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

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ENGLISH
July, 1989

MODERNIZATION
OF
COPPER AND COPPER ALLOY SCRAP PROCESSING
in
Shanghai
People's Republic of China

UC/UD/CPR/87/224

FINAL REPORT

Prepared for the Government of the P.R. of China by the United Nations Industrial Development Organization acting and executing agency for the

United Nations Development Programme

Based on the work of TESCO/UVATERV as Subcontractor

VIENNA

CONTENTS

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1. BACKGROUND INFORMATION

Recovery and utilization of wastes materials has a long history in Shanghai, the People's Republic of China, which is one of the largest industrial centres in the country.

The population of the city is 11 million. The city has an advanced collecting and processing system for wastes.

Being only state-owned company in this field, the Shanghai Resource Recovery and Utilization Company (SRRUC) handles collection and treatment of several millions of tons of metallic and non-metallic wastes annually, among others that of many thousands of tons of coper and its alloys.

As a follow-up of the Technical Assistance (SI/CPR/85/803) of 1985, a new project No. UC/UD/CPR/87/224 has been initiateed for the modernization of a unit of SRRUC in Yang Pu.

The immediate goal is to establish techno-economic basis for the modernization program of the copper processing unit in Yang Pu through revising the process used at present and through introducing new processes.

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When launching the project (October, 1988) rehabilitation of a furnace was in progress in the copper processing unit and slag processing (washing with water) and waste preparation (break-up grading) were run at a reduced capacity.

Some days after black copper production using bronze and brass chips and slag with copper content was commenced and a chance was being offered to study the production using slag.

In order to evaluate the conditions of the unit, technical documents made available and equipment in and out of operation were studied.

The market showed large demand for copper products manufactured of waste, such as copper castings, black copper ingots, chatode copper etc.

The material testing and quality control system played an important role in the activity since they have basic importance in the development. It could be concluded that the chemical composition of products using the casting process marketed in commerce significantly scattered even within the same quality group and in many cases the qualification had been unreliable.

It has been an expressed intention of the management of SRRUC to develop a reliable quality control system during manufacturing and for the final products. The fact that the Chinese industry produces many products of high quality which can be used in the unit to be developed, is advisable to be considered. Thus the development costs can be reduced significantly by domestic purchases which may be advantageous in the spare part supply in the future, as well.

The Hungarian team completed the field mission by the end of December, 1988. Three months were devoted to the elaboration, processing and evaluation of the collected data and information, as well as preparation of the written documentation.

The Draft Final Report was submitted to UNIDO in April, 1989. Remarks and comments were discussed and incorporated in the present Final Report.

According to the Terms of Reference of the subject contract a Chinese team of experts visited Hungary to study the copper and copper alloy scrap processing in Hungary. The proposed and accepted programme is attached as Annex H. The study tour has been implemented accordingly. The findings and recommendations of the study tour are included in Annex J. for further consideration and action.

2. GENERAL CONDITIONS, JUSTIFICATION FOR DEVELOPMENT

Under the conditions of the existing buildings and infrastrutural facilities, the unit in Jang Pu can produce some 1000 tons of cast copper ingots for processing.

Subject to the technology used and equipment operated the quality of the final products is rather dependant on the raw materials, thus both quality and price are low.

The plant is located at the edge of an industrial zone, in the vicinity of a housing estate. The layout of the industrial facilities inside the plant are shown on Figure No.1. The total area of the plant is 7000 m^2 of which 2000 m^2 is covered by buildings and the balance is concreted.

The technical conditions of the available buildings are acceptable, i.e. after rehabilitation at minimum costs (painting, glazing, canalization) they can be used for the purpose of the development. The built-in areas are shown on Figures No. 2., 3. and 4. . The plant possesses all utilities necessary to the operation /power supply, water and sewage network, heating centre, shower and dressing rooms etc./. Characteristic data are given in Annex A. (see page 135.).

Electric energy is available up to a limit of 200 kW for process purposes presently. Power supply to the plant is provided by an aerial transmission line from the neighbouring plant's transformer station. Its capacity is 380 V/400 A. The energy distribution within the plant is done through a 2 x 100 A main switch with aerial cables to the buildings.

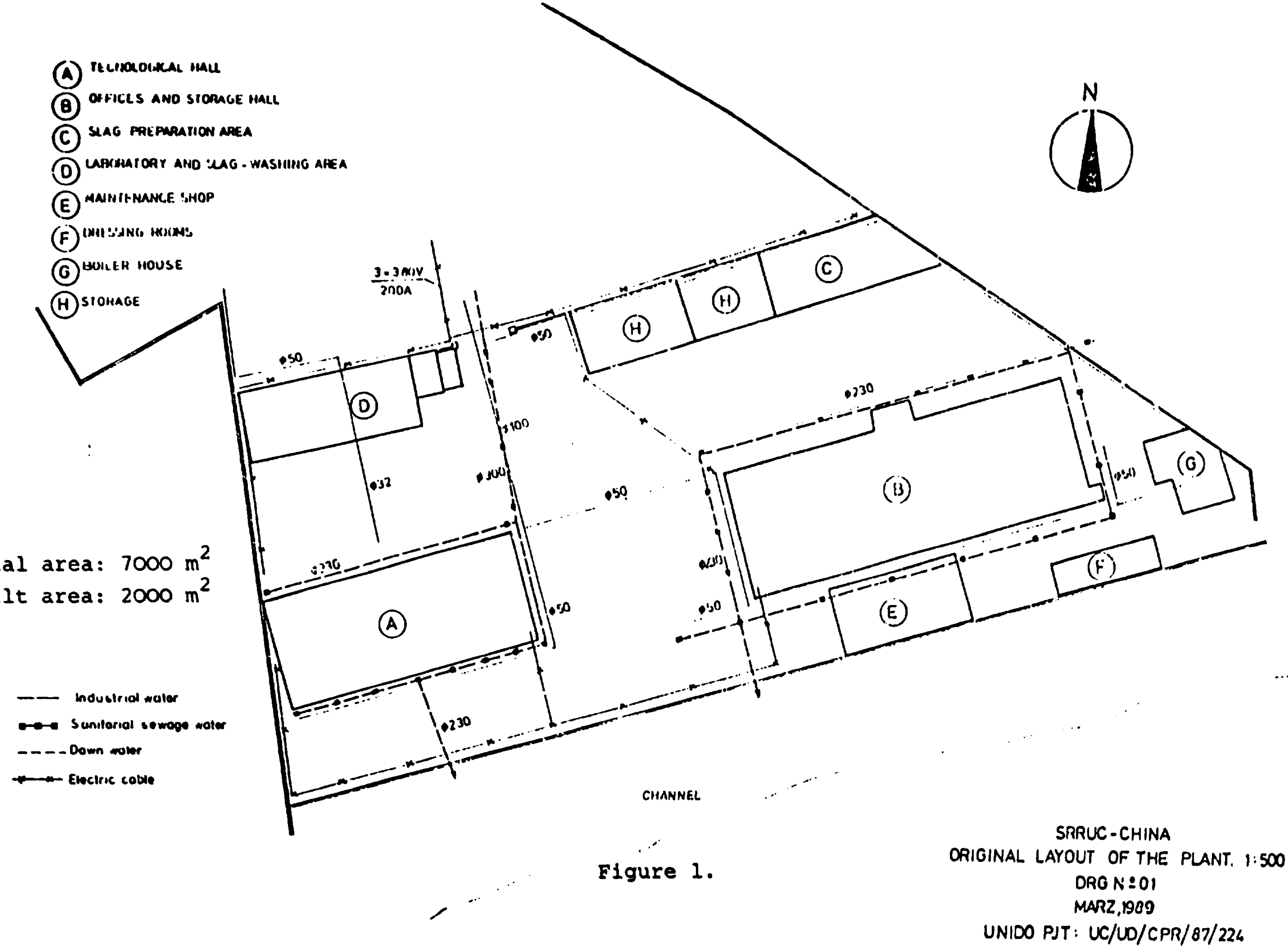
The water supply of the plant is solved from the industrial water-system of the neighbouring unit, using a separate meter. Water network is built within the plant. The generated process and communal waste water flows without any treatment to an open collecting channel at the boundary of the plant in ceramic pipes.

Rainwater is collected in a closed channel and discharged to the municipial channel.

Compressed air is provided using mobile compressors at locations according to requirements.

The maintenance workshop is located in a separate building (marked 'E'). Basically it can solve fast trouble-shootings only.

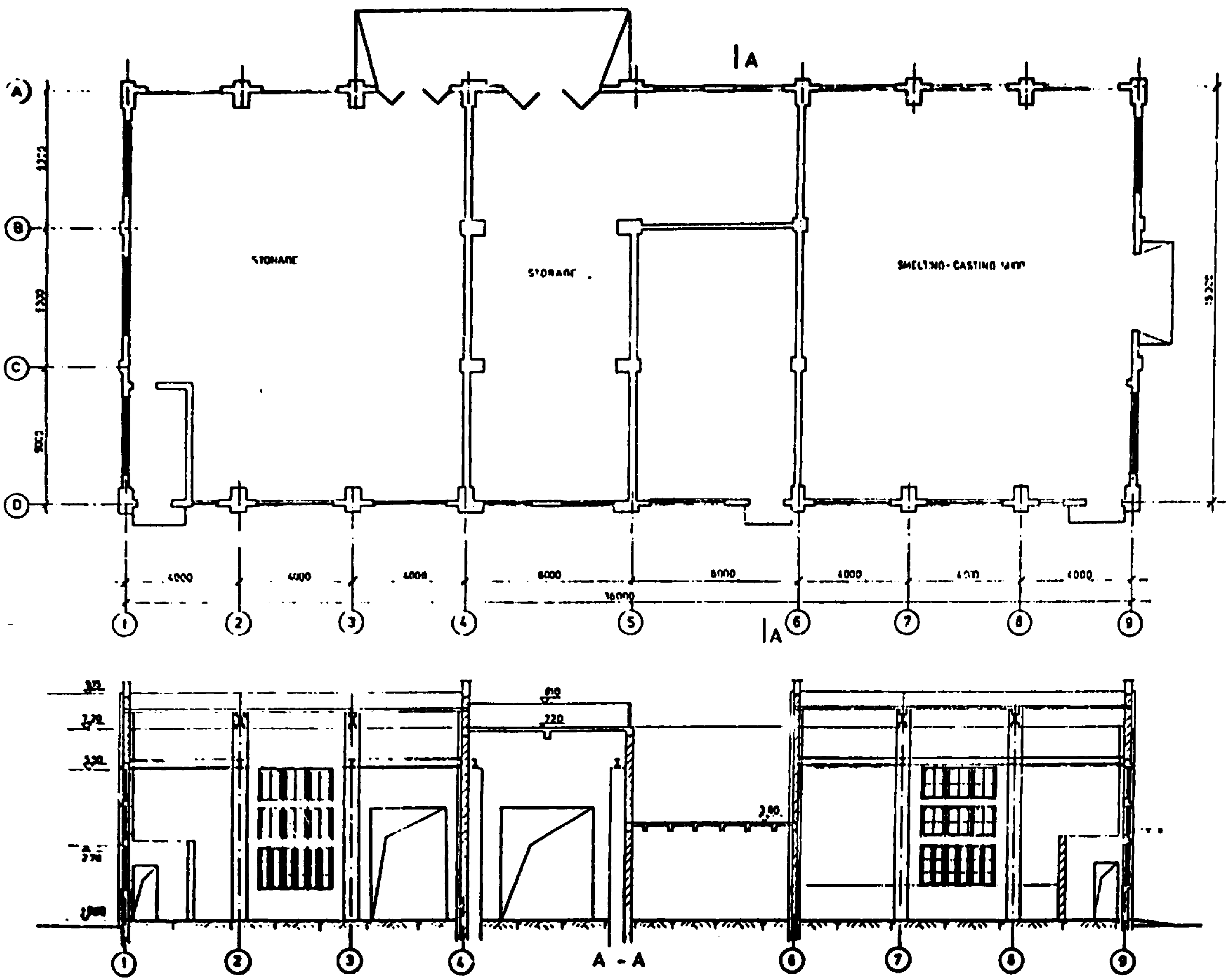
The dressing and shower rooms and toilettes are located on the ground floor in building market 'B' and in the separate building marked 'F'. The hot water required for the shower rooms is supplied by boiler house marked 'G'.



Total area: 7000 m^2

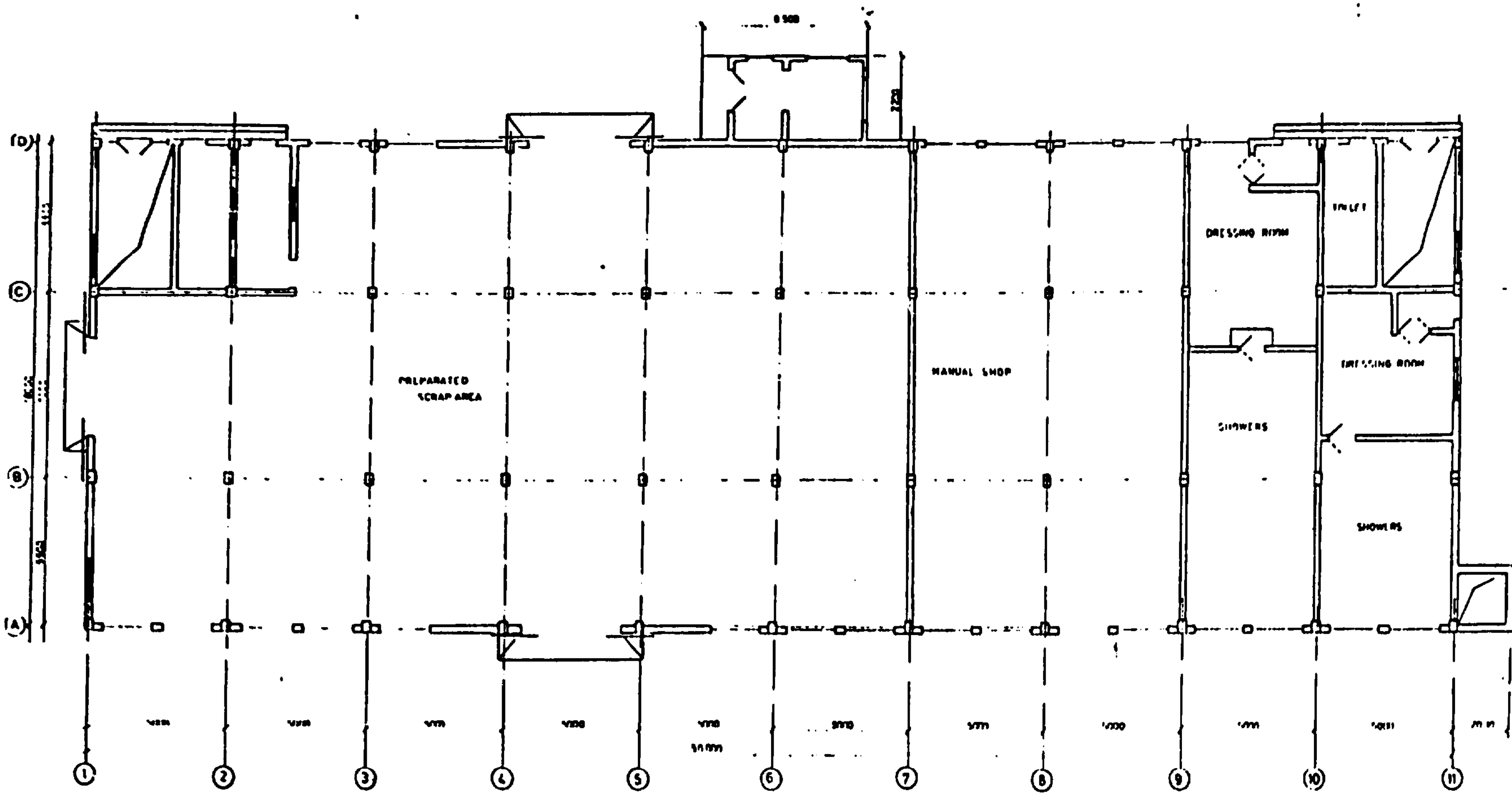
Built area: 2000 m^2

Figure 1.



"SRRUC" - CHINA
TECHNOLOGICAL HALL "A" 1 : 100
PRESENT SITUATION
DRG N°02/1
MARZ 1989
UNIDO PJT: UC/UD/CPR/87/224

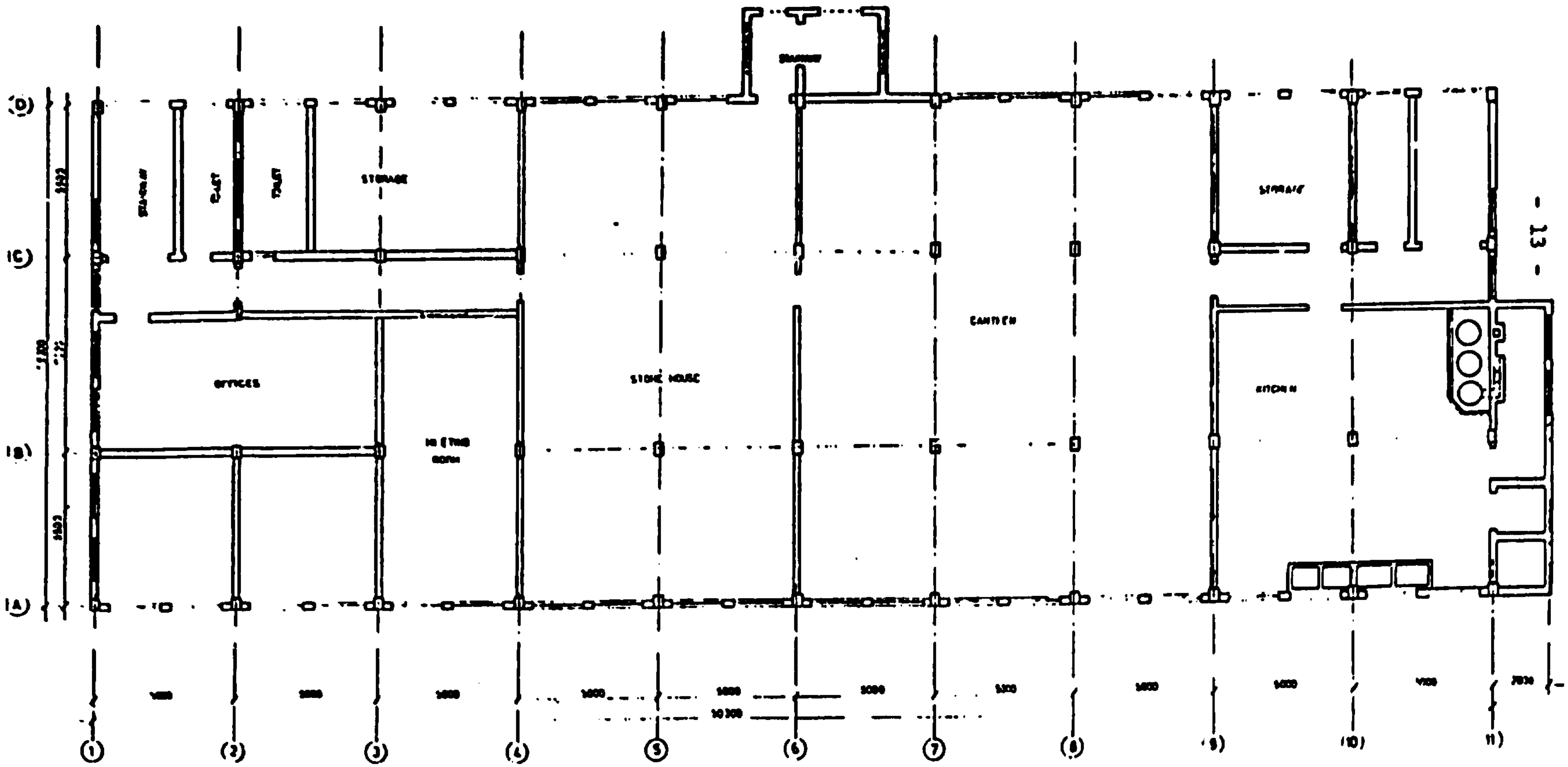
Figure 2.



FIRST FLOOR ±0,00m

Figure 3.

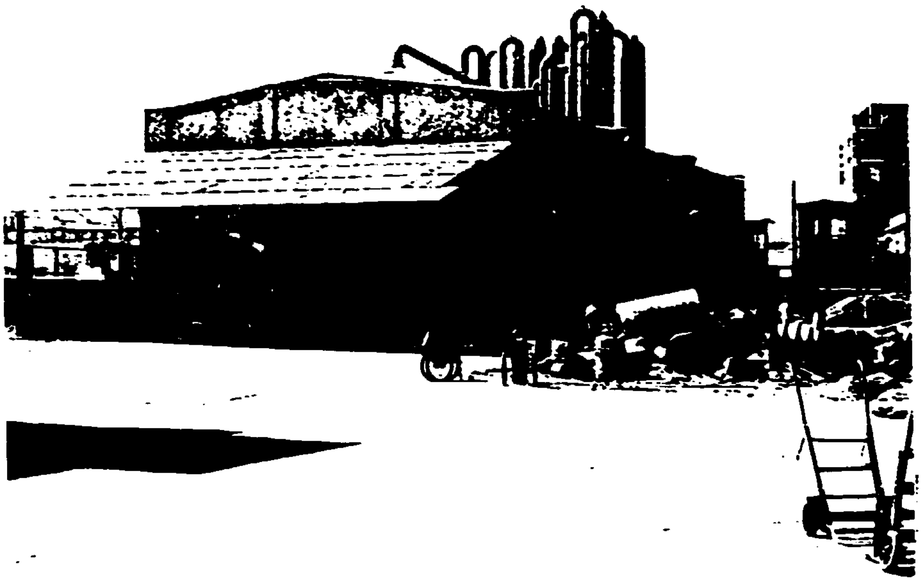
SRRUC-CHINA
OFFICES AND STORAGE HALL "B", 1:100
PRESENT SITUATION
DRG Nº 03/1
MARZ, 1989
UNIDO PJT: UC/UD/CPR/87/224



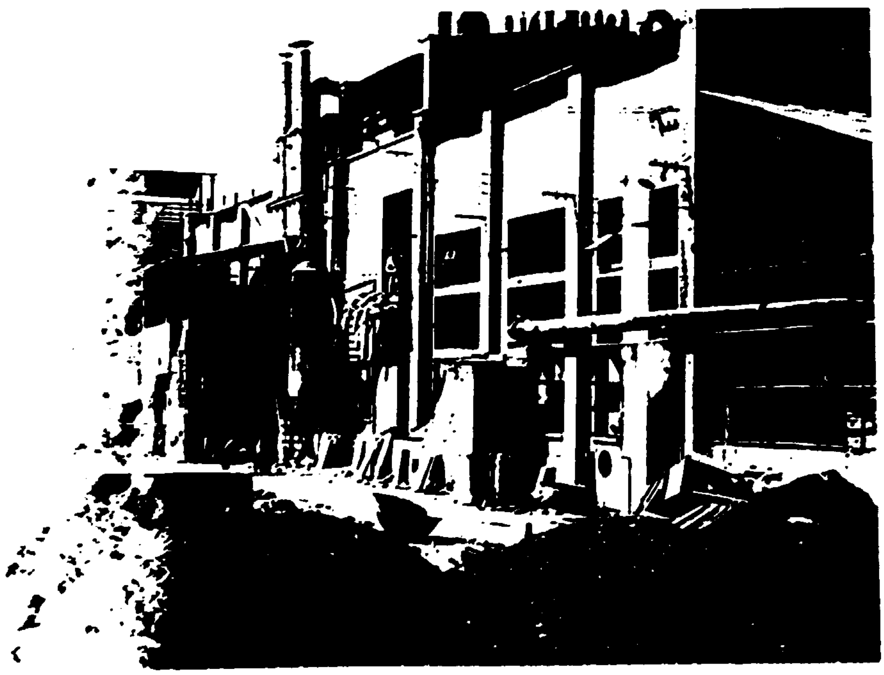
SECOND FLOOR: + 5,00m

Figure 4.

SRRUC-CHINA
OFFICES AND STORAGE HALL "B": 1:100
PRESENT SITUATON
DRG Nº 03/2
MARZ, 1989
UNIDO PJT: UC/UD/CPR/87/224



TECHNOLOGICAL HALL
Photo 1.



TECHNOLOGICAL HALL - SOUTHERN VIEW
Photo 2.

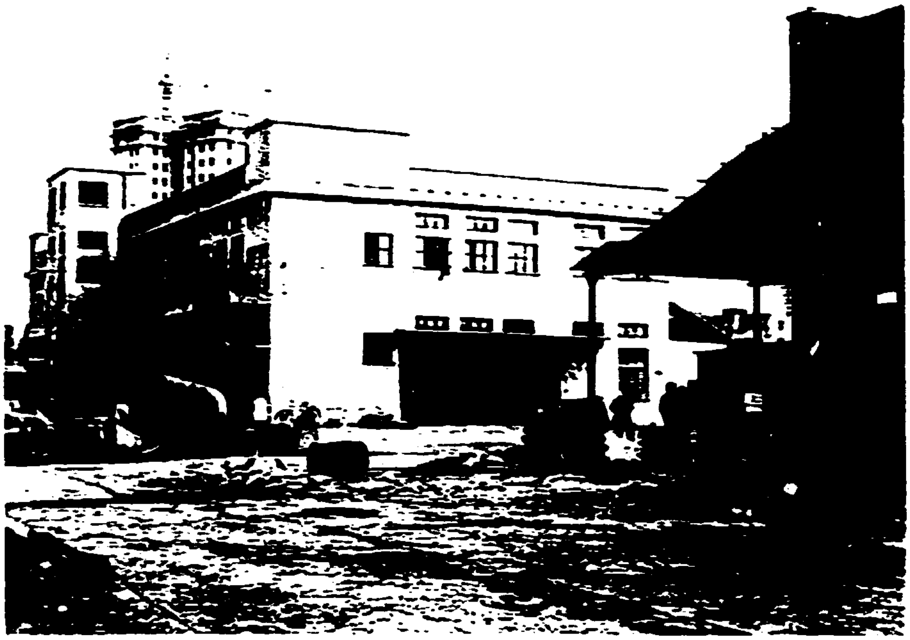
TECHNOLOGICAL HALL - SOUTHERN VIEW

Photo 3.

TECHNOLOGICAL HALL

EASTERN VIEW
Photo 4.

SOUTHERN VIEW - WITH
FLU GAS COOLING SYSTEM
Photo 5.



TWO-FLOOR COMBINED OFFICE AND
WORKSHOP BUILDING

Photo 6.

SCRAP DISMOUNTING AREA
LABORATORY BUILDING

Photo 7.

SLAG PROCESSING BUILDING

Photo 8.

ROUGH SLAG STORAGE AREA

Photo 9.

2.1. The presently used scrap processing technology

The copper scrap and slag with high copper content is processed after a minimal preliminary preparation in the reverberatory open-hearth furnace located in the technological hall marked 'A'. The reverberatory open-hearth furnace is shown in Figure 5. (see Photos 14.,15.,16.,17.)

Processed copper and brass scrap

- Brass chips with high contamination in mixed form. Needle-form and fibrous chips mixed with odd materials (textile, plastics etc.) and iron as well as aluminium chips.

