6．ミニッツ

6－1　ミニッツ署名に至る経緯

前回と同様に、調査団のミニッツと合同委員会のミニッツをそれぞれ作成のうえ、署名し、後者を前者に添付することとした。別々にミニッツを作成したのは、署名者が異なるためである。つまりR/Dによれば、合同委員会における議長はUTN長官が務め、マレイシア側代表はUTN副長官、日本側代表はチームリーダーが、それぞれ務めることになっており、合同委員会のミニッツにはこの3者が署名すべきであると考えられる。これに対して、調査団のミニッツには、調査団長とマレイシア側代表、すなわち今回はUTN長官が署名すべきだからである。

6－2　ミニッツ（別添）

THE MINUTES OF MEETING

BETWEEN THE JAPANESE ADVISORY SURVEY TEAM AND

THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF MALAYSIA

ON THE RADIATION APPLICATIONS PROJECT

The Advisory Survey Team (hereinafter referred to as "the Team"), organised by the Japan International Cooperation Agency (hereinafter referred to as "JICA") and headed by Dr. Shoichi Sato, Director General, Takasaki Radiation Chemistry Research Establishment (TRCRE), Japan Atomic Energy Research Institute (JAERI), visited Malaysia from January 9 to January 16, 1992, for the purpose of understanding the progress and achievements concerning the implementation of the Radiation Applications Project (hereinafter referred to as "the Project") and reviewing the technical cooperation with the authorities concerned of the Government of Malaysia.

During its stay in Malaysia, the Team exchanged views and had a series of discussions with the Malaysian authorities concerned.

As a result of the discussion, both sides came to the understanding concerning the matters referred to in the documents attached herewith.

Malaysia, January 15, 1992

DR. SHOICHI SATO
TEAM LEADER,
ADVISORY SURVEY TEAM
JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)

DATUK DR. MOHD. GHAZALI B. HJ.
ABDUL RAHMAN,
DIRECTOR GENERAL
NUCLEAR ENERGY UNIT (UTN)

THE ATTACHED DOCUMENTS

I. The Team attended the Second UTN-JICA Joint Committee Meeting on the Radiation Applications Project, 13 - 15 January 1992. The list of participants from Malaysia and Japan appears as Annex 1.

II. The progress report of the project in the JFY 1991 was reviewed and evaluated. The significant accomplishments appear as the minutes of the Second Joint Committee Meeting.

III. The team appreciated the progress made by UTN and JICA experts, in the implementation of the Project in JFY 1991. The Malaysian representatives informed that the Low and High Energy EB Machines were commissioned in March and June , 1991 respectively. Both machines are in good operating conditions. The research projects on the Sterilisation of Medical Products and Radiation Curing of Surface Coatings are in progress.

IV. The project plan for JFY 1992 was discussed in the meetings. The proposed plan is shown in the minutes of the Second Joint Committee Meeting.

Annex 1

LIST OF PARTICIPANTS

A. Malaysian Representatives

I. Nuclear Energy Unit (UTN)

1.	Y.Bhg.Datuk Dr.Mohd.Ghazali b. Hj. Abdul Rahman	Director General
2.	Ms. Fatimah bt. Mohd.Amin	Act. Dep. Director General
3.	Mr. Razali b. Hamzah	Act. Director of Operations
4.	Dr. Norimah bt. Yusof	Act. Director of Research
5.	Dr. Khairul Zaman b. Hj. Mohd. Dahlan	Head, Radiation Processing Program
6.	Dr. Zahrah bt. Abdul Kadir	Radiation Processing Program
7.	Mr. Nik Ghazali b. Nik Salleh	Radiation Processing Program
8.	Ms. Noriah bt. Mod Ali	Health & Radiation Control Department
9.	Mr. Mohd. Sidek b. Othman	Engineering Dept.
10.	Mr. Zulkafli b. Mohd Nor	Health & Radiation Control Dept.
11.	Mr. Raja Abdul Aziz b. Raja Adnan	Planning Unit

