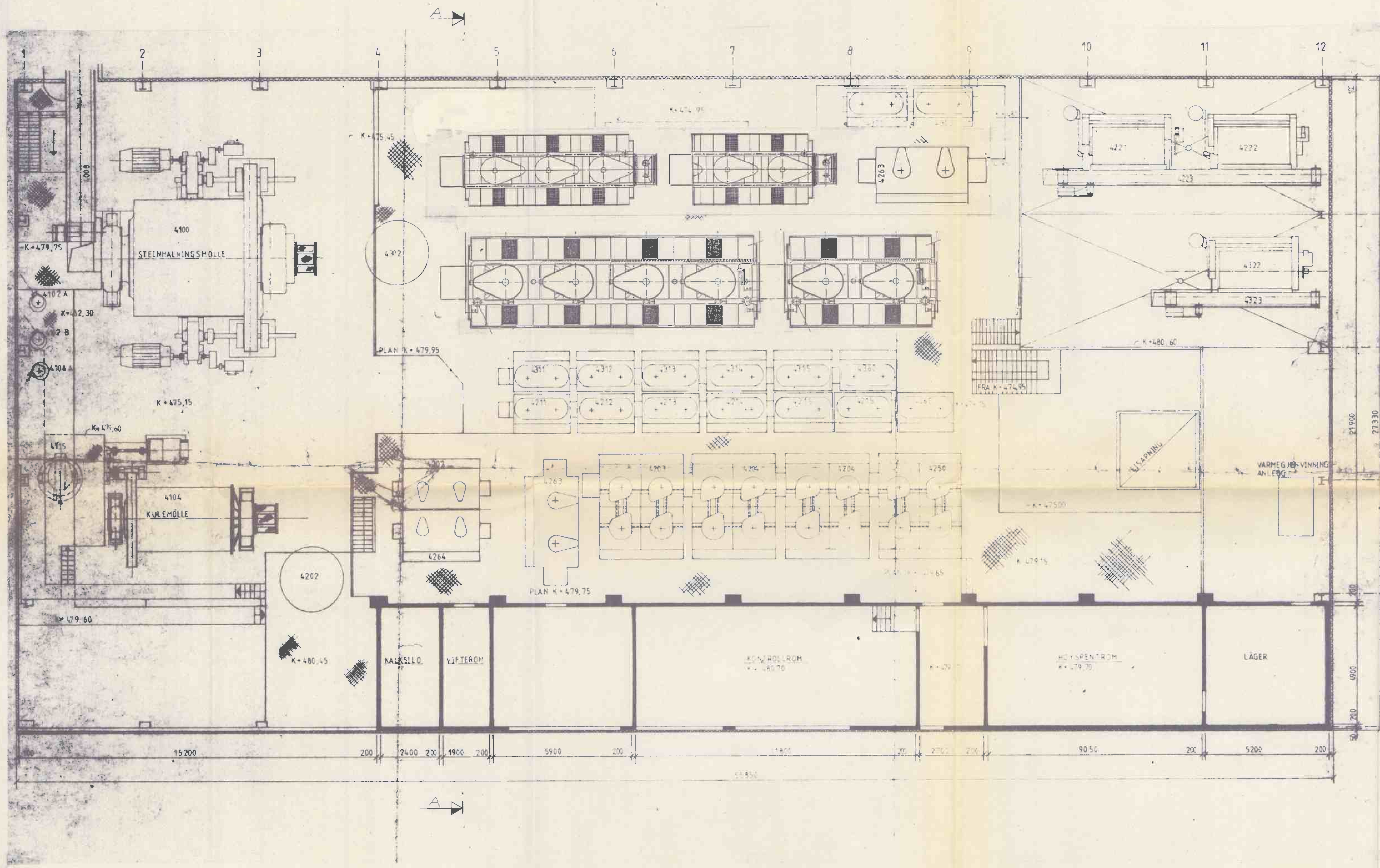
25.05.1988 PE/VOT

APP. 2



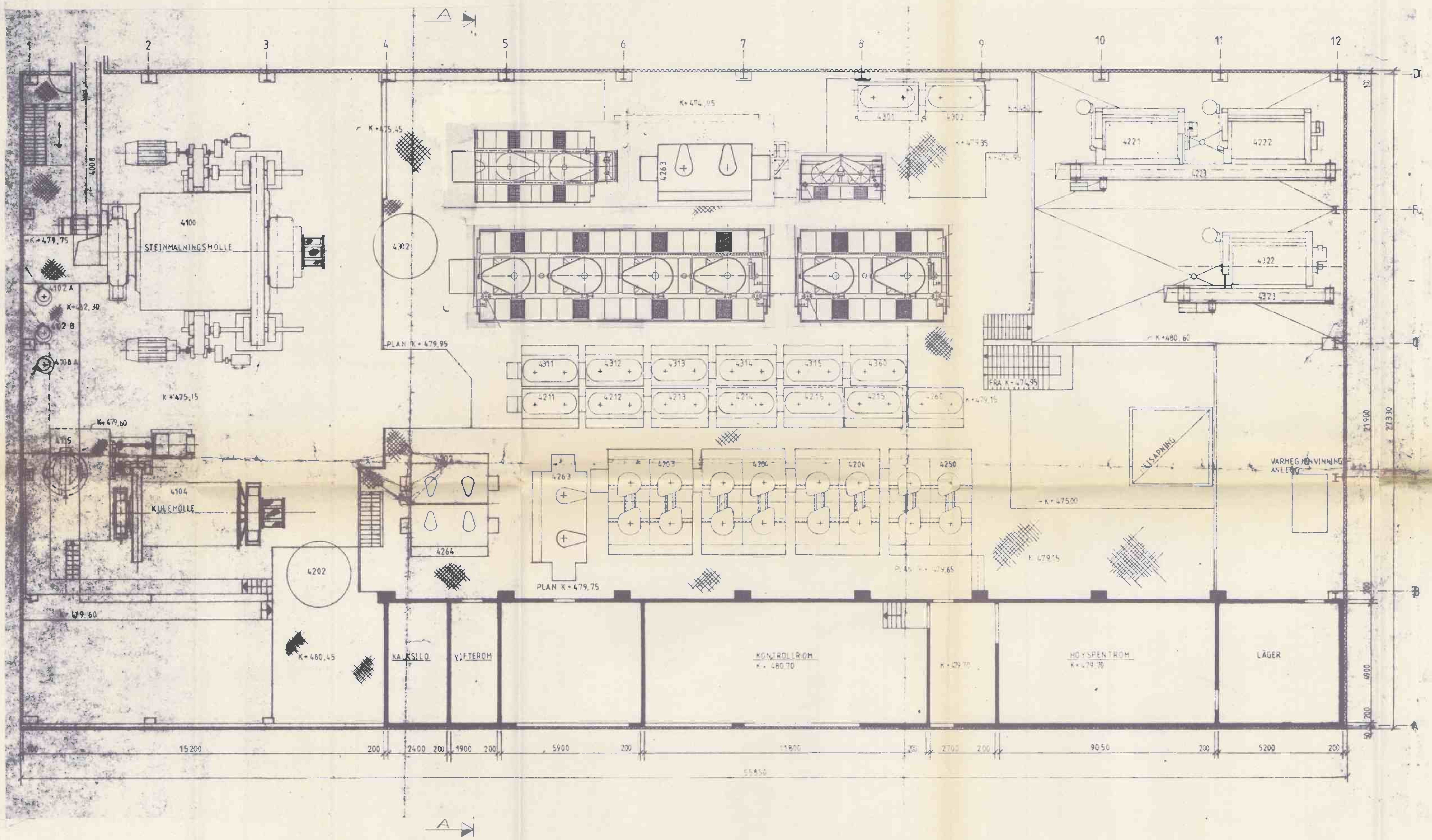
APP. 3A

901639-1	SECTION A-A												
DRAWING NO.	REFERENCE DRAWINGS	REVISION NO.	REVISIONS	DATE	DRAWN	CHECKED	APP'D	MICRO-FILMED	REVISION NO.	REVISIONS	DATE	DRAWN	CHECKED	APP'D	MICRO-FILMED

