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SUGAR CANE TRAINING AND DEVELOPMENT CENTRE

DP/EGY/81/010

EGYPT

Technical report: Cane sugar industry training methodology*

Prepared for the Government of Egypt
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Hans J. Delavier,
consultant in cane sugar industry training methodology

Backstopping officer: K. Sepic, Agro-Based Industries Branch

United Nations Industrial Development Organization
Vienna

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INTRODUCTION

According to the job description, the main duties of the consultant were to:

- make an assessment of the existing facilities, equipment, training programmes and materials for training in specific skills required by the cane sugar industry;
- make an assessment of qualifications and capacity of trainers and of training methodology applied at present;
- advise on the future requirements of the Centre in respect of the facilities, equipment, audio-visual aids and materials as well as of professional trainers and their specialization required for carrying out future training programmes;
- elaborate specific methodology for theoretical and practical training programmes to be carried out for sugar technologists, plant operators, sugar chemists and various skills and trades.

The assignment was originally planned for one month but it was reduced to 18 days including travel time and stop-over in Vienna for de-briefing. It was felt that once the pilot plant equipment is delivered and installed, a longer return mission will be required to look into the practical aspects of training programmes utilizing the equipment which is expected to be completed by the end of 1986 and delivered and installed during the first quarter of 1987.

The working programme of the consultant was as follows:

1 September 1986 - Travel to Cairo;

2 - 7 September - Briefing at UNDP office, meetings and discussions with counterparts and UNDP officers;

7 - 10 September - Travel to Kous, visit to the sugar factory, discussions with counterpart personnel;

10 September - Return to Cairo;

11 - 16 September - Further meetings and discussions with counterparts and UNDP representatives in Cairo, preparation of the report;

16 September - Travel to Vienna;

17 September - De-briefing at UNIDO in Vienna;

18 September - Return to home country.

ACTIVITIES

Following the agreement that the duration of the assignment be reduced and on the basis of the working programme outlined above, the activities of the consultant were carried out around the following points:

1. Discussion with the representatives of the Société des Sucreries et de Distillerie d'Egypte (SSDE) and staff of the experimental (pilot) plant at Kous Sugar Factory, on the installation of equipment to be supplied.
2. Clarification regarding the present lay-out of the experimental plant and of instrumentation contained in the quotation of Messrs. Utzschneider of 21 July 1986; should instruments' probes and sonsors be installed on the site or at tne manufacturers facilities.
3. Discussion on the provision of the second centrifuges as originally recommended by the consultant. This original proposal was changed because SSDE wanted to supply the second centrifuge on their own. As continuously operating centrifuges of the required small size are not available

on the market, purchasing a second batch of operating centrifuges like the one already offered, may be considered.

4. Review of additional aid material required for operating the experimental plant.

5. Clarification on the expected timing of starting operation of the plant at Kous after installation of equipment, and on the additional assistance to be provided. For this assistance, assignment of an assistant who was engaged at the Khartoum University, Sugar Technology Laboratory, for several years, would be very helpful during the first weeks of the plant's operation, particularly in case of any trouble-shooting.

6. Preparation of a training programme for technical operations of the experimental plant.

7. Reviewing with SSDE staff possibilities of research activities to be carried out in the plant.

8. Discussing and clarifying the list of laboratory equipment needed for the plant.

CONCLUSIONS AND RECOMMENDATIONS

(See Annexes)

ANNEX I

Suggested Personnel for the Experimental Plant

Staff

1 Supervisor General - responsible for the total management of the Experimental Plant, the co-ordination of the activities with the sugar factory at Kous, the administration of the financial affairs and budget, the supervision of the training and the research activities following the Research Board's advice, etc.;

1 Secretary - can act also as store keeper;

1 Typist;

3 Supervisors
- 1 Juice purification section;
- 1 Evaporation section;
- 1 Chrystallization section;

3 Assistants to the Supervisors;

1 Supervisor for the laboratory of the Experimental Plant;

3 Laboratory technicians (if necessary more depending on the amount of work to be done during training or research activities);

1 Electrician;

1 Mechanic.

ANNEX II

Research Board

Chairman	-	General Manager-Production;
	-	1 Secretary;
Members	-	2 General Directors (Technical), sugar factories;
	-	General Director (Technical), sugar refinery;
	-	General Director Central Laboratory;
	-	General Director Cane Breeding Station;
	-	Supervisor General Experimental Plant;
	-	1 Financial Adviser.