- Copper scrap; mainly dismounted cables, foils from purchased and own scrap.

- Alloyed-copper chips, production scrap with known content.

- Alloyed-copper powder, production scrap with known content and some lumpy components.

- Copper metallurgical slag, dross with an average Cu content of 30% and with unknown other components. Generally this incorporates lumpy components and high iron contamination.

Fuels

- Coal powder
- Coake powder

Auxiliary materials

- Flurorite

TECHNOLOGICAL FLOW-SHEET

Present Situation

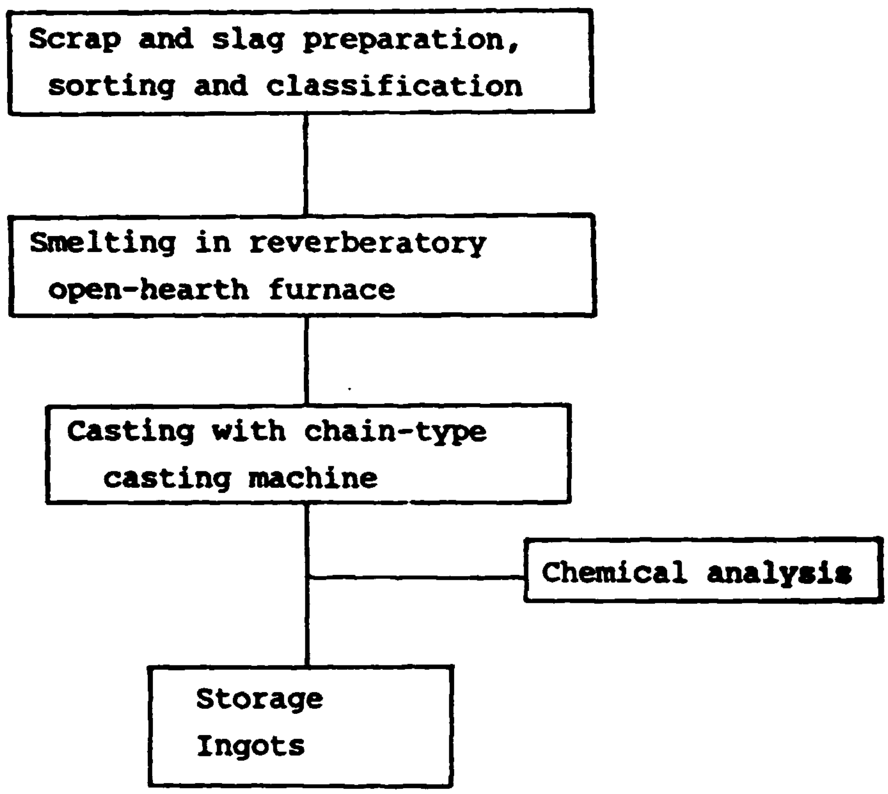


Figure 6.

2.2. The presently used melting process[x]

The flow-sheet on Figure 6., page 20.

The various types of raw materials are processed separately. The raw materials are loaded onto a manually pushed car with solid rubber tires and transported to the plant where weighing is carried out.

The weighted material on the car is lifted onto a feeding platform using an overhead trolley and is tipped into the furnace through a feed hopper (see Photos 18., 19., 20.). During furnace charging firing is stopped. The whole charge is loaded into the furnace if it fits. When loose materials, such as brass chips are charged and the space is not sufficients, the surplus is charged into the furnace after suitable melting. This is shavelled in the furnace through the slagging door.

Following the charging the material is levelled in the furnace through the slag charge door and an opening made in the wall near the burner. After this operation is complete, the opening is walled in and the firing is started.

The firing is continuous. The sticking material lumps are loosened frequently with steel scrapers, while the pool is stirred. When melting enriched slag, if the slag is too much, part of it is skimmed.

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[x]Note: Results of audits and examinations on site are shown in Annex B. (page 138 .)

After complete melting of the charge, part of the slag is removed through the slagging door into a pit. A steel hook is inserted in the melt slag. When solidified it is used to lift the block out by means of an overhead troley and to put it on a hand car. It is hauled to a slag deposit site afterwards.

When slag removal is complete, the casting line and and the discharge are started. The charge is continuously discharged.[x] Subject to the speed of discharge, the velocity of the casting line is controlled using a manual switch. If the metal jet is too strong, the discharge opening is throttled with a plug. During discharge firing is continuous. Release of the metal blocks from the casting line is promoted by tapping with hand tools.

The removed block falls onto a hand car and it is immediately transmitted to the storage area. Upon completion of the discharge, firing is stopped and insides of the cast chain moulds are blackwashed using silver graphite, the firing equipment is maintained and fuel needed for the next charge is prepared (see photos made on site).

An approx. 3 to 5 cm slag layer remains in the furnace.
When melting metal no auxiliary material is used.
When processing enriched slag 120 to 150 kgs of fluorite mineral is added as slag former to the charge.

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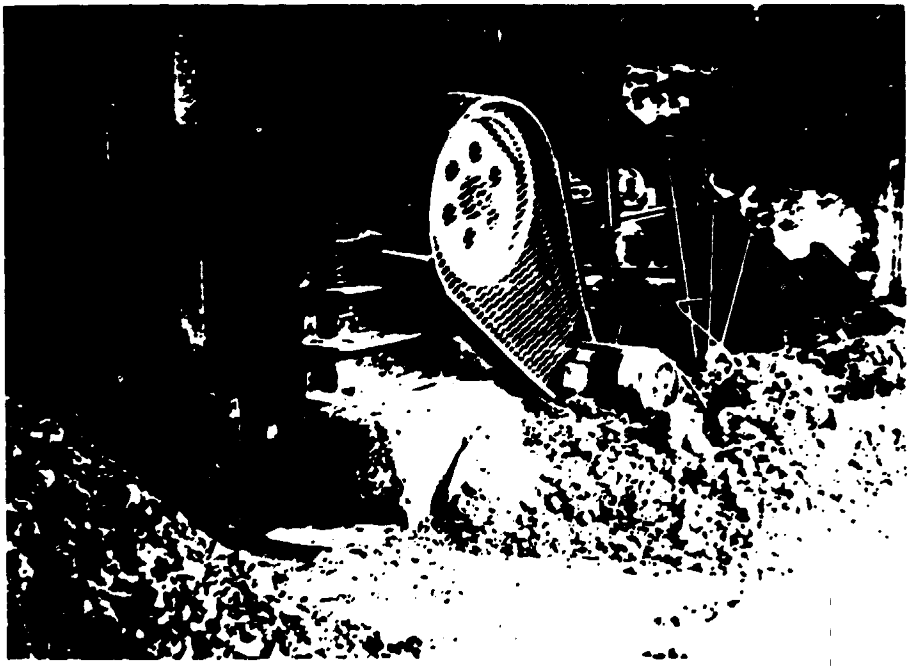
[x]see Photos 21., 22.

ROUGH SLAG

Photo 10.



SLAG CRUSHING

Photo 11.

CRUSHED SLAG
Photo 12.

SLAG WASHING POTS
Photo 13.

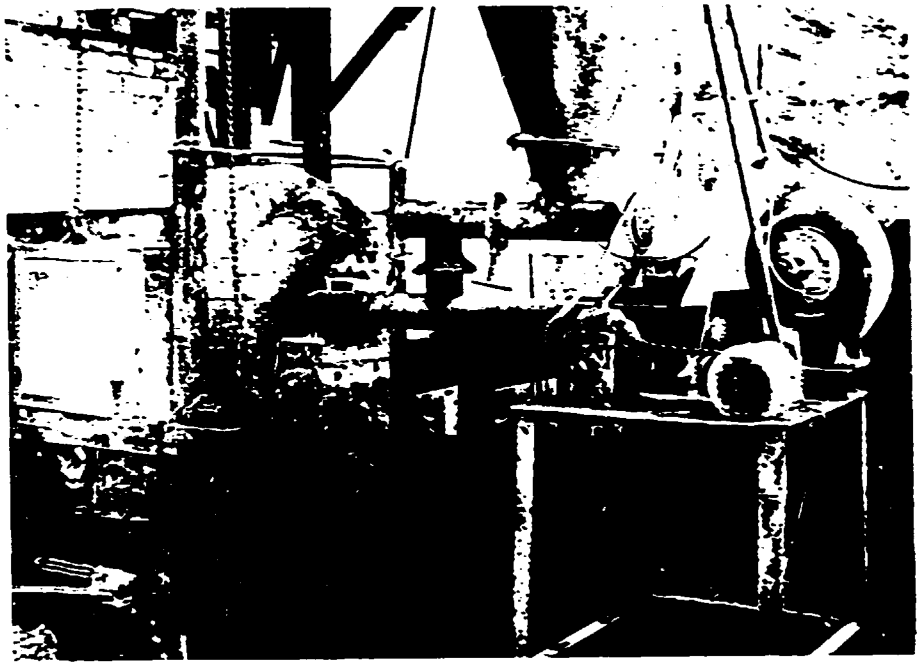
REVERBERATORY OPEN-HEARTH FURNACE

Photo 14.

REVERBERATORY OPEN-HEARTH FURNACE
UNDER REHABILITATION

Photo 15.

Photo 16.



FIRING SYSTEM OF REVERBERATORY
OPEN-HEARTH FURNACE
Photo 16.

COAL POWDER CHARGING SYSTEM
Photo 17.

Photo 18.

CHARGING OF THE RAW MATERIAL INTO
REVERBERATORY OPEN-HEARTH FURNACE

Photo 19. Photo 20.

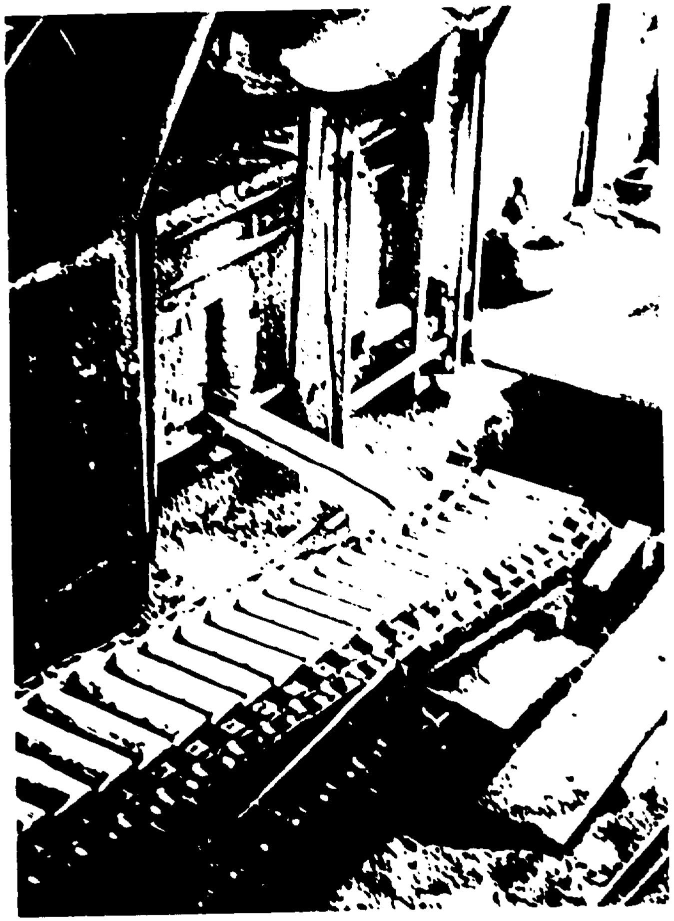


Photo 21.

Photo 22.

CASTING MAHINE
(CHAIN LINE)

PIPE LINES AND FILTERHOUSE

Photo 23.

FILTERHOUSE WITH OPENED DOOR

Photo 24.

FILTERBAGS

Photo 25.

2.3. Slag enriching process

The slag - using a pneumatic hammer - is broken up into a size of a child's head, while the large iron pieces are removed. The material so prepared is chopped in a jaw crusher to sizes between diam. 4 to 8 cm, then further ground in hammer mill.[x]

The next phase is grading on a manual sieve. The particles smaller than 5 mm, are removed for washing, while the larger ones are recirculated.[xx] The metallic and slag fractions are separated by means of manual was bowls washing with water. Both are dried. The metallic fraction is melted, while the slag fraction is marketed.

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[x] see Photos 10., 11.

[xx] see Photos 12., 13.

2.4. Quality control system at present

Based on the answers on the questionnaire and the experience obtained ruding the field mission, the plant laboratory can meet the requirements imposed by the present process only and a comprehensive quality system is non-existing. The laboratory provides possibilities to analyse the chip wastes as raw materials and the ingots as products, for elements Cu, Zn, Fe, Sn, Pb as alloy components, when puurchasing raw materials and supporting price negotiations for product marketing.

The chemical examination met. od used i.e. titration is established safe, accurate and simple chemical means to determine alloy elements. During sample preparation no rinsing with alcohol or other method is used to remove fat contents and to dry the sample, thus the measuring error, with the weight determination and in case of some heavily contaminated samples the measurement is impossible and meaningless due to this fact. The above conditions prevents the laboratory from determining oil and moisture contents. This information would be very important in many cases as to metallurgical aspects.

The personnel in the laboratory is not trained to analyse slag, has no knowledge of chemical methods to determine metal oxide contents.

At present two trained chemical technologists work in the laboratory. The adoptation of chemical formulas or determinational other contaminant contents may be the first step to serve the manufacturing process with testing methods.

Regarding its present location, the laboratory is not located perfectly for accurate measurements since the metallurgical unit is too near. Therefore, in case of unfavourable wind direction the laboratory receives a lot of dust and highly contaminated air from the operating melting furnace. The present room does not suit for implementing development in the future.

3. RECOMMENDATIONS

All the basic information the Chinese partners could disclose to us are summarized in Annex C.

It was the submitted data which served as a basis for elaborating our concept of development in numerical form. However, there are several other pieces of information at our disposal which are of crucial importance but cannot be expressed in numbers, such as:

- the existing reverberatory furnace is worn out and out-of-date;
- the technology used in the reverberatory furnace is simple melting without any metallurgical process;
- the site has a free indoor area for development purposes, i.e. the buildings can be enlarged;
- the site is surrounded, so it cannot be extended to a significant extent;
- market trends indicate that the demand for raw copper (anode copper) is on the rise now.

Considering the potentials and future possibilities, we make the following recommendations for plant development:

a) it is necessary to introduce a well-organized reception and preparation of raw materials;

b) the probably oxide-type minde product (approx. 25% copper content and 50-60 g/t gold content), whose potential availability amounts to about 5000 tons/ year, should all be processed;

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c) with a new technological process (in a cupola blast furnace), even the highly contaminated copper wastes could be processed effectively;

d) the adaptation of mould casting technology could lead to new product lines and access to new markets;

e) an up-to-date quality control system should be launched to ensure guaranteed quality of final products;

f) development should take into account the requirements of environmental protections.

In addition to the above recommendations we propose that you use the following main technological equipment and processes to be discussed in detail later in this paper:

- briquetting equipment to process dust-containing wastes (slag);

- cupola blast furnace and attached flue gas purifying system to process (melt) mixed contaminated copper wastes and slag;

- induction melting furnace to process wastes suitable for direct casting;

- special casting machine to cast tubes and sleeves;
- gravity casting procedure;
- sand moulding procedure;

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- rough-machining of castings;
- up-to-date metal testing method.

To meet technological requirements, the supply systems should be expanded:

- electric power supply[x]
- cooling water supply
- compressed air supply

3.1. Advantages of technology development

- Through qualification and grading, using waste separation and fast chemical analysis, the materials get to the optimal processing are keeping their value.

- Supplying the qualification system with fast chemical analysis equipment giving results in a few minutes will enable the manufacturing method easily controllable and an accurate final product qualification.

- The induction furnace proposed for installation is flexible in adopting the consistency of the varying raw materials and the liquid metal demands of the following process phases.

- The products by the foundry will have a wider range of application and can flexibly follow the market demand.

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[x]Note: energy sources may be electric power and coal dust

- The casting techniques to be introduced (centrifugal casting, gravity-type mould casting, sand mould casting can easily be trained and can be introduced gradually.

- In the blast furnace type furnace any copper metallurgical process waste (slag, skimmings etc.) and other wastes containing copper in oxide, hydroxide or carbonate form can be processed if the copper content surpasses 10 percent.

- During processing in a blast furnace the most common contaminants of the raw metal can be removed to a large extent. Large portion of zinc (Zn) volatilize and can be filtered from the flue gases as flying powder with zincoxide (ZnO) content; while a larger portion of iron contents and a small portion of the zinc content is bonded to the slag.

- The black copper obtained from the blast furnace is a very suitable raw material for the copper refineries.

- Both the powder with high zincoxide (ZnO) content and the slag with low copper content (Cu: 1.5 to 2%) can be marketed. All other wastes or by-products can be recirculated into the system.

- Considering the existing conditions the project can be implemented gradually without interrupting the processing activities.

- If required the technology designed for the Jang Pu plant can be relocated to other suitable plots after the necessary adaption.

3.2. Negative features of the recommended development

It must be mentioned that, in addition to the advantages stated in the development proposal, disadvantageous characteristics will also be encountered.

- The variety of raw materials pre-estimated for processing with their small quantity in particular and in total will result in a low utilization of the equipment.

- No blast furnace type furnace of such limited capacity - which would be suitable for continuous processing of the quantity encountered - can be built: thus the annual utilization of the new equipment to be installed will be low if the amount of waste materials collected fails to be increased.

Comment

No chemical, mineralogical, etc. data are available on the said oxide-type, copper-containing material mined in an amount of some 5000 tons/year, which makes the actual usability of the material uncertain. We suggest that you have an in-depth analysis of this mine product carried out as soon as possible for it may represent a substantial quantity of raw material for the shaft furnace and has an influence on further copper waste supply, as well.

If cannot be left out of consideration either that the amount of copper-containing waste referred to in Annex C. is insufficient for the continuous operation of the cupola blast furnace. That is why we have been able to assess annual material supply relying only on the amount actually available at present.

Recommendations for development are shown on Figure 7.

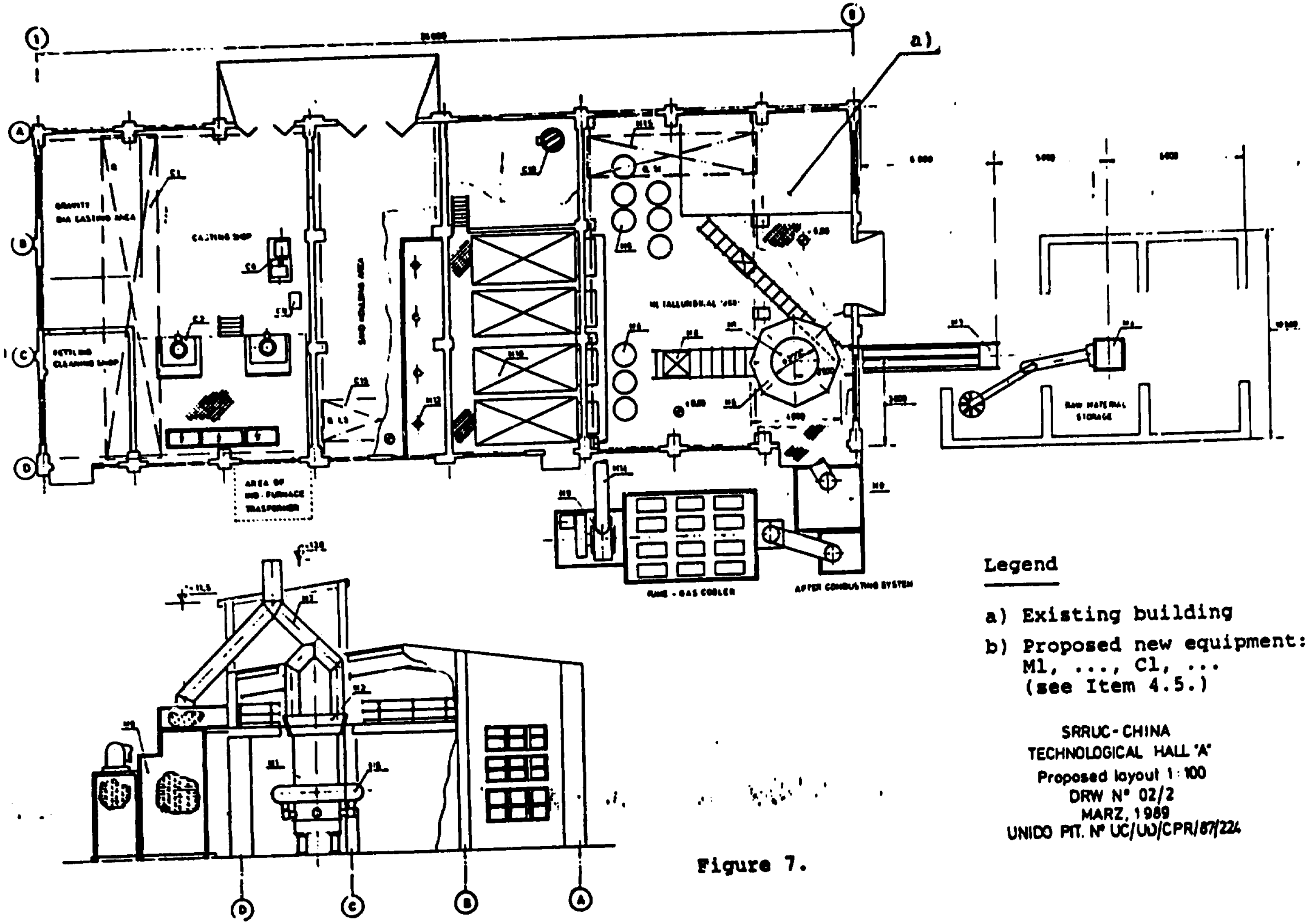

Figure 7.

<u>Legend</u>

a) Existing building

b) Proposed new equipment:
M1, ..., C1, ...
(see Item 4.5.)

SRRUC-CHINA
TECHNOLOGICAL HALL 'A'
Proposed layout 1:100
DRW N° 02/2
MARZ, 1989
UNIDO PIT. N° UC/UD/CPR/87/224

3.3. Implementation of the proposed technology development

As a first step it is recommended to develop the laboratory and material preparation, to renew the reverberatory furnace and to introduce a new melting process. To improve the material preparation a suitable laboratory and a resolute material receiving organization are required in the first place. In addition to the existing one a complete material preparation unit should be implemented by installing a hydraulic cutter and a magnetic separator.

Materials are to be classified as early as upon their arrival by their source and physical state and possibility for their mixing must be prevented. The composition must be determined both for useful alloy elements and harmful contaminants using material analysis. The further use of the raw material can be decided upon: it may be sent to alloy manufacturing (cast ingots or cast products), black copper manufacturing or maybe refined copper manufacturing. Making this selection is justified economically even if only the reverberatory furnace is in operation. Manufacturing of an ingot with standard composition is much more economical than that of black copper.

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Therefore, whereever possible casting ingot should be made, qualified and marketed. The reverberatory furnace in use is suitable for introducing the slag metallurgical processes, but the melt sampling and the fast analysing should be resolved, as well as the necessary slag forming materials purchased. Through developing a suitable slag, the metal contamination or burn losses can be reduced.

In case the reverberatory furnace will be renewed, introduction of refining operations is also advisable. The majority of the contaminants may be removed from the melt using oxidation that can be implemented by air blast.

For wastes that contain only a few marketable alloy materials, increase of copper content by refining is advaisable. One example is the processing of enriched (washed) slag. Contrary to the presently used process, slag charge and removal should be continued as long as the furnace is filled with metal melt, followed by forming a new slag and oxidizing the contaminant by air blast, or their significant proportion. Then slag should be removed, reduced to the necessary extent and the metal then discharged only. Thus the copper contents in the ingot can significantly be increased. From suitable waste copper of acceptable purity alloy can be produced and the unit can utilize it to manufacture ingots, or sell on the market as required.

When renewing the reverberatory furnace, it is expedient to remove the excess pipings, to develop lccal exhaust :ntillation over the coal powder feeder and metal discharge opening as well as to modify the exhaust hood over the slag removal door. All exhaust hoods must be fitted with a control and closing butterfly valve.

The fans completely worn out and of a non suitable capacity must be replaced. The flue gas exhaust fans must have a minimum out-put of 8500 m^3/h and a minimum pressure difference of 350 mm vo. The local exhaust is also of the same type. The exhaust units imply a flue duct of about 550 mm diameter. All flue and dust ducts are to be of closed construction to prevent decrease of efficiency. To protect the filter unit it is recommended to install a unit supplying cooling air which is controlled according to the flue gas temperature (see Photos 23,24,25.).

In addition to the exhaust system the ventillation of the building internal space can be implemented by installing a duct on the roof opening or by an axial fan with a direct outlet. Besides all steelworks in the buildings require repair, corrosion protection and window renewal.

The experience to be obtained by introducting the melting process and the material preparation described above can properly be used to commission the foundry to be constructed in the meantime. The foundry will equipped with induction furnace, a centrifugal casting machine suitable for casting sleeves and bushings and a mould cast unit. Production of sand mould castings will also be possible.

After commissioning and running the melting equipment of the foundry the complete re-melting of the metal wastes can be re-organized using these furnaces (calculating with 750 tons of wastes).

As soon as the foundry is operating continuously and safely it is advisable to review and decide upon the necessity of the blast furnace type furnace project, since the amount of slag and skimmings produced will drop to approx. 100 tons. This 100 tons of slag contain some 30 to 40 tons of valuable metals that can be marketed in that fomr. It equals to the metal content of the slag marketed presently. Since no slag has been purchased so far and onyl the slag generated locally have been processed, a comprehensive market survey is necessary regarding quantity and quality of metallurgical copper wastes, slags, skimmings, workshop trimmings etc. on the market. The variety of non-processed or non utilized wastes with copper content are to be surveyed. In case the amount of copper to be collected this way reaches 1500 to 2000 tons, the construction of a blast furnace type furnace will be economical.

With its 30% Cu content the 1400 tons of slag indicated at present, contain 400 tons of copper that is raw material for about 500 tons of black copper. The load of the furnace including the copper wastes calculated is about 25%.

Processability of the pure powder potentially available must be examined because in a positive case it would load the blast furnace capacity.

The construction of the blast furnace and its auxiliary equipment is possible while the waste processing is being continued and will not cause difficulties in production or commerce.
Upon putting the furnace into operation purchasing of a briquetting press is also required.

During plant development the quality control system will have to meet the requirements of the technological processes in the whole plant, i.e. comprising the following phases:

- raw material qualification and classification,
- inspection during manufacturing both metallurgical operations in the blast furnace and alloys in the induction furnace,
- quality control of final products
- control with feedback to the metallurgical operations with qualifying the dust separated and slag discharged,
- laboratory must be made suitable to come up to environment protection by carrying out periodic examinations of the cleaned flue gas in accordance with the stipulations of the environment protection standards.

The project can be implemented with the new technology being introduced step by step carrying out the basic functions continuously.

4. BRIEF SUMMARY OF THE NEW TECHNOLOGY

The main process phases of the recommended technology is shown in Figure 8.; it comprises transportation of the copper scrap to the plant up to storage of the finished products (see page 47 .).