OUTOKUMPU OY
MINING CONSULTING

DESIGNED	CHECKED	APPROVED	MICRO-FILMED
22.06.88			
VOT			

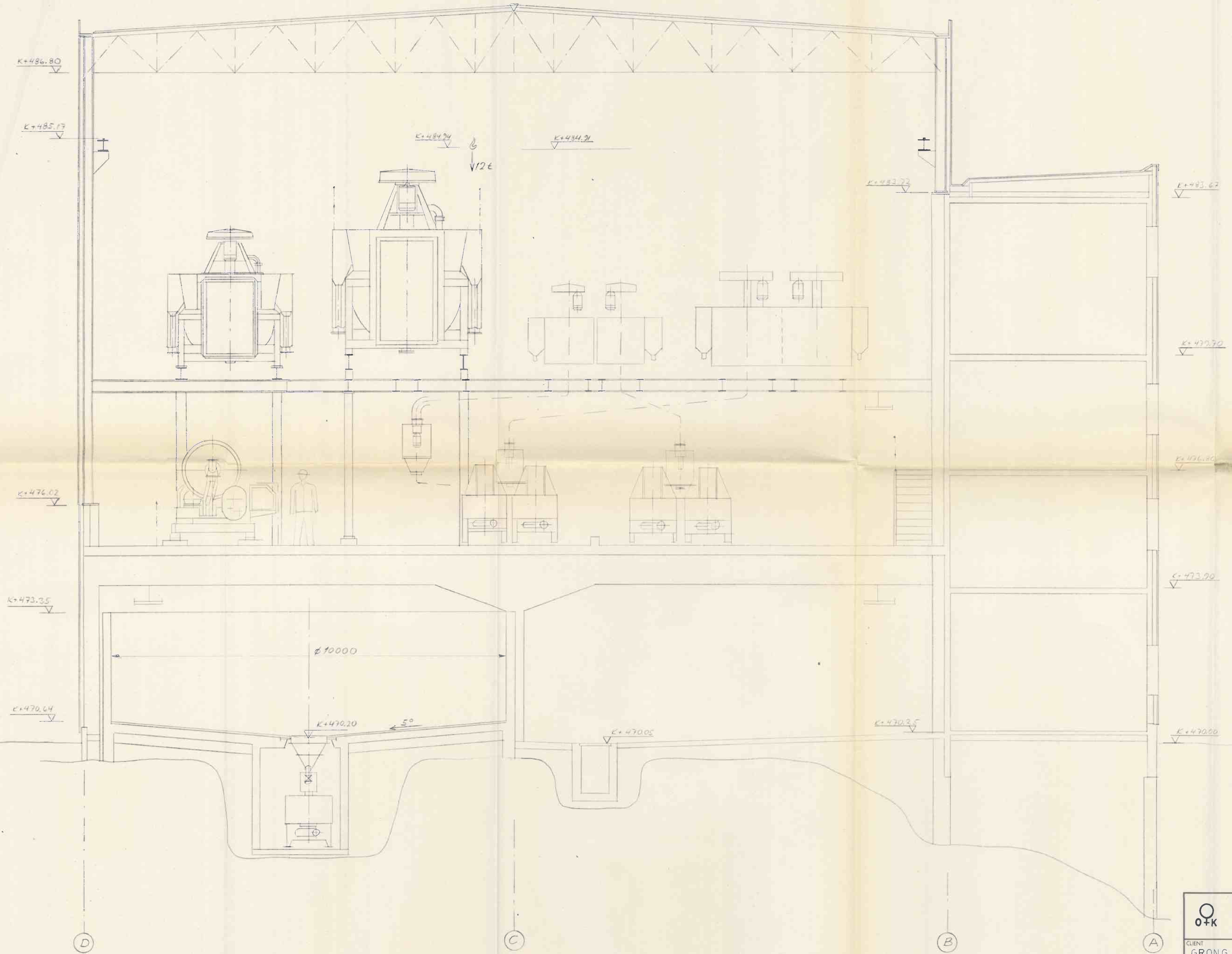
CLIENT: GRONG GRUBER A/S
CLIENTS DWG NO.
PROJECT: RENOVATION OF ZINC FLOTATION
DRAWING TITLE: LAY-OUT ALTERNATIVE A
ORIGINAL SCALE: 1:100
REF. DWG
DWG NO. 901637-1
REV. NO.