Budgeting

The budget for the Experimental Plant shall include coverage of:

- fixed cost (personnel, etc.);
- operational cost (process aid material like lime, SO_2- and CO_2-gas, phosphoric acid, phosphate, filter media kieselguhr etc., chemicals for cleaning, steam, water, etc.);
- operational cost for laboratory in Experimental Plant (chemicals, glass ware, equipment);
- maintenance cost;
- ad-hoc problems investigation cost should be re-imbursed by "client", fully or partly;
- budget for long term research projects shall be determined separately.

ANNEX III

Training of Experimental Plant staff

Before erection of the plant:

- Study of the plans and work drawings in Egypt;
- Explanation of the functioning of the equipment by Société staff in Egypt;
- Training of
  one mechanic and one electrician
  for two weeks each at Utzschneider's workshop
  before shipping of the plant and trial runs;
- Study of principal processes in sugar technology using literature, especially on juice purification, juice concentration, sucrose crystallization by evaporation and by cooling, sugar factory routine control processes, special analytical methods according to ICUMSA etc.

After erection of the plant:

- Checking of the equipment, motors, valves, etc.;
- Checking of the plant with cold water for tightness, if necessary correction;
- Checking of the plant with hot water, control of measuring instrument, etc., if necessary correction;
- Operation of the plant with a model sugar solution prepared from raw sugar plus water of about 15 % dry-matter; such solution can be reproduced at any time (in comparison with cane raw juice which cannot be reproduced) for investigating the basic technological characteristics of the plant.
  The staff shall be trained by using such solution until all operations are well understood and personal mistakes are eliminated. Only the elimination of personal errors in operating such a plant, comparable and reproducable results from experiments can be expected and secured.
  The following process can be applied as "Standard":
  - raw juice limed to pH = 9,0 at room temperature heating to boiling within a predetermined time, e.g. 5 min;
  - boiling for 2 min;
  - addition of a predetermined amount of filter aid, calculated on the dry-matter mass basis

filtration of the suspension,
if wanted: a second liming, etc. and filtration
concentration of the filtrate, which shall be optically clear, to syrup,at a certain temperature, e.g. 115 °C in the first effect, to 65 % dry-matter;
further concentration of the syrup to massecuite of 92 % dry-matter, by addition of a predetermined amount of fine crystal sugar for "full seeding", at e.g. 75 °C
cooling of the massecuite to 60 °C in cooling crystallizer
centrifugalling at a predetermined rotational velocity for separating into sugar and mother liquor run-off.

A Standard Process shall be determined which shall be the basis for comparing all other experiments, and this Standard Process shall be the one which corresponds to the main process applied in the Egyptian Sugar Industry. While operating the plant for a certain time, sufficient data will be made available for evaluating sugar factory process simulations, abnormal operation conditions, etc.

ANNEX IV

The Experimental Plant

Tasks

1 Training of:

1.1 Sugar Industry Personnel; Supervisors and Operators in sugar factories

1.2 other interested people; e.g. from sugarcane production

2 Research:

2.1 ad hoc problems;

2.2 long term research projects.

ad 1 The training in sugar factory operations shall be carried out according to the specification of the personnel to be trained. The Experimental Plant will allow to simulate raw juice purification operations applying "liming" ("defecation"), "liming + phosphatation", "liming + carbonation", "liming + sulphitation", also combinations of these processes and multiple steps purification processes.

The concentration of the clarified juice by evaporating water may be done under various conditions of the process, e.g. temperature, retention time, addition of anti-scalants or other material, e.g. for investigating the formation of colorants.

The crystallization of the sucrose shall be carried out under varying conditions of temperature, retention time, footing, etc., as well as the cooling crystallization.

The centrifugalling of the crystal suspension, e.g. magma, massecuite may be done under varying rotational velocities (centrifugal force), varying additions of washing water, etc.

ad 2.1 Ad-hoc problems occuring in the sugar industry during the processing season, problems which need quickest solution, shall be formulated by the respective sugar factory or the refinery, forwarded to the chairman of the Research Board who, after quick checking, may(or may-not)forward it to the Experimental Plant Supervisor General for a quick detailed frame study and elaborating proposals about the execution of the investigation of the problem.
The way of elaborating the investigation shall be discussed with the "client" in order to secure a close co-operation between the Experimental Plant staff and the "client".

