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INDIA

Technical report: Printed circuit board manufacturing laboratory*

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

Based on the work of H. Hoeger, expert in printed circuit board technology

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United Nations Industrial Development Organization
Vienna

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1. INTRODUCTION

Under the terms of the UNDP contract this author is concerned with the establishment of an Printed Circuit Board (PCB) Manufacturing Laboratory in the Electronics Service and Training Centre (ESTC) at Ramnagar.

At the time of arrival the state of PCB Manufacturing Lab was not satisfactory. On the one hand, the building has been finished, except for the connection of electric power. On the other hand, there wasn't any layout of the PCB Manufacturing Lab, and the basic demands on a PCB Manufacturing process had not been taken into consideration. In addition to that, the list of required equipment was not completed. These facts called for the following activities to be undertaken:

1. To clear the role of PCB Manufacturing in ESTC.
2. To make a list of all the equipment needed for PCB Manufacturing Lab in collaboration with the ESTC staff.
3. To make a draft of PCB Manufacturing Lab layout and to define the basic demands on the installation of equipment.

This report lists the results of these activities, agreed upon with the ESTC staff. It is intended to speed up the progress of work with respect to the forthcoming installation of a PCB Manufacturing Lab at ESTC Ramnagar.

2. The role of PCB Manufacturing Laboratory at ESTC

The PCB Manufacturing Laboratory has a very important role to play at ESTC Ramnagar. The significance of this Laboratory will become clear from the following points:

- (1) PCBs are the basic components for the assembly of electronics items.
- (2) PCB Manufacturing is a sophisticated technological process including more than 70 mechanical, chemical and physical steps.
- (3) Rules are necessary for all the steps, and those rules must be strictly followed. The contents of these rules depends on the specific equipment and chemicals used in the manufacture of PCBs. Consequently, the quality of PCB manufacture will be affected.
- (4) The PCB manufacture process must be run through completely. Inputs are
 - the base materials,
 - the pattern artwork and master drawings (copies) produced by the PCB design laboratory.Outputs are
 - the fully structured PCBs after visual inspection.
- (5) The electroplating process should be run, if possible, continuously, in the first period, e. g. one week per month. It is necessary to check the baths regularly, and to retain the quality (if it has become bad) by re-adding chemicals or, if required, by renewal.

By creating the facilities as listed in the report, and taking into account the above listed requirements, it would be advisable for the ESTC Ramnagar to manufacture two basic types of PCBs (single and double-sided). These PCBs should be a practically usable basic component for work in other labs (assembly, testing and quality control) so that electronic items can be produced as a final ESTC product.

In addition to these two basic types further PCBs may of course be manufactured in lab-conditions on requests from neighbouring firms.

As far as the usefulness of the PCB Manufacturing Laboratory for surrounding industries is concerned, it should be taken into account that at the present stage the electronic units near Ramnagar (e. g. Telectronics Bhimtal) are getting the PCB's from other firms (Ghaziabad or Delhi) in India. They do not have any plans to establish facilities of their own. These units will be in need of PCB's to develop new electronics items as well as to manufacture these new items at short notice.

The PCB manufacture lab in ESTC will be the most modern facility for the production of PCB's with a high level of quality and (quantity) in the next five to ten years. It is also proposed to extend the facilities for the production of Multilayer PCBs in a further period.

Hence it follows from what has been explained above that the education of the staff of ESTC PCB manufacture laboratory must be high. They must control the PCB manufacture process and all the equipment. They also must be able to give advices to PCB designer and manufacturer in the other electronic Units.

The need for skilled workers who have to be trained in the ESTC in the field of PCB production will be smaller compared with the PCB assembly personnel.

The visits of electronics units in the region and the talks with Mr. C.P. Joshi, Mr. K.P. Singh and Mr. D.K. Rastogi, who are engaged in electronics production, confirm the important role of the PCB manufacture lab and the necessity of PCB manufacturing facilities in the ESTC.

3. Clarification on PCB manufacturing equipment

Together with the Indian counterparts a new list of equipment named No. 1/88 has been prepared, on the base of the requirements of the PCB manufacturing process and the objectives of ESTC (See Annex 'C'). The following observations, however, have been made:

- (1) The manufacturing of multilayer PCB will be realized in a subsequent period of ESTC establishment. The most important equipment necessary for multilayer PCBs is listed in Annex 'F'.
- (2) Screen printing facilities should not be set up in the first period of PCB manufacturing lab but the needed equipment related to indigenous list No. 35 should be purchased as soon as possible.
- (3) The size of PCB will be limited to a maximum of 400 x 400 mm². The size of tanks of electroplating units etc. must be max. 500 mm.
- (4) The capacity of the PCB manufacturing line must be about 5 sq. m. per day.
- (5) The electroplating equipment should be purchased from the same supplier who can deliver the chemicals needed. The chemicals used shall allow for the reduction of pollution to a minimum and should be replaced by similar chemicals from Indian manufacturers at a later period.
- (6) The photolithographic process will be based on dry photoresist alkali-soluble. There are no assigned liquid resist and dip coating in the process.

After having reviewed previous documents available the counterpart holds the following position related to the equipments for PCB manufacturing in ESTC.

(Remark: Numbering of equipment: refers to the updated list No. 1/88. see Annex 'C' and 'D'.)

- (7) Equipment Nos. 1, 4, 7, 12, 15 are clarified. The purchase can be ordered locally.
- (8) Equipment "Shearing machine for laminates" motordriven (Indigenous list No. 34) is deleted for this time. It is recommended to purchase this equipment later in connection with multilayer facilities.