II. Others

1.	Mr. Mohd. Sani b. Mistam	Economic Planning Unit (EPU), The Prime Minister's Department
2.	Mrs. Rahimah bt. Mohd. Said	Ministry of Science, Technology & the Environment (MOSTE)

B. Japanese Representatives

I. Advisory Survey Team

1.	Dr. Shoichi Sato	Director General, TRCRE, JAERI
2.	Dr. Isao Ishigaki	Dep. Director, Material Development, TRCRE, JAERI
3.	Dr. Jiro Okamoto	Manager, Irradiation Services, TRCRE, JAERI
4.	Mr. Shizuo Momma	Head, Health Physics, NIRS
5.	Mr. Yoshihiro Fuchigami	Section Chief, Atomic Energy Bureau, STA
6.	Mr. Naoto Hattori	Social Development Cooperation Dept., JICA

II. Others

1.	Mr. Kenzo Yoshida	Team Leader, UTN-JICA
2.	Mr. Kiyoshi Honma	Coordinator, UTN-JICA
3.	Mr. Satoru Kohiyama	JICA Malaysia Office
4.	Mrs. Yoshie Yamashita	JICA Malaysia Office
5.	Mr. Toshiyuki Akagi	Embassy of Japan

THE SECOND UTN-JICA JOINT COMMITTEE MEETING ON THE RADIATION APPLICATIONS PROJECT 13 - 15 JANUARY, 1992

The Second UTN-JICA Joint Committee Meeting on the Radiation Applications Project (hereinafter referred to as "the Meeting"), was held at the Nuclear Energy Unit, The Ministry of Science, Technology and the Environment, Malaysia, on the 13th - 15th January, 1992 for the purpose of evaluating the progress and the achievements in the implementation of the Radiation Applications Project (hereinafter referred to as "the Project") and reviewing the technical cooperation between the authorities of the Governments of Malaysia and Japan.

The Meeting was held in accordance to Para. VII(5) of the Record of Discussions between the Japanese Implementation Survey Team and the Authorities Concerned of the Government of Malaysia on the Technical Cooperation for the Radiation Applications Project signed on 5 July 1989.

As a result of the meeting, both sides came to the understanding concerning the matters referred to in the minutes of the meeting attached herewith.

Malaysia, January 15, 1992

MR. KENZO YOSHIDA
TEAM LEADER
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MS. FATIMAH BT. MOHD.AMIN
ACT. DEPUTY DIRECTOR GENERAL
NUCLEAR ENERGY UNIT (UTN)
MINISTRY OF SCIENCE, TECHNOLOGY AND THE ENVIRONMENT
MALAYSIA

Y.BHG. DATUK DR. MOHD. GHAZALI B. HJ. ABDUL RAHMAN
CHAIRMAN OF THE MEETING
DIRECTOR GENERAL
NUCLEAR ENERGY UNIT (UTN)
THE MINISTRY OF SCIENCE, TECHNOLOGY AND THE ENVIRONMENT
MALAYSIA

MINUTES OF
THE SECOND JOINT COMMITTEE MEETING OF UTN-JICA
RADIATION APPLICATIONS PROJECT
13 - 15 JANUARY 1992

DATE : 13th, 14th and 15th January 1992

PLACE : Nuclear Energy Unit (UTN)
Ministry of Science, Technology and the Environment,
PUSPATI Complex, Bangi
43000 Kajang
Selangor Darul Ehsan
MALAYSIA

CHAIRMAN : Y.Bhg. Datuk Dr. Mohd. Ghazali b. Hj. Abd. Rahman
Director General, UTN