2.2 Long term research projects shall be elaborated by the Research Board on the basis of recommendations from the sugar factories, based on needs due to the general development in the world sugar industry (e.g. introduction of new processes, new aid materials), etc., such research projects shall be fixed every year. A close control about the progress and the results of such long term projects is necessary in order to allow corrections in time, i.e. progress reports and such meetings shall be held regularly.

It has been found beneficial for the sugar industry of a country to formulate every year a "general topic" within the closer investigation in which all factories are involved. Such general topics shall also be supervised by the Experimental Plant Supervisor General in connexion with the Research Board and the General Directors of the sugar factories, etc., depending on the matter concerned.
General topics of main interest may be:

Sucrose losses by microbiologic activity;
Fate of sucrose in so-called "undetermined losses";
Formation of colorants during the processes in the sugar factory;
Reduction of sucrose losses in final molasses;
Economy of sucrose crystallization under varying footing conditions;

but the final decision should rest with the Research Board.

ANNEX V

Note on the Meeting at Kous Site from 8 to 10 September 1986

Participants in the Meetings at Kous Sugar Factory:

Kous	:	Dipl.-Ing. Abdel Hadi Mohamed Farag	Deputy General Director
		Dipl.-Ing. Abdel Wakhab Mohamed	General Manager Engin.
		Hamdi El Said	General Manager Prod.
		Dr. Abu El Fatou	Chief Chemist
		Ragab	Chief Engineer
		in alternating presence	
Cairo Office	:	Dr.-Ing. Salama Fathalla Shweil	Director General Proj.

Consultant

Following the schedule prepared 7 September 1986 at UNDP office, the travel to Kous and the meeting were realized as planned.

1. The building for the Experimental Plant - as already fixed 1985 September - shall be the existing building of the cane receiving station. Due to a principal change in the receiving policy of the cane from the farmers, the receiving plant will remain in the building, but the building will be extended for the Experimental Plant, see drawing, so that after separating the receiving station from part of the old building plus the newly to be erected part it will take the Experimental Plant. The free space between the two parts of the Experimental Plant - the juice purification station and the evaporation plus crystallization stations - will be about 3 m. This space shall be sufficient for movement between the plant. In case of later extension due to the installation of other equipment, the building can be easily further extended due to free outside space.

2. The supply of steam shall be of the required quality - saturated steam of a certain pressure - as the lay-out of the heating surfaces is based on the given data.

3. The supply of raw juice, etc. shall be done by means of a mobile tank: the pumping of the juice - due to the long distance between sugar factory extraction plant and Experimental Plant - would need an intensive sterilization of the piping for avoiding deterioration of the raw material for the Experimental Plant. This sterilization or sanitation will be difficult. Furthermore, as experiments should be carried out with "diffuser juice", first mill juice, last mills juices, etc., this pumping should be done from different points in the sugar factory extraction plant. For being free in choosing the raw material, it is recommended to supply by Kous Sugar Factory a mobile tank with an immersion pump; the respective raw juice, etc. will be filled into the mobile tank, transported to the Experimental Plant, from which the juice shall be pumped into the storage tanks. The mobile tank shall have a volume of 500 dm^3, the immersion pump shall have a lifting rate of some 50 dm^3/min or being adequate.

4. All the other points of the proposal shall be discussed with Sucreries 13 September (instead of 11 September as proposed earlier) and with UNDP and Sucreries 14 September 1986.

Cairo, 11 September 1986.

ANNEX VI

Note on the Meeting at Sucreries' Office 13 September 1986

Participation	Mr. Bedewy	Sucreries
	Dr.-Ing. Schweil	"
	Consultant	

Basis of the Meeting was Consultant's Proposal of 2/3/4 September 1986 and his Note of the Meeting on 8 to 10 September 1986.

Proposal:

- No. 01 covered - the location of the Experimental Plant was fixed during the Meetings at Kous Site, 8 to 10 September 1986, see drawing;

- 02 instrumentation will be decided 16 September 1986, at 12.00 noon, out of the quotations on Sucreries' tendering;

  instrumentation lay-out of Messrs. Utzschneider - as such - is accepted by Sucreries;

- 03 installation of instruments should be preferred at Kous Site, but provisions for installation shall be already done by the supplier of equipment;

- 04 purchase of the second centrifuge is cancelled;

- 05 process material for operation of Experimental Plant will be available at Kous Site: lime, H_3PO_4, phosphate, SO_2- gas, CO_2- gas, filter aid, flocculant, cleaning material, etc.