- (9) The so called "Equipment to manufacture D/S PTH boards" according to UNDP Requisition 86/2, No. 20 consist of some diverse items different by each of the suppliers. Input is the PCB after raw cutting and drilling all the holes (reference holes and insertion holes). Output is the full structured PCB with tinned conductive paths and plated through holes. In the list No. 1/88 these are the items Nos. 5, 6, 7, 8, 9, 11, 12.
- (10) Equipment No. 8 resist laminator is generally clarified, but a final decision is still needed in connection with No. 9 (Bench vacuum frame exposure)
- (11) There are no suppliers with sufficient mechanical specifications and prices in relation to equipment Nos. 2, 3, 9, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 25. Further clarification is necessary both by ESTC and UNIDO (see remarks on Annex 'C', 'D' and 'K').
- (12) There are quotations available related to equipment No. 5, 6, 10, 11, 24 but not sufficiently for final clearance (see on Annex 'C', 'D' and 'K').
- (13) Contrary to an earlier decision it has been decided now that equipment No. 24, neutralizing tank, is necessary to guarantee the pollution control.
- (14) Annex 'E' gives a comparative statement of financial input of UNDP and Indian sides.
- (15) There are no lists or documents on tools, vessels, auxiliary materials, process chemicals needed for PCB manufacturing.
- (16) In addition to the equipment No. 1 to 25 some furniture is necessary for function of the PCB manufacturing lab, such as
- | | |
|--|---------|
| Adjustable stool | 10 pcs. |
| Working table with drawer, lockable | 10 pcs. |
| Working table with water consumption & discharge | 2 pcs. |
| Shelves (standard sizes) | 3 pcs. |
| Shelves 2000 x 1200 x 1500 | 1 pcs. |
| Cupboard, lockable | 3 pcs. |

- (17) Annex 'F' gives the list of some equipment necessary for creating the manufacture of Multilayer PCB and PCB design. The detailed specification is not given now. The details regarding to PCB design will be worked out by UNDP expert in this area. Since multilayer facilities are to be purchased later the details will be worked out in due course .

4. The draft of PCB Manufacturing Laboratory layout

Based on the equipment in list No. 1/RR a draft layout of PCB Manufacturing lab has been prepared (see Annex 'G'). The equipment for PCB design, except the reproduction camera (No. 21 in UNIDO Requisition 86/2) and the screen printing facilities could not be included in the room planned for the PCB Manufacturing lab. The distribution of all the equipment has to take place with a minimum of construction work in the building. The fundamental claims for rebuilding and installing the equipment are written down in Annex 'H'.

5. RECOMMENDATIONS

Based on the work done and discussions held the author recommends:

1. To recruit the working staff for the PCB manufacturing lab as soon as possible, consisting of
 - 1 Chemist (Degreed)
 - 2 Electronic Engineer (degreed, for NC drilling)
 - 1 Technologist (diploma holder)
 - 1 High skilled worker (mechanical knowledge)
 - 1 High skilled worker (chemical knowledge)
2. To define from the counterpart's side two final electronic products to be manufactured by ESTC, consisting of a single and a double-sided PCB respectively and to prepare for these items a complex run through all labs of ESTC and to plan all the materials which are needed per month and per year.

3. To prepare by ESTC and UNIDO expert a basic technological run-off, which contains all the working operations and working tools, the most important technical specifications and the user manuals.
4. Expert instructions for operation and maintenance to be prepared by ESTC and UNIDO expert after having purchased the equipment and chemicals.
5. To define by counterpart and UNIDO expert the chemicals needed for PCB manufacturing.
6. To clear finally by Indian counterparts the technical specifications (on the base of the recommendations in Annex 'D') and Indian suppliers of the equipment Nos. 2, 13, 14, 16, 17, 18, 20, 21, 22, 25.
7. To order further technical specifications and quotations for the equipment Nos. 3, 5, 6, 14, 16, 19, 23, 24 (Annex C).
8. To include equipment No. 9 into the UNDP requisition, if no suitable suppliers can be found in India. The offer of Bulgaria is acceptable for the ESTC but final decision has to be taken in connection with equipment No.8.
9. To purchase the equipment Nos. 5, 6, 10, 11 together with the required chemicals, if possible, from the same supplier by UNIDO funds and to include the training of a person at the suppliers premises and additional training and commissioning after installation into the scope of performances to be provided by the supplier.
10. To arrange, if appropriate, by UNIDO a technical negotiation with suppliers of equipment Nos. 5, 6, 10, 11 and chemicals before taking final decisions. Proposed participants in this meeting should be the Substantive Officer, the Expert in PCB manufacturing and the Director (Training) of ESTC (two days' stay in Vienna as soon as possible).
11. To include by UNIDO equipment No. 19 into the UNDP requisition.
12. To prepare by Indian counterpart a complete programme for all the required rebuildings and installations and to order suitable firms in India for executing.

13. To plan by UNIDO and counterparts the second mission of UNDP expert in PCB manufacturing at that time when the installation of PCB manufacturing equipment will be finished, but not later than January 1989.
14. To accelerate by the counterpart the preparation of the PCB Assembly lab (completed list of equipment included a wave soldering machine and a repair soldering station, Layout, furniture).