MEMBERS

A. Malaysia

1.	Ms. Fatimah bt. Mohd.Amin	Act. Dep. Director General, UTN
2.	Dr. Norimah bt. Yusof	Act. Director of Research, UTN
3.	Dr. Khairul Zaman b. Hj. Mohd. Dahlan	Head, Radiation Processing Program UTN
4.	Mr. Mohd. Sani b. Mistam	Economic Planning Unit (EPU), The Prime Minister's Department
5.	Mrs. Rahimah bt. Mohd. Said	Ministry of Science, Technology & the Environment (MOSTE)
6.	Dr. Zahrah bt. Abdul Kadir	Radiation Processing Program, UTN
7.	Mr. Nik Ghazali b. Nik Salleh	Radiation Processing Program, UTN
8.	Ms. Noriah bt. Mod Ali	Health & Radiation Control Department, UTN
9.	Mr. Mohd. Sidek b. Othman	Engineering Dept. UTN

10.	Mr. Zulkafli b. Mohd Nor	Health & Radiation Control Dept., UTN
11.	Mr. Raja Abdul Aziz b. Raja Adnan	Planning Unit, UTN

B. JICA

1.	Mr. Kenzo Yoshida	Team Leader, UTN-JICA
2.	Mr. Kiyoshi Honma	Coordinator, UTN-JICA
3.	Dr. Shoichi Sato	Director General, TRCRE, JAERI
4.	Dr. Isao Ishigaki	Dep. Director, Material Development, TRCRE, JAERI
5.	Dr. Jiro Okamoto	Manager, Irradiation Services, TRCRE, JAERI
6.	Mr. Shizuo Momma	Head, Health Physics, NIRS
7.	Mr. Yoshihiro Fuchigami	Section Chief, Atomic Energy Bureau, STA
8.	Mr. Naoto Hattori	Social Development Cooperation Dept., JICA
9.	Mr. Satoru Kohiyama	JICA Malaysia Office
10.	Mrs. Yoshie Yamashita	JICA Malaysia Office

OBSERVERS

Malaysia

1. Mr. Hilmi b. Mahmood
(UTN)

2. Mr. Kamarudin b. Bahari
(UTN)

3. Ms. Mek Zah bt. Salleh
(UTN)

4. Mr. P. Chandrasekaran
(MOSTE)

5. Mr. Shari b. Jahar
(UTN)

6. Mr. Kamarudin b. Buyong
(UTN)

7. Mr. Abdul Ghani b. Harun
(UTN)

Japan

1. Mr. Toshiyuki Akagi
(Embassy of Japan)

AGENDA OF THE SECOND UTN-JICA JOINT COMMITTEE MEETING ON RADIATION APPLICATIONS PROJECT 13TH - 15TH JANUARY, 1992

Monday, 13th January 1992

0930 hrs	- Opening of the Second UTN-JICA Joint Committee Meeting on Radiation Applications Project by: 1. Welcoming Address by the Director General, UTN 2. Opening Remarks by the Director General, TRCRE, JAERI 3. Remarks by the Team Leader JICA - UTN Project
	- Adoption of Agenda
	- Adjournment of the Meeting
1015 hrs	- Tea/Coffee Break
1045 hrs	- Presentation of Papers on the Review of Project Implementation in JFY 1991 1. "Installation, Commissioning, Operation and Maintenance of EBM" presented by Mr. Mohd. Sidek b. Othman 2. "Dosimetry for EBM" presented by Ms. Noriah Mod. Ali 3. "Evaluation of Safety for EB Facilities" presented by Mr. Zulkafli b. Mohd. Nor 4. "Sterilization of Medical Products using EBM" presented by Dr. Zahrah bt. Abd. Kadir 5. "Radiation Curing of Surface Coatings" presented by Mr. Nik Ghazali b. Nik Salleh
1245 hrs	- Lunch
1430 hrs	- Discussion on the Review of Project Implementation in JFY 1991
1600 hrs	- Adjournment of the Meeting
	- Afternoon Tea/Coffee

Tuesday, 14th January 1992

0900 hrs	- "Planning Schedule for JFY 1992 and Future Plans" presented by Dr. K. Yoshida
0930 hrs	- General Discussion
1030 hrs	- Tea/Coffee Break
1100 hrs	- Continue Discussion
1200 hrs	- Lunch
1400 hrs	- Preparation of the Minutes