- 06 finishing of erection of the Experimental Plant is expected by the middle of March 1987;

  the last week of erection and the first week of starting trial operations shall overlap, duration of first training and operation of the plant, in total, expected up to one month - to be clarified with UNDP/UNIDO;

- 07 the technician-assistant to the Consultant will be accepted by Sucreries on the expenses of the project, to be clarified with UNDP/UNIDO;

- No. 08 model proposal shall be elaborated by Consultant for first operations of the Plant;

- 09 laboratory equipment needed at Experimental Plant Laboratory - according to Note of 3 September 1985 - will be made available;

others Sucreries agrees to send two technicians - one electrician and one mechanic to Messrs. Utzschneider's workshop for two weeks instruction each - depending on availability of project funds - to be further clarified;

Staff for Experimental Plant following Consultant's recommendation will be available on time;

Regarding the "Research Board" - as recommended - Sucreries has a twice-yearly meeting of the General Directors of the Company under the chairmanship of Sucreries' President, before and after the crushing season, during which meeting - among others - further investigations/research problems are discussed, and forwarded to the respective organs of the Company for further consideration.

Note of 11 September 1986

- No. 01 see 01 before;

- 02 will be made available;

- 03 will be forwarded to Kous - as the "mobile tank" was already discussed at Kous Site and has found acceptance due to the logic basis of the proposal, especially for avoiding the difficult sanitation of the piping for raw material.

Cairo, 13 September 1986

ANNEX VII

P R O P O S A L

regarding operations in the Experimental Plant

1. Training of the staff by using a raw sugar solution as described in Annex III.

- Raw sugar II or III (low grade product) to be dissolved by water at 80 °C to dry-matter content of about 15 % (refractometer, or spindel ≙ 15 °Bx);	Analyses as in sugar factory process, in addition: invert sugar content by Lane & Eynon standard method, color value by ICUMSA method
- limed by milk of lime to pH = 9,0 at room temperature;	
- heated to boiling within a predetermined time, e.g. 5 min;	
- 2 min boiling;	
- neutralization by H_3PO_4 to pH = 7,0;	Analyses of suspension
- addition of a certain amount of filter aid (kieselguhr) - the amount must be found by experimenting in order to allow a sufficient filtration rate and an optical clear filtrate;	Analyses of filtrate
- limed to pH = 9,0 and as before ... filtration;	Analyses of filtrate
- concentration of clear solution by evaporation of water to a dry-matter content of about 65 %; Temperature in I. effect 115 °C (or about);	Analyses of syrup
- evapo-crystallization of the syrup for I. Product in the biggest of the three apparatusses nucleation without addition of fine sugar concentration of the massecuite to a dry-matter content of about 92 %;	Analyses of massecuite
- cooling time 1 h at given room temperature in cooling crystallizer without forced cooling;	
- centrifugalling of massecuite without addition of water for affination, at max. rotational velocity of centrifuge, 5 min running time;	Analyses of sugar and run-off

This experiment shall be repeated until all operations are well-done and from results a certain tendency of the characteristics of the Plant can be obtained.

2. Trials on various types of "raw juice":

2.1 first extracted juice;

2.2 extract from the solid-liquid extractor ("diffusion plant");

2.3 raw juice ("mixed juice");

the dry-matter content of the three samples shall be adjusted to the lowest one by addition of water to the samples with higher dry-matter content,

the juice purification shall be carried out as similar as possible in order to prove the "purificability" of the three types of juice

- juice sample to be limed to pH = 9,5 by means of milk of lime during 2 min (addition of milk of lime must be adjusted to 2 min for reaching the pH-value),	Analyses of the samples on routine data plus invert sugar content by Layne & Eynon method
- heating to boiling within, e.g. 5 min (it is important that all trials are run as similar as possible),	
- boiling for 2 min,	Sample after boiling for sedimentation test: Analysis of clear supernatant
- addition of filteraid for clear filtration,	Analyses of filtrate
- Filtrate shall be collected for concentration in order to collect syrup from the Plant for further operation.	

The results of the purification tests shall be compared and interpreted

The same experiment shall be carried out, adding H_3PO_4 to the juice samples in order to have a respective P_2O_5 content of 300 mg/kg raw juice; to be added amount depends on the result of the phosphate content of the raw juice analysis, as carried out in Egyptian sugar industry.