The flow of annual material quantities involved in the production process and being connected with technology is shown in Figure 9. (see page 48 .).
Hereinafter the different phases of the technology will be explained in details.

4.1. Main Phases of the Scrap Preparation Technology

The scrap received at the plant may be homogenous or miscellaneous. Homogenous scrap must be stored analysed, separated having determined its composition and transferred to the storing place. Preparation of material can be performed on the site being used currently.

In case of miscellaneous scrap it must be determined, if it contains parts worth of selecting. These parts have to be selected, sample, analysed and stored together with materials of the same quality. Miscellaneous, contaminated slag must also be sampled, its Cu content analysed and stored together with other miscellaneous materials.

PROPOSED TECHNOLOGICAL FLOW-SHEET

Metallurgical and Casting Process

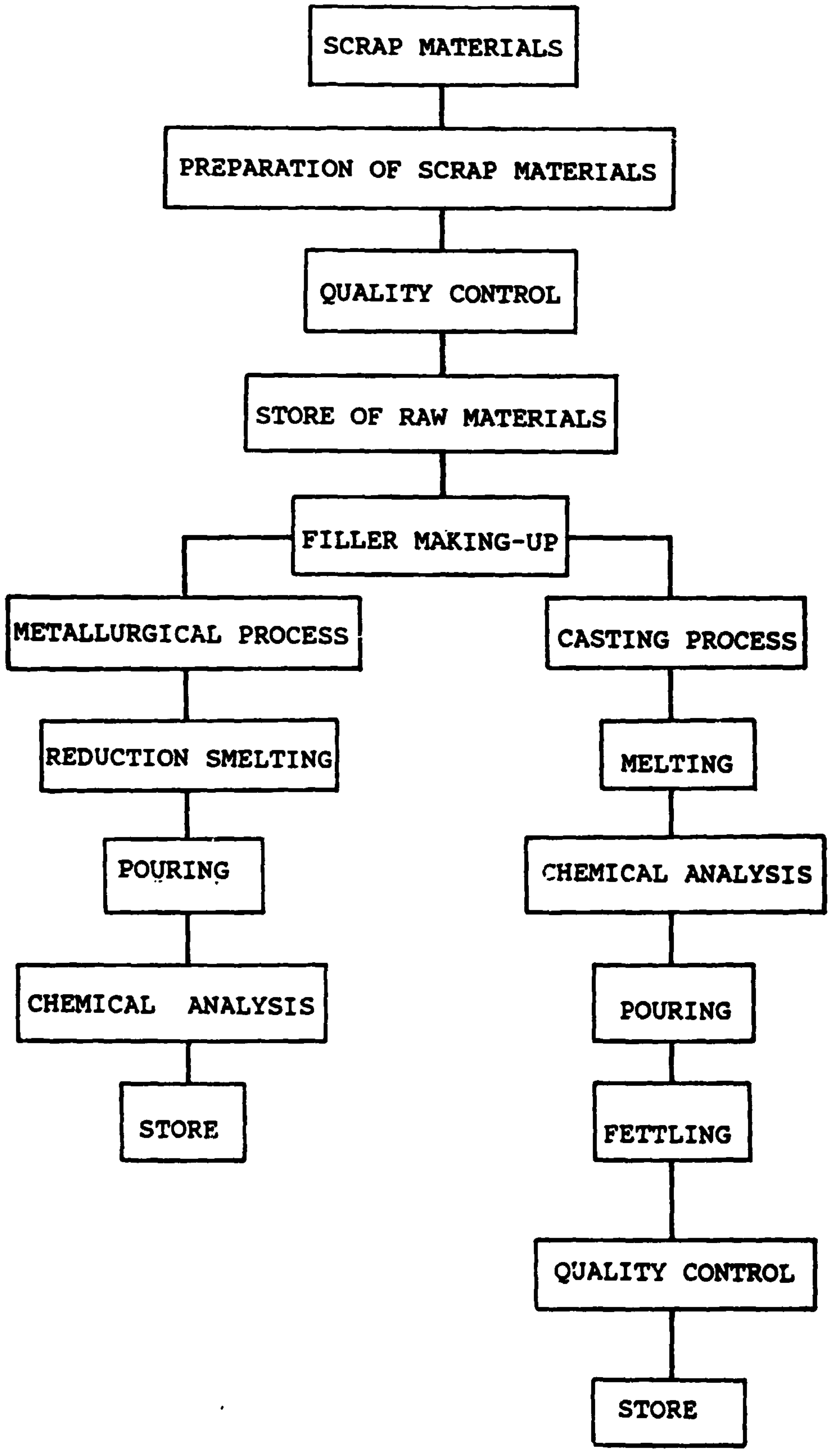

Figure 8.

PROPOSED TECHNOLOGICAL FLOW-SHEET
- Scrap preparation -
Main Line

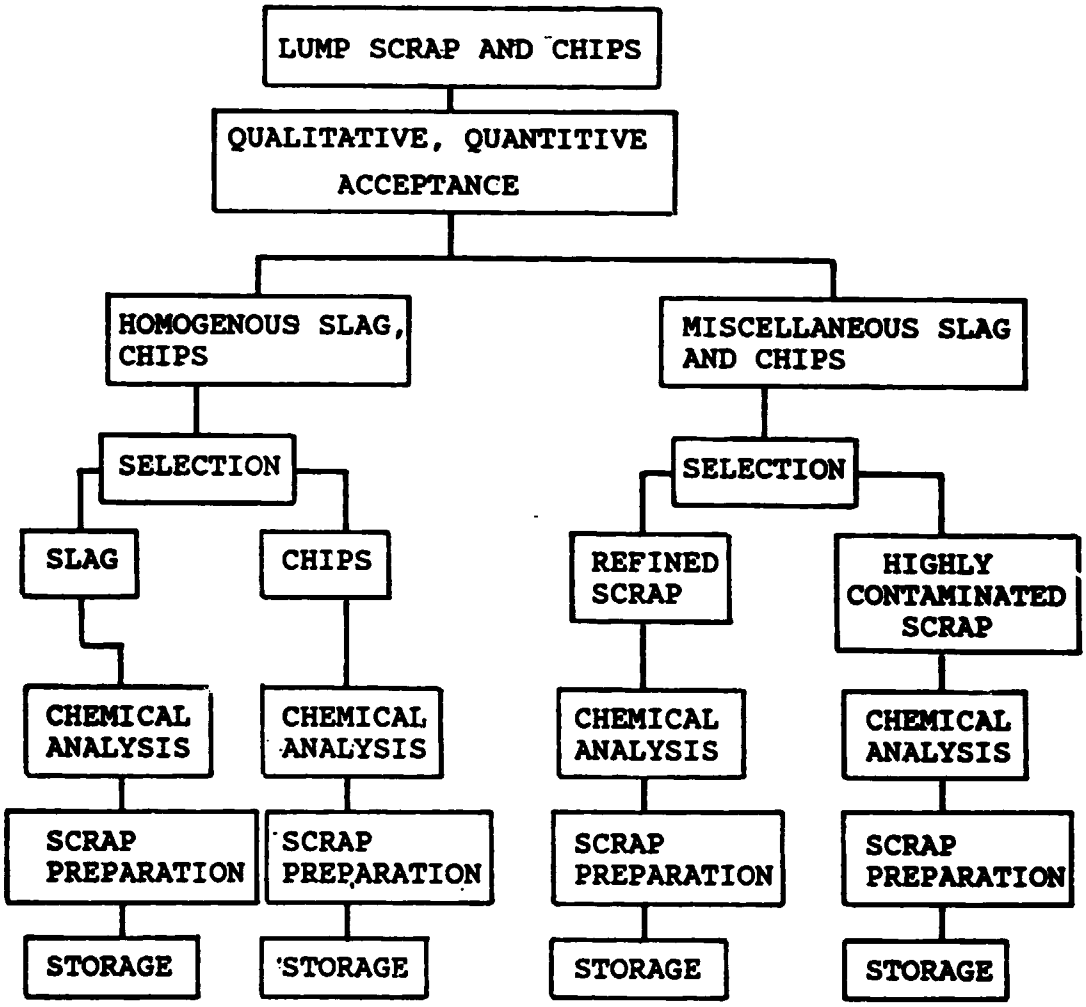

Figure 9.

The above mentioned procedures must be done for both the scraps and the lump scraps and they must be stored separately.

Main flow of the preparation is shown in Figures 9. and 10. (see page 48., 50.).

Scrap preparation

The received scrap - separated according to refined scrap and contaminated one - must be sorted and selected.

PROPOSED TECHNOLOGICAL FLOW-SHEET

- Slag preparation -

Main Line

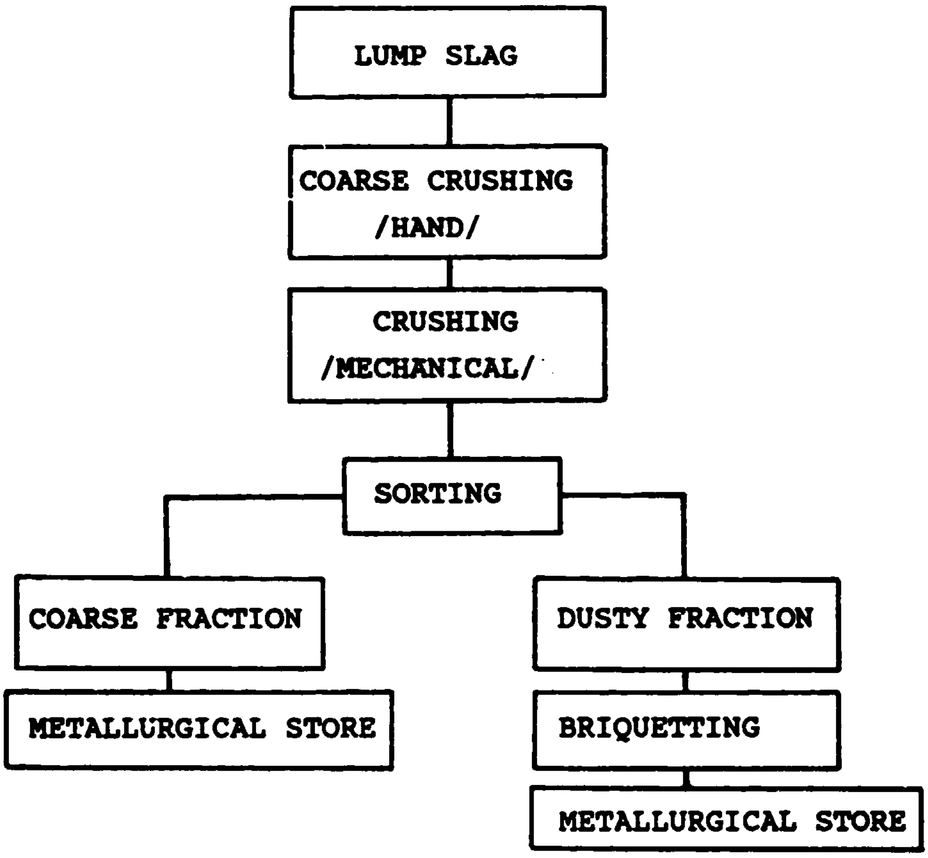

Figure 10.

Odd materials must be removed. Fibrous, curly scrap is to be crushed squeezed in baling press or embaled according to its physical properties. Crushed scrap is returned to screening, while the embaled one is transferred to the cutting shears. After chopping this material is added to the prepared miscellaneous material and stored in the store of the blast furnace. Iron is removed from the small scrap of homogenous quantity and separated by sort using magnetic separator and the deironed pure scrap of known composition is transferred to the foundry store according to its composition.

Contaminated, miscellaneous small scrap and the ferrous fraction obtained from the separator is briquetted in the press and stored in the store of the blast furnace.

Slag stored separately based on its chemical grade, is prepared according to its physical conditions. Compacts slags, having maximum diameter less than 30 cm, are transferred according to their quality either to the foundry store or to the store of the blast furnace.

Slag bigger than the above mentioned ones are chopped by the cutting shears to the required size and transported to the adequate store.

Bigger, curly-fibrous or hollow etc. materials must be embaled in the baling press to have a thickness of 10-15 cm. Afterwards the bales are to be cut into four and transported into the store that suits its quality.

Slag is to be disintegrated by hand-operated compressed-air hammer to a size allowing feeding of the slag into jaw crusher; big-sized iron and metal-parts must be removed. Slag containing copper is transported into the store of the blast-furnace. Slag disintegrated to the required size is to be crushed in the jaw crusher to have a dia. of 80 mm. Crushed slag, dusty slags are screened. Coarse part gets to the store of the blast-furnace, dusty part is briquetted using CaO hydrate as binder.

The above mentioned materials are sampled in the store and the Cu, Sn, Zn, Pb, Fe, CaO and SiO_2 content of the samples are to be analysed.

Charge is composed of material known composition and prepared as explained for the blast-furnace.

4.2. Main Phases of the Metallurgical Technology

The cupola blast-furnace is suitable for different metallurgical processes, such as: reduction melting, reaction melting etc. so it allows metals, copper melt very efficiently. Cupola blast-furnace has good heat utilization and metallurgical efficiency. It is possible to obtain high-fluid slag of good composition in addition to low metal waste. As coke is utilized as energy-carrier in this instance the blast-furnace is the most advantageous for treating slag and dross.

The metallurgical process is shown in Figure 11. Fuel and reducing material of the furnace is foundry coke, 80-110 mm diameter.

Chips to be processed are to be prepared to nearly the same size. Dust and scrap are to be briquetted, lumpy slag and slagging medium are to be crushed and lumpy waste metal to be cut. Charge, containing 25% of copper as a minimum and 40% (Cu) as a maximum is to be composed of the materials described above and fed into the furnace periodically alternating with coke of required quantity (see Photos 26.,29.)

Operation of the furnace always begins with drying of the heart, that of the furnace jacket, if required. For this purpose wood, later on coke are to be used. Hearth together with the burning cokes must be pushed under the furnace, sticked with heat-resisting material and pressed up by the help of screw spindles.

PROPOSED TECHNOLOGICAL FLOW-SHEET

\- Metallurgical process -

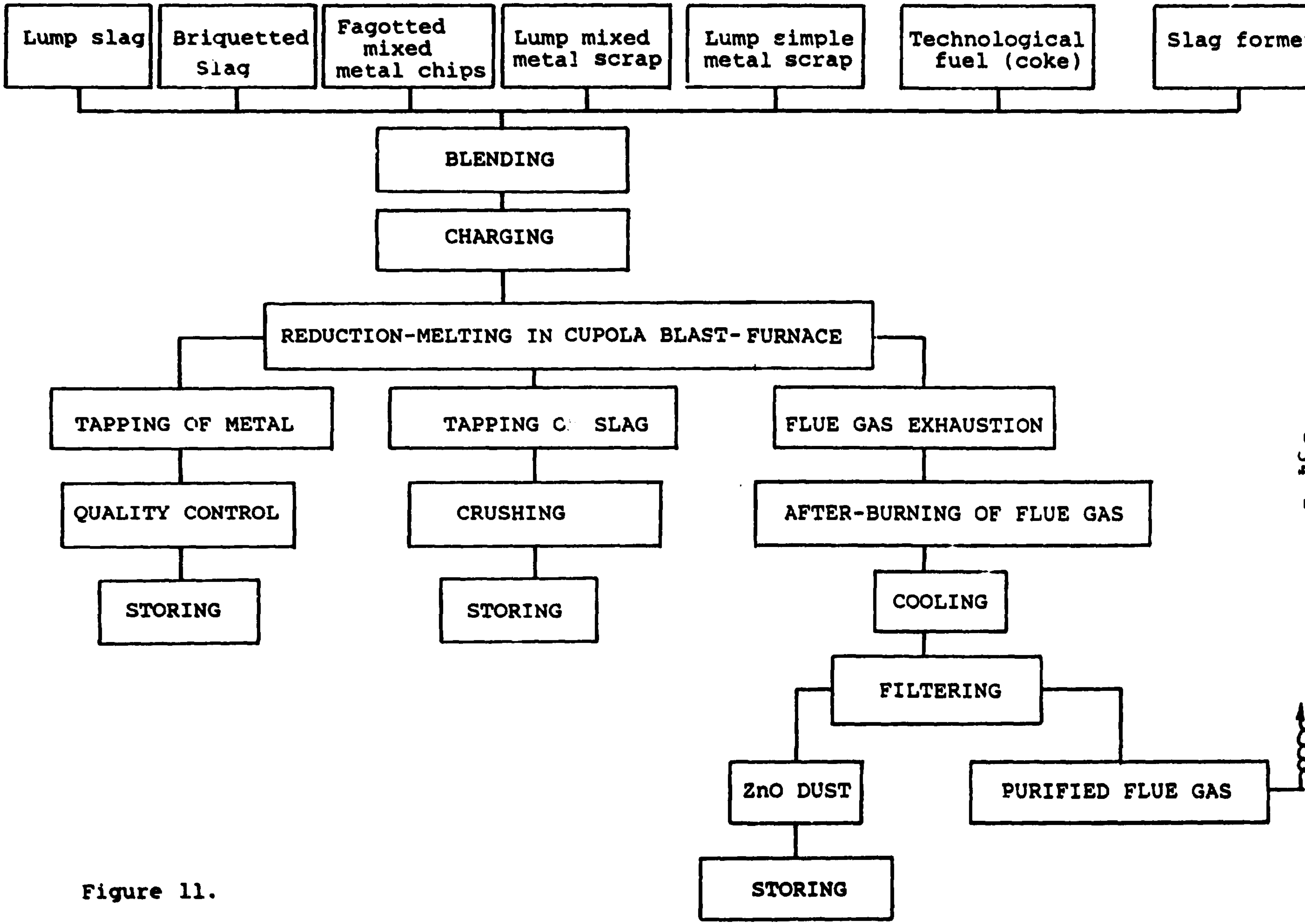

Figure 11.

Coke is charged into the furnace as explained, is burnt by the blasted air, thus heating up the furnace.

Melting is always to be started by slag-melting. The slag heats up the furnace well due to its high thermal capacity. After the first slag tapping - the hearth is full of melted slag - feeding of the metal charge, i.e. that of the prescribed charge may be started. Charge of such volume is expedient that allows feeding of coke of a full skip as a minimum at once, that will be followed by the predetermined charge of metal content and necessary slag forming materials. It is important that a suitable coke-bed be always in the furnace and may be corrected by changing the charge or feeding extra coke.

Thus the furnace can be operated continuously, it can be fed in accordance with the height of the charge, this later one can be checked and measured by hand appliances. Pressure of the blast air is also an indicative figure showing the changes in the height of the charge.

Slag is to be discharged frequently, nearly continuously. The metal is to be discharged periodically, when the hearth is full of metal up to the discharge hole for slag.[x] It can be checked when discharging the slag. Slag is discharged either into conic slag vessel or into granulator depending on the further processing. Should the slag be used for road or railway construction as crushed ballast, the slag is discharged into slag vessels from which it is emptied after cooling and is crushed by jaw crushers. If it is intended for use as cleaning material for castings and metals (instead of sand) it must be granulated and sorted.

Metal is tapped into moulds.[xx] Billets weighting about 400 kg lifted from the moulds are ready for sale. If sale of such big billets is not possible, metal may be discharged into casting chain, too. Quantity of the black copper at one discharged amounts to 1000-1500 kg.

Operation of the furnace can be checked based on the discharged slag. The operation is abnormal if the slag is not thin-liquid. It may be caused by cold run, when the slag is not hot enough and is not of adequate fluidity. This problem can be eliminated by increasing the coke charge; inappropriate composition of the slag may be the other reason. To determine the reason and the way of its elimination, composition of the slag must be known. At least quantity of the three main compon-

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[x] see Photos 27., 28.

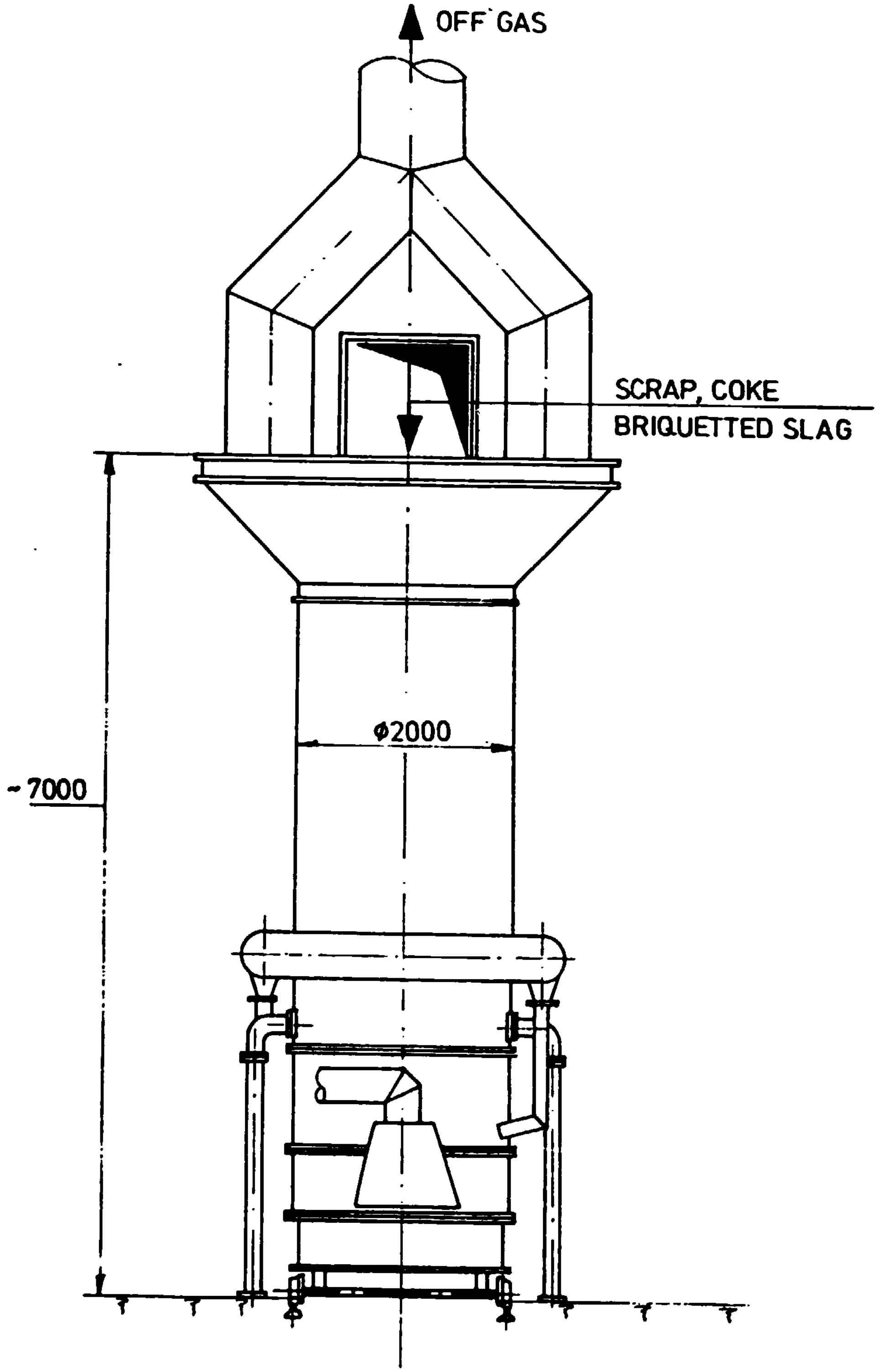
[xx] see Photos 28., 31.

ents - CaO, FeO, SiO_2 - must be determined and correction must be made adjusting their quantities.

Samples for analysis must be taken from the discharged melt. Samples must be taken from the billets and from the slag periodically from the melt-jet during discharging. Samples are to be collected and those from one shift can be analysed together.

If the slag has utilizable metal content it is to be tapped again. Metal billets and the samples are to be numbered, thus composition of the billets can be identifiable. It is expedient to analyse complete composition of the metal, but at least Cu, Sn, Pb, Zn, Fe, Cd, Sb and Ni content in relation to the national standards or the requirements of the buyer. After solidification - but yet in hot condition - metal billets are lifted out from the moulds by crane, and put on pallets by batches (6 billets, about 2500 kg suits for one batch). Full slag vessels are placed in line in the workshop and the slag is lifted out when it is completely cooled down and solidified. Complete cooling takes place in 10 hours approximately.

The blast-furnace has a blast area of $\sim$2 sq.m. and it is an equipment of cylindrical shape, supported by three columns. The furnace has water-cooling in the zone of the blast-pipes with heat-resistant walls above them. The bottom part is a heat-resistant cylindrical equipment, supported by three columns.



SKETCH OF CUPOLA BLAST FURNACE
Figure 12.

Hearth, applying heat-resistant clay and walled of refractory bricks is a part of the bottom. It has the same diameter as the cylindrical part; the former can be placed on car and pushed under the furnace amoung supporting columns on a track. Metal discharge duct can be joint in . The slag spout is formed above the hearth at the bottom of the water-cooled furnace-shell. Blast-pipes are led in and uniformly distributed around, through the water-cooled shell, just above the slag discharge opening.[x] Air is supplied to the blast-pipes from the ring duct, installed around the furnace. Blast pipes starting from the pressure side of the blow funs, join the ring duct.

Charge can be fed into the furnace at the upper part of the cylindrical furnace body through a feeding system with bubble cup.[xx] Material is fed to this feeding system by an inclined hoist. Skip of the inclined hoist is filled by a rotary loader from the material storing area to be found within the working radius of the loader.

Flue gases get in the water cooled pipeline through the annular section which is left free in the furnace mouth by the bubble cup and through the furnace head. This pipe-line leads to the coarse dust-separating chamber. After this dust-separating chamber there is a secondary-

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[x] see Photo 27.