APP. 3B

OUTOKUMPU OY — MINING CONSULTING	DESIGNED: 22.06.88 VOT
CLIENT: GRONG GRUBER A/S	CLIENTS DWG NO.
PROJECT: RENOVATION OF ZINC FLOTATION	
DRAWING TITLE: LAY-OUT ALTERNATIVE B	ORIGINAL SCALE: 1:100
	DWG NO.: 901638-1

DRAWING NO.	REFERENCE DRAWINGS
901639-1	SECTION A-A



APP. 4

DRAWING NO.	REFERENCE DRAWINGS	REVISION NO.	REVISIONS	DATE	DRAWN	CHECKED	APP'D	MICRO-FILMED

REVISION NO.	REVISIONS	DATE	DRAWN	CHECKED	APP'D	MICRO-FILMED

OUTOKUMPU OY
MINING CONSULTING

DESIGNED	CHECKED	APPROVED	MICRO-FILMED
22.06.88			
VOT			

CLIENT: GRONG GRUBER A/S

CLIENTS DWG NO.:

PROJECT: RENOVATION OF ZINC FLOTATION

DRAWING TITLE: LAY-OUT SECTION A-A

ORIGINAL SCALE: 1:50

REF. DWG: 901637-1, 901638-1

DWG NO.: 901639-1

REV. NO.:

APP. 5

REVISION NO	REVISIONS	DATE	DRAWN	CHECKED	APP'D	MICRO-FILMED

OUTOKUMPU OY
MINING CONSULTING

DESIGNED	CHECKED	APPROVED	MICRO-FILMED
22.06.88			
VOT			

CLIENT: GRONG GRUBER A/S

CLIENTS DWG NO:

PROJECT: PROPOSAL FOR PYRITE PRODUCTION

DRAWING TITLE: PLOT PLAN

ORIGINAL SCALE: 1:1000

REF. DWG:

DWG NO: 901636-3

REV. NO.:

GRONG GRUBER A/S

RENOVATION OF ZN CIRCUIT

Alternative A

Equipment list

Item	Units	Equipment	FIM x 1000
101	1	Flotation machine OK-16-4 - feed box - discharge box equipped with Dart valve	1 189 (101–102)
102	1	Flotation machine OK-16-2 - discharge box equipped with Dart valve	
103	1	Flotation machine OK-8-3 - feed box - back plate with connection,	350
104	1	Flotation machine OK-8-2, existing - feed box - back plate with connection	50
105	1	Flotation machine Aker 2 x 5 m^3, existing (4363)	50
106	2	Slurry pump Vasa 436-6, existing	9
107	1	Slurry pump SPV 365-6, existing	9
108	1	Slurry pump SPV 365-6, existing	9
109	1	Slurry pump SPV 365-6, existing	9
110	1	Slurry pump SPV 365-6, existing	9
111	1	Flotation air blower HBDD 024, 110 kW - flotation air piping	100 150

112	Flotation machine steel structures 30 t x 12 mk/kg		360
113	Process piping		240
114	Instrumentation		225
115	Electrification		330
117	Engineering		150
118	Project management		50
119	Dismantling of old equipment		50
120	Transportation		100
121	Contingency, 15 %		515
	Total	FIM x 1000	3 954
		MNOK	6,083

GRONG GRUBER A/S

RENOVATION OF ZN CIRCUIT

Alternative B

Equipment list

Item	Units	Equipment	FIM x 1000
201	1	Flotation machine OK-16-4 - feed box - discharge box equipped with Dart valve	) 1 189 (201–202)
202	1	Flotation machine OK-16-2 - discharge box equipped with Dart valve	
203	1	Flotation machine OK-8-2 - feed box - back plate with connection, existing	50
204	1	Flotation machine Aker 2 x 5m^3 existing (4363)	50
205	1	Flotation machine OK-3-2, second-hand	100
206	2	Slurry pump Vasa 436-6, existing	9
207	1	Slurry pump SPV 365-6, existing	9
208	1	Slurry pump SPV 365-6, existing	9
209	1	Slurry pump SPV 365-6, existing	9
210	1	Slurry pump SPV 365-6, existing	9
211	1	Flotation air blower HBDD 024, 110 kW	100
		- flotation air piping	150