3. Trials on different degrees of liming of raw juice as affecting the invert sugar content, the color and the "color stability" of the clear juice

- raw juice is limed, by the addition of lime during the same duration(of time) of 2 min to pH = 6,0 pH = 7,0 pH = 8,0 pH = 9,0 pH =10,0	Analyses as by routine Sedimentation test
- after heating to boiling and 2 min boiling the sedimentation test is done,	Analyses of clear supernatant
- filtration as before,	Analyses of filtrate
- filtrate to be collected for further trials in the plant,	*Colour stability test

The results shall be compared and interpreted; if possible - if variations are small enough (statistics) - statistical analysis of results.

4. Trials on different (available) phosphate content of raw juice for investigating the influence of the phosphate content on the "clarificability" of the juice;

- raw juice is treated with different amounts of H_3PO_4 to have the following P_2O_5 content:	Analyses as routine plus: invert sugar content, phosphate content as mg P_2O_5 per kg juice (ppm)
4.1 original juice: if 200 mg/kg juice	
4.2 250 mg/kg	
4.3 300 "	
4.4 350 "	
4.5 400 "	
4.6 450 " or respective	
- limed to pH = 9,5, heated to boiling, 2 min boiling,	sedimentation test Analyses as before
- filtration as before, - filtrate to be collected for further trials in the plant.	

The results shall be compared, if possible statistically analysed, and interpreted.

*samples of the juice are heated in sample glasses at 80 °C for 2 h, before and after the colour value determined

5. Trial on "Evaporation" of water from clear juice

The colour value of syrup shall be investigated, affected by retention time within the evaporation station.

All clear juice storage tanks shall be filled before the evaporation station is started; it is recommended to adjust at sufficient juice level in the evaporator vessels before the steam valve is opened, and a certain equilibrium shall be reached in the plant, i.e. a certain flow rate and a certain dry matter content in the syrup.

5.1	clear juice is pumped at a certain rate into the first vessel, temperature e.g. 115 °C in I. vessel and sequence respectively to the last vessel at about 55 °C, - a certain retention time will be reached, - juice samples shall be drawn from each vessel for comparison (adjusted to same dry-matter content).	Analyses of the clear juice by routine method plus: invert sugar content, colour value Analyses of syrup as clear juice
5.2	clear juice is kept in the evaporation for double the time as before by shutting the steam valve and the vapour valve in front of the condensator, and the temperature is kept constant by opening the steam valve from time to time, - juice samples can be drawn from each vessel as before,	
5.3	the flow rate is doubled over that of 5.1, independently on the dry matter content of the syrup, in order to half the retention time to that of 5.1	Analyses as before

The results shall be compared by calculating them on equal bases, and interpreted.

6. Trial on evapo-crystallization ("vacuum pan operation")

- Syrup is collected from foregoing trials;	Analyses of syrup or concentrated raw sugar liquor by routine, plus: invert sugar content, colour value;
- Due to foregoing training trials, the initial volume for starting the strike is known. This volume is taken into the apparatus, the pipeline to the condensor opened, steam valve opened, the boiling for concentrating started; the solution is concentrated until crystal nuclei are formed in the solution, by avoiding secondary nucleation, the strike is finished, dropped into the cooling crystallizer;	
- after 30 min the crystallisate is separated from the mother liquor: no washing of crystals in the centrifuge;	Analysis of massecuite by routine methods, plus: invert sugar content, colour value;
	crystallisate is investigated under microscope for regularity, visual evaluation;
	Sugar and run-off is analysed by routine methods, invert sugar content, colour value; fine crystals in run-off to be checked by microscope;
	sugar sample is dried in drying chamber at 100 °C, then screened;
- The trial is repeated by adding a predetermined mass of fine crystal sugar (no powder) of a to be determined crystal size, i.e. (0,2 to 0,3) mm; the amount to be added will be determined on the basis of results of the training trials;	Analyses as before;
- the process is done as before, the sugar being added at the point of metastability to be calculated;	
- the final strike is treated as before;	

7. Trial on centrifugal separation

- Massecuite samples will be affinated by the addition of wash water at various rates, e.g. 0,5 kg/100 kg massecuite 1,0...up to 5 %	Analyses of sugar and run-off, as before the mass of sugar dissolved to be calculated
- Results shall be compared and interpreted.	