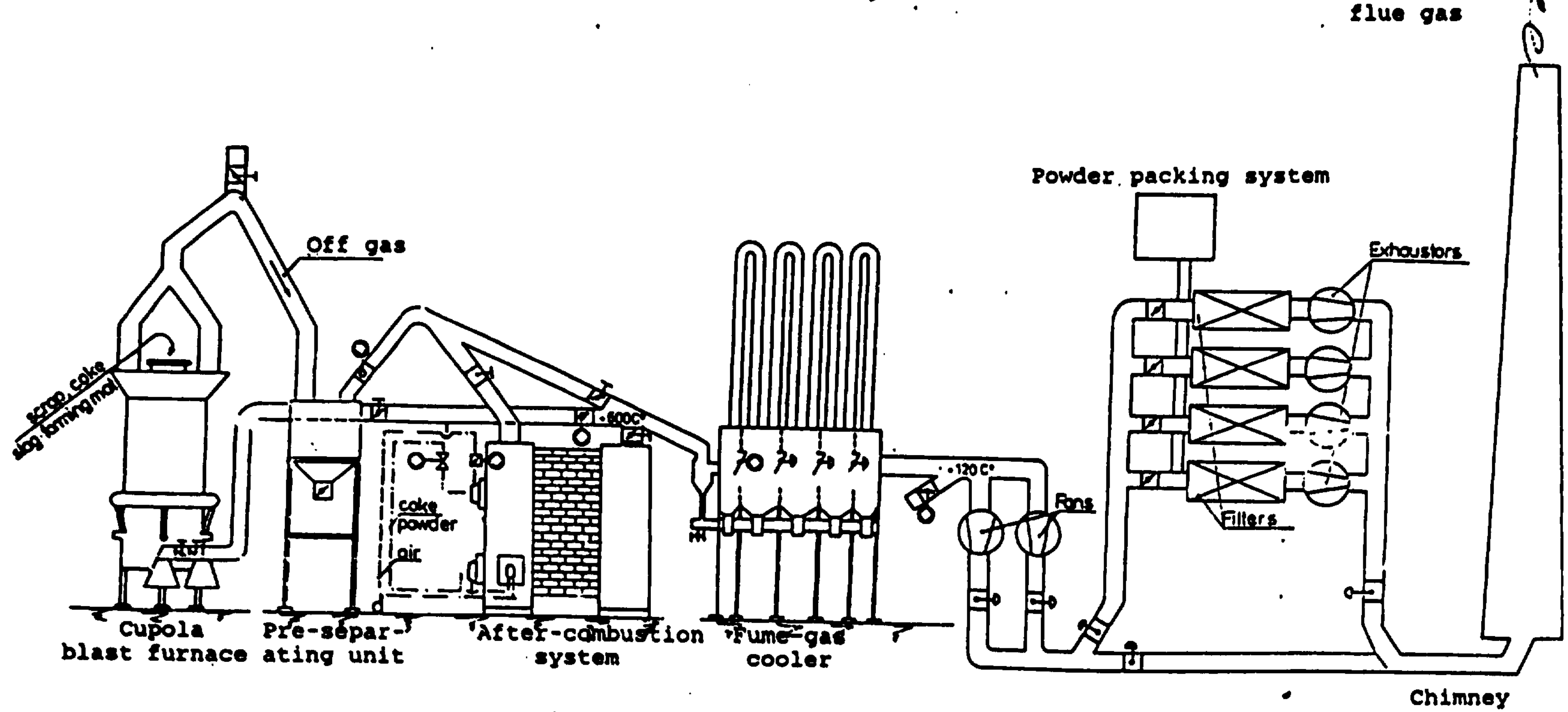
[xx] see Photo 29.

firing equipment to oxidize the steam of non-ferrous metals, that of coal-dust and carbon monoxide, carried by the flue-gases, to protect the filters. An air-cooling system is also installed; a fan serves for exhausting the air-cooling system together with the dust-separating chamber (see Photo 30.). Inlets of the gas-filtering equipment join in line with each-other from the pressure side of the fan.

There is one fan for exhaustion from each bag-type filter cell with pneumatic vibration. From the pressure side of each fan a pipe outlet leads to the open air.

The flue gas cleaning system is of automatic operation, the final unit, i.e. packing of the ZnO-containing powder is to be carried out manually, which mut be done continuously. In case of trouble a sound signal is given drawing attention to the necessity of intervention. Instruments indicate the defect. Structure of the dust-separating system joining the blast furnace is shown on Figure 13.

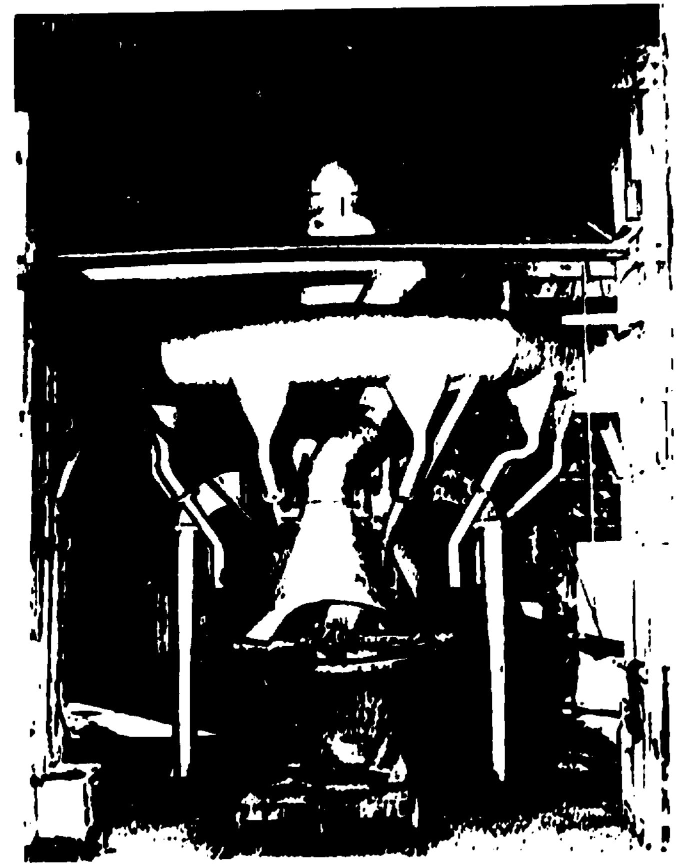
Figure 13.



CONNECTION BETWEEN THE BLAST FURNACE AND THE DUST SEPARATING SYSTEM

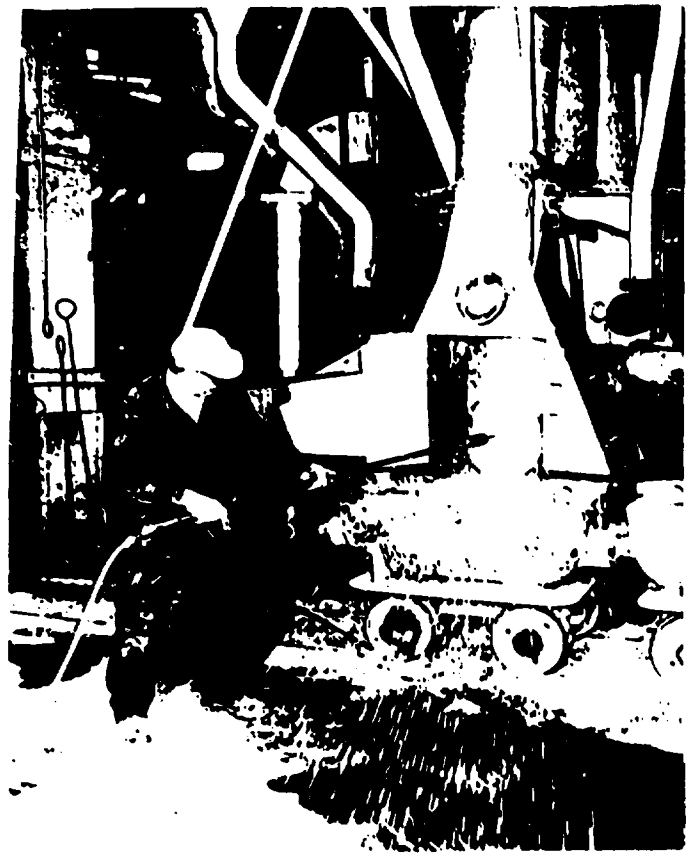
CHARGING SYSTEM

Photo 26.

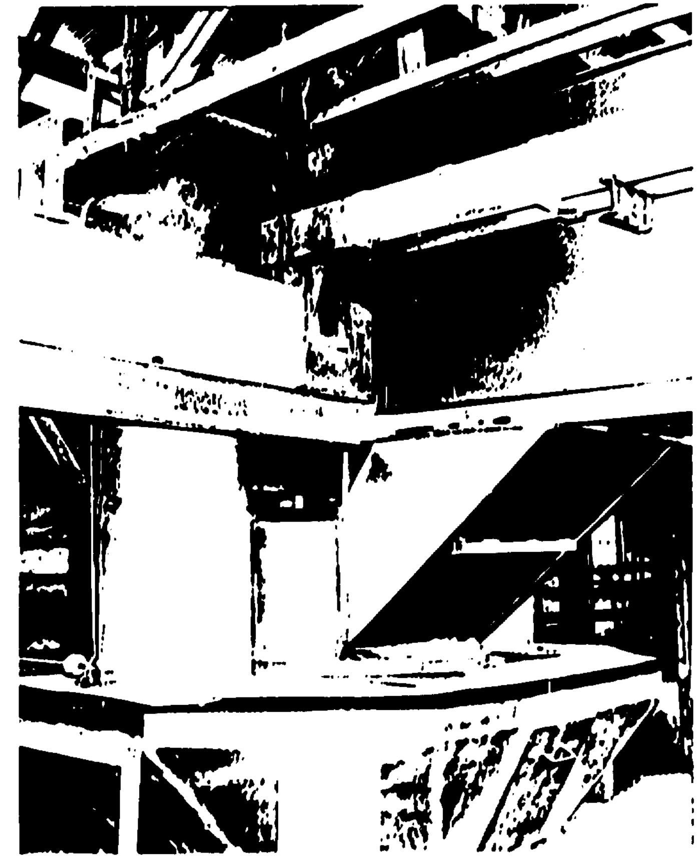


DISCHARGING CAR
BOTTOM PART OF BLUST FURNACE

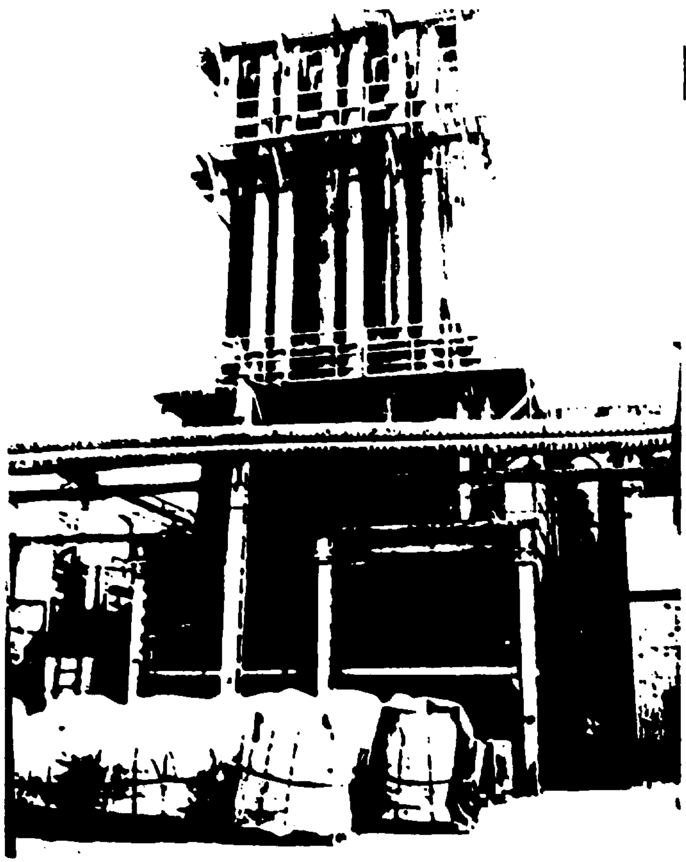
Photo 27.



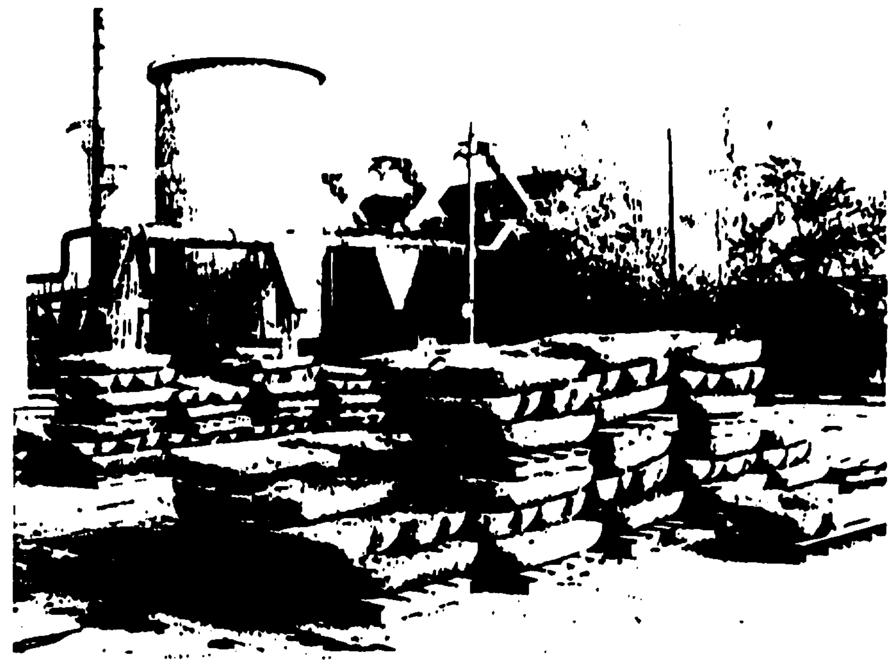
DISCHARGING OF THE BLAST FURNACE
Photo 28.



CHARGING AND EXHAUSTING HOPPER
Photo 29.



FUME-GAS COOLER
Photo 30.



BLACK COPPER INGOTS
Photo 31.

4.3. Main Phases of the Casting Technology

Flow-sheet of the casting technology is shown on Figure 14, page 66.

4.3.1. Induction melting

Metal disposing of good metallurgical and casting properties (gas and inclusion free, homogenous, high-fluid) must be produced from the scrap of different sorts and compositions. Coreless induction furnace is the most suitable one for this purpose. This type of furnace is easy to put out and put into operation and different copper-alloys can be manufactured in it. The furnace is suitable for processing lumpy waste materials and chips, the process of alloying may be performed exactly, superheating and temperature holding are possible, if required. The furnace walling materials is easy to replace. To attain the production capacity of 400 tons determined by the Chinese counterpart, an induction furnace with a capacity of 800-1000 kg is recommended.

The actual capacity of the furnace is influenced significantly by the fact that scrap is mostly chips. The composition of the liquified metal is to be analyzed, set to the standard value and holding of temperature of the metal is to be ensured during the process of pouring.

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PROPOSED TECHNOLOGICAL FLOW-SHEET

- Casting process -

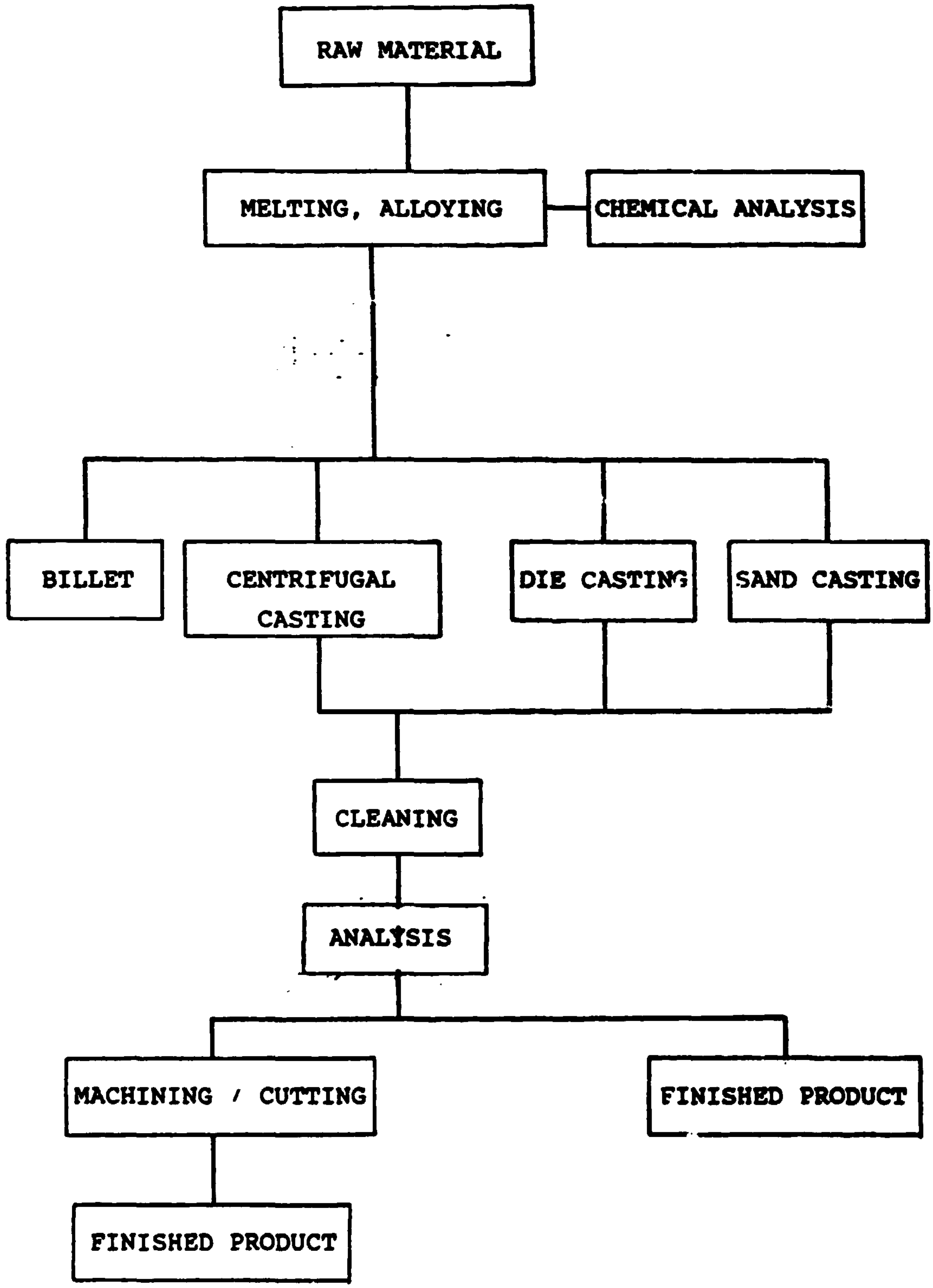


Figure 14.

If chips are melted the complete discharging of the kiln is to be avoided. Charges of max. 500 kg are to be melted.

The required annual 400-ton castings can be produced in 180-200 working days, operating in three shifts. The balance capacity may be utilized depending on the demand of the market and the raw material available.

The chain-type casting machine (C3) being in operation may be transferred into the foundry, if necessary. It is expedient in case if there is a continuous and considerable deviation from the standard composition in the chemical composition of the raw material (metal-chips) got for the foundry. This solution cannot be, however, recommended for a long time.

It is worth mentioning that it is not advisable to install the casting machine in the metallurgical workshop, as discharging of the blast-furnace cannot be made at such frequency which would be required by the casting machine.

4.3.2. Centrifugal casting

Centrifugal casting ensures the best qualities for casting bushes and thin-walled (20-25 mm) pipes with bigger diameter (200-400 mm). Machining allowance of 2-4 mm can be achieved due to application of up-to-date casting technology and exact measuring of the weight of the liquid metal.

The centrifugal casting machine (e.e.m.) with horizontal axle allows casting of bearing bushes in multiple length.

Regulable revolution speed allows setting of optimum r.p.m. in case of castings with various diameters. Water-cooling results in quick solidification which together with the compacting effect of the centrifugal force ensures excellent structure and mechanical properties (see Photos 34.,35.,36.).

Copper alloy amounting to 130 tons approx. and brass about 270 tons can be utilized for casting purposes which do not fill the entire capacity of c.c. machinery of the foundry. The machine is easy to put in and out of operation, its maintenance does not imply any additional costs.

4.3.3. Rod and bush casting into metal casting dies
/Gravity die casting technology/

In accordance with information received from the Chinese counterpart, rods (bars) and pipes are easy to sell on the market. The biggest demand appears within the range of diameters 60-80 mm.

This technology is suitable for production of rods and pipes having the above mentioned sizes. It is advisable to choose 500 mm as casting length. Pouring is gravitational. Ladle containing the melt is henged on crane and transported to the pouring area (see Photos 32., 33.).

When determining the quantity of manufacturing tools, demand of the market and volume of metal to be melted in one batch are to be considered. Preparation of the manufacturing tools does not require considerable investment. The production is not continuous, the technology is simple, easy to acquire, requires small place, can be easily adapted to the demand of the market. The manufacturing tools consist of two halves in which suitable dimensions for castings are adjusted.

4.3.4. Mould making and casting applying sodium silicate

Applying this method production of moulds and cores for various machine parts, in addition to the mentioned cores and inlet fillers, is possible. Advantage of the production method is that the dies are quick to cast, accurate to dimension and economic even in case os small series and unique production.

Its further advantage: good solidity properties of the dies, the cores and dies (moulds) can be stored and they are less damagable during transportation. The method is suitable also for making more sophisticated dies. Introduction of the mould-making technology does not require considerable investment, preparation of the moulding mixture is simple.

When applying this technology the dry, clay-free froming sand is mixed with fluid sodium-silicate. This mixture hardens under effect of CO_2 gas.

Solidified castings are to be removes from the mould box. Sand is transported to the waste material storage, the castings to the cleaning shop. Unnecessary metal parts are removed from the casting in the cleaning shop for recycling and surface of the casting is cleaned (see Photos 43.,44.,45.,46.,47.,49.,50.,51.)

4.3.5. Machining of rod and bush castings

Advantages offered by machining within the plant are as follows:

a) Higher profit can be gained, price of the sold products is better than the one of the rod and bush castings without machining (appr. 5-15%);

b) Quality requirements may be met better as possible casting defects are revealed during machining; thus image of the manufacturer, its reliability can be maintained on high level;

c) Chips resulting from machining and being of known composition remain in the factory, thus quantity of the raw material being at disposal can be increased by 10% approximately.

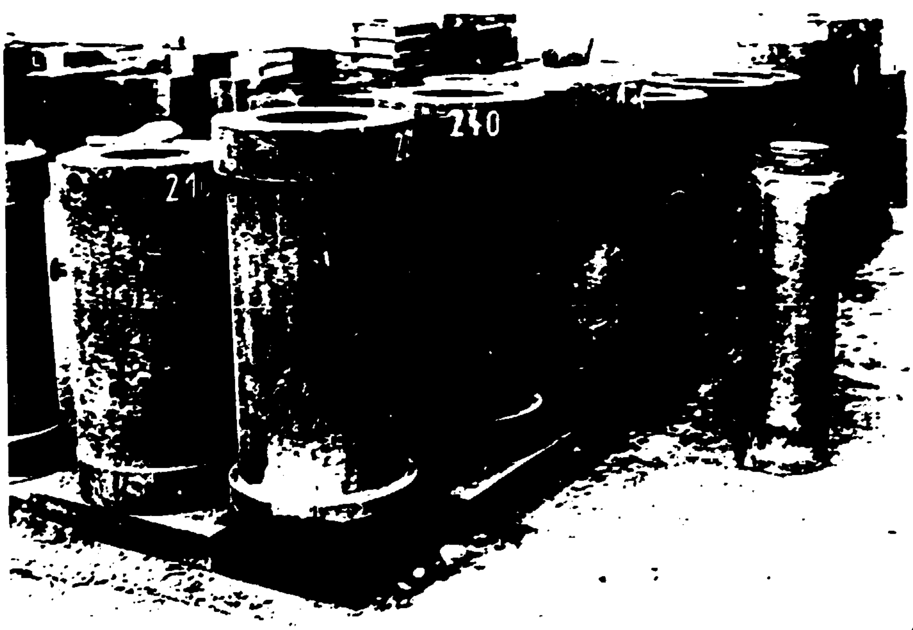
A lathe is advisable to be used for machining purposes, by means of which part of the castings can be shaped or finished. For finished goods storage and transportation without damages must be ensured. Machining can be done in existing building 'B' (see Photos 39.,40.,41.,42.).

Note:

Tabulated data for products of the foundry are given in Annexes D, E, F. (see page

GRAVITY CASTING

Photo 32.



DIES OF GRAVITY CASTING

Photo 33.

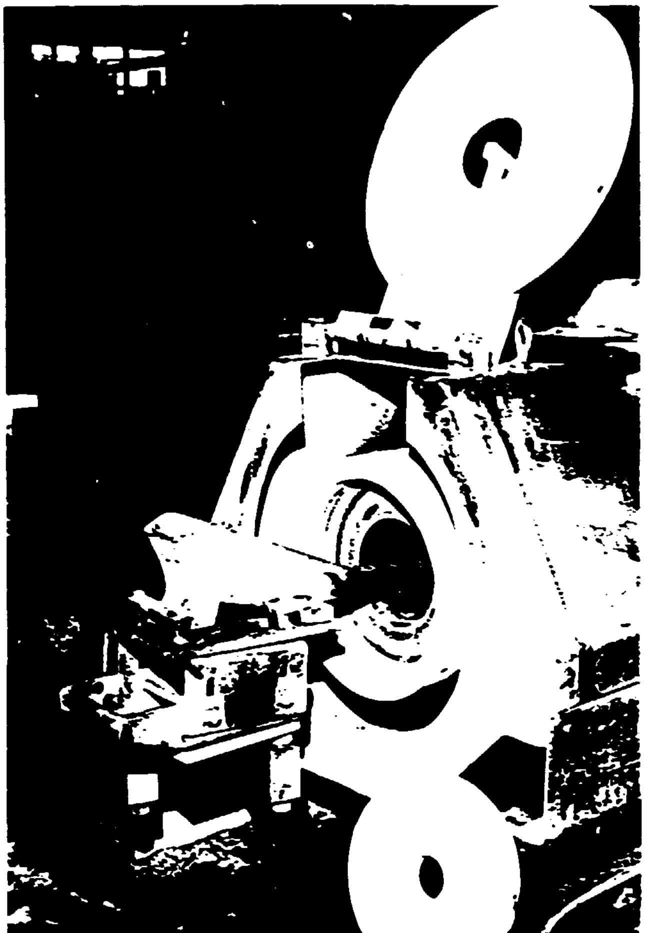


Photo 34.

Photo 35.