ANNEX 'A'

Minutes of meeting held in the room of Small Industries Development Organization with UNDP expert Mr. Hoeger (PCB Manufacture)

Mr. Hartmut Hoeger arrived in Delhi on January 19, 1988. After his visit to UNDP he came in the office of Industrial Adviser Shri A. K. Basak at 3.00 PM. Following persons were present in this meeting:

1. Shri A. K. Basak, Industrial Adviser (Electronics) SSI, Delhi
2. Shri P. P. Malhotra, Director (Electronics) SSI, Delhi
3. Mr. Hartmut Hoeger, UNDP expert
4. Shri N. N. Bhargava, Director (Training) ESTC, Ramnagar

Shri Basak explained the objectives of establishing the centre at Ramnagar to the UNDP expert and also discussed the purpose of his assignment. Following decisions were taken:

1. Mr. Hoeger will make the list of all the PCB manufacturing equipment (UNDP as well as Indian) with detailed specifications along with ESTC Ramnagar staff.
2. He will advice on that particular PCB technology which does not adversely affect the purity of environment (Wild life, agriculture and air). The chemicals used in the plant should be so disposed that no pollution is created. The plant should be quite modern and should take care of future development in this technology.
3. It was decided that in first instant we shall limit our requirement of equipment for the manufacture of single & double sided PCB & requirements for Multilayer PCB will be taken at a later stage.
4. It was also decided that the Training in PCB manufacture will be of two types. One kind of training could be for those persons who have to learn only to 'process of PCB manufacture'.

This could be for two months. The other type of training could be the one in which along with manufacture process details regarding PCB machines and their maintenance could also be included. Such a training has to be a long training.

5. Shri Basak pointed out that the UNDP experts are effectively only for 10 days for the project. The period is too short for any substantial output. Time is spent in briefings at Vienna, UNDP, Ministry of Industry (SSI) and journey. Since the briefings are very necessary the period for UNDP experts should be extended. The same thing happened with Chief Technical Adviser Mr. El Hadidy. He came to India on 28-9-1987 and went back on 24-10-1987. He spent only 14 days at ESTC Ramnagar.
6. Mr. Hoeger expressed his desire to visit the electronic industries around Ramnagar and it was agreed that ESTC staff will take care of this aspect of UNDP expert.

Mr. Hoeger then went to UNDP office and it was decided that he will leave for Ramnagar in afternoon of 20-1-1988 along with Shri N. N. Bhargava, Director (Training) ESTC Ramnagar.

ANNEX 'B'

Work Programme of the expert on PCB manufacturing

Duration = 0.5 m/months

Period of stay at ESTC & Delhi = 15 days (19-1-88 to 2-2-88)

| S. No. | Activity | Planned No of working days | Realized Date |
|--------|---|-------------------------------|---|
| 1. | Discussions at Delhi | 01 | 19-1-88 (UNDP & DC SSI) |
| 2. | Discussions at Ramnagar | 02 | 21-1-88 (Showed ESTC laboratories) |
| 3. | Chalk out Programme for fellowship | 01 | 30-1-88 |
| 4. | Draft of PCB manufacturing process | 02 | 28-1-88 |
| 5. | Finalisation of the type of equipments for PCB manufacturing | 02 | 24-1-88 25-1-88 |
| 6. | Draft layout of PCB manufactu- ring lab | | 26-1-88 (partly) |
| 7. | Course design & syllabus for PCB training | 02 | 29-1-88 |
| 8. | Visit to nearby industries | 02 | 22-1-88 23-1-88 26-1-88 (partly) 27-1-88 |
| 9. | Discussion in Delhi | 01 | 1-2-88 2-2-88 (partly) |
| 10. | Journey from Delhi to Ramnagar and return | 02 | 20-1-88 31-1-88 |
| | Total | 15 | 15 |

ANNEX 'C'

Basic List No. 1/RR of Equipment for PCR Manufacturing Laboratory

| S. No. | Name of the Item | Indian List | UNDP List | Open | Expect. Cost | Remark |
|--------|--------------------------------------|-------------|-----------|------|--------------|--|
| | | | 86/2 | | | |
| 1. | Gullotine shearing machine | 38 | | | Rs. 8,000,- | In Indian list it is written as "Hand operated laminate shear" |
| 2. | Hand drilling machine - medium speed | 45 | | | Rs. 12,000,- | 10,000 - 12,000 rpm |
| 3. | NC drilling machine - two heads | | 22 | | \$ 50,000,- | Should have routing facility |
| 4. | Lining up table & Retouching desk | 29 30 | | | Rs. 20,000,- | 3 pieces required (one after drilling, two after etching) |
| 5. | Machine for mechanical disoxidation | | 20 | | \$ 15,000,- | Part of PTH-PCR-line Usable for copper and tin surfaces |
| 6. | Laboratory electroplating equipment | | 20 | | \$ 48,000,- | Chemical cleaning must be included in this item |
| 7. | Whirler/drying oven | 42 | | | Rs. 5,000,- | |
| 8. | Resist laminator | | 20 | | \$ 7,000,- | Dry film laminator; In place of dipcoater |
| 9. | Bench vacuum frame exposure | 31, 32 | | | ? | single sided exposure sufficient |
| 10. | Developer | | 20 | | \$ 4,000,- | Spray system. |
| 11. | Resist stripper | | 20 | | \$ 6,000,- | As far as possible No. 10 and No. 11 should purchased from the same manufacturer |