212	Flotation machine steel structures 30 t x 12 mk/kg		360
213	Process piping		240
214	Instrumentation		225
215	Electrification		330
217	Engineering		150
218	Project management		50
219	Dismantling of old equipment		50
220	Transportation		100
221	Contingency, 15 %		570
	Total	FIM x 1000	3 669
		MNOK	5,645

GRONG GRUBER A/S

A PRELIMINARY PROPOSAL FOR THE DEVELOPMENT OF

PROCESS CONTROL

Distribution:

Norsulfid A/S
Grong Gruber A/S (2)
NMG/Mikko Palviainen
Technical Services/Välttilä, Eerola

SUMMARY

Because of the wide and frequent variations in processing results the development of automation was seen necessary. This preliminary proposal includes the purchase of second hand Courier-30 on-stream analyzer from Lökken Mine, the purchase of an Analyzer Operator System (AOP) having also capacity for control and reporting functions and the purchase of basic process instrumentation for process control. Two alternatives with different scope are presented.

The estimated investment is 2,0/2,5 MNOK. The increase of operating margin is difficult to estimate, 1 MNOK/a was the result of present calculation.

It is suggested that for finding the optimal scope of the project a study with some detailed work for instrumentation would be prepared.

INTRODUCTION

In discussions at Joma (22.4.1988) it was agreed that a proposal for the development of automation would be prepared by Technical Services. Grong Gruber has already negotiated about the purchase of Courier 30 from Lökken Mine. This very preliminary study attempts outline a moderate development project which would include, besides the on-stream analyzer, also some basic process control functions. At this stage the cost estimates, especially concerning the field instrumentation are very preliminary.

In this study the basic needs have been estimated for process control including the number of measurements (AI) and control outputs (AO). The way of doing this has been very "process orientated". The next step would be to let an automation expert make a detailed study after the basic plans have been decided.

OUTLINE OF THE PROCESS CONTROL

The process is quite complex, Cu- and Zn-concentrates are produced and there is a special stage, hot reverse cleaning for zinc concentrate, from where pyrite-sphalerite-chalcopyrite middling is returned to grinding circuit. In metallurgical results, the variations are wide and frequent.

Today the process control tools include Minexan on-stream analyzer (8 streams) and some conventioal instrumentation. It must be emphasized that the on-stream analyzer is today very useful. There have been some maintenance problems and Grong would also like to have computer facilities to develop on-line process control.

There is a Courier-30 (5 lines) available at Lökken. Outokumpu Electronics Division has given a proposal for providing the Lökken Courier-30 or the existing Minexan system with an Analyzer Operator P, which would facilitate to include some reporting and control functions into the system. In app. (1) is a list of inputs and outputs. They are divided in two priority categories. In the following are some highlights of the consideration behind the list:

- 5 Courier-30 assays are not enough. If possible, Minexan should be kept at least partly in operation.
- The control of secondary grinding cyclones and flotation feed density is important.
- All reagent flows should be computer controlled. This enables the assay-based control of flotation. The actual measurement for every single flow is not a necessity at this stage.
- Control of air feed is needed also in Cu-flotation (old Sala BFP equipment).
- The hot reverse Zn-cleaning should be effectively controlled.

The development and maintenance of the proposed system requires resources. This is an important aspect when the project is considered.

INVESTMENTS

In app. 1 there is a list of instruments with price estimates. In app. 2 is a cost estimate including instruments, installation of instruments, Courier30 and AOP. The total costs for the two alternatives are 2,0 vs. 2,5 MNOK. For the sampling system and the probably necessary extra programming work (the basic work is included in Outokumpu Electronics offer) should perhaps 100 000 NOK be reserved.

The cost estimate is partly very preliminary. The instrumentation costs are based on the experience of Outokumpu mines, for Courier-30 and AOP there are offers from Lökken Mine and Outokumpu Electronics but some checking is needed. The revised offer (the original was given 15.10.87) for AOP is in app. 3. In the cost estimate the number of Control Loop Units (CLU) has been reduced (8/10 vs. 15) to match the number of analog inputs/priority I and II.