ANNEX VIII

Note on the Meeting at UNDP Office 14 September 1986

Participants: Mrs. Hetata — UNDP

Mr. Bedewy — Sucreries

Consultant

The results of the Meeting at Sucreries' Office of 13 September 1986 were discussed, especially the subjects 06, 07 and others, namely the training of two Egyptian technicians from Sucreries Kous at Messrs. Utzschneider's workshop before packing and shipping of the equipment of the Experiemental Plant.

Mrs. Hetata checked for the budget of the project for 1986 and 1987:

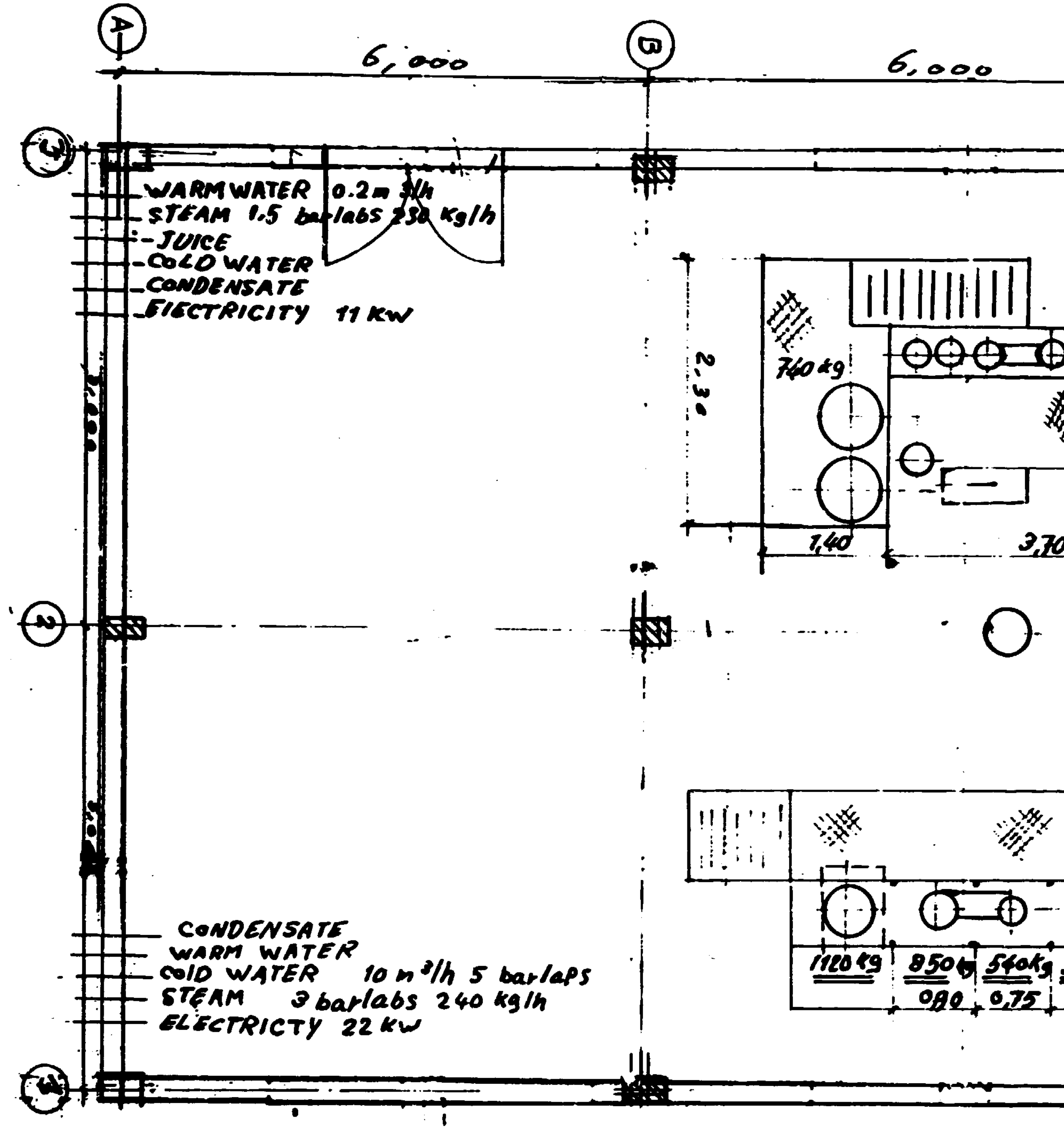
06/07 For short term consultancy in 1986 and 1987 about 2,5 man-months (1986: ca. 0,5 month, 1987: 2 months) are available, which means that the Consultant and his Khartoum assistant, Mr. Jenns Hofmann, could stay for this time - each about 1,25 months - on the project in order to properly put it into operation.