ANNEX 'C', page 2

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----|--|----|---|-----------------|--------------|--|
| 12. | Etching machine | 28 | | | Rs. 12,000,- | possible, that included in equipment No. 6 |
| 13. | Laboratory equipment for gold plating | 36 | | | Rs. 5,000,- | |
| 14. | Routing Machine for PCB | 46 | | | ? | To find details in case equipm. No. 3 does not give this facility |
| 15. | Water deioniser | 40 | | | ? | |
| 16. | Redistillation equipment | | | x | | Necessary for redistillation of chemicals |
| 17. | Chemical analysing for quality control of chemicals | | | x | ? | |
| 18. | Miscellaneous equipment (i) laminar flow for dark & yellow room (ii) Yellow room facilities (iii) Airconditioning cabins (iv) Flow-meter, pH-meter, Microscopes & lenses | 43 | | | Rs. 20,000,- | Details to be found from Delhi/Bombay/Pune. |
| 19. | Equipment for visual inspection | | | x (proposed) | \$ 8,000,- | It is proposed to add this item in the list of UNDP equipment |
| 20. | Refrigerator 286/290 litres | 41 | | | Rs. 20,000,- | In Indian list only one piece is recommended. To keep chemical at low temperature. |
| 21. | Vacuum cleaner | x | | | ? | New item proposed to be included in the list. |

ANNEX 'C', page 3

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----|---|----|----|---|--------------|---|
| 22. | PCB inspection jig magnifier | 47 | | | Rs. 6,000,- | Specifications & suppliers have to be found. |
| 23. | Equipment for measurement of thickness of copper & tin layer | | 23 | | ₹ 5,000,- | This equipment is proposed in place of Reto scope. |
| 24. | Neutralizing tank and pump assembly with pH-metering facility | | 25 | | ₹ 25,000,- | Details of specifications are in the list Annex 'D' |
| 25. | Screen printing equipment including frames screens | 35 | | | Rs. 20,000,- | No supplier known, to clear by ESTC |

ANNEX 'D'

Technical Details and Demands on the Equipment for the PCB Manufacturing Laboratory

| No. *) | Name of the Item *) | Size/mm | Demands | Desirable technical data/ Possible supplier **) |
|--------|--------------------------------------|----------------------------|---|---|
| 1. | Gullotine shearing machine | H 1140 L 1200 D 760 | - | Size of blades: 51" (I): JMT Jeeth Machine Tools Corporation/Delhi |
| 2. | Hand drilling machine - medium speed | H 780 L 1000 D 800 | Elec 1ph, 100 VA Air pressed, clean, dry | Spindle speed 10.000 - 12.000 rpm Working area of table 1000 x 700 mm Drill sizes 0,3 - 6,0 mm if possible with optical inspection (I): unknown, to clear by ESTC (N): possible, Type unknown (U): Type FTX Optical Drilling machine |
| 3. | NC drilling machine - two heads | H 1800 L 2500 D 1500 | Elec 3ph, 3 kW Air pressed, clean, dry Air condition. | Spindle speed 20.000 - 60.000 rpm Usable PCB-size 400 x 400 mm Reliability + 0,01 mm Two spindles, Routing facility (U): Type CNC-100 R Drilling & Routing machine possible supplier: (L); Schmolli Maschinen GmbH D-6242 Kronberg; I.T.C. Intercircuit GmbH D-8000 München; Roll GmbH D-2000 Hamburg 13; Heeh GmbH D-6057 Dietzenbach |

*) In accord with List 1/PR - ANNEX 'C'

- **) (I) Indian supplier
(N) Bulgarian Academy of Sciences
(O) OMI/Austria
(U) UNIT EXPORT / U.K.
(L) Laif Galvanotechnik / West Germany
(N) Nissel Trading Co / Japan

ANNEX 'D' - page 2

| 1 | 2 | 3 | 4 | 5 |
|----|--|--------------------------------------|---|---|
| 4. | Lining up table & Retouching desk | H 790 L 1630 D 1200 | Elec 1ph, 100 W | (I): Monotype India Limited/ Calcutta Type 441 |
| 5. | Machine for mechanical disoxidation | H 400 L 950 D 950 | Elec 5 kW Water connect. Water discharge | Working width max. 400 mm Rotating abrasive brushes for de- burring and cleaning (R): Mechanical disoxidation device (U): Type 600/DSBC/O Double sided board cleaner Supplier finally to clear by UNIDO/ Expert |
| 6. | Laboratory electro- plating equipment | H 1300 L 6000 D 650 (1500?) | Elec 3ph, 11 kW, DC 150 A Water connect. Water discharge Air compressed Air discharge | Consist of arrangement of the dips for - chemical cleaning - electroless precopperplating - galvanic copper precipitation - galvanic tin precipitation Max. finished PCB size: 400 x 400 mm Capacity: about 3 sq.m per day (R): Type LLM-2 Laboratory line for PCBs (U): Type Labline PTH Processing Unit or Type Compact-300 (L): Type LGA 1, LGA 2, LGA 3 Lahorgalvanikanlage or Type LGKA Laboratory electroplating equipment (N): Type "SUNIIAYATO" D/S PTH Boards (Specification unknown) Supplier finally to clear by UNIDO/Expert |

ANNEX 'D' - page 3

| 1 | 2 | 3 | 4 | 5 |
|-----------------------------------|--------------------------|--|---|--|
| 7. Whirler/drying oven | H 555 L 555 N 555 | Elec 1,5 kW | | Working area: 455 x 455 x 455 (I): Type HO-3 Allied Instruments/Delhi |
| 8. Resist laminator | H 622 L 670 N 656 | Elec 2,0 kW Room with yellow light | | Working width: max. 400 mm, unilaterally (R): Type LM-350 Dry film laminator (O): Type L.50-2 Laminator (U): Type GX 18 Dry film laminator Supplier finally to clear by UNIDO/ Expert |
| 9. Bench vacuum frame exposure | H 400 L 1030 N 820 | Elec 0,6 kW | | Working width: 400 x 400 mm Exposing time: 10 s ... 5 min unilaterally, vacuum frame (I): to clear by ESTC if available in India, otherways put in UNDP list (R): Type PK-100 Exposure unit (U): Types PL 90 MK II, PL 91, vacumat 3 (L): Type LGS 9 (N): Included in No. 6, without specification Final decision by UNIDO necessary |
| 10. Developer | H 850 L 800 N 520 | Elec 3ph, 4 kW Water connect. Air pressed | | Working width: 400 x 400 mm Tank volume: 25 l Spray system, for dry resist (R): Type PM-1 Developer (L): Type LGS 6 Final decision by UNIDO. |