CENTRIFUGAL CASTING MACHINE

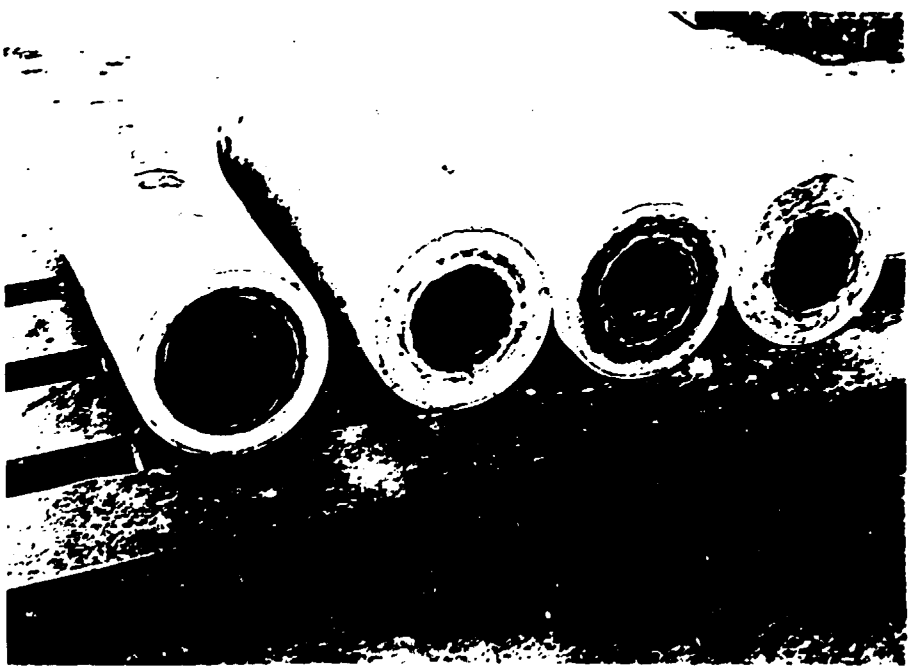
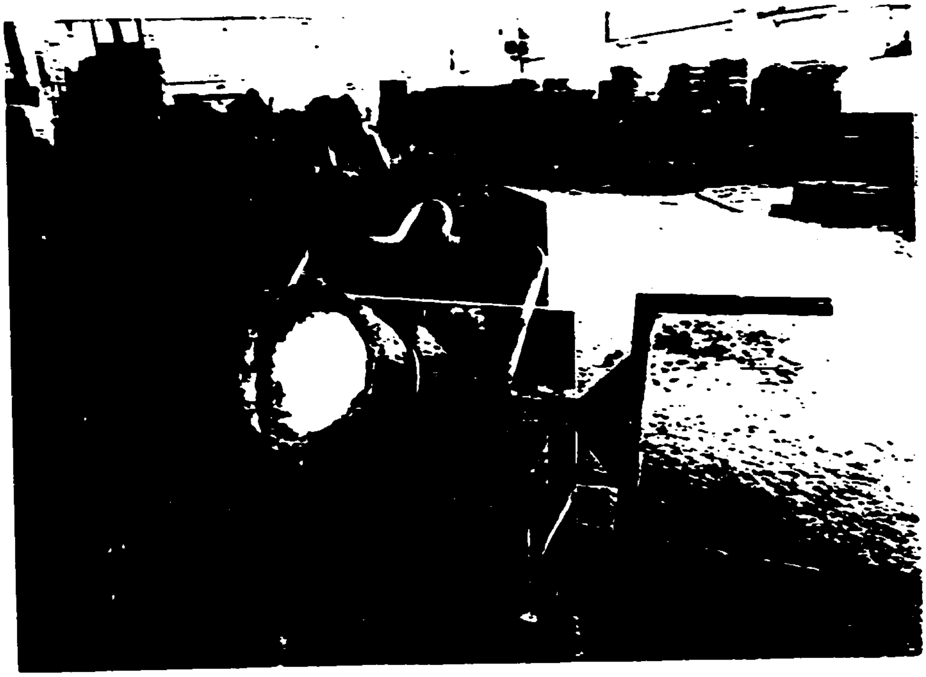


Photo 36.

CAST BUSHES



CASTING LADLE

Photo 37.

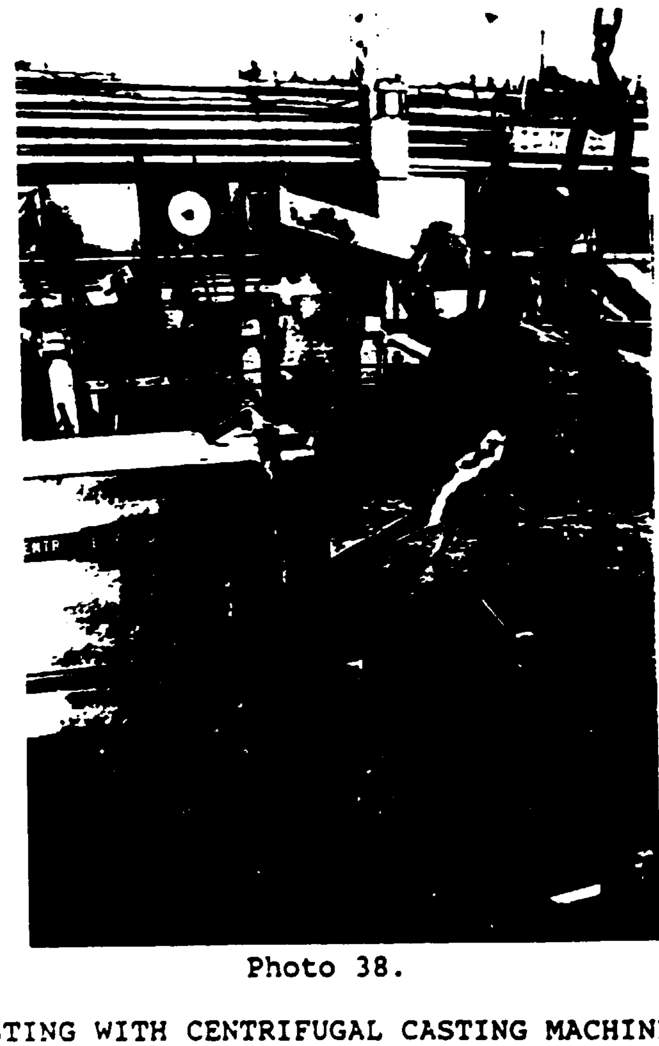
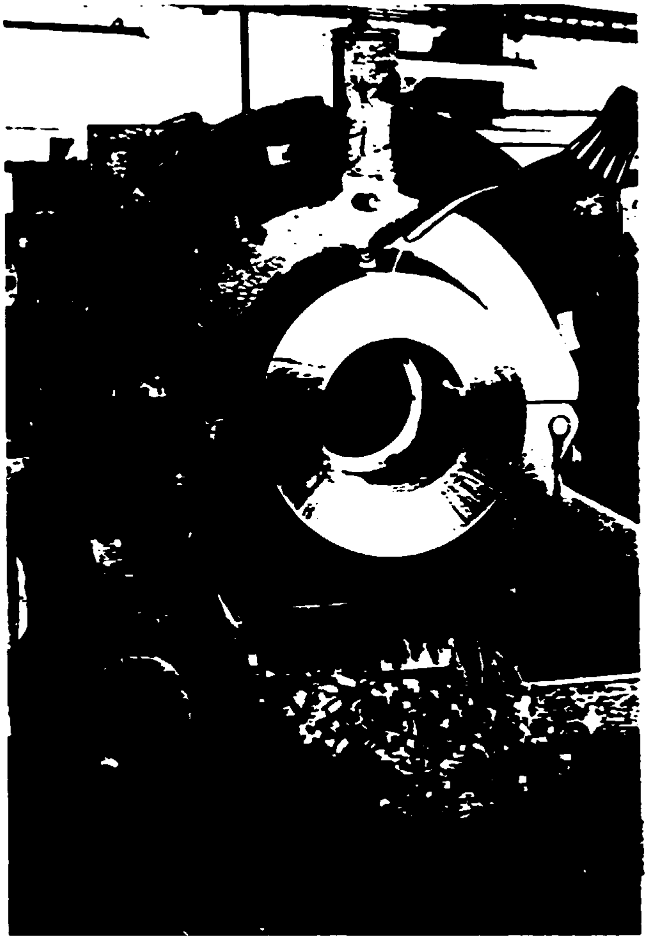


Photo 38.

CASTING WITH CENTRIFUGAL CASTING MACHINE

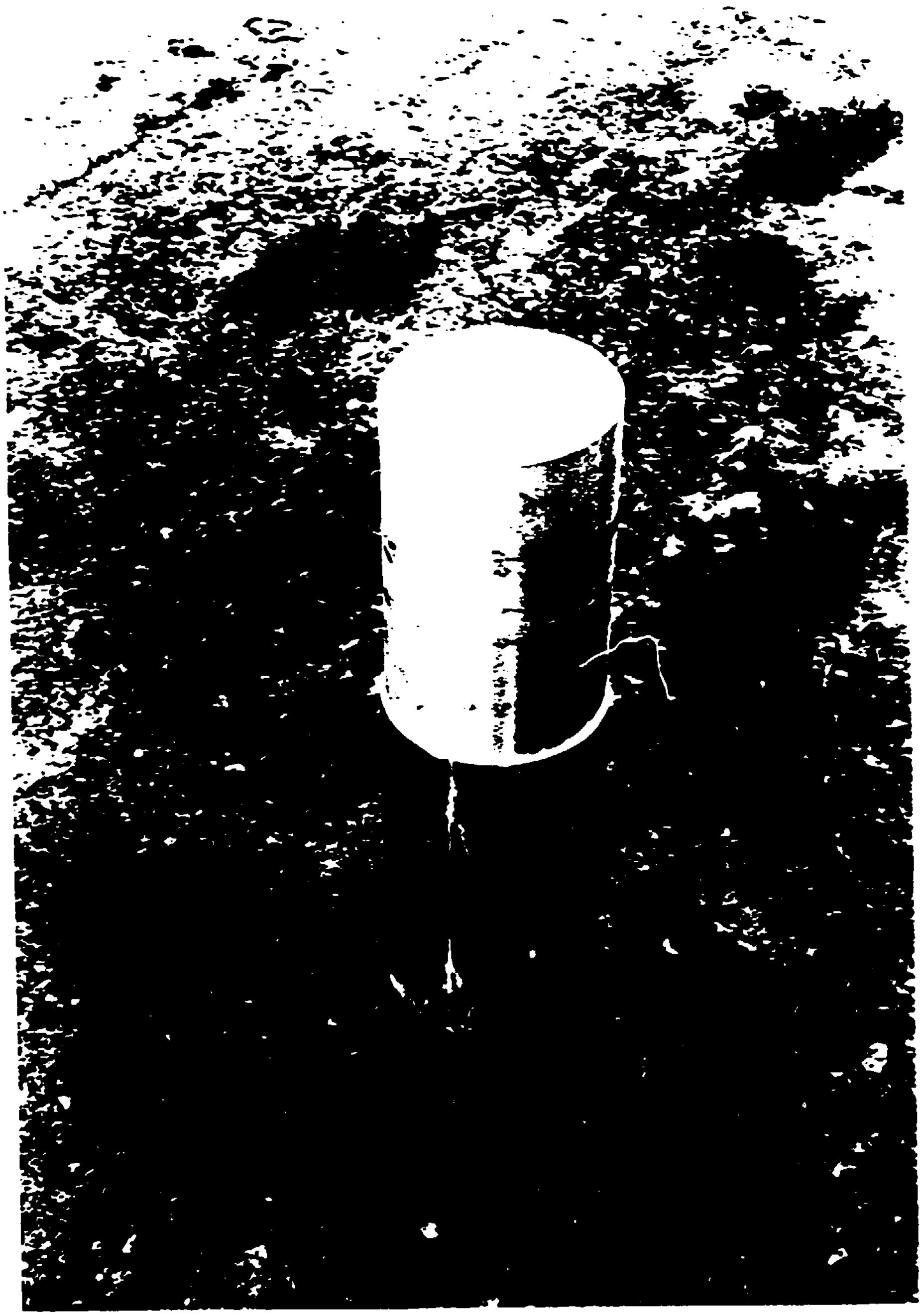


MACHINING OF BUSH

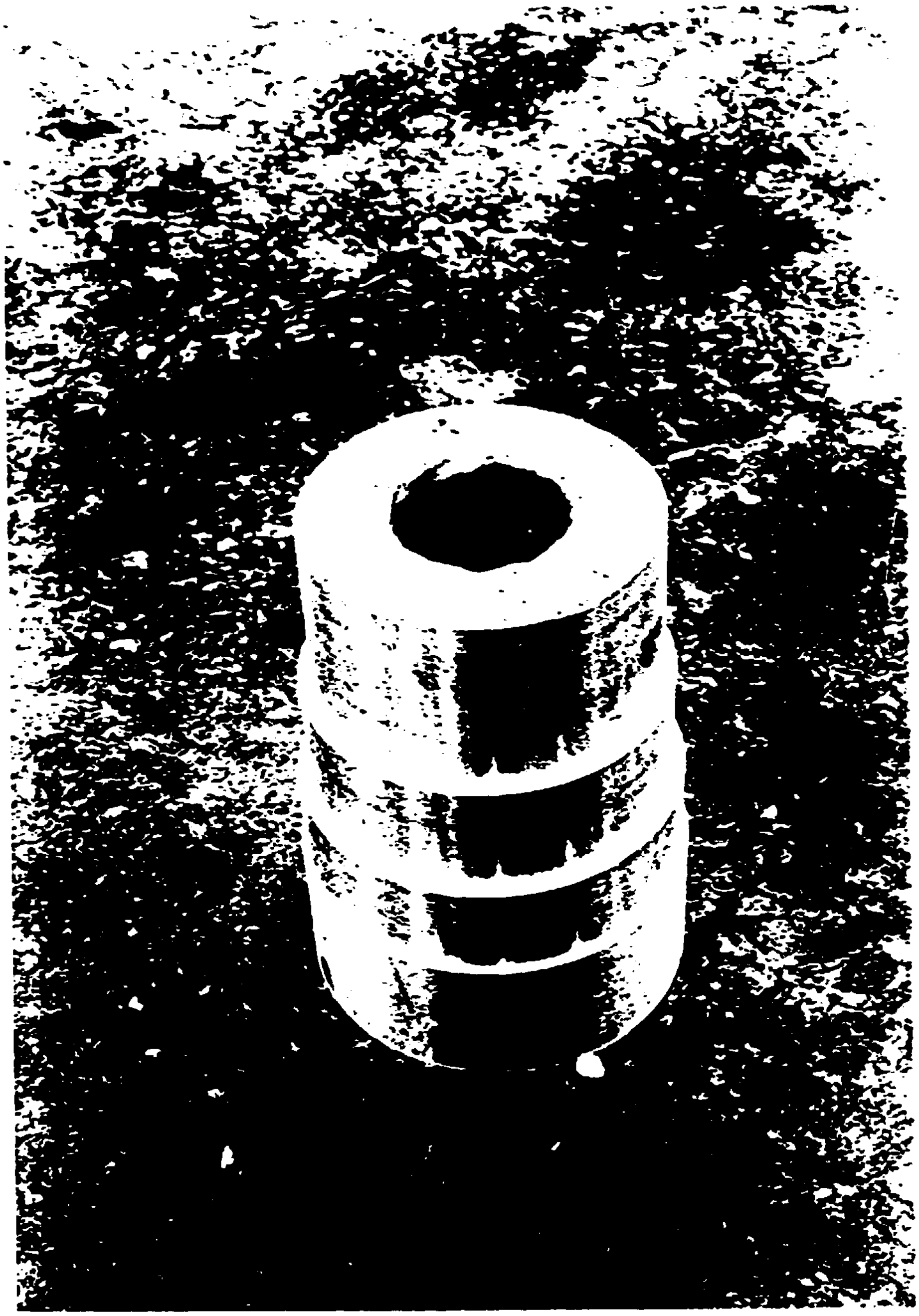
Photo 39.

Photo 40.

BUSHIES AND RINGS AFTER MACHINING



CAST BAR - WITH PRELIMINARY MACHINING
Photo 41.



CAST-BUSH - AFTER CONTROL MACHINING
Photo 42.

SAND-MODEL PREPARED FOR CASTING

Photo 43.

Photo 44.

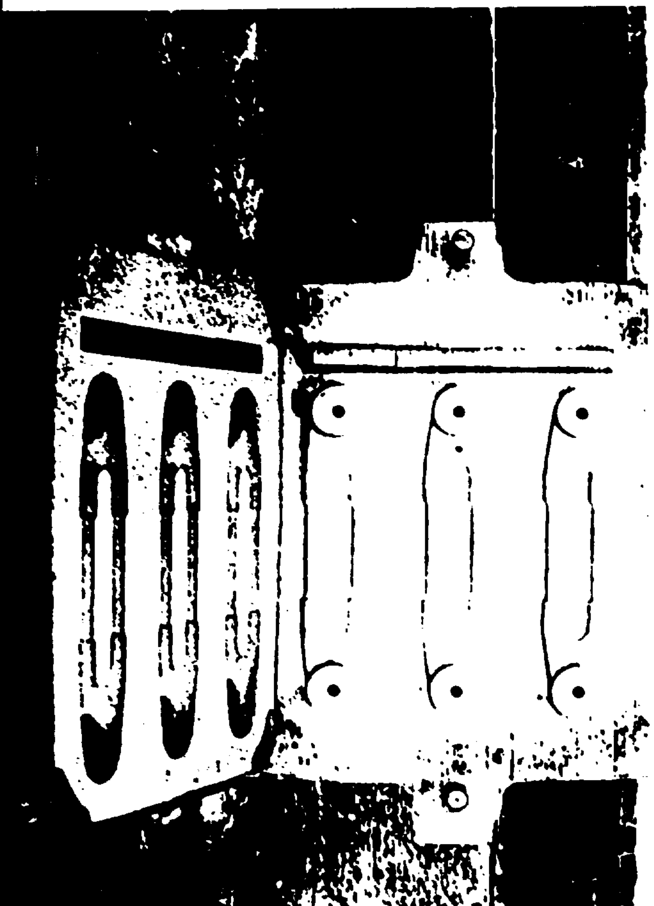


Photo 47.

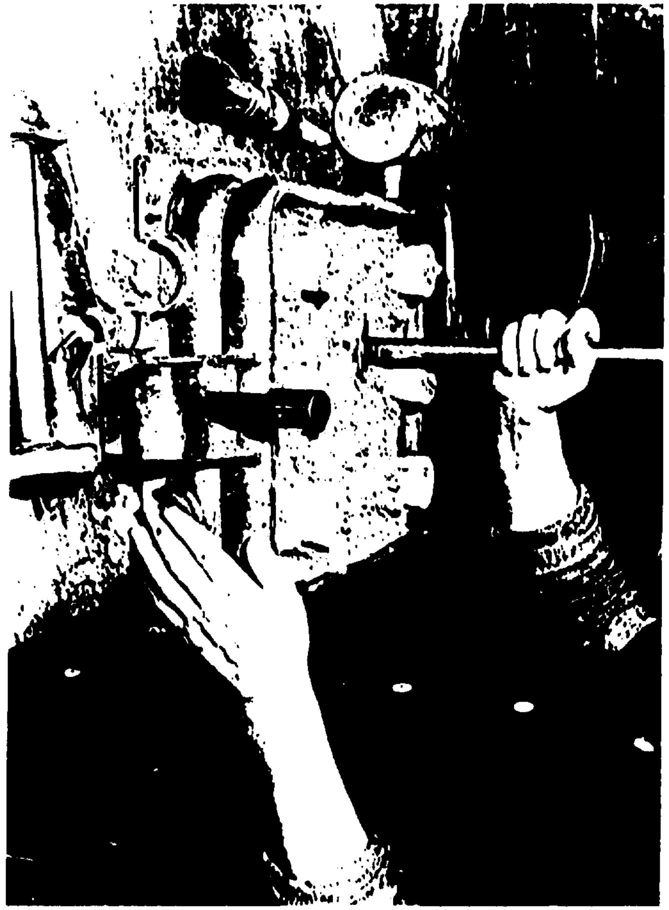


Photo 46.

Photo 45.

MAIN PHASES OF MANUAL MOULDING

Photo 48.

SAND- MOULD CASTINGS

Photo 49.

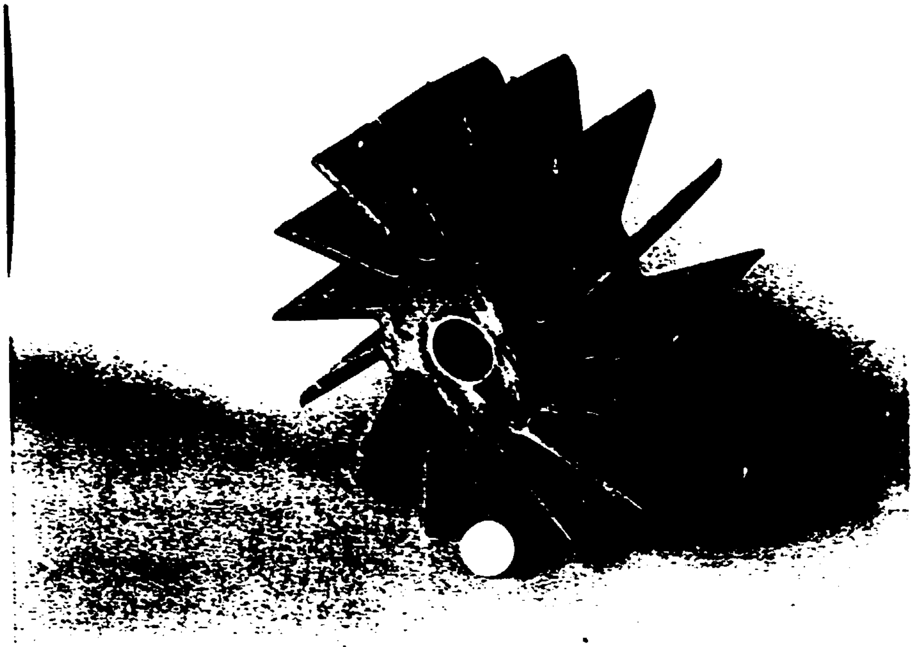


Photo 50.

SAND-MOULD CASTINGS

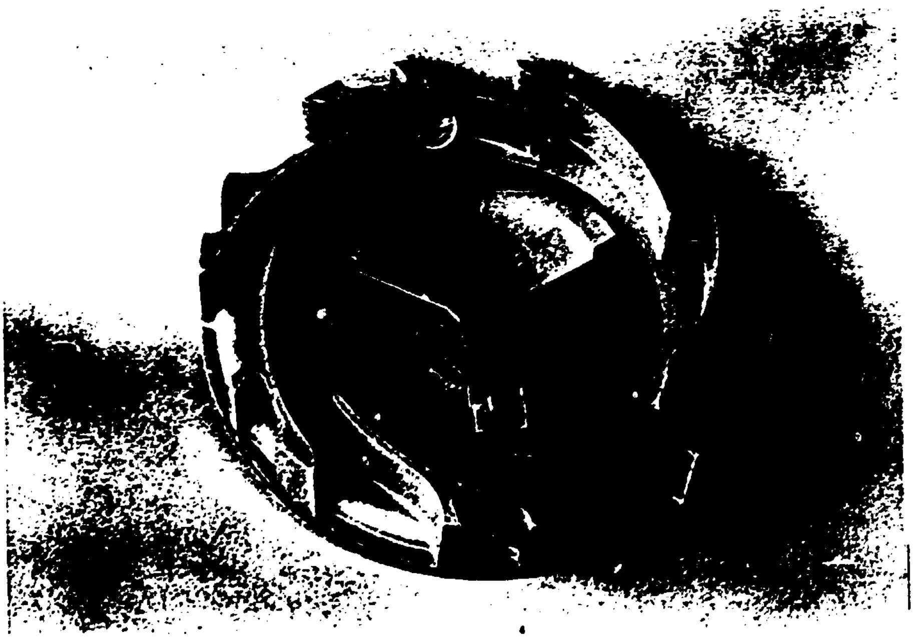


Photo 51.

4.4. Material Testing

The quality control is suited into the production process of the workshops and serves qualification of the finished product.

In addition to these basic tasks such physical-chemical and other test will also be carried out that are needed only periodically according to special needs but are connected with the production process necessarily.
Organization of the quality control system is also to be established.

Functional relationship between the laboratory and the technological phases is shown in Figure 15.

The new laboratory should be installed on the second floor of building 'B'; it is shown in Figure 16.

The new laboratory will be separated from the existing store and the canteen area by glass walls. The testing system with instruments, the mould preparatory units, the balance-room and the traditional chemical laboratory will be installed in separate premises.
A separate store will be provided for chemical agents.

Main units of the new laboratory [x]

Sequential optical emission spectrometer makes measurement and detection from the following metals, oxides

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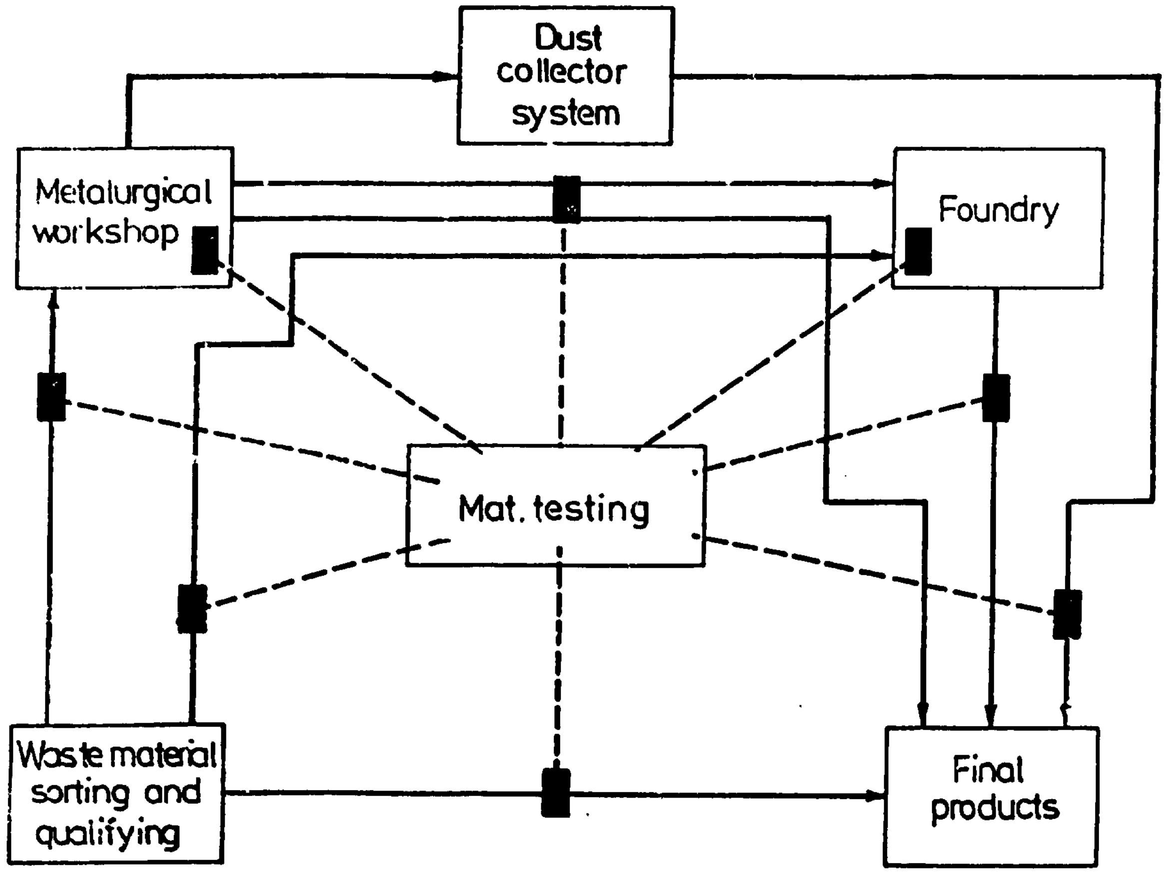
[x] Some internationally recognized suppliers:

a) Applied Research Laboratories
b) Jobin Yvon Division of Instruments SA.
c) Philips Eindhoven

.Functional relationship between the laboratory and the technological phases



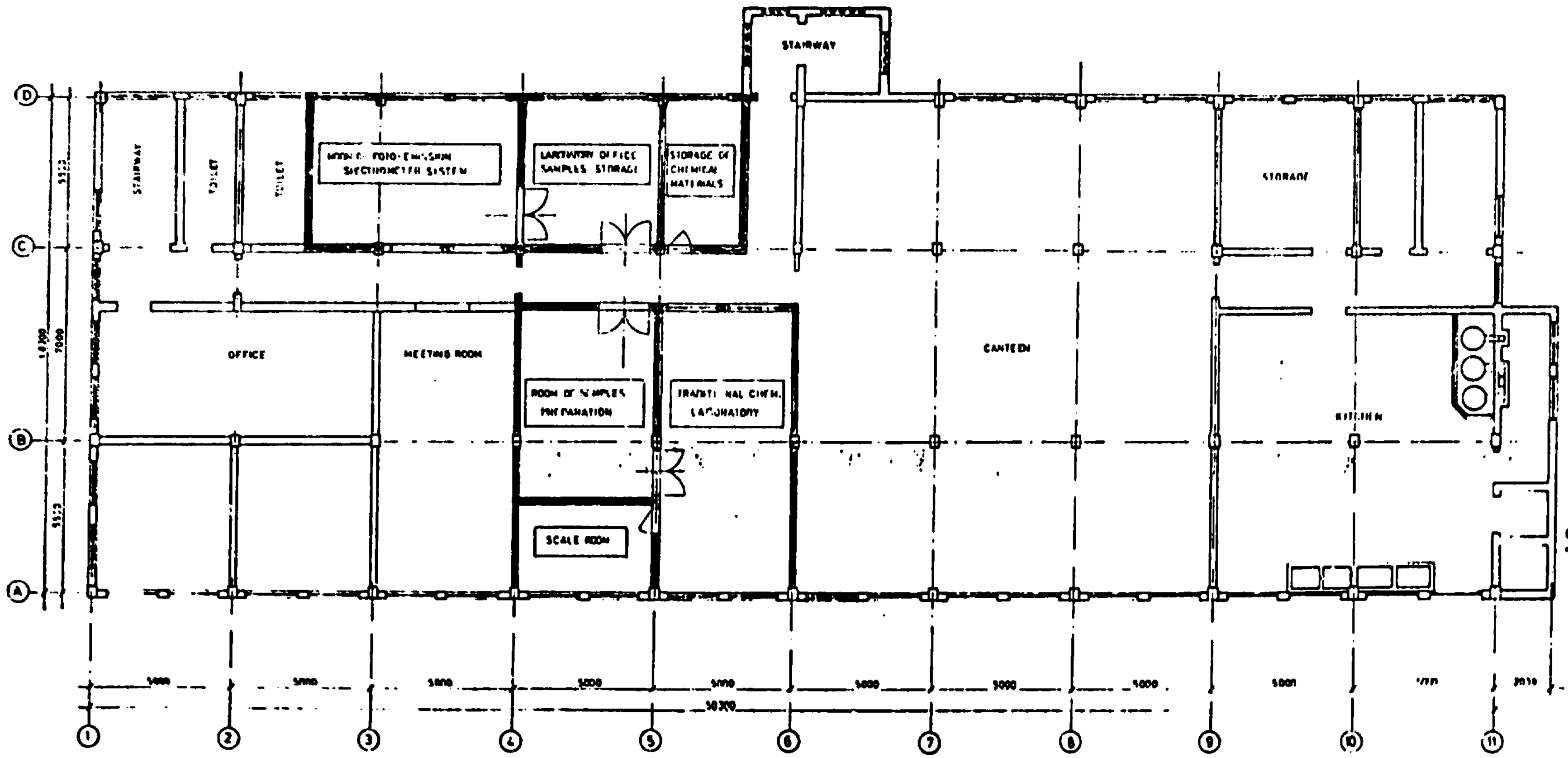
Legend

———— one-way functional connection

- - - - interactive connection

▮ checking point

Figure 15.