INCREASE OF OPERATING MARGIN

The benefits of the development of process control are generally difficult to estimate. In this case when there is at the same time another project, the renovation of zinc flotation, under consideration, the estimation is even more problematic. To keep it simple, it is supposed that the zinc circuit renovation would increase the recoveries, the development of process control would improve the concentrate grades and save reagents. So for the process control project is estimated that the benefits would be (see app. 4).

Improvement of Cu conc. grade from 24,0 -> 24,5 % Cu.	400 000 NOK/a
Decrease of Zn losses to Cu conc.	70 000 "
Improvement of Zn conc. grade from 53 -> 54 % Zn	420 000 "
Savings in reagent costs (~5 %)	100 000 "
Total	990 000 NOK/a

CONCLUSION

This paper is a very preliminary proposal for the development of process control at Grong Gruber. It is hoped that it would be discussed and thereafter a study based on some more detailed work, especialy on instrumentation, would be prepared.

APPENDICES

1. List of field instruments
2. Capital cost estimate
3. Revised offer for AOP etc. (Outokumpu Electronics)
4. Increase of operating margin

OUTOKUMPU OY
Technical Services

APPENDIX 1

Paavo Eerola/PAL

June 18, 1988 1 (3) 266/88 Ri

GRONG GRUBER A/S

DEVELOPMENT OF PROCESS CONTROL

List of field instruments

	Priority	Measurement (Input) FIM	Control (Output) FIM
Primary grinding:			
Ore feed	I	x	
Water flow	I	6 000	4 000
Cyclone pressure	II	2 000	
Pump sump level	II	4 000	
Pump speed	II		100 000
Mill power	I	3 000	
Cyclone feed flow	II	20 000	
Secondary grinding:			
Water flow	I	6 000	6 000
Pump sump level	I	4 000	
Pump speed	I		80 000
Cyclone pressure	II	2 000	
Cyclone feed flow	II	20 000	
Mill power	I	3 000	
Flotation feed density	I	30 000	
Flash flotation:			
Pulp level	I	x	x
Air feed	I	9 000	10 000
Cu-flotation:			
Air feed, roughing	I	9 000	10 000
Air feed, scavenging	I	9 000	10 000
Air feed, cleaning	I	9 000	10 000
pH	I	x	

x) existing instruments
Instrument price estimates in FIM

	Priority	Measurement (Input) FIM	Control (Output) FIM
Zn-flotation:			
Air feed, roughing	I	x) included	(x
Air feed, scavenging	I	x) in flot-	(x
Air feed, cleaning	I	x) ation	(x
Pulp level, roughing	I	x) equipment	(x
Pulp level, scavenging	I	x) project	(x
Pulp level, cleaning (3)	I	x)	(x
Froth height, roughing	I	4 000	
Pulp flow, middling	II	20 000	
Pulp density, middling	II	30 000	
pH, feed	I	x	
Zn reverse cleaning:			
Pulp flow, feed	I	20 000	
Pulp flow, concentrate	I	7 000	
Pulp density, feed	II	30 000	
Pulp density, concentrate	II	30 000	
Temperature, feed	I	2 000	
Steam flow	II	9 000	5 000
ph	I	x	
Reagents:			
Lime, total feed	I	6 000	12 000
- 4 feed points			
Hostaflot			
- 1 feed point	I		4 000
Amyl xanthate			
- 5 feed point	I		x
Ethyl xanthate			
- 3 feed points	I		x
$CuSO_4$			
- 1 feed point	I	11 000	7 000
MIBC (frother)			
- 3 feed points	I		x
$Na_2S_5O_5$			
- 1 feed point	I	11 000	7 000

On-stream assays:

Primary cyclone overflow	Courier
Flash flotation concentrate	Minexan
Final Cu concentrate	Courier
Cu flotation tailing	Courier
Zn flotation feed	Minexan

x) existing instruments
Instrument price estimates in FIM

	Priority	Measurement (Input) FIM	Control (Output) FIM
Zn rougher concentrate		Minexan	
Zn scavenger concentrate		Minexan	
Zn flotation tailing		Courier	
Zn cleaner tailing		Minexan	
Zn 3rd cleaner concentrate		Minexan	
Zn reverse cleaner concentrate		Minexan	
Final Zn concentrate		Courier	