ANNEX 'D' - page 4

| 1 | 2 | 3 | 4 | 5 |
|---|----------------------------|--|--|---|
| 11. Resist stripper | H 1000 L 1610 D 750 | Elec 3ph Water connect. Water discharge | Working width: 400 x 400 mm three chambers, rotating brushes (U): Type Labline finishing or part of Compact-300 (L): Type LGS T Final decision by UNIDO | |
| 12. Etching machine | H 920 L 560 D 600 | Elec 2,5 kW Water connect. Water discharge | Working width: min. 300 x 300 mm Tank volume: min. 15 l Spray etching, built-in rinsing facility (I): Supp. Monotype India limited, Type 501 (L): LGS 15 Compact Spray Etching Machine (N): Included in "SUNHAYATO" | |
| 13. Laboratory equipment for gold plating | On working table | Elec 1 kW DC | Working width: min. 300 mm Depth of gold tank: 25 mm Tank volume: 125 ml (I): unknown, to clear by ESTC (U): Type Mini-gold plating | |
| 14. Routing machine for PCB | H 1600 L 1530 D 1050 | Elec Air pressed | (I): unknown, to clear in relationship with equipment No. 3 by UNIDO/Expert and also the possibility of local purchasing by ESTC | |
| 15. Water deioniser | H L D | Elec Water connect. | Capacity 15 liter/h (I): Chemsworth/Bombay, Type M1111-RO | |

ANNEX 'D' - page 5

| 1 | 2 | 3 | 4 | 5 |
|-----|---|---------------------------|---|---|
| 16. | Re-distillation equipment | H L D | | No quotation and specification available. Possible supplier: Intercircuit GmbH 8000 München Type Drechhöhl Single System-Solvent Recovery To clear both by ESTC and UNDP expert. |
| 17. | Chemical analysing for quality control of chemicals | H 1600 L 2400 D 800 | Elec Water connect. Water discharge | Chemical Analysis Kit Coparator Kit two pairs of scales (1 g ... 1000 g, 1 kg ... 10 kg) (I): Unknown, to clear by ESTC (U): Chemical Analysis and Coparator Kit |
| 18. | Miscellaneous accessories | | | (I): unknown, to clear by ESTC |
| 19. | Equipment for visual inspection | H 1600 L 1000 D 600 | Elec | Working area: 300 x 400 mm magnification: min. 10 x, 20 x, 35 x through and up light (U): Type Vista Traversing Inspection Unit further supplier: - Oswald Doll GmbH, 2 Hamburg 13, Type Doll-Visex V-300/V-400-D/G - pluritec Italia, Strada di Breda 10010 Burdo d' Ivrea, Type Scopica Machine for printed circuit visual control Final decision by UNIDO/Expert |

ANNEX 'D' - page 6

| 1 | 2 | 3 | 4 | 5 |
|-----|--|---------------------------------|---------------------|---|
| 20. | Refrigerator | II 1600 L 600 D 600 | Elec | 2 pieces, 290 litres local purchasing, to clear by ESTC |
| 21. | Vacuum cleaner | | Elec | Local purchasing, to clear by ESTC |
| 22. | PCB inspection jig magnifier and tem- plate | II 1600 L 1200 D 600 | Elec Air, compr. | No quotation and specification available, to clear by ESTC |
| 23. | Equipment for measure- ment of thickness of copper & tin layer | | | Instead of Betascope (No. 2? requis. 86/2) No quotation and specification available. To clear by UNIDO/Expert. |
| 24. | Neutralizing tank and pump assembly with pH-metering facility | To set up outside the lab | | Throughput efficiency: 2 m ³ /h circulation efficiency: 180 m ³ /h (L): Type LG-NEU-17 Continuous Neutralization Equipment (N): Type PH 7 further supplier: - Poligrat GmbH, D-8000 München, Chiemgaustr. 109 Type Kleinanlage zur Abwasserauf- herleitung/Neutralisationseinheit final decision by UNIDO |
| 25. | Screen printing equip- ment including frames and screens | | | Usable for single sided PCB only. Supplier and specifications unknown. To clear by ESTC. |

ANNEX 'E'

Overview about the expected costs for UNDP and Indian Equipment

1. UNDP Equipment

| S. No. | No. related to list 1/88 | to list 86/2 | Name of the Equipment | Cost (expect.) |
|--------|--------------------------|--------------|---|----------------|
| 1. | 3 | 22 | NC drilling machine, two heads | \$ 50.000,- |
| 2. | 5 | 20 | Machine for mechanical disoxidation | \$ 15.000,- |
| 3. | 6 | 20 | Laboratory electroplating equipment | \$ 48.000,- |
| 4. | 8 | 20 | Resist laminator | \$ 7.000,- |
| 5. | 10 | 20 | Developer (Spray System) | \$ 4.000,- |
| 6. | 11 | 20 | Riston stripper | \$ 6.000,- |
| 7. | 19 | proposed | Equipment for visual inspection | \$ 8.000,- |
| 8. | 23 | 23 | Equipment for measurement of thickness of copper and tin layer | \$ 5.000,- |
| 9. | 24 | 25 | Neutralization tank and pump assembly with pH-metering facility | \$ 25.000,- |
| TOTAL | | | | \$ 168.000,- |