Wednesday, 15th January 1992

0900 hrs	- Confirmation of the Minutes of the Meeting
1030 hrs	- Tea/Coffee Break
1100 hrs	- Continue Confirmation of the Minutes
1200 hrs	- Lunch
1430 hrs	- Signing of the Minutes of the Second UTN-JICA Joint Committee Meeting on the Radiation Applications Project
1500 hrs	- Closing 1. Closing Remarks by Team Leader of UTN-JICA Project 2. Closing Address by the Chairman, UTN
	- Tea/Coffee

MINUTES OF THE MEETING

1. Opening of the Meeting

1.1 The Second UTN-JICA Joint Committee Meeting on "Radiation Applications Project" was chaired by the Director General of Nuclear Energy Unit (UTN).

1.2 The meeting was officially opened by the Chairman and his opening remarks is as in Appendix 1.

1.3 The Leader of the Advisory Survey Team and the Team Leader of the Project delivered their opening remarks as in Appendices 2 & 3 respectively.

2. Adoption of Agenda

2.1 The tentative agenda of the meeting was adopted by the meeting without amendment.

3. Review of the Project Implementation in JFY 1991

3.1 5 papers were presented by UTN

3.1.1 "Installation, Commissioning, Operation and Maintenance of EBM" presented by Mr. Mohd. Sidek b. Othman (See Appendix 4)

3.1.2 "Dosimetry of EBM" presented by Ms. Noriah Mod. Ali (See Appendix 5)

3.1.3 "Evaluation of Safety for EB Facilities" presented by Mr. Zulkafli b. Mohd. Nor (See Appendix 6)

3.1.4 "Sterilization of Medical Products using EBM" presented by Dr. Zahrah bt. Abd. Kadir (See Appendix 7)

3.1.5 "Radiation Curing of Surface Coatings" presented by Mr. Nik Ghazali b. Nik Salleh (See Appendix 8)

3.2 The project implementation JFY 1991 was presented by Dr. Khairul Zaman b. Hj. Mohd. Dahalan as shown in Appendices 9 & 10.

4. Planning Schedule for JFY 1992 and Future Plans

4.1 "The Planning Schedule of Project Implementation and Future Plans" in JFY 1992 was prepared by the Project Team and presented by Mr. Kenzo Yoshida (See Appendices 11 & 12).

5. General Discussion

5.1 Cooling System

The present cooling system is found to be adequate under the current operating conditions. Should the need arise, only then UTN will construct a heat sink after receiving advice and specifications from JICA.

5.2 Floor Finish

The present floor finish has been improved to ensure the smooth movement of the conveyor system.

5.3 Safety System

It was stressed that the interlock systems are adequate. However, improvement of other safety requirements will be carried out in due time including establishment of administrative procedures.

5.4 Entrance to the conveyor

The present door is made of fire resistant wood as prescribed by the Malaysian Fire Department (fire rating - 1 hour). This door will not be replaced with a steel door. UTN would ensure the locking system is improved.

5.5 Noise levels

UTN has taken several steps to reduce the noise levels. These include:

a. bypassing the purge blower;
b. reducing exhaust blower speed; and
c. removing the duct projection in the irradiation room.

However, the noise levels in certain areas are still unacceptable. UTN requested that JICA send an expert on noise control in JFY 1992 to rectify this problem.

5.6 Ancillaries

UTN has provided the necessary ancillaries in the 3 MeV irradiation room for experimental work.

5.7 Radiation curing supervisor

It was also noted that the long term expert (Radiation Curing Supervisor) has not been despatched in JFY 1991. Considering the difficulties at finding a suitable expert, JICA suggested to implement this component by sending several short term experts.

5.8 Dosimetry

The Meeting agreed to develop procedures for standardisation and calibration of dosimeters for the electron beam as well as to establish linkage for traceability to a reference laboratory. UTN requested an expert in this field to be despatched in JFY 1992.