SECOND FLOOR: +5,00m

Legend

Laboratory area

SRRUC-CHINA
PROPOSED NEW CHEMICAL LABORATORY, 1:100
BUILDING "B"
DRW Nº 03/3
MARZ,1989
UNIDO PJT: UC/UD/CPR/87/224

Figure 16.

from prepared samples in a few minutes:

- metal cake (sample preparation by pressing)
- from metal powder or chips sample (sample preparation by melting)
- from slag sample (sample preparation by crushing and carbon powdered tabletting)
- from metal samples taken from the melting in accordance with the requirements for analysis during the production process (it is also possible to determine possible gold (Au), silver (Ag) and mercury (Hg) content.

Taking into consideration the quantity and frequency of the tests to be carried out annually it is only the sequential optical emission spectrometer that can fit. The sequential optical emission spectrometer can be replaced by Simultaneous optical emission spectrometer[x] could also be used for similar tests. This latter one has higher analysing accuracy and speed but it is by far more expensive than the sequential optical emission spectrometer and level of its utilization would be very low.

For operation of the sequential optical emission spectrometer some equipment are necessary for sample preparation. These equipment have great influence on quickness of analysis and reproduceability.

It is expedient to use mobile photo emission equipment in case of an annual quantity of 600 tons.

. / .

[x] X-ray fluorescence spectrometer

Level of utilization of this equipment would be approximately 50%, but its mobility, nearly unlimited possibility of its use is very useful in scrap sorting. It should be noted that this equipment is not able to work with such an accuracy as the fixed optical amission spectrometer.

It is advisable to purchase both the fixed and the mobile emission spectrometers from the same manufacturer.

Traditional chemical laboratory

It is suitable for making the necessary tests utilizing the traditional chemical analysing methods.

It provides possibility for carrying out the following test:

- determination of moisture and oil-content of metal chips;

- determination of alloying elements: Cu, Zn, Sn, Pb, Fe;

- determination of contaminations: Zn, Fe, Pb, Sn, Sb, Ni, Al, Mn and S, from
    - metal chippings,
    - metal powder, and
    - lumpy waste material

- determination of basic components of slag: Cu, Zn, Sn, Pb, Fe

./.

- determination of oxides: FeO, SiO_2, CaO, MgO, Al_2O_3, ZnO

- determination of compounds: PbO, ZnO; and elements: Pb, Ca, S from separated dust

- analysis of fume gases (utilizing ORSAT device) to determine gases: CO, CO_2, SO_2, H_2S, NO_x, O_2 Cl_2, F_2

4.5. Necessary Machines and Equipment for the development

4.5.1. Scrap preparation

Item	Qty	Denomination	Type	kg/pc	Total weight	Note
S1	1	Jaw Crusher	-	-		Existing[x]
S2	2	Rotary Breaker	-	-		Existing
S3	1	Belt-Conveyor	600x5000 mm	450	450	Rubber belt (portable)
S4	1	Belt-Conveyor	600x5000 mm	450	450	Rubber belt with magnetic separator (portable)
S5	2	Pedestal screen, screen aperture	50x50 mm	30	60	(portable)
S6	1	Baling press	-	-	-	Existing
S7	1	Hydraulic Shears	knife 1000 mm	2500	2500	
S8	1	Hydraulic Brick Press	100x100x200 mm	2000	2000	
S9	1	Mixer equipment Capacity 300 l		800	800	Portable
S10	10	Container Capacity: 0,6 m^3	600x600x1600 mm	180	1800	
S11	1	Fork Lift Capacity: 2 tons	Diesel	3400	3400	

./.

[x]Existing means that the machine i.e. equipment is presently already available

Item	Qty	Denomination	Type	kg/pc	Total weight	Note
S12	1	Wheel loader	-	-	-	Existing
S13	1	Balance car Capacity: 500 kg		300	300	
S14	1	Belt conveyor		-	-	Existing

4.5.2. Metallurgical Shop

Item	Qty	Denomination	Type	kg/pc	Total weight	Note
M1	1	Blast-furnace, water-cooled	MTLG			Cross section of blasting area 2 m^2
M2	1	Bubble-cup for M1 with motor drive				
M3	1	Feeder for M1				Skew track system
M4	1	Rotary-loader for M3				Electro-hydraulic polyp-grab
M5	2	Air fan 12.000 m^3/hour Δp:1.200 mm hdyro-static pressure head		3.200	6.400	1 in operation 1 stand-by
M6	1	Air distributing pipeline system				
M7	1	Water-cooled fume-gas pipe-system				
M8		Auxiliary equipment for operation of the blast-furnace				
a	2	Bottom part of the furnace (hearth)				(with refractory walling)

Item	Qty	Denomination	Type	kg/pc	Total weight	Note
b	2	Hearth supporting and moving car with rail track				Loading capacity: 30 tons
c	1	Slag-bowl supporting and moving car with rail track				Loading capacity: 2 tons
d	20	Slag bowls				Cast iron
e	3	Discharging car and rail track				Loading capacity: 1 ton
f	9	Discharging die				Cast steel
g	-	Lifting tools, hand-tools				Various
h	1	Servicing platform				Steel structure
M9		Dust pollution cooling and collecting system with automatic control				
a	1	Rough separating unit				Cyclone-system
b	2	After-combustion unit				Refractory walling with firing equipment
c	1	Fume-gas cooling system				Natural air cooling
d	2	Fume-gas exhausting fan	30.000 m^3/hour Δp: 750 mm hydro-static pressure	2700	5400	1 in operation 1 stand-by

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Item	Qty	Denomination	Type	kg/pc	Total weight	Note
e	1	Heat-insulated fume-gas piping				
M10	4	Sack dust-separting equipment with automatic dust shaking system, screw dust discharge, servicing platform	90 m^2 filtering surface			
M11	1	Air tank, air filtering and handling systems for M10				
M12	4	Suction fan for M10	10.000 m^3/hour Δp: 500 mm hydrostatic pressure	1900	7600	
M13	1	Automatic regulating system for operating of M9-M12				Installed in the operator's room
M14	1	Piping for M10				
M15	1	Crane for casting	overhead crane with two main girders	4500	4500	Span 8 m loading capacity: 5 tons, control from cabin

<u>Notice:</u>

Steel structure and piping total	-	-	93.300	M1-M14
Refractory material total	-	-	17.700	M1-M9

4.5.3. Casting Shop

Item	Qty	Denomination	Type	kg/pc	Total weight	Note
C-1	1	Crane for casting	overhead crane controlled from the ground	4000	4000	Loading capacity 3 tons span: 14 m
C-2	1	Induction furnace	coreless	-		Capacity: 800-1000 kg
C-3	1	Casting equipment		-	-	Available
C-4	4	Casing crucible		15	60	
C-5	2	Crucible supporting fork		30	60	For item C-4
C-6	1	Centrifugal casting equipment	horizontal	1500	1500	with different instruments for casting dies
C-7	1	Black washing and spreading equipment		25	25	for item C-6
C-8	2	Pre-heater for crucibles and dies		3	6	Gas cylinder PB
C-9	1	Balance for measuring the weight of the liquid metal	mechanic	200		Capacity: 300 kg
C-10	1	Sand-mixer with S-shovel		400	400	Capacity: 85 l
C-11	1	Quick cutter	desk-type	50	50	Cutting disc: dia. 500 mm

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Item	Qty	Denomination	Type	kg/pc	Total weight	Note
C-12	2	Hand grinder	electric	5	10	grinding wheel: dia. 180
C-13	2	Compressed-air hammer, hand-operated			-	Pneumatic
C-14	1	Rotary saw machine	dia.400	500	500	for cutting of castings
C-15	1	Crane for moulding	controlled from the ground	800	800	Loading capacity 1 ton
C-16	1	Lathe		3600	3600	dia. 500x1500 mm

4.5.4. Material Testing Laboratory

4.5.4.1. Wet analytical laboratory

Item	Qty	Denomination	Type	kg/pc	Total weight	Note
L1	2	Chemical cabinet	-	500	1000	2400x800 mm
L2	1	Gas analyzer	Orsat	10	10	
L3	1	Digital pH-meter	OP 111	-	-	
L4	1	Analitical balance	LB1051	19	19	Measuring range: 200 g, Readibility: 0,1 mg
L5	1	Technical balance	LB 802	6	6	Weighing range: 500 g Readibility: 0,01 g
L6	1	Electrolyzer	-	12	12	3-stand
L7	1	Annealing furnace Inner dimensions	LR 203	30	30	900°C 170x110x350 mm
L8	-	Furniture for the laboratory	-	-	-	work-table, cupboards, etc.
L9	-	Glassware for laboratory		-	-	various types
L10	-	Cupboards for chemicals		-	-	1200x400 x 1700 mm

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4.5.4.2. Sample_preparation_equipment

Item	Qty	Denomination	Type	kg/pc	Total weight	Note
L11	1	Bench lathe		200	200	for preparing the metal patterns
L12	1	Bench drilling machine	FA12	70	70	dia. 12mm
L13	1	Bench grinder		25	25	dia. 200mm
L14	1	Melting crucible (electric)		15	15	Capacity: 1 kg
L15	1	Sizing sieve-set		13	13	
L16	1	Grinding mill	HSM250	-	450	720x500 x1190 mm
L17	1	Tabletting machine for powder samples	HTP40	-	525	800x950 x1300 mm
L18	1	Milling machine	HAF/2		400	1000x800 x1350 mm

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4.5.4.3. Analysis Instruments

Item	Qty	Denomination	Type	kg/pc	Total weight	Note
L19	1	Metal analyser for Cu and slag analysis	3520 OES	-	-	Sequential Optical Emission Spectrometer for 14 elements
L20	1	Argon gas purification system		-	-	for item L-19
L21	1	Voltage stabilizer		-	-	for item L-19
L22	1	Sorting instrument (metal analyser)				for raw material, portable
L23	1	Air conditioner	-	-	-	window type

4.6. List and Description of Main Technological Machinery

Scrap preparation area

S1. Jaw Crusher - serves crushing of the slag after crushing it with compressed-air hammer

S2. Rotary Bracker-serves for further crushing of the slag

S3-S4-S14.
Belt Conveyors- serve for loading of the material to the milling equipment, mobile type

S5. Pedestal screen- portable, serves sizing of the scrap, handled by hand

S6. Baling Press - for baling sheets, chips and other scrap

S7. Hydraulic Shear - cuts the bales

S8. Hydraulic Brick Press - presses the copper chips that cannot be baled into brick-form

S9. Mixer equipment - additional equipment for S8, serves for mixing of the binder and the metal scrap

S10 Container - serves for feeding the prepared metal scrap into the induction furnace

S11. Fork lift - for transportation of containers and finished goods within the factory

S12. Wheel-loader- for moving of waste materials

S13. Balance car - for measuring of the prepared metal scrap components

Metallurgical Shop

M1. Blast-furnace

It has a circular section ~ 2 sq.m. cylindrical shape and refractory lining and can be moved by carriage.

M2. Bell cup, motor driven

It serves for feeding and closing of the furnace. It ensures even distribution of the charge in the furnace and prevents getting of the technological fume-gases to the opern-air and into the shop-hall respectively. An electric winch serves for moving of the bell cup.

M3. Charging equipment

It is an inclined skip hoist with steel structure serving for forwarding of the fuel of the furnace that of the charge onto the bell cup. It has an electric winch as drive.

M4. Rotary loading equipment

It takes the materials from the material-storage area of the workshop to the inclined skip hoist. It is a hydraulic rotary loading equipment of fixed arrangement, has a radius of operation about 6 m, and scoop clam-shell. An electric motor serves for its drive.

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M5. Fan

High-pressure fan or fan-unit supplying the air to the blast-furnace, for combustion.

M6. Air distributing pipe-network

It is a piping-system supplying air from the fan to the furnace and distributing it. It consits of a ring duct, mounted on the furnace, from tuyeres, and the supplying pipes.

M7. Water-cooled pipe-system for fume-gas

It is a water-cooled system for taking the fume-gases off, made of double-walled steel pipes. It takes the fume-gas having temperature 150-900 ^{o}C when leaving the furnace to the rough separator.

M9. Fume-gas exhausting and cleaning system

The system serving for secondary treatment and cleaning of the furnace gases separates, first of all, solid contaminations contained in the fume gases.

M9/a Rough separator

It serves for separation of the rough grains taken away by the fume gases from the charge. It is a bumper chamber or cyclone, made of steel.

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M9/b After-burning equipment

It is a labyrinth furnace with refractory lining, installed in a stell frame, and serves for burning of the combustible components of the fume gas, causing pyrophoric characteristics of the flue dust, separated without treatment.

M9/c Fume-gas cooling equipment

Multi-step air-cooling equipment built of steel pipes for cooling of the hot fume gas, leaving the after-burning equipment and having high dust-content, so allowing feeding of the gas into the sack-filter.

M9/d Exhaust fan

It serves for exhaustion of the fume-gases of the blast furnace as well as for neutralization of the air resistance of the installed pipe-system, that of the rough separator, after-burning equipment and the fume gas cooling equipment. It pressure (delivery) side joins the chimney and the sack dust-separator respectively.

M9/e Heat-insulated fume-gas pipe

It is a heat-insulated steel pipe leading the fume-gas cooled to 130 °C to the sack filtering equipment. Heat insulation is required to avoid further, excessive cooling and condensation of the steam vapour.

M10. Sack dust-separator

Double-spaced steel chambers, equipped with filter-cloth tubings, set against frames made of steel wires. Leading the fume gases through these chambers, the filter cloth removes the solid parts. Dust is removed from the filter-tubings compressed-air impulses injected into contraflow. Dust fallen down to the bottom of the chambers is removed by worm conveyor.

M11. Air compressor, and compressed air tank

The former serves for production the latter for storing of the compressed air, required for the pneumatic systems operating the dust chambers.

M12. Suction fans

They exhaust the purified fume gas from the dust filtering chamber and take it into the trumpet. For each chamber there is a suction fan installed.

M13. Automatics for regulation

It is a system for co-ordination of operation of the entire fume-gas exhausting and purifying systems, for measuring and recording of the required parameters, operation of the adjusting units and for signalling of defects.

M15. Casting crane

It is an overhead crane 5 t. serving the blast furnace and transporting hot slag and metal within the hall. It is operated from cage.

Casting Shop

C1 Casting crane

It performs lifting within the shop, it is capable of moving in three directions. Charging of the induction furnace and the casting are done using this crane.

C2 Induction furnace

It serves for melting the metal scrap and production of copper alloys.

Technical characteristics:

- crucible capacity:	max. 1000 kg of melt
- melt capacity :	1000 kg/Hr /approx; /bronze/
- number of the melting crucibles:	2,1 of them being in use
- overall dimensions of the furnace body :	1800 x 1500 x 1400 mm /length x width x height/
- input capacity :	390 kVA
- melting frequency:	500 Hz
- titling of the melting crucible :	hydraulic
- cooling system :	closed system with recycling and water/water heat exchanger

C3 Casting equipment

It serves for baling of the melted metal. It is a spliced chain, to which baling casting dies are fastened. It can be moved step-by-step after a casting die have been filled. Its utilization in production is eventual.

C4 Casting crucible

It is capable of holding approx. 300 kg of melted metal and serves for casting of the liquid material into the casting die.

C5 Crucible supporting fork

It serves for reliable and safe handling of the crucible.

C6 Centrifugal casting machine

A casting die is fastened along a horizontal shaft; the former is rotated by an electric motor with variable speed. The outer side of the dies is water-cooled. The liquid metal is poured into the die through the running gate. The equipment has protecting sheeting. A black waste agitating and spreading equipment belongs to the spin casting equipment.

Technical specification:

- maximum casting diameter	500 mm
- maximum casting length	600 mm
- maximum balanced load	1400 kg
- top speed	1200 RPM
- drive power	8 kW
- avarage total load	1300 kgs

C7 Black waste agitating and spreading equipment

It serves for coating the casting die of the spin casting equipment with black waste and for prevention of settling of the black waste.

C8 Pre-heater for crucible and dies

It serves for pre-heating of the casting crucible before tapping and of the die respectively before casting. It can be oil- or gas-fired type.

C9 Balance for measuring the weight of the liquid metal

It serves for exact measuring of the weight of the liquid metal; it can be installed on the crane, or on the ground level; it can be either mechanic or electric.

C10 Sand mixer

It serves for production of water-glass and sand mixture.

C11 Quick cutter

It removes the runner tunning system's parts of the castings. It is a motor-driven equipment with high number of revolutions (3-4 thousands) and plastic disc on the desk of which the casting can be fastened.

C12 Hand grinder

It is a grinder serving for removal of smaller castings' parts, it has electric drive (high number of revolutions, 4-5 thousands) plastic disc and hand-operated.

C13 Hand-operated compressed-air hammer

Hand-operated, pneumatic appliance, serving for removal of burned sand etc.

C14 Rotary saw

Serves for cutting off of big-sized pads. In case of castings having smaller diameters fram saw and quick cutter respectively can be used.

C15 Crane for moulding

It is a simple lifting device, controlled from the ground for moving of mould boxes, and joining of the mould-halves.

C16 Lathe

It serves for cutting, for rough machining and finishing of cast rods and tubes.

Material Testing Laboratory

L 19 Metal analyses: sequential optical emission spectrometer

Spectrometer for the quantitative determination of elements by direct photo-electric measurement of characteristic wavelengths.

Vacuum version

Consisting of:

SEQUENTIAL SPECTROMETER

with 1080 1/mm grating. Consisting of:

Fully computer controlled monochromator that permits measurement of any wavelength in the range of the spectrometer.

Optical system permits rapid and precise (less than plus/ minus 1 micron) positioning for wavelength peak measurement. Movement from any wavelength to another is less than 2,5 seconds.

Two programmable photomultiplier tubes of different spectral sensitivities. Programmable filter holder to suppress unwanted orders.

EXCITATION STAND AND SOURCE

Argon-stand

Including one table, electrode holder assembly and water cooling system.
- 1 additional table and electrode holder assembly

High repetition rate source

400 Hz - with High Energy Pre-Spark (HEPS)

INTEGRAL MEASURING ELECTRONICS SECTION

Microprocessor based electronics for control of the instrument.

Status measuring module

SPECTROMETER AUTOMATION SYSTEM

consisting of:

MICRO-85 Microcomputer System

with:

- 64k bytes of memory
- 2 serial asynchronous lines
- Dual drive 5.25" floppy-disk unit (512k bytes/drive)

Graphics Visual Display Terminal

for black and white graphics.

Printer Terminal

250 car./sec., without keyboard.
Paper width: max. 24.1 cm

Analytical software for spectrometer

Analytical software package as per software product description. Includes SAS/STORING for result storage and retrieval.

GRAPHICS

Support of graphics visual display terminal for presentation of calibration curves and wavelength scans.

5. FEEDSTOCK TO THE DEVELOPED FACTORY

In case the development will be realized the total annual feedstock to the factory is shown in the Shankey-diagram (Figure 17.).

The most important annual data from the diagram are as follows:

Inputs

Purchased slag	:	1,400 tons, copper content: 420 tons
Purchased scrap	:	750 tons, copper content: 525 tons
Coke	:	600 tons
Slag-formers	:	500 tons

Products

Black-copper billet	:	830 tons, copper content: 620 tons
Copper-based foundry product	:	400 tons
Separated, marketable dust (with ZnO content)	:	200 tons

5.1. Feedstock of the metallurgical shop

Slag, scrap, lumpy metal waste containing copper are delivered to the factory for processing. After preparation, explained in the foregoing parts, material is fed into the metallurgical furnace in a form suitable for further processing.

Annual material quantity

Proposed

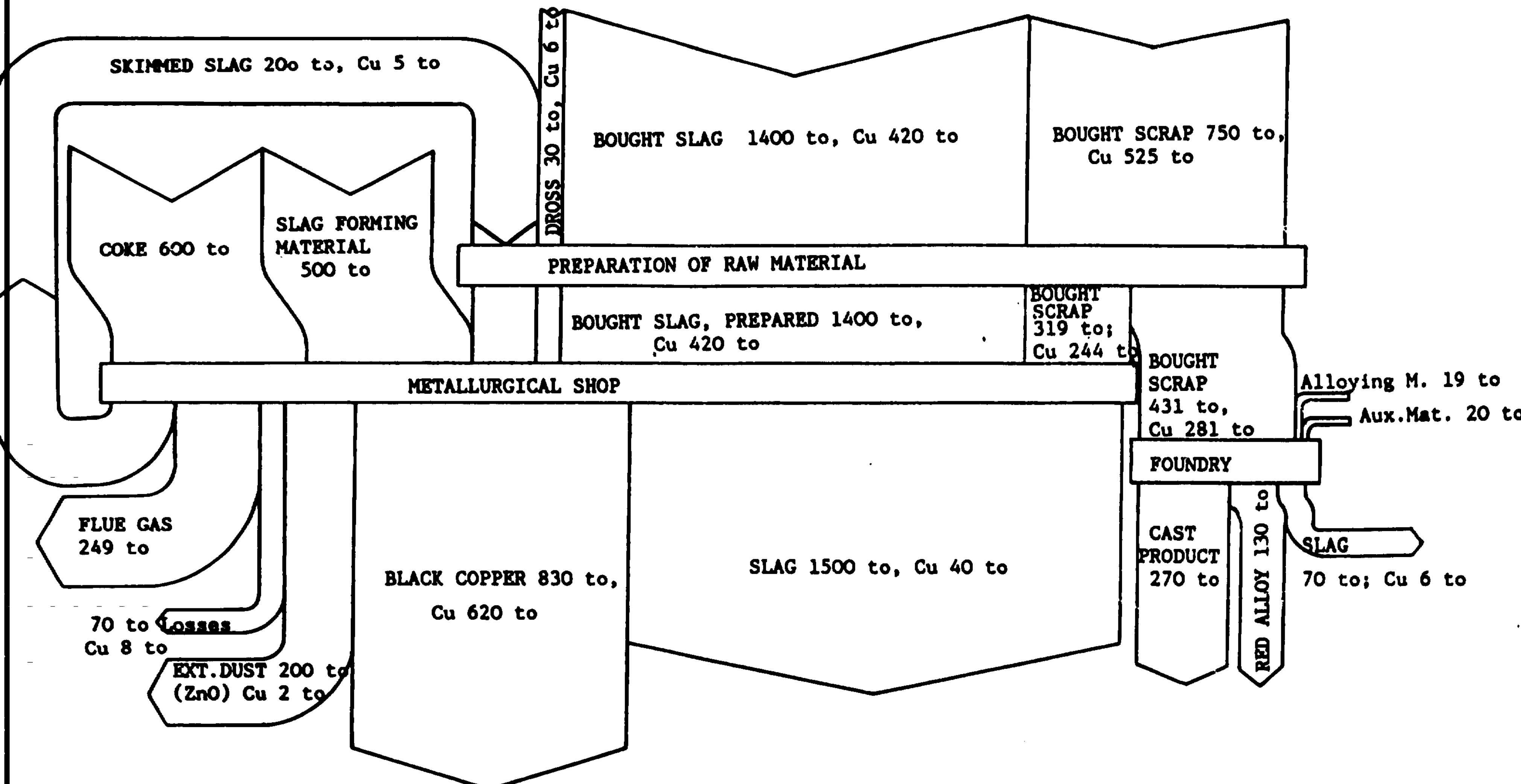

Figure 17.

Small mixed scrap with chemical contamination and small ferrous waste are transferred to the storage area then to the blast furnace having been briquetted.

Lumpy waste is to be stored seprarately according to the chemical content after crushin.

Fibrous, strip-like materials musb be embaled in the baling press; the bales must be cut to the sizes allowing feeding, then stored and utilized.

The copper-rich slag is crushed and transferred to the storage area. Dusty, small-size fraction, arising from crushing is briquetted using lime hydrate as binder.

5.2. Feedstock to the foundry

The foundry is capable of producing approx. 130 tons of copper and approx. 270 tons of brass as foundry product from the raw material being available. These two types of raw material have different physical forms: chips, needle-form scrap and lumpy waste.