2. Indian Equipment

| S. No. | No. related to list 1/88 | Name of the Equipment | Cost (expect.) | Remark |
|--------|--------------------------|---|----------------|---------------------|
| 1 | 1 | Guillotine Shearing Machine | Rs. 8.000,- | |
| 2 | 2 | Drilling machine-medium speed | Rs. 12.000,- | |
| 3 | 4 | Lining up table & Retouching desk | Rs. 20.000,- | 3 pieces required |
| 4 | 7 | Whirler/drying oven | Rs. 20.000,- | |
| 5 | 9 | Bench vacuum frame exposure | ? | Prize to be found |
| 6 | 12 | Etching Machine | Rs. 12.000,- | |
| 7 | 13 | Laboratory equipment for gold plating | Rs. 5.000,- | |
| 8 | 14 | Routing machine for PCB | ? | |
| 9 | 15 | Water deioniser | ? | |
| 10 | 18 | Miscellaneous equipment | Rs. 20.000,- | |
| 11 | 20 | Refrigerator 286/290 litre | Rs. 20.000,- | Two pieces required |
| 12 | 21 | Vacuum cleaner | Rs. ? | |
| 13 | 22 | PCB inspection jig-magnifier and template | Rs. 6.000,- | |
| 14 | 25 | Screen Printing facilities | Rs. 20.000,- | |
| TOTAL | | | Rs.143.000,- | |

ANNEX 'F'

Proposed List of PCB Design Lab and Subsequent Multilayer Facilities

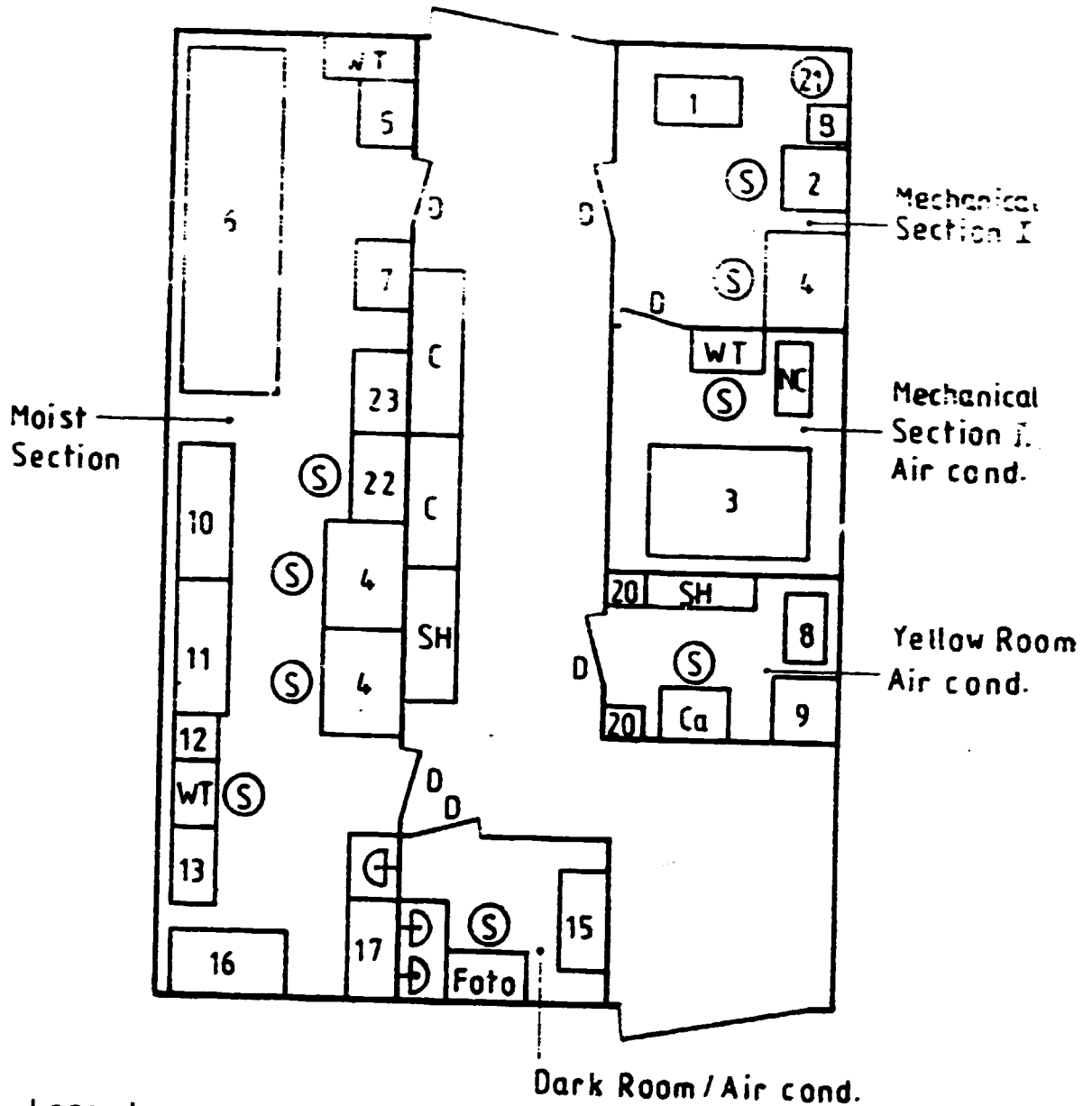
| S. No. | Name of the item | Indian List | UNDP Requi. 86/2 | Cost | Remark |
|-----------------------|--|-------------|------------------|------------|--|
| PCB Design Lab | | | | | |
| 1. | Drafting table and accessories, 1000 x 1500 mm pieces | 44 | 24 | | to be purchased locally |
| 2. | Reprocamera desired spec.: automatic timer, vacuum film holder, Overall screen size: about 500 x 600 mm Enlargment and reduction (ratio 2:1:2) | | 21 | \$ 4.000,- | UNDP full detailed quotation necessary |
| 3. | Photochemical facilities (Developing e. q.) | | | | to be purchased locally |

Remark: UNDP Requisition 86/2 item No. 25 "Frame holding lifting vacuum assembly" must be included in item No. 21, "Reprocamera" and then No. 26 could be deletead.