5.9 Exhaust system for the 200 keV EB machine (Curetron)

UTN raised the question on the need to incorporate an exhaust system to the 200 keV EBM to ensure the ozone levels are within the permissible limits in the working area. However, it was pointed out by the JICA team that they do not expect that ozone levels to exceed this permissible limits.

5.10 Manpower

JICA requested UTN to assign more personnel to the Project.

6. Implementation and Future Work Plan

6.1 Both parties were satisfied with the overall implementation of the Project in JFY 1991. The despatch of experts were as scheduled and all equipments were received in time.

6.2 The Final Workplan for JFY 1992, incorporating several amendments to the draft, was adopted and agreed by the meeting to be proposed to JICA for approval (Appendices 13 & 14).

Appendix 1

WELCOMING ADDRESS BY THE DIRECTOR-GENERAL OF THE NUCLEAR ENERGY UNIT AT THE SECOND JOINT COMMITTEE MEETING OF THE UTN-JICA PROJECT ON RADIATION APPLICATIONS 13-15 JANUARY 1992

Dr. Shoichi Sato,
Director-General of Takasaki Radiation
Chemistry Research Establishment, JAERI
and leader of the JICA Advisory Survey Team,

Mr. Kenzo Yoshida,
team leader of the UTN-JICA Project on Radiation Applications,

Members of the JICA Mission,

Ladies and Gentleman.

First and foremost, I wish to extend to you, Dr. Sato and members of your mission a very warm welcome.

For the information of those of you who are not too familiar with this Project, let me reiterate that the UTN-JICA Project on Radiation Applications which started in 1989 is aimed at exploiting the potential of radiation technology, in particular through the utilization of the Electron Beam Machine (EBM) for industrial development. The Joint Committee Meeting is therefore convened once a year to assess the progress of this Project as well as to set out the plan for the following year's activities. I note that the one and the half days allocated is rather short for an in-depth deliberation. Nevertheless, I presume that the informal discussions between UTN counterparts and the JICA Advisory Survey team held last week would have dealt with some of the matters before us such as outstanding matters raised during the First Joint Committee Meeting.

Ladies and Gentleman,

I am happy to note that several important progress have been made during the 1991 fiscal year. The two EBMs provided to us by JICA have been commissioned after some delay; the 200 kv machine in March 1991 and the 3MV machine in June 1991. Although most of the problems related to the design, construction and operation of the EBM and associated components has to a large extent been resolved, there remain a few areas that warrant further improvement. While UTN would do its utmost to improve existing conditions and in this connection, we have a small group of trained operations personnel to undertake the task, at the same time we hope that JICA would also consider assisting us, where appropriate in this matter.

With respect to the research activities, I am pleased to note that the UTN counterparts have been actively utilizing the two EBMs for their research work. The despatch of JICA's short term experts as scheduled coupled with the presence of the long-term experts have greatly contributed to the smooth implementation of this project. I would like to take this opportunity to thank all experts for their dedication and spirit of co-operation.

I note that there has been a slight change of format in the presentation of papers. If you recall, in the First Joint Committee Meeting, the presentations were on overall progress of the project, but this time, each of the counterparts would be presenting the status of their work. This goes to show that substantive progress has indeed taken place and I look forward to these presentations.

As I mentioned before, we would have about one and half days to deliberate on items in the agenda before us. But with your expertise and wisdom, I am confident that we would complete our task in time.

Before I end my address, let me once again welcome you, Dr. Sato and your mission members and wish you an enjoyable stay in Malaysia.

Appendix 2

Opening Remarks by Director General of
Takasaki Radiation Chemistry Research Establishment, JAERI:

SECOND JOINT COMMITTEE MEETING OF UTN-JICA
RADIATION APPLICATIONS PROJECT

Datuk Dr. Mohd. Ghazali b. Hj. Abd. Rahman, Director General of UTN, Ms. Fatimah bt Mohd. Amin, Deputy Director General of UTN, Dr. Norimah bt Yusof, Director of Research, UTN and Distinguished Members and Participants of the Joint Committee Meeting of UTN-JICA Radiation Applications Project.