These scrap and wastes are prepared, as explained so that they would be suitable for feeding into the induction furnace and for melting.

Chips arising when rough-machining the cast sleeves and pipes are of high quality and known composition so they may be recycled to the production process.

Elements of the charging system forming during mould casting are also very valuable raw materials being of known composition.

Classification of the produced products according to standards

In accordance with the SRRUC's investigation foundry billets with standard marking ZHPbD59, ZHSn D60-1, ZQSn D6-6-3, ZH62, ZH68 meeting the stipulations of the Chinese standards are required by the market.

It is probable that only ZQSn D6-6-3 is suitable for billetting because of the contamination of the waste material, as the stipulation for contamination is very strict. All the above indicated types of alloys can be however, produced from pure waste materials of copper chips by alloying.

In the field of castings production ZH62, ZH68, ZHPb 59-1 and ZQSn 6-6-3 castings of standard composition are required. These material-qualities are easier to produce as the allowed impurity values are higher, allowing production from waste material. (Except casting ZHPb 59-1 as it must not contain Sn as impurity.)

In addition to the above mentioned products gears made of alloy ZQSn 8-4, and ZQSn D 7-0,2 phosphor bronze rods are in demand. The former ones may be produced of waste material, the latter ones need addition of copper scraps.

5.3. Raw and auxiliary materials for the metallurgical workshop and the foundry

Scrap metal and slag containing metal as raw material is provided by the collecting network of SRRUC. Slag forming materials can be purchased from the local market, but we could not collect information in details.

Metallurgical workshop

Raw materials	Qty tons/year	Copper content (tons)
Recycled slag obtained from production, drossing	230	11
Purchased slag	1400	420
Purchased, prepared metal waste	319	244
Auxiliary materials		
Slag forming materials	500	-

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Foundry

Raw materials

	Qty tons/year	Copper content (tons)
Purchased, prepared metal waste	431	281
Alloying auxiliary materials		
Alloying additional materials (e.g. Zn,Sn)	19	-
Slag forming materials	20	-
Reducing materials	4	-
Grain fining materials etc.	1	-

5.4. Electric Power

Built-in output	1,000 kW
	- 350 kW (10 kV)
	- 650 kW (380 kV)
Simultaneous peak	680 kW
Average load	550 kW
Electric power consumption	4,900 kWh/ton

5.5. Water Supply

Industrial water (nominal)	1 m^3/hour
Temperature	min. 10 ; max. 25 ^{o}C

Recycled water	20 m^3/hour
Pressure	min. 4 kg/cm^2
Water consumption (recycled)	4-6 m^3/ton

5.6. Sewage Water

Capacity	there is no need for expansion

5.7. Compressed Air

Pressure	6 kg/cm^2
Capacity	100 Nm^3/hour
	Pipe network is to be constructed
Consumption	150-180 m^3/ton

Power supply

The existing electric power supply system, ensuring 200 kW is expedient to be replaced by a new one to be constructed from the transformer substation to the consumers. A new distributing switch must also be installed in the plant. It is expedient to provide power supply for the induction furnace from 10 kV thus it is recommended to supply electric energy from the existing distributing-transformer substation to the foundry through underground cable. Expansion may be realized gradually in accordance with development.

Water supply

A 1 m^3/hour increase in the required water quantity over that used mainly in the wellfare premises of the workshop now is to be considered. this additional 1 m^3 does not involve any problem.

For cooling of the new technological equipment a closed recirculation system is recommended. For cooling the water fed back, a heat-exchanger of water/water system, and cooling towers with air circulation are to be installed. For storage of the secunder water a basin must be built, but a water-tower may also be suitable for this purpose, as it may also serve increasing of pressure. Pumps can be installed in the premise 'D'. A storage tank and a cooling tower to be installed on the third level of the building 'B' may also be considered. This solution also ensures the required quantity of cooling water for a duration of 1 hour approximately in case of mains power cut-off.

Similar solutions are applied at several industrial palants in Chine and the structure of the above mentioned building is suitable for this purpose.

Sewage collection and disposal

The existing sewage collecting and disposing system will suit for the future requirements as well thus there is no need for expansion.

Compressed-air supply

The compressed air supplying system is adequate in its existing form quantity of air required for smoke chambers and slug crushing can be supplied by the existing compressors. A pipe-line for the cleaning workshop must be built.

A stand-by compressor is to be provided.

6. MANPOWER DEMAND

6.1. Workers

Scope of work	Skilled worker	Trained worker	Unskilled worker	Total
Scrap preparation	-	4	-	4
Metallurgical workshop	12	12	-	24
Foundry	12	10	4	26
Laboratory	-	4	-	4
T O T A L :	24	30	4	58

6.2. Employees

Scope of work	Engineer, technicians	Administrative	Total
Head of workshops	2	-	2
Technicians	2	-	2
Foreman	6	-	6
Clerk	-	2	2
Head of Laboratory	1	-	1
T O T A L :	11	2	13

6.3. Labour Demand

The following chart shows the summary of the capacity, load and necessary working hours in the various scopes of work:

Scope of work	Capacity Annually (tons)	Capacity Actually (tons)	Approximate extent of utilization (%)	Annual working hours needed
Scrap preparation	3-4,000	2,150	70	6,720
Metallurgical shop	3-4,000	830	25	14,400
Foundry	5-600	400	70	43,680
Laboratory	-	-	100	9,600
T O T A L :				74,400

Specific use of working time for the final product:

$$\frac{74{,}400 \text{ working hours}}{1{,}230 \text{ tons}} \simeq 60 \text{ wh/tons}$$

7. POSSIBILITIES OF ACCOMPLISHMENT OF THE PLANT

7.1. Project Description

The technological improvement of the present copper waste collecting and processing plant will bring about considerable advancement in product quality and production structure.

Before actually starting such development, it is recommended to improve the present conditions first, i.e. to renew the existing reverberatory furnace and to correct the system of flue gas removal.

As the amount of wastes is continually increasing, it is necessary to gradually introduce the new preparation technology as a basis for further developmental measures.

The application of mould casting techniques (which would not disturb the operation of the reverberatory furnace will result in the production of new products.
The induction furnace to be applied for the melting procedure creates flexible capacity concerning the processing of varying-quality and -composition raw materials, on the one hand, and casting requirements, on the other hand.

Nowadays, there is much demand for solid rods and tubes made by gravity dies casting and its introduction as soon as possible has become a necessity due to such features as the simplicity and low capital intensity of production.

According to plant visits and information received from the Chinese counterpart

China has great traditions in the field of cast moulding, so the expert staff for shaped casting production can easily be made available, and shaped casting products are at all times much in demand (not only should industrial applications be taken into account but it is also expedient to satisfy the increasing demands for art reproductions, plaquettes, etc. marketed commercially or for tourists).

A further step of development is to introduce centrifugal casting process into production. This would help the plant meet even more sophisticated demands as regards both sleeves and bush castings.

Simultaneously with gradual expansion of waste collection, a considerable qualitative change should be made during metallurgical processing or, if development studies unambigously reveal the reliable raw material source, the shaft furnace should be installed during the reverberatory furnace has previously been pulled down.

The new flue gas purification system will be able to retain the valuable by-product (ZnO dust) and, at the same time, will prevent the environment from being polluted.

The product (black copper) of metallurgical shaft furnaces is used as a raw material in copper refining plants, and its improved quality leads to better economic results.

The estimated production costs, incomes and profits after the completion of the development are included in Annex G (page

Data on prices, cost factors and other relevant information have bee:. provided by the Chinese counterpart (Annex C,page

7.2. Supply System

The expansion of supply systems should be planned with special care, taking into account the varoius stages and complexity of development.

The costs are highly dependent on the basis supply of potential sites as well as of the stage of development and technical parameters of the supply systems.

When planning electric power supply for the finally selected site, it is of great importance to obeserve the induction furnace supplier's instructions about the supply of the furnace transformator. The distribution system should be built accordingly. In our present project, the applicable supply is 10 kV.

Concerning water supply, the location and shaping of the reservoirs can and should be chosen from among several possibilities, based on the characteristics of the site.

The water drainage system (industrial sewage, precipitation) does not require expansion in the Jan Pu plant, except that some new junction and connection points should be developed.

As the consumption of compressed-air is inconsiderable, the present facilities will meet the requirements.

7.3. Material Testing System

The recommended material testing system is one of the most up-to-date systems in use today and, at the same time, it is not uneconomic.

The apparatus used for chemical analysis is capable of performing a wide range of tasks and, together with the 'traditional' chemical laboratory, can adequately satisfy the daily and long-term requirements of the plant. The laboratory equipment can provide for the quick and accurate chemical analysis of products at the interim phases of production and that of the end-product, which is a basi requirement for active intervention in technological processes.

7.4. Training and Education, Timing of the Project

The guidelines for introducing the metallurgical, casting and material testing procedures discussed in the chapter about development may not be completely unfamiliar to workers operating in the existing plant, although they involve the adoption of some processes not having been applied so far.

In order to acquire the necessary know-how and experience, it is recommended to form groups. The workers may be trained either in foreign plants (reasonably in one of the supplier's plants who delivered the equipment or the technological know-how) or in the already finished Chinese plant, under own circumstances, with the assistance of invited experts.

It is advisable to involve in the assembly operations those workers who will later work with or maintain the equipment and machines.

As far as the chemical laboratory is concerned, it should be noted that, during (simultaneously with) the installation of the photoemission equipment, the experts of the supplying firm can carry out both theoretical and practical education or training, resulting in higher training efficiency for the workers and lower costs for the investor.

The project as a whole should be performed by adequate expert teams, embracing all the activities from starting of the project to its final inauguration.

Concerning the work, the following expert's activities or tasks were taken into account:

- Project Co-ordinator
- Foundry and Metallurgical Expert
- Training Instructor

- Ad-hoc Consultants
- Comprehensive Engineering, Design and Planning
- Training of Supervisory Technical Staff
- Training
- Training
  Fellowship
  Study-tour

According to our calculations, the number of people and their working hours required for the performance of the above tasks accounts for 100 manmonths.

The time requirement of the project is 36 months (see Figure 11.)

In order to acquire the proposed technology the following training programme is recommended:

Denomination	Duration	Place of[x] training
Metallurgical shop		
- Handling of furnace, smelting, casting	4 trainess x (3+4)m = 28 m/m	A + B
- Handling of flue-gas cleaning-system	2 trainees x (1+2)m = 6 m/m	A + B
- Electrical and pneumatic maintenance	2 trainees x (1+3)m = 8 m/m	A + B

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[x]Remark:

A - Training in the premises of the Supplier

B - Training in the newly established shops of SRRUC

Denomination	Duration	Place of[x] training
Casting shop		
- Handling of induction furnace, smelting	3 trainees x (1+4)m = 15 m/m	A + B
- Preparation of moulds, casting	3 trainees x (1+3)m = 12 m/m	A + B
- Centrifugal casting	2 trainees x (1+2)m = 6 m/m	A + B
Material testing laboratory		
- Handling of spectrometer	4 trainees x 3 m = 12 m/m	B
	T o t a l	87 manmonths

[x]Remark:

A - Training in the premises of the Supplier

B - Training in the newly established shops of SRRUC

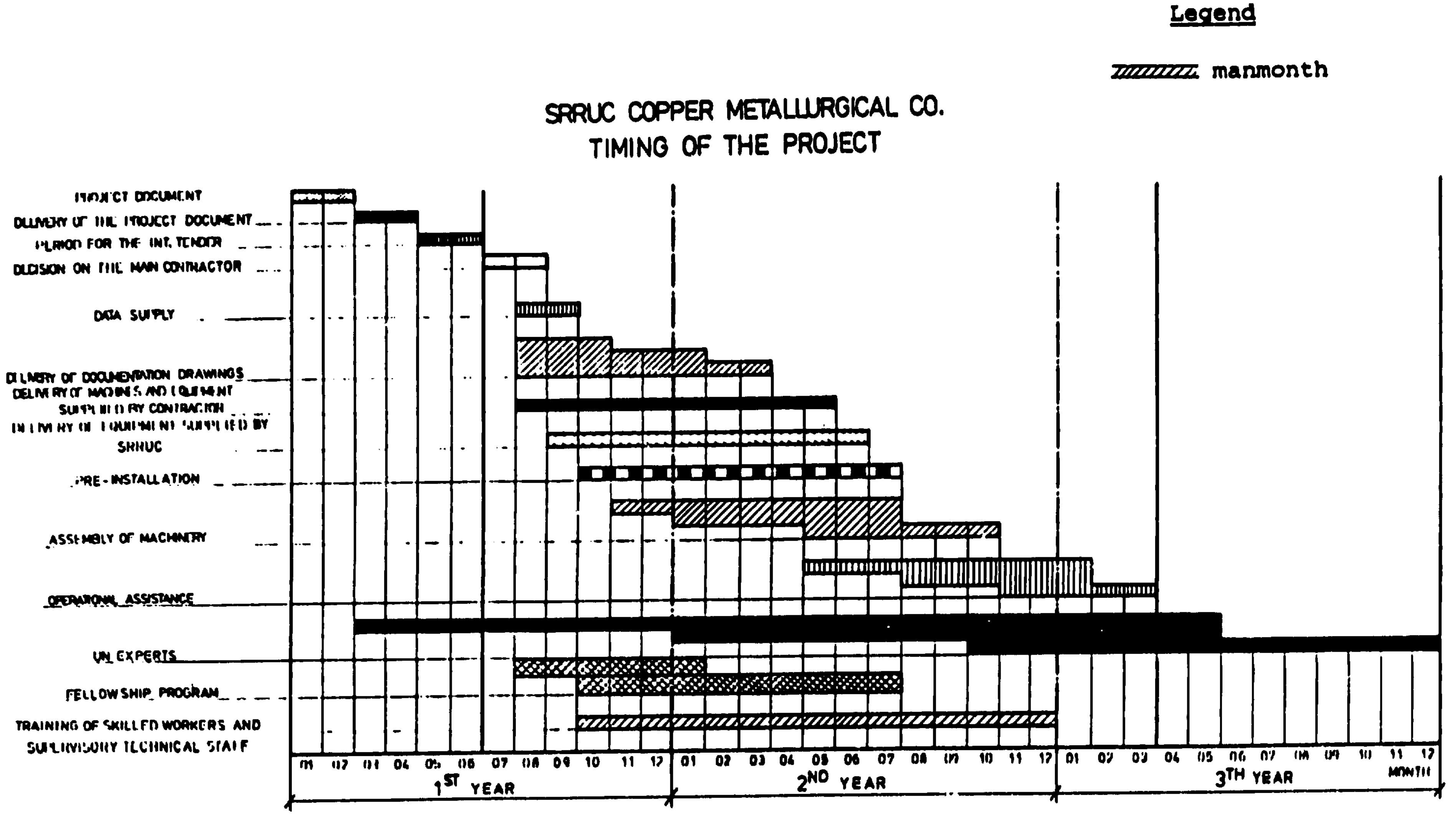
Legend
manmonth
SRRUC COPPER METALLURGICAL CO.
TIMING OF THE PROJECT
PROJECT DOCUMENT
DELIVERY OF THE PROJECT DOCUMENT
PERIOD FOR THE INT. TENDER
DECISION ON THE MAIN CONTRACTOR
DATA SUPPLY
DELIVERY OF DOCUMENTATION DRAWINGS
DELIVERY OF MACHINES AND EQUIPMENT SUPPLIED BY CONTRACTOR
DELIVERY OF EQUIPMENT SUPPLIED BY SRRUC
PRE-INSTALLATION
ASSEMBLY OF MACHINERY
OPERATIONAL ASSISTANCE
UN EXPERTS
FELLOWSHIP PROGRAM
TRAINING OF SKILLED WORKERS AND SUPERVISORY TECHNICAL STAFF
01 02 03 04 05 06 07 08 09 10 11 12
1ST YEAR
01 02 03 04 05 06 07 08 09 10 11 12
2ND YEAR
01 02 03 04 05 06 07 08 09 10 11 12
3TH YEAR
MONTH

Figure 11.

8. CAPITAL REQUIREMENTS

The cost estimate of the building erection and infrastructural investments is based on verbal, local information received and on-the-spot experimental data collected.

The prices of machines and equipment are calculated, i.e. estimated on the average international market prices prevailing in the period of December, 1988 - April, 1989 of identical or similar machines with same or similar parameters. The prices are to be understood C.I.F Shanghai.

When calculating the machines to be manufactured locally expenses have been based on cost norms and factors provided by the Chinese counterpart.

8.1. Construction

The following construction works mut be carried out in the course of development:

Technological hall 'A'

- The roof structure of the hall must be elevated in bays C8-9 and D8-9 respectively (+ 1.5 m).
- Construction of new columns; B8 and C8 for the crane truck.
- Erection of new crane track consoles on columns A6, B6, C6, D6 and A8 , B8, C8, D8 respectively.
- Construction of a new roof, protecting smoke chambers against rain in bays C5-6 and D5-6.
- Construction of foundation for the blast-furnace 2.5 x 2.5 m.

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- Construction of foundation for the induction furnace 8 x 5 m.
- Construction of foundation for the flue gas exhausting system - 14 x 10 m.
- General reconstruction of building inside and outside (glazing, replacement of the rain gutters etc.).

Hall 'B'

- New laboratory on the second floor of the building, floor area: 16 x 5.5 m and 10 x 10 m.
- Room for the spectrometer: air-conditioning applied to windows with darkening possibility for the windows and insulating covering for the floor.
- Traditional laboratory (wet chemical room) with cold flooring, tiled walls, two basins, hot-cold water, ventillation by fans are required.
- Balance-room: a room with warm flooring and air-conditioning.
- Chemicals' store: with cold flooring and continuous ventillation.
- Patterns' store: with warm flooring, it is used also for office purposes

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Building 'C'

It serves for slag preparation, does not require constructing work during expansion.

Building 'D'

Premise of the existing laboratory will be transfered for other purpose, the switch-room, next to the laboratory does not require any extension.

Builiings E, F, G, H do not require any expansion in the course of development.

Supply with recirculated cooling water:

Required pumps and coolers etc. can be installed on the covered ared 'D'; for installing of the storage basin, cooling tower etc. several solutions are possible.

Electric power supply:

The development does not require construction work, for cable laying trenches are required.

Compressed-air supply:

It does not require construction work.

Estimated construction costs:

Reconstruction of the technological hall	USD	110,000
Laboratory	USD	20,000
Cooling water supply	USD	60,000
Electric power supply	USD	25,000
Construction work total :	USD	215,000

8.2. Technological equipment

Main items of the production plant are as follows:

Scrap preparation	USD 77,000	(see chapter 4.5.1.)
Metallurgical shop	USD 460,000	(see chapter 4.5.2.)
Casting shop	USD 550,000	(see chapter 4.5.3.
Material testing laboratory	USD 346,000	(see chapter 4.5.4.
Technological equipment total:	USD 1,433,000	

8.3. Auxiliary equipment

Water supply	USD 55,000
Electric supply	USD 180,000
total:	USD 235,000

8.4. Other costs

Engineering, know-how	USD 265,000

8.5. Summary of capital requirements

Construction	USD 215.000
Technological equipment	USD 1,433,000
Auxiliary equipment	USD 235,000
Other costs	USD 265,000
Grand total (rounded)	USD 2,250,000

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Remark:

Prices are subject to confirmation with suppliers

ANNEX A.

Page 1.

Summary of the existing infrastructural facilities of the Yang Pu Smelter

1. Electric power supply

Recently used power	80 kW (permitted)
Possible maximum of the usable power	200 kW
Parameters of electricity	3/380 V 50 Hz
Voltage fluctuation	+3, -10 %
Power cut data	1-2 occasions / month 12 hours / events announced 24 hours prior to cut-off

2. Water supply

Quality	industrial water
Recently used quantity	1.2 m^3/hour
Maximum capacity of the supply system	8 m^3/hour
Main tube size (steel tube)	dia. 4 inches
Pressure (nominal)	0.6 bar

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Hardness (CaOreff)	< 250 mg/l
Slurry content	< 0.008 g/l
Running (hot) water for baths	for 110 workers/day

3. Sewage water collection and treatment

Present method of sewage water	without cleaning system
Main collecting tube size (ceramic tube)	dia. 24 inches
Present quantity of sewage water	1 m^3/hour
Present quality of sewage water	waste water from slag washing, from bathes, Wc-s and precipitation
Transmission of the sewage water	channel (river)

4. Compressed-air supply

Present capacity	54 Nm^3/hour (maximum)
Nominal pressure	6 bars
Network	no
Type of equipment	Mobile for painting

. / .

5. Transportation supply

In-plant transportation

- vehicle (2 pieces) capacity	5 t + 2 t
- scoop shovel (1 piece) capacity	3 t (mobile)
External transport (hired vehicle)	2-3 tracks (10 tons) 1-2 occasions/year

6. Capacity of storage of materials

Raw materials	min. 40 t ; max. 250 t
Finished products	min. 20 t ; max. 200 t

ANNEX B.

Results of audits and examinations on site

Page 1.

First batch inspection Date: 29.10.1988

p.m. shift

Raw material:
Bronze chip and bronze powder

2.00-2.50

The shift was started with the feeding of the furnace. The fed material was mainly bronze chip, with some less bronze powder and lump bronze scrap. Feeding was performed by the above discussed method so that the chip and powder would be mixed during feeding.

2.50 -

They started heating the furnace. During the heating process, the stack of raw materials was spread twice by hand tools.

7.25 -

They skimmed out the upper part of the slag - about 120 kg - and alloyed into the melt 120 kg of Zn in metal scrap form . The remiaining part of the slag was definitely kept in the furnace during the full batch time.

7.40 -

They started tapping down the melt into the ingot moulds of the casting conveyor. During this procedure, the coal

burner was working permanently. The tapping was finished at 8.30. Inside the furnace, there remained 3-5 cm thick slag which covered the bottom of the furnace.
At the end of tapping, the coal burner was stopped, so the temperature of the slag decreased and the slag became pulpy.
No auxiliary material was used for the melting procedure of the batch.

ANNEX B.

Page 3.

Second batch inspection

Date: 31.10.1988

a.m. and p.m. shift

/the data relate to the a.m. shift/

Raw material:

Brass chip

6.00 - 6.45

The furnace was fed in two steps. First, at starting, the upper part of the brass chip (3505 kg) and some slag (470 kg) - pretty irony - were put into the furnace in the above discussed way.

6.45 - 10.25

When the full amount of the material had been melted, they shovelled the rest of the chip (555 kg) across the slagger door into the furnace; during this work, the coal burner was stopped heating.

10.25 a.m. - 1.00 p.m

When the total amount of the batch had been melted, they skimmed the upper part of the slag and then started tapping the melt.

The surface of the ingots showed grey colour and it was easy to break; the colour of the broken surface was grey-yellow. All these reflect the high impurity content of the ingots.

During the melting procedure, no auxiliary material was used.

1.00 - 1.55

From the finishing of the tapping procedure to the beginning of the p.m. shift, the furnace heating was stopped, so the furnace considerably cooled down.

Third batch inspection

Date: 01.11. 1988

a.m. and p.m. shift
(data relate to the a.m. shift)

Raw material:

Enriched slag

6.00 - 6.45

The total amount of the raw material was fed into the furnace - 16 hand cars with 3 shovels of fluorite mineral on each as slag-forming auxiliary materials was put thereinto.

This batch consisted of 5-8 mm diameter slag granules with a lot of metal-impure bronze and iron pieces.

6.45 a.m. - 0.45 p.m.

They started heating the furnace. When most of the batch had been melted, they spread the material and then skimmed down parts of the slag. This procedure was repeated 5 times between 9.15 and 0.45 p.m.

The skimmed slag was cooled by water and then taken out from the smelter's hall. The skimmed slag contained a lot of metal drops.

0.45 - 1.40

They proceeded with the tapping of the ingots. The second shift immediately started work.

./.

ANNEX B.

Page 6.

Material and metal balance of the inspected batches

(Annex to Chapter 2. page)

1. First inspection

Material	Weight (kg)	Cu (%)	Cu (kg)
Raw material	6040	85.1	5143
Alloying elements	120	-	-
Ash content of coal powder	117	-	-
Total	6277		5143
Oil and water content of raw material	120	-	-
Skimmed slag	120	9.61	11.5
Extracted dust	80	-	-
Other losses	243		246
Ingot	5714	85.5	4885.5
T o t a l	6,277		5,143

./.

ANNEX B.

Page 7.

2. Second inspection — 3. Third inspection

Material	Weight (kg)	Material	Weight (kg)
Raw material	4530	"	4115
Auxiliary material	-	"	230
Ash content of coal powder	117	"	156
Total	4647		4501
Oil and water content of raw material	226	"	-
Skimmed slag	1450	"	2320
Extracted dust	150	"	80
Other losses	321	"	489 x
Ingot	2500	"	2590
Total	4,647		4,990

x Remark:

Some slag and melt always remain in the furnace which causes errors in the calculations.