Multilayer Facilities

| | | | | | |
|----|---|---|---|--|--|
| 1. | Equipment for Black-oxidising | x | x | | |
| 2. | Equipment laminating press | | x | | |
| 3. | Equipment for Desmearing | | x | | |
| 4. | Bare Board Tester | | x | | |
| 5. | Fusing system | x | x | | |
| 6. | Shearing machine for laminates, motordriven | x | | | |

Proposed Layout of PCB Manufacturing Lab



Legend

Numbers relating to list of equipments No 1/88

- (S) Stool
- WT Working table
- B Box
- Ca Camera
- D Water
- SH Shelves
- C Cupboard
- D Door

AREA : 14,4 x 10,3 sqm

M : 1cm $\hat{=}$ 1m

ANNEX 'H'

Fundamental Claims for PCB Manufacturing Laboratory Installations

Mechanical SECTION II

Air conditioning

Electric power supply 220/380 V 3ph, .. KW

Compressed air

Moist SECTION

Acid-proof flooring

Water-proof walls

Water connection 1/2", 3/4"

Waste Water pipe in the floor to the neutralizing tank

Compressed air

Waste air

Electric power supply 220/380 V 3ph, 30 (?) KW

Yellow room

Electric power supply 220 V 1ph, 25 (?) KW

Air conditioning

Dark room

Electric power supply 220 V, 1ph, ? KW

Water connection

Waste water

Air conditioning

ANNEX 'I'

Course Design for PCB training use and operation of following machines

| No. | Name of Machine | Knowledge/Skill | No. of days |
|-----|---------------------------------------|---|-------------|
| 1. | Shearing machine | Principle of working and practice on machine | 1 |
| 2. | Handdrilling machine | Principle of working, practice on operation | 2 |
| 3. | NC drilling machine | - do - | 10 |
| 4. | Retouching desk | Practices in locating faults in PCB | 2 |
| 5. | Machine of mechanical disoxidation | Principle of working, practice on operation, rating the quality | 2 |
| 6. | Laboratory electroplating equipment | Principle of working, importance of each step in explanation, practice on operation | 10 |
| 7. | Whirler/drying oven | Principle of working, practice on operation | 1 |
| 8. | Resist laminator | Principle of working, practice on operation | 2 |
| 9. | Bench vacuum frame exposure | Principle of working practice on operation | 1 |
| 10. | Developer | - do - | 1 |
| 11. | Resist stripper | Principle of working practice on operation | 1 |
| 12. | Etching machine | - do - | 2 |
| 13. | Laboratory equipment for gold plating | Operation by Chemist | - |
| 14. | Routing machine for PCB | In connection with No. 3 | - |

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| No. | Name of Machine | Knowledge/Skill | No. of days |
|-----|--|---|-------------|
| 15. | Water deioniser | Principle of working, practice on operation | 1 |
| 16. | Redestillation equipment | - do - | 1 |
| 17. | Chemical lab for quality control of chemical | Explanation of methods for quality control | 1 |
| 18. | Miscellaneous accessories | Principle of working, practice on operation | 2 |
| 19. | Equipment for visual inspection | Principle of working, practice on operation and fault location | 2 |
| 21. | Vacuum cleaner | Practice on operation | 1 |
| 22. | PCR inspection jig magnifier | Principle of working, practice on operation and fault location | 4 |
| 23. | Equipment for measurement for thickness of copper / tin layer | Principle of working, practice of operation | 1 |
| 24. | Neutralizing tank | Principle of working practice on control of the quality of work | 1 |

TOTAL No of days = 49

Remarks:

1. This Training course is planned for preparing skilled worker in the process of PCR manufacturing.
2. The entry qualification for such a person could be high school/intermediate.
3. A more detailed and intensive course including maintenance of the machine and equipment could be designed for diploma holders.

ANNEX 'J'

Extended List of Electronics Units in Adjoining Area

| S. No. | Name of the unit | Product | Remarks |
|--------|--|--|---|
| 1. | Teletronics Limited Rhimtal | TV | Plans for expansion, modern assembly techni- ques being created, visited on 23-1-88 |
| 2. | Kumtel, Rhimtal | TV | New factory being set up, production started, visited on 23-1-88 |
| 3. | FACIT ASTA Ltd, Rhimtal | Electronic typewriter | Building made, factory not functioning |
| 4. | Debikay Electronics, | Process Control Equipment | Not functioning |
| 5. | HMT Ranibagh | Parts of HMT watches, atches | Factory functioning Good tool room visited on 22-1-88 |
| 6. | UP Digital, Rhowali | HMT watches; atch cases (U.P.S.I.D.C.) | Factory functioning visited on 23-1-88 |
| 7. | Himtron, Haldwani | CTV receiver | Factory not functioning. Made an effort to visit on 22-1-88; Informed that factory is not working. |
| 8. | Canelec India Ltd, Almora | Computer peripherals | Building going to be ready in one or two month. Three employers: An Engineer, Stores clearks & Pon visit on 27-1-88. Factory at NOIDA working. |
| 9. | Himalayan Video Colour(P) Ltd., Almora | TV | Under construction |
| 10. | Dyanora, Dashiipur | Colour TV | Visit not made; |
| 11. | Relwal Electronics, Kashiipur | Facsimile equipment | Visit not made; |