Others: For training purposes, sufficient funds are available to send two Egyptian technicians to Messrs. Utzschneider in West Berlin for two weeks each - one electrician and one mechanic - for training on the equipment.

It will be necessary to shift the amount of money for 1987 to the end of 1986.

Further discussed - between Mrs. Hetata and Mr. Bedewy - was the cost sharing situation in the project on the basis of the new exchange rate between US$ and L.E.

Cairo, 14 September 1986



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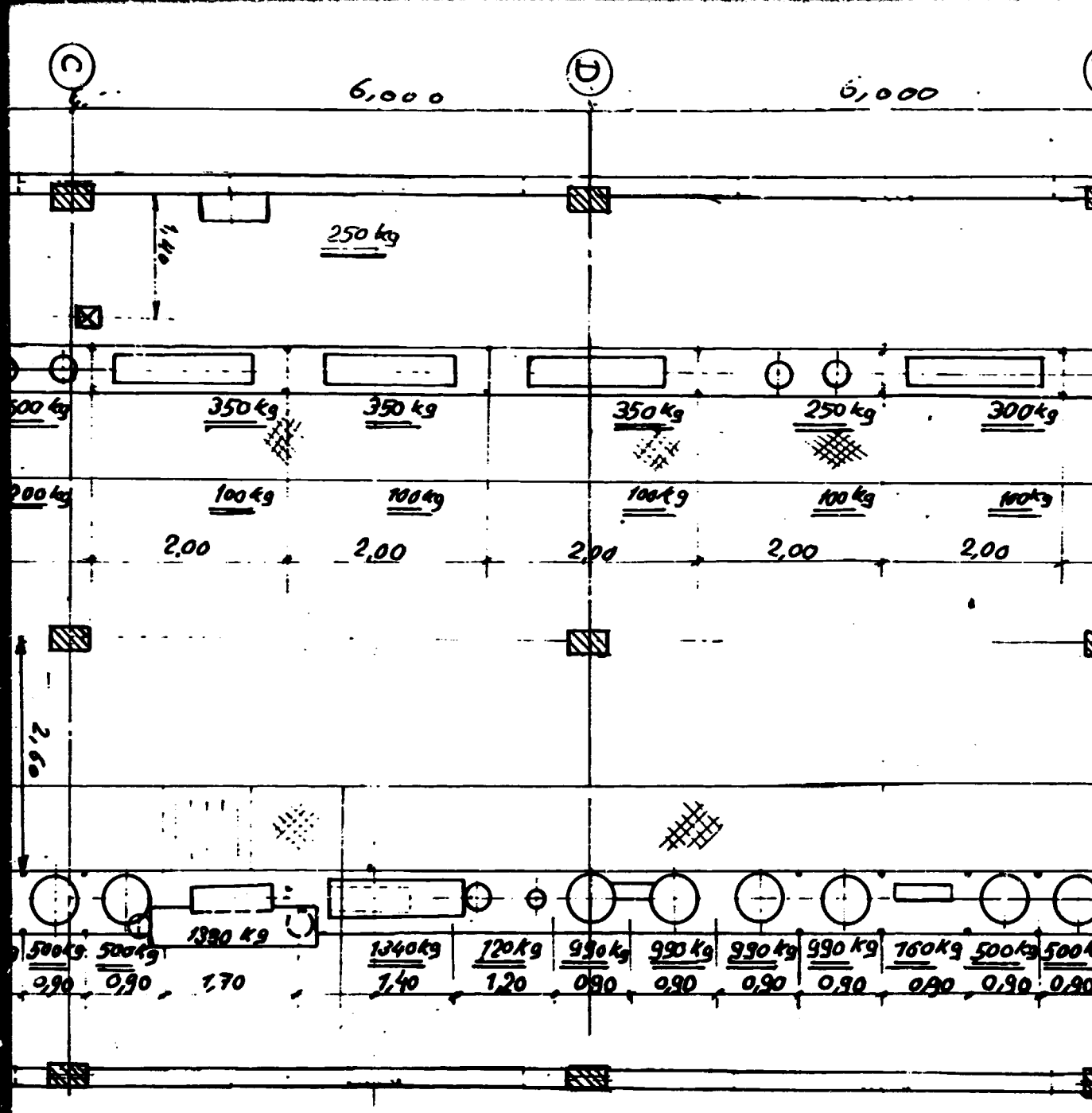
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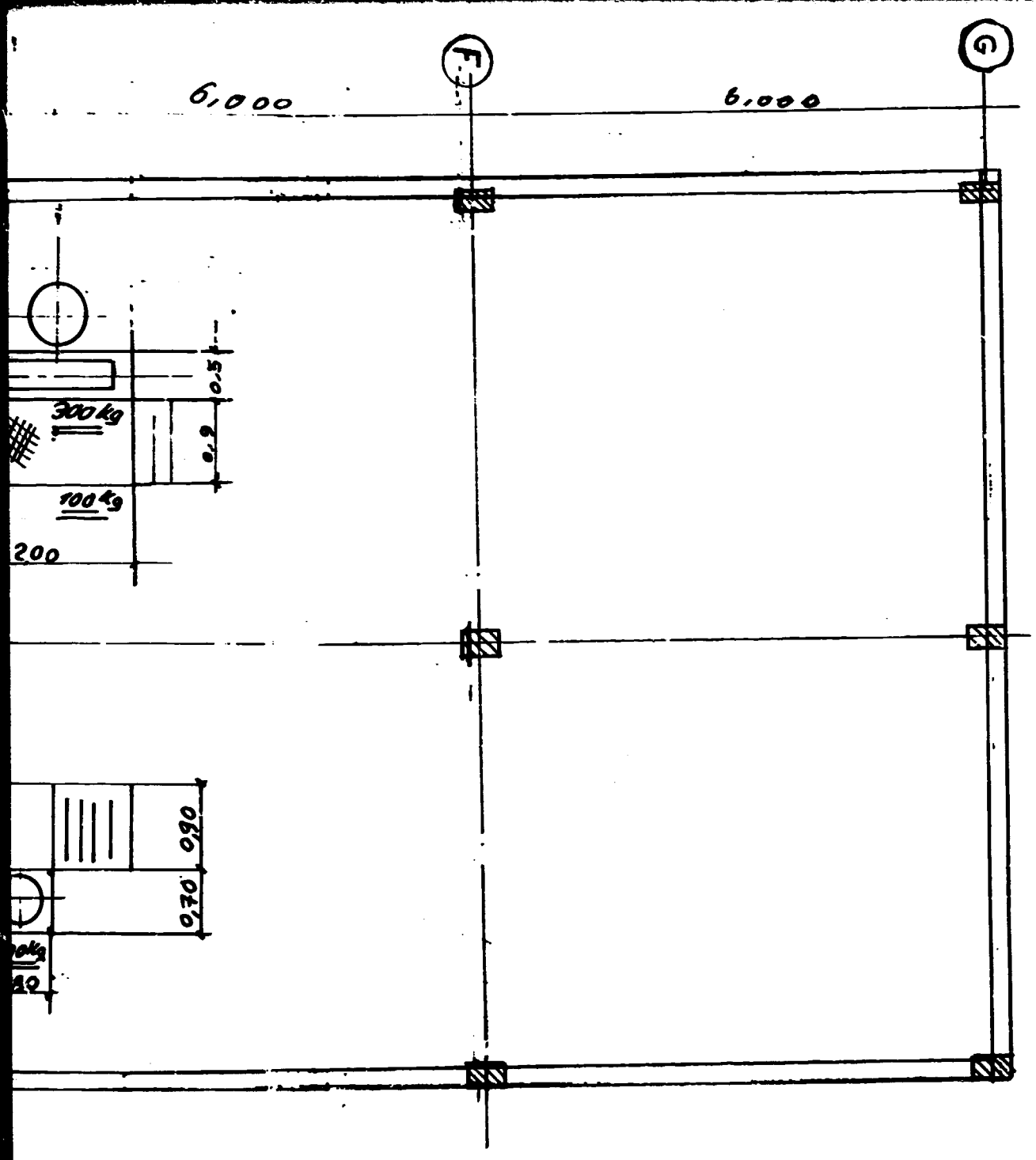
SECTION 2



SECTION 3