Table

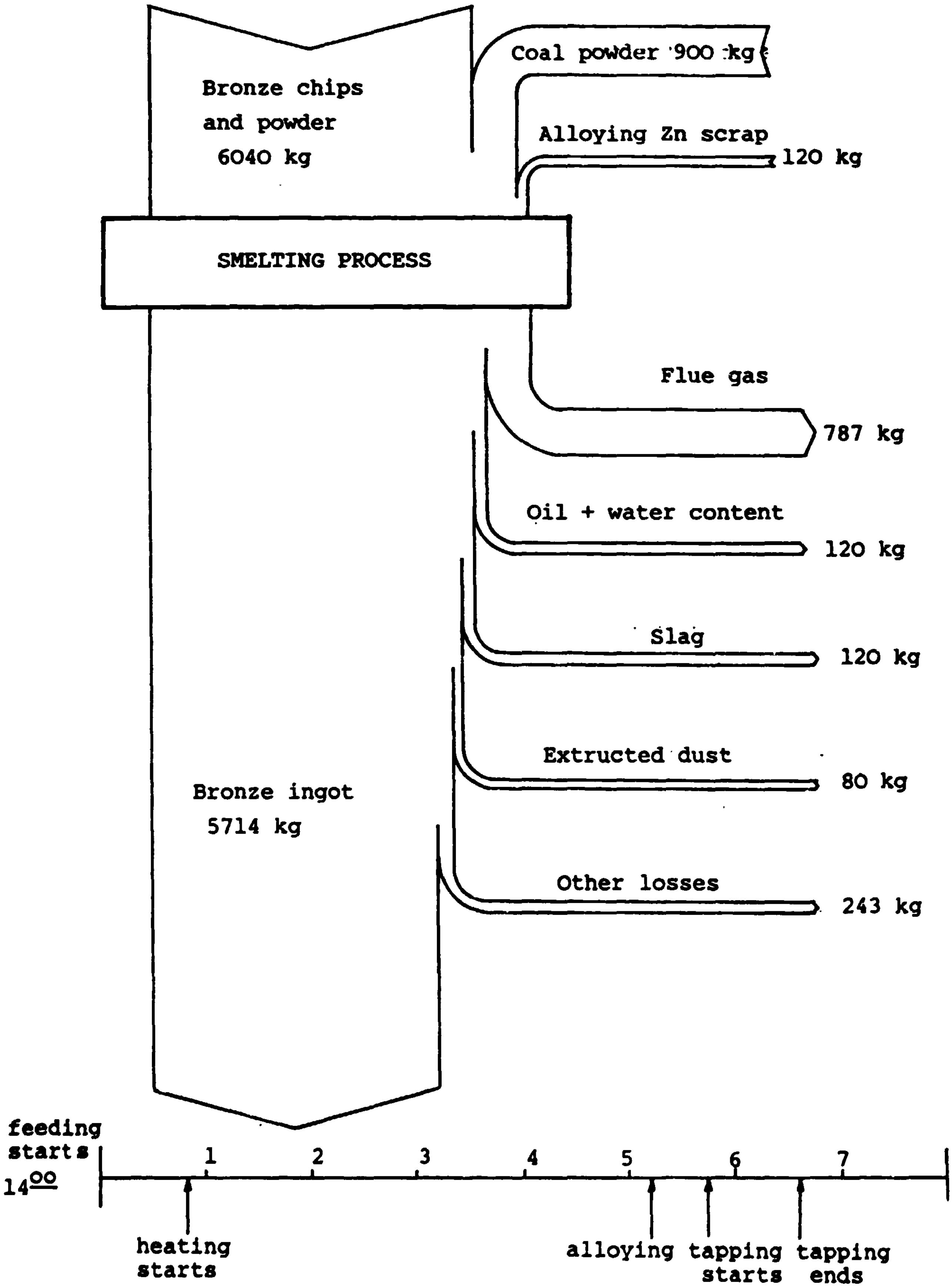
Main data of the inspected batches

No. of inspection	Raw material	Amount	Alloying elements	Ingots	Fluorite stone	Slag	Coal powder	Black coal	Extracted dust	Yield[x]
1	Red alloy chips and powder	6040	120 Zn	5714	-	120	900	180	80	1057
2 a.m.	Brass chips	4530	-	2500	-	1450	900	150	150	1812
2 p.m.	Brass chips	4695	-	2550	-	1500	720	150	150	1841
3 a.m.	Enriched slag	4115	-	2590	230	2320	1200	200	no data	-
3 p.m.	Enriched slag	4140	-	2070	250	1970	720	290	no data	-

Remarks: [x] - yield relates to 1 t of final ingots

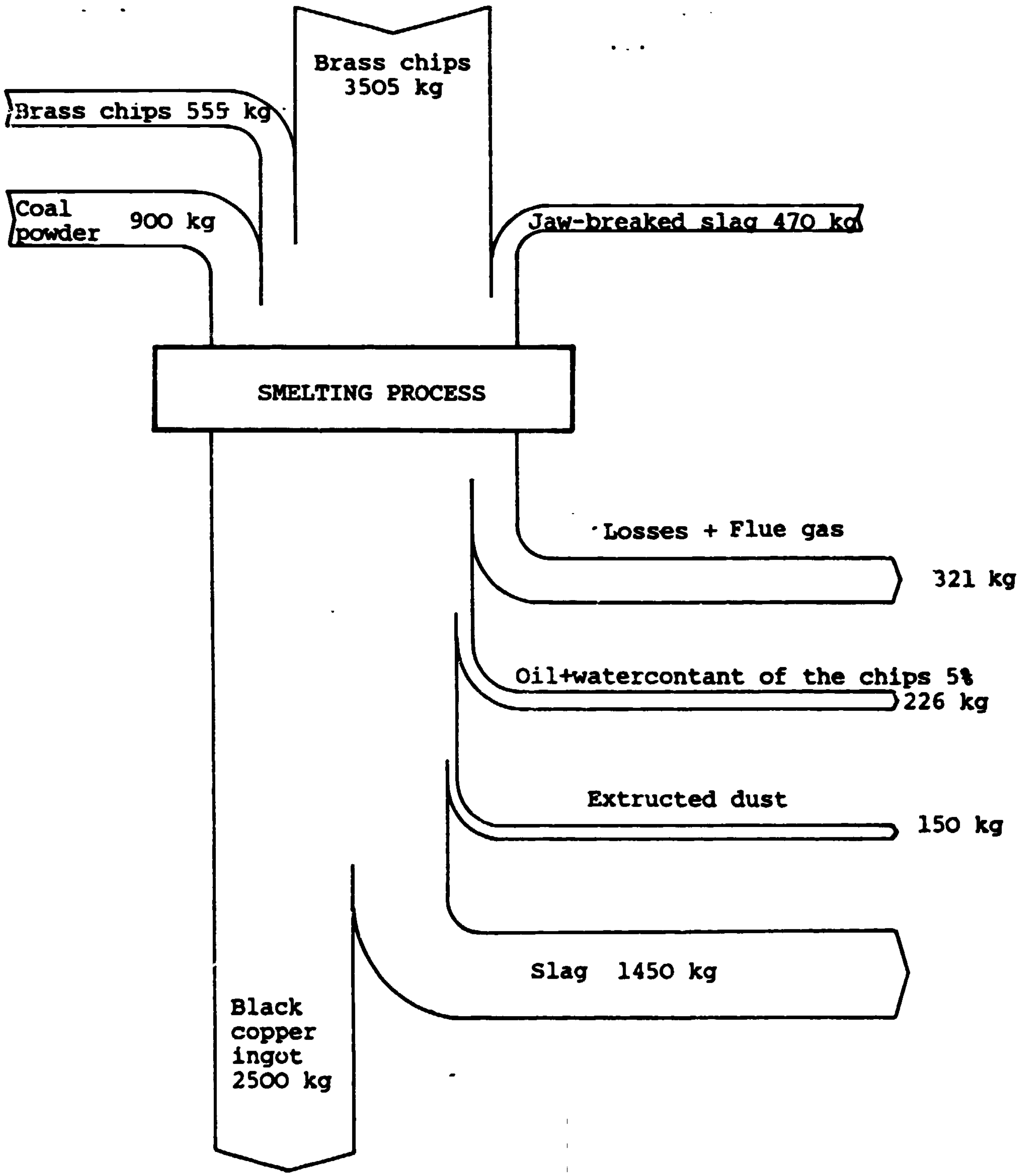
- all data are given in kg

Shankey-figure related on the first inspection

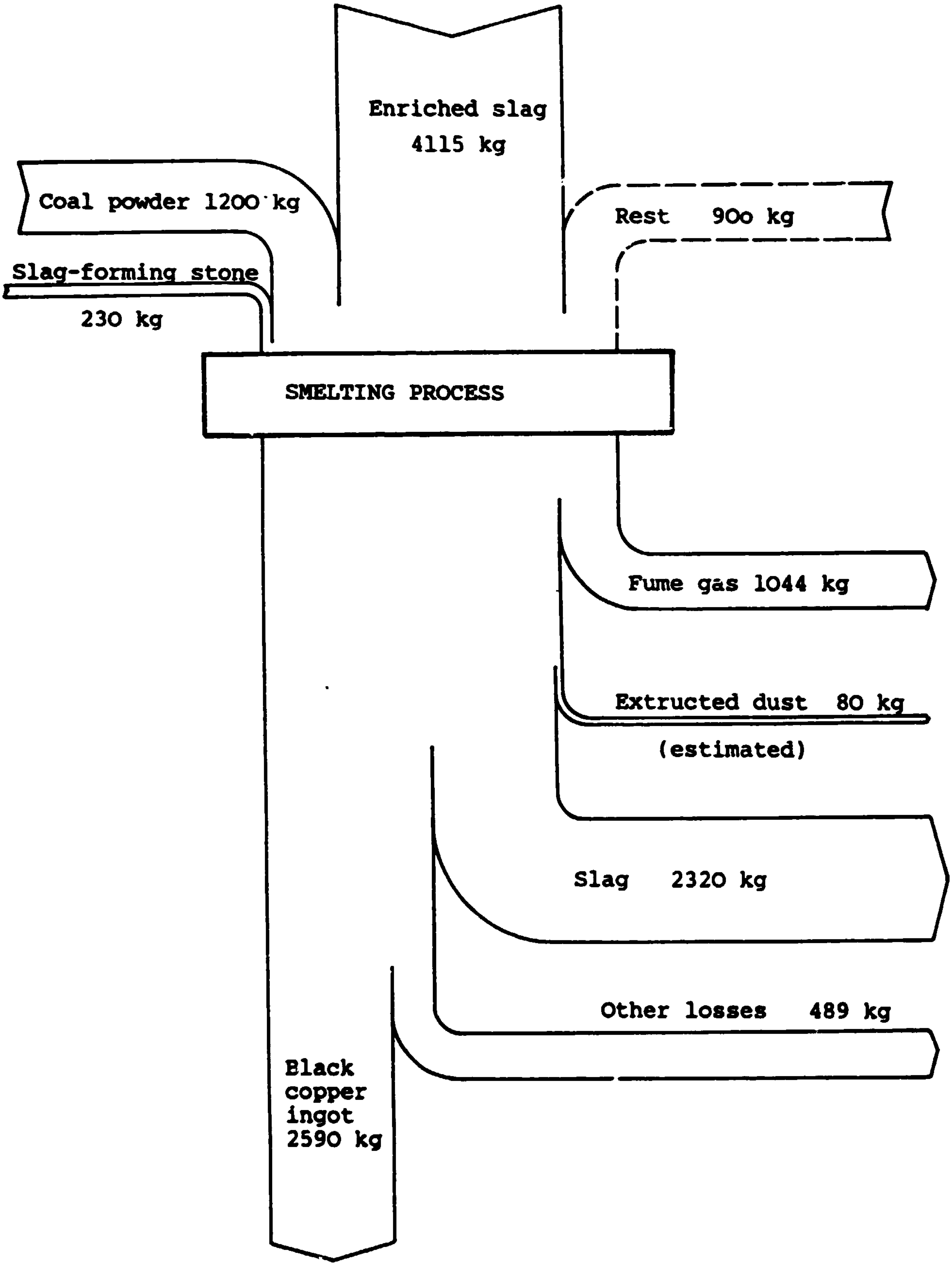


Time - diagramme

Shankey-figure related on the second inspection related on the a.m. shift



Shankey-figure related on the third inspection



QUESTIONNAIRE IN CONNECTION WITH THE UC/UO/CPR/87/224 PROJECT

LAYOUT – BUILDINGS – INFRASTRUCTURE

1. Layout of the present situation:
   a plan sketch of 1:500 scale was given by Yangpu Smelter
2. Building construction drawings:
   one set of 1:100 scale drawing has been given by Yangpu Smelter
3. Total area: 7000 m^2
   built- in area: 3,000 m^2
   technological area: 824 m^2(among the total 464m^2 are of simple building)
   stockhouse area: 671 m^2
   maintenance area: 45m^2
   bureau area: 156 m^2
   special area, namely: 1,123 m^2
   divertion of storm water: has been given with a plan sketch
   characteristic wind direction: southeast in summer, northwest in winter
   loading capacity of the crane track (t): big one: 5-ton, small one: 2-ton
4. Possibilities to increase the total area: no
5. Transportation
   Internal transport:

vehicle:	piece:	capacity:
big	1	5 tons
small	1	2 tons

   External transport: your own vehicle: the 5-ton truck can be used for external transportation if not in use for internal purpose.
   hired vehicle: 2 to 3 10-ton trucks might be hired by the factory if needed for business
6. Depot of materials
   Min. and max. amount of the raw materials (t): 40--250
   Min.and max. amount of the final products (t): 20--200

ENERGY CONSTRUCTION

7. Available fuels in the future:

material:	calorimetric value:	ash content (%):	S content:	price (y/t):
coal	6,250 - 7250 Kcal/Kg	12 - 15	0.8 - 1.0%	150 - 160
coke	6,000 - 7,000 "	10 - 18	< 0.8%	200 - [illegible]
heavy oil	9,500 - 10,000	< 0.3	1.5 - 2.0%	600
cracking oil	9,000 - 11,000	-	-	600

8. Electrical power supply
   recently used power: 80KW (permitted)
   possible maximum of the usable power: 200 KW (permitted)
   necessary conditions for further increase of the power supply (building, transformer,etc.): possible to have 300 KW more
   parameters of electricity: 380 V, 3 phases, 50 Hz
   max. and min. of the voltage fluctuation: +3%, -10%
   power cut data: 1 -- 2 occasion/month, 12 hours/events, announced 24 hours before
   unit price: 0.23 yuan/KWh
9. Water supply

quality: industrial water
recently used amount: 1.2 m^3/h
max. capacity of the supply system: 7 -- $8m^3/h$
hardness: CaO < 250 mg/l
pressure: 0.4 -- 1.2 bar, normally 0.6 bar
slurry content: 0.008 g/l
water supply points in the factory halles and its capacity: has been given with a plan sketch

10. Sewage water conditions
present capacity: 1 m^3/h
capacity of the cleaning system: no
sewage water collecting point and its capacity in the factory halles: to be given with a plan sketch
present method of the sewage water cleaning: no
leading of the cleaned sewage water: to a river

11. Compressed air conditions:
present capacity: 54 Nm^3/h, mobile, chinese type
available maximum capacity: 54 Nm^3/h
nominal pressure: 6 bars
network: no

RAW AND AUXILIARY MATERIAL, FINAL PRODUCTS

1. Raw materials - in the present situation:

material:	amount (t):	price (yuan/t):	Cu content (%):
own slag	470	478	17
bought slag	-	-	-
lump metal scrap	1,215	5,250	70

2. Planed raw materials - in the future:

own slag	900	600	18
bought slag	1,400	1,200	30
lump metal scrap	750	10,000	70

3. Lump metal scrap distribution
Present situation:

material:	lump		chips		powder		other	
	proportion	price	%	price	%	price	%	price
CuZn (brass)	13%	5,986 ¥/t	63%	4,943 ¥/t				
CuZnSnPb	-		-				11%	3.75¥/1%Cu
CuSn (bronze)	-		-					
red Cu	7%	6,489	6%	5,562				

Future situation (planed)

CuZn (brass)	13%	13,000¥/t	63%	8,000¥/t				
CuZnSnPb	-		-				11%	750¥/t
CuSn (bronze)	-		-					
red Cu	7%	18,000	6%	12,000				

4. Auxiliary materials used in the present situation:

material:	amount (t):	price (yuan/t):	Composition(%):
fluorite	20Kg/t final prod.	132	$CaF_2 \geq 90$

auxilliary materials necessary in the future:

Cu10%P alloy		20,000	P9-11% impurity 0.5%
Borax (sodium tetraborate)		2,850	

5. Final products:

in the present:

material:	amount (t):	price (¥/t)	content (%): Cu	Zn	Sn	Pb
Black copper	300 (1988) 800 (1987)	6,200	75			

in the future:

black copper	700	15,000	85	3-6	2-3	2-4
red copper alloy	400	14,600-18,000				

6. Residuals:

in the present situation:

material:	amount (t):	price (¥/t):	content (%):
ZnO powder (including fly ash)	30-40t/year	400	60-70% ZnO
dead material	250-300t/year	20	3% Cu

7. Standards of castings of China concerning the copper cast products has been given with attached pages

8. Average price of copper cast products (¥/t):

materials:	ingot;	centrifugally casted:	continuously casted:	mould casted:
black copper:	15,000(85%Cu)	-	-	
brass:	12,133	13,680	12,833	
red alloys:	-	-	-	16,300
tin bronze:	15,300	-	16,000	

TECHNICAL AND TECHNOLOGICAL CONDITIONS

list of the present working facilities	productivity	energy consumption(KW)
rotary bracker: 1	2t/shift	13
jaw crusher: 1	3t/shift	15
washer: 0		
smelter: 1	3-4t/shift	6.5
casting conveyor: 1	5t/hour	10
dust collection system: 4	6,600 m^3/hour	63

FINANCIAL SURVAY

1. Charges of the enterprise:
   - annual amortisation (%): 6
   - annual wage costs including the wage taxes: 148,977 yuan
   - other costs burdening the wages: 85,600 yuan
   - tax ratio (%): products 5, sales 3, income 55, energy & transportation found 3.15
   - charges of the rents: 0.74%
   - dues: a third or fourth part of raw material value of one year
2. Firm charges:
   - payments to the budget of the headquarters: 11% of total profits
   - transportation costs: 76,023 yuan/year
   - depot costs: no
   - headquarters wage costs and wage taxes: no
   - minimum investment recovery term: half part of investment period
3. Worktime regulation:
   - days of work/year: 300
   - days of work/week: 6
   - shifts/day: 3- if the smelter is working, 1- if the smelter is not working

man hours/shift: 80/10 workers

batch-time: 6 hours

4. Labour

education:	metallurgical:	other:
engineer:	1	1
technician:	3	2
skilled worker:	8	25
trained worker:	22	45 = 106

QUALITY CONTROL AND ENVIRONMENTAL STANDARDS

1. What kind of test methods were applied till now?

chemical: yes optical emission: no ICP system: no X-ray emission: no

other, namely: no

laboratory or on-site analysis: laboratory

long test or on-line test: long test

2. At which technological steps do you apply tests?

raw materials: yes internal product (melt): no final products: yes

3. Survey of the present situation:

element	method	testing time	raw materials: mixed:	powder:	chips:	slag:	melt	final prd.
Cu	chemical		•	•	•	•	•	•
Zn	"		•	•	•			•
Sn	"		•	•	•			•
Pb	"		•	•	•			•
Fe	"		•	•	•			•

(only for slag)

SiO_2

CaO

FeO not be tested at present

ZnO

Al_2O_3

4. Expectations for the future development:

Cu prompt analyses with equipments for all kinds of samples

Zn

Sn

Pb

Fe

5. List of the present facilities which are used for testing:

one"full-automatic electro-optical analytic balance"

one "721-100 modle spectrophotometer"

one "far infrared radiation dryer"

6.Present labour conditions for testing:

engineer (which kind of): no

technican (skilled or trained): two skilled technicians

Environmental

1. Please attach the state environmental standars for air, water, noise, earth, etc.: to be attached with seperated pages

2. What kind of environmental testing do you have for (method and equipment):

sewage water:
smoke: all are done by environmental monitor centre
noise:
earth:

3. What kind of environment testing will you need for the future development (methods and/or equipments)?

for sewagewater:
smoke: portable monitor equipments
noise:
earth:

4. In present situation do you perform analysis for

sewage water:

element	method	testing time
settling slurry ct.:		
sulfates:		
Pb	•	one week
Cd	•	
Cu	•	
Zn	•	
Fe		
solute metal ct.:		
Pb	•	
Cd	•	
Cu	•	
Zn	•	

for smoke:

element	method	testing time
powder ct.:		
ZnO	•	
Pb	•	
Cd	•	
Sn		
Cu		
gas ct.:		
SO_2	•	
NO_x	•	
CO_2		
CO	•	

5. Based on the environmental standards your proposal for environmental testing:
see the table:

for sewage water:

element	method	testing time
settling slurry ct.:		
sulfates:		
Pb	•	
Cd	•	
Cu	•	
Zn	•	
Fe		
solute metal ct.:		
Pb	•	
Cd	•	
Cu	•	
Zn	•	

for smoke:

element	method	testing time
powder ct.:		
ZnO	•	
Pb	•	
Cd	•	
Sn		
Cu		
gas ct.:		
SO_2	•	
NO_x	•	
CO_2		
CO	•	

88.12.5

ANNEX D.

Coordination of centrifugal casting technology and available materials[x]

Size casted (mm)	Weight of casting (kg)	Number of pieces producible during one shift	Total weight producible during one shift (kg)	Chemical composition[xx]	Available raw material (t)	Bound machine capacity (shift)	Utilization of capacity (%)
Ø 120/80x600	33	16	520	ZQSn D 6-6-3	130	250	28
Ø 180/120x600	74	14	1036	"	130	126	14
Ø 220/180x600	66	14	924	"	130	141	16
Ø 280/220x600	123	12	1480	"	130	88	10
Ø 380/320x500	143	10	1430	"	130	91	11
Ø 120/80x600	32	16	512	ZH62	270	528	59
Ø 180/120x600	72	14	1008	"	270	268	30
Ø 220/180x600	64	14	896	"	270	302	34
Ø 280/220x600	119	12	1428	"	270	190	21
Ø 380/320x500	139	10	1390	"	270	195	22

[x] Yearly capacity is based on 3x300 = 900 shifts

[xx] According to Chinese casting standards

ANNEX E.

Die Castings

Size casted	Material	Weight of casting (kg)
Ø 40x500	Brass alloy	5
	Red alloy	5
Ø 60x500	Brass alloy	12
	Red alloy	12
Ø 80x500	Brass alloy	21
	Red alloy	22
Ø 120x500	Brass alloy	46
	Red alloy	49
Ø 290x500	Brass alloy	270
	Red alloy	286
Ø 120/40x500	Brass alloy	41
	Red alloy	44
Ø 140/50x500	Brass alloy	55
	Red alloy	58
Ø 140/100x500	Brass alloy	31
	Red alloy	33

ANNEX F.

Sand Castings

Name	Proposed material	Size casted	Weight of casting (kg)
Bearing	Tin bronze Lead bronze Red alloy	from Ø 400	max. 750
Boss	Special brass	depends on max. size mould box	max. 750
Bush	Red alloy	Outer: Ø min. 400 Bore: Ø min. 140 Length: min. 20	max. 750
Warm and wheel	Tin bronze Red alloy	for sizes over Ø 400	max. 750
Nut	Tin bronze Special brass	from Ø 30x120 to Ø200x700	2-200
Bedges and works of art	Brass	-	max. 750

ANNEX G.

Page 1.

Expected economic parameters after development

Expenditures per year

Used waste metal	750 t;	Cu: 70%	
- brass waste	97.5 t x	13,000 Y/t	1,267,500 Y
- brass chips	472.5 t x	8,000 Y/t	3,780,000 Y
- copper chips	45.0 t x	12,000 Y/t	540,000 Y
- copper waste	52.5 t x	18,000 Y/t	945,000 Y
- mixed waste	82.5 t x	7,500 Y/t	618,000 Y
Total	750 t;	Cu: 525 t	7,151,250 Y
Used slag	1400 t;	Cu: 30%	
- prepared slag	1400 t x	1,200 Y/t	1,680,000 Y
		Cu: 420 t	
Alloying elements	19 t;	(Zn, Sn, Pb)	188,000 Y
- Zn		6,600 Y/t	
- Sn		16,000 Y/t	
- Pb		6,000 Y/t	

./.

Auxiliary materials, slag formers	20 t + 500 t 520 t x 132 Y/t	68,640 Y
Coke	600 t x 200 Y/t	120,000 Y
Wages, wage extras		200,000 Y
Other wage-related costs		100,000 Y
Transport and other operational costs		100,000 Y
Total costs		9,6067,890 Yuan

Total copper content: 945 t

Revenues

	Quantity	Cu content	Revenue
Castings and slugs	400 t;	Cu: 173.5 t	5,500,000 Y
Type 'ZQSnD 6-6-3'	130 t		
Type 'ZHD 62'	270 t		
Black copper (75-84% Cu)	730 t;	Cu: 620 t	10,950,000 Y
730 t x 15,000 Y/t			
Final slag (tailings)	1500 t		30,000 Y
1500 t x 20 Y/t			
Flue dust (ZnO)	200 t		80,000 Y
200 t x 400 Y/t			
Total revenues			16,560,000 Yuan
Total copper content:	894 t		

Profit: 16,560,000 - 9,608,000 = 6,952,000 Yuan

Copper recovery: 94.6%

ANNEX H.

Page 1.

PROGRAMME

of

the study - tour delegation of the Shanghai Resource Recovery and Utilization Company in the framework of UNIDO project no.
UC/UD/CPR/87/224
in the period of
20 June - 4 July, 1989

20 June	Tuesday	Arrival to Budapest International Airport Transfer to hotel
21 June	Wednesday	Visit to the offices of TESCO Preliminary talks and finalization of the study-tour programme Evaluation of the Draft Final Report
22 June	Thursday	Visit to the premises of METALLOCHEMIA - study of the copper scrap recycling plant : preparation, processing in blast furnace
23 June	Friday	Visit to the premises of METALLOCHEMIA - quality control of castings, flue-gas cleaning system
24 June	Saturday	Visit to the premises of Heavy Metal Foundry in Székesfehérvár General introduction of copper casting technologies
25 June	Sunday	Day-off
26 June	Monday	Visit to the premises of the Hungarian Waste Processing Trust (MÉH) - general introduction of the waste materials recycling and processing in Hungary

27 June	Tuesday	Visit to the premises of Heavy Metal Foundry : waste preparation, processing, casting technologies
28 June	Wednesday	Visit to the premises of Heavy Metal Foundry: factory management, organization of production, chemical laboratory
29 June	Thursday	Study of aluminium and bronze scrap processing and casting technologies Visit to sand and die casting plants
30 June	Friday	Visit to the premises of Qualital Aluminium Waste Processing Plant
1 July	Saturday	Visit to bulky waste processing plant, study of technologies
2 July	Sunday	Day-off
3 July	Monday	Visit to the premises of the Copper Procesing Plant in Csepel, study of processing technology and quality control
4 July	Tuesday	Finalization of talks, consultations signing of the Aide Memoire Departure from Budapest International Airport

Useful addresses :

TESCO
1054 Budapest Rosenberg hp utca 21.
tel: 110 - 850

UVATERV
1051 Budapest Vigadó tér 1.
tel: 186 - 990

AIDE MEMOIRE

made on the study-tour of the five-member SRRUC study team in the framework of UNIDO project no UC/UD/CPR/87/224 in Hungary in the period of
20. June - 4. July 1989

1. The detailed study-tour programme has been elaborated by TESCO-UVATERV and has been submitted to the study team upon their arrival. See Annex 1 attached hereto.

2. The programme has been accepted by the study team and it has been implemented accordingly.

3. The study team expresses full satisfaction over the organization, warm reception and convenience provided to achieve the aim of the study tour programme.

4. The Final Report prepared by TESCO-UVATERV has been carefully studied by the study team and has been accepted. This report will serve as a basis for the modernization of the scrap copper and copper-alloy processing for the planned development in the premises of SRRUC.

5. The study team proposes to UNIDO the acceptance of the Final Report with its present content, in its present form. SRRUC expresses gratitude to TESCO-UVATERV's experts for preparing such a comprehensive, valuable and development-oriented study. SRRUC expects the in-time delivery of the Final Report for discussing the concrete follow-up actions to be taken.

6. To discuss and speed-up the follow-up co-operation among UNIDO, SRRUC and TESCO-UVATERV in the field of non-ferrous scrap processing, with the financial help of UNIDO SRRUC expects the visit of Hungarian experts to make a techno-economic study for the aluminium scrap processing. The study team took the opportunity of the present study-tour to visit some aluminium scrap processing plants in Hungary.

7. SRRUC initiates to launch a UNIDO project for the preparation of a detailed techno-economic study on aluminium scrap processing in Shanghai. The detailed discussions of this aluminium project and the finalization of the copper project could take place in October-November 1989 in Shanghai with the participation of the representatives of UNIDO and TESCO-UVATERV.

8. UNIDO was kept informed on the preparation and implementation of the study-tour programme. The representative of UNIDO, Dr E.T. Balázs participated in the final discussions of the follow-up actions for the continuous collaboration amoung UNIDO, SRRUC and TESCO-UVATERV especially the aluminium and copper scrap processing project.

Budapest, 4th July 1989

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U N I D O	S R R U C	TESCO-UVATERV