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| S. No. | Name of the unit | Product | Remarks |
|-------------------|-------------------------------------|---|---|
| 12. | Jolly Radio & Sound Service, Rampur | Radio & Transistor etc. Carradio, Radiogram, TV sets | Did not visit; Told that it is functioning |
| 13. | Modi Xerox, Pampur | Plain paper copiers | Did not visit, Factory functioning |
| 14. | Agrawal Industries, Rampur | Automatic emergency, Tube lights, Conducting glasses | Did not visit; Told factory functioning |
| 15. | RHEL, Rudrapur | Control equipment | Did not visit |
| 16. | BEL, Kotdwar | Electronic equipment | Did not visit |
| 17. | KUMTRON, Rageshwar | Radio receivers | Did not visit |
| 18. | Omni India Ltd, Dehradun | Folo Diskette | Did not visit |
| 19. | Sears TV, Dehradun | TV | Did not visit |
| 20. | Sai Components Ltd, Almora | Electronic equipment | Not functioning; land acquisition |
| 21. | Instrumentation Ltd Muni-ki-Rati | Process control Equipment | Did not visit |
| 22. 23. 24. | UPTRON | Advise Video equipment, Corless Telephones, Facsimile equipment | Don't know where do they exist. |
| 25. | Prakash Tubes Ltd, Kashipur | Tube lights & GLS bulbs | Mr. E. Hadidy & Mr. S. V. Singh visited the factory. |
| | | <u>Note:</u> Probable areas of Collaboration | People met: Mr. R. K. Gupta Glass plantmanager Mr. A. K. Bas Gupta Instrumentation Engineer |

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| S. No. | Name of the unit | Product | Remarks |
|--------|--|---|---|
| 26. | Prakash Pipes & Industries Ltd, Kashipur | Testing, trouble shootin & Making of PCP required as spares for the plant 14" P/E TC Picture tubes | Mr. El. Hadidy & Mr. S. V. Singh visited the factory. |
| | | <u>Note:</u> Collaboration Testing & Supply of trained manpower to the plant. | <u>People met:</u> Mr. R. D. Agarwal, General Manager Mr. C. D. Ahuja Dy Manay (Q.A.) |
| 27. | Electronics Consortium P. Ltd., Kashipur | 14" & 20" P/E TV <u>Note:</u> Collaboration Testing, supply of trained manpower to the plant | Mr. El. Hadidy & Mr. S. V. Singh visited the plant <u>People met:</u> Mr. P. K. Saxena Production Manager |

ANNEX 'K'

Evaluation of Offers under Consideration

1. Bulgarian Academy of Sciences:

Offer in line with ESTC project's request.

However additional information is necessary.

a) Technical specification on "drilling machine"

b) Technical/chemical specification on "Laboratory line for P.C.R. LLM-2"

- tank layout ?

- chemical cleaning included?

- tank material?

- resist stripper included or single equipment possible?

c) Technical specification on "etching module"

2. Nissei Trading Co., Ltd.

Offer invalidate (ended April 1987), no technical specification available.

3. Unit Export (Great Britain) Ltd

Pro forma invoice only, but offer assured if more required details available.

Items which are quoted (seller's reference 'Project 456' high productivity) are not in line with ESTC project's request,

But quotation and specification should be requested by UNIDO on following items

| Prod. Ref. | Description |
|------------|---------------------------------------|
| 27-18046 | FTX Optical drilling machine |
| 17-18095 | CNC-100 R Drilling and Poling machine |
| ? | Double sided board cleaner |
| 20-25057 | Labline PTH processing Unit |
| 20-25058 | Compact-300 |
| 27-22801 | GX 1R Dry film laminator |

| Prod. Ref. | Description |
|------------|----------------------------------|
| 26-13062 | PL 90 MK II Exposure unit |
| 26-13064 | PL 91 |
| 32-13092 | Vacumat |
| 20-25042 | Lahline finishing unit |
| 27-25032 | Mini-gold plating |
| 45-300/5 | Chemical Analysis Kit |
| 45-300/6 | Comparator Kit |
| 42-300/1 | Vista Traversing Inspection Unit |

4. O'T International (Austria) Ges. m.b.H.

Time of validity of the offer No. A 8805: until 19 april 1988
Size of items Module-x TH: (max length 12.000 metres,
max PCP size 500 x 500 mm) not in line with ESTC project's
request.

However quotation on PCP chemicals is acceptable. The chemicals
are in line with the request to produce a minimum of pollution.
Therefore UNJDO should call on new offer on items (max PCP size
400 x 400 mm).

Remarks:

Alternative offer on equipment for the production of prototypes
and small batches of PTH PCP (PCP size min. 300 x 300 mm, max.
400 x 400 mm, capacity about 2 sq.m per day) should be ordered
by UNJDO from

- Laif Galvanotechnik GmbH
Happerschoss
D-5202 WENNEFF/SIEG 1
West-Germany
Telefon (022 42) 3051/52 Telex 889 634 laif d

- Circuitape Ltd
Chamberlain Road, Avlesbury
HP 19 3 DE Puckinghamshire
England
Telephone 0296 23451 Telex 383 765