Cu-concentrate dewatering:

	Priority	Measurement (Input) FIM	Control (Output) FIM
Pulp density, thickener underflow	II	30 000	
Oil feed, rotary dryer	II	5 000	6 000
Temperature, rotary dryer (2)	II	4 000	
Air feed, rotary dryer (2)	II	18 000	20 000
Belt scale, dried concentrate	II	50 000	

Zn-concentrate dewatering:

	Priority	Measurement (Input) FIM	Control (Output) FIM
Pulp density, thickener underflow	II	30 000	
Oil feed, rotary dryer	II	5 000	6 000
Temperature, rotary dryer (2)	II	4 000	
Air feed, rotary dryer (2)	II	18 000	20 000
Belt scale, dried conc.	II	50 000	

x) existing instruments
Instrument price estimates in FIM

OUTOKUMPU OY
Technical Services

APPENDIX 2

Paavo Eerola/PAL

June 18, 1988

1 (1) 266/88 Ri

GRONG GRUBER A/S

DEVELOPMENT OF PROCESS CONTROL

Capital cost estimate

		FIM	NOK
Instrumentation, total:			
Instruments			
-	I priority	335 000	515 000
-	II priority	242 000	372 000
Installation			
-	I priority	140 000	215 000
-	II priority	100 000	154 000
Total			
-	I priority	475 000	730 000
-	II priority	342 000	526 000
I + II priority		817 000	1 256 000
Courier -30 from Lökken		260 000	400 000
Analyzer Operator System			
-	I priority	546 000	840 000
-	I + II priority	575 000	885 000
Total:			
-	I priority	1 281 000	1 970 000
-	I + II priority	1 652 000	2 541 000

Costs for sampling system and extra programming back-up are not included for them, at least 100 000 NOK ought to be reserved.

PROCESSAUTOMATION SAMT MINEXAN SYSTEMETS
UPPGRADERING FÖR GRONG GRUBER A/S

Vi offererar följande alternativ. De offererade processinterface enheterna är en uppskattning och bör närmare preciseras.

Pos.	St.	Beskrivning	Pris/enhet FIM	Tot.Pris FIM
1				
ALTERNATIV 1				621.280,-
1.1	1	ANALYSATOR OPERATOR STATION, AOP110-3A, MED INTELLIGENT PROCESSINTERFACE SAMT KOMMUNIKATION MEDELST PROSCON X10 DATA HIGHWAY	230.000,-	

Hårdvaran

* PDP 11/53 microdator med 1.5 MByte MOS halvledarminne med floating point option
* 9-kanalers interface
* 1.2 MByte floppy disk drive och interface, RX33
* 41 MByte Winchester skivminne, RD32
* Datorskåp för processorn och interfaceenheterna samt den nödiga spänningsmatningsenheten
* Processinterface enheten med plats för 17 interface enheter

Mjukvaran

* Dokument och text program
* RSX-11S realtids operativsystem-licens
* AOP110 applikationsprogrammet för:
  - kommunikation och data management
  - statistik och aritmetiska operationer
  - alarmbehandling
  - raportgenerering
  - interaktivt systemunderhåll
  - färggrafik och interaktiv operatörskommunikation
  - process data behandling, PID och sekvensstyrning
  - beräkning av analyser

8

511 GB

Pos.	St.	Beskrivning	Pris/enhet FIM	Tot.Pris FIM
1.2		PROCESS INTERFACE ENHETER (uppskattning)		242.300,-
1.2.1	15	Control Loop Enhet, CLU 2133, med fyra (4) PID styrning var och en med 4-20 mA ut- och ingångskanaler för Direkt Digital Styrning.	14.500,-	217.500,-
1.2.2	2	Analog Input Enhet, AMU 2200, med kanaler för 16 signaler. Varje kanal är galvaniskt isolerad och enheten har en egen A/D omvandlare.	12.400,-	24.800,-
1.3		TERMINALER		73.980,-
1.3.1	1	Operatörs färgbild monitor 20", funtionstastatur och videogenerator, PTS 1402	59.680,-	
1.3.2	1	Video Terminal, VT320, med tastatur för konfigurering	14.300,-	
1.4		PROJEKTARBETE - 3 veckor		33.750,-

* inmatning av data, konfigurering av mätningar, styrninar
* special programmering
  - sekvenser
  - bilder
  - raporter
* systemtest före leveransen
* dokumentering

1.5		MONTAGE- OCH IDRIFTTAGNING I JOMA		11.250,-
		Uppskattat till en vecka, exklusive rese och logikostnader		
1.6		SKOLNING		30.000,-
		Operatörshandledning vid idrifttagningen samt systemkurs för drift- och instrumenteringspersonalen i Finland två (2) veckor för två personer, exklusive rese och logikostnader		

8

2
ALTERNATIV 2 — 647.530,-

2.1		Enligt alternativ 1		
		Pos. 1.1	230.000,-	
		1.2	242.300,-	
		1.3	73.980,-	
		1.4	33.750,-	

511 GB

Pos.	St.	Beskrivning	Pris/enhet FIM	Tot.Pris FIM
2.2		MONTAGE OCH IDRIFTTAGNING I JOMA	22.500,-	
		Uppskattiningsvis två (2) veckor * översyn av COURIER 30 * AOP systemet		
2.3		SKOLNING	45.000,-	
		Såsom i alternativ 1 pos 1.6 samt därtill en (1) veckas COURIER 30 skolning		
SUMMERING		ALTERNATIV 1		FIM 621.280,-
		ALTERNATIV 2		FIM 647.530,-

VILLKOR

LEVERANSVILLKOR
FOB (Incoterms 1980) Helsingfors inkluderande exportemballage. Vi tillämpar NLM 80.

LEVERANSTID
4 månader från beställningen.

BETALNINGSVILLKOR
20 % av det fixerade totalpriset vid beställing, 30 dagar netto.

80 % av det fixerade totalpriset vid leverans medelst L/C.

Efter slutförd montage och idrifttagning (pos. 1.5 resp. 2.2) samt skolning (pos 1.6. resp. 2.3) erlägges betalning mot separat räkning, 30 dagar netto.

GARANTI
Leveransen är garanterad för en period om 12 månader (enligt NLM-80) från slutförd installation, dock ej mera än 18 månader från levernasdatum.

GILTIGHETSTID
Offerten är i kraft till den 30 September 1988.

Högaktningsfullt

OUTOKUMPU OY
Elektronik Divisionen

Eric Sippel

8

511 GB

OUTOKUMPU OY
Technical Services

APPENDIX 4

Paavo Eerola/PAL June 18, 1988 1 (2) 266/88 Ri

GRONG GRUBER A/S

DEVELOPMENT OF PROCESS CONTROL

Increase of operating margin

1
IMPROVEMENT OF ZN CONC. GRADE 53 -> 54 % Zn

Value of 1 kg Zn in conc. at mine.
(separate calculation 22.6.88):

53 % ~ 2,284 NOK/kg
54 % ~ 2,339 NOK/kg

7 575 t Zn in conc. x 1000 x
(2,339 - 2,284) =

416 000 NOK/a.
=============

2
IMPROVEMENT OF CU CONC. GRADE

24,0 % Cu, 160 g/t Ag, 1,3 % Zn
-> 24,5 % Cu, 163 g/t Ag, 1,2 % Zn.

2.1
Increase of value of conc. at the mine

35 709 000 - 35 308 000 =

401 000 MNOK/a.
==============

2.2
Decrease of zinc losses in Cu conc.

330 t - 299 t = 31 t

Value of zinc 31 x 1000 x 2,339 =

73 000 NOK/a.
============

3
SAVINGS IN REAGENT COSTS (5 %)

$$\frac{5}{100} \times 4{,}5 \text{ NOK/t} \times 525\ 000 \text{ t} \sim 118\ 000 \text{ NOK}$$

~100 000 NOK/a.

Basis of estimation:

Ore production 525 000 t/a, Cu 1,35 %, Zn 1,70 %.

Medium term prices:

Zn 900 USD/t, Cu 6,30 FIM (9,69 NOK/kg)
Ag 1000 FIM/kg (1 538 NOK/kg)
TC/Zn conc. 168 USD/t, TC/Cu conc. 435 NOK/t
RC/Cu 1 545 NOK/t, freight 250 NOK/t.