It's my great honor and pleasure to participate in this committee meeting. In June, last year, I succeeded the position which Dr. Sueo Machi had assumed until his move to the new position at IAEA. Our establishment understands very well that he was enthusiastic about this cooperation from the very early stages and we regard the cooperation very important. We would like to see its success, just the same.

This project has contributed to the exchange of scientists and engineers of both institutes and to the mutual understanding which is the most important basis of cooperation. By the success of this project, we are convinced that the merits of radiation applicatins will be materialized technically and economically. We will try our best for the implementation of the project towards this goal.

Also, taking this opportunity, I would like to express our appreciation of the hospitality extended to the Japanese members by the Malaysian side.

Thank you for your attention.

Opening remarks for the 2nd Joint Committee Meeting

Datuk Dr. Ghazali, Director General of Nuclear Energy Unit, Dr. Sato, Director General of Takasaki Radiation Chemistry Research Establishment, ladies and gentlemen.

It is a great honour for me to extend my most sincere and heartfelt congratulations on the happy occasion of the opening of the Second Joint Committee Meeting, on behalf of Japanese team of JICA-UTN Radiation Application Project.

The objective of the Project is to establish the technology of radiation applications using electron beam machine at UTN and to enhance the research and development capabilities on radiation processing. 3 MV electron accelerator, donated by JICA for this purpose, commissioned in July, 1991 and we have experienced a half year operation without any troubles. The start of operation delayed 6 months from the original schedule due to unexpected various difficulties, but the condition of the EBM, fortunately, is very good, so I think the delay will be recoverd soon.

In this meeting, the progress and achievment of the Project in 1991 will be introduced from the counterparts. We can easily understand the status of the technology transfer from these presentations and discussions. Then, the work plan in 1992 will be formulated through discussions. The original TSI (Tentative Schedule of Immplementation) will be revised if necessary.

In 1992, we can fully use the two accerelators and many research equipments. A remarkable progress is expected in the sterilization of medical products and the curing of surface coating. In order to assure the progress, the exchanges of experts and trainees will be important as well as the donation of equipments.

Finally, I would like to express my hope that this committee meeting will be succeed to improve the mutual understanding on this Project and further strengthen the friendly relations existing between Japan and Malaysia.

Thank you.

REPORT ON INSTALLATION, COMMISIONING, OPERATION AND MAINTENANCE OF HIGH ENERGY ELECTRON BEAM MACHINE IN 1991

Prepared by: Mr. Mohd Sidek Hj Othman

A INSTALLATION

1 Introduction

The building construction commenced in March 1990 and was expected to be completed by December 1990. However, several circumstances caused it to be delayed up to March 1991.
The EBM installation started on November 15,1990(delayed by a a month) and is planned to be commisioned in February 1991. However, it was delay up to Jun 21,1991 due to several factors which are discussed below.

2 Installation

Installation works were executed by Nuclear Energy Unit(UTN) of Malaysia and Nissin High Voltage Co., Ltd(NHV) of Japan. All works were supervised by NHV. Generally, installation works may be divided into four phases as described below:-

2.1 FIRST PHASE -- Mechanical & Electrical- 37days (Nov 15 - Dis 21,1990)

Nissin's Experts: Mr. Takayama and Mr. Moriwaki

a) Unpacking and checklist.
b) Sorting and carrying equipments to their repective places.
c) Equipments positioning such as high frequency inverter, compensating reactor blowers, etc.
d) Installation of power supply tank, Cockroft Walton circuit, accelerator tube, etc.
e) Conveyor system.
f) Plumbing works.

2.2 SECOND PHASE -- Mechanical & Electrical- 31days (Dis 22,1990 - Jan 21,1991)

Nissin's Experts: none

a) Installation of safety boxes, limit switches and other safety features.
b) Plumbing works.
c) Wiring works.
d) Installation of EBM switchgear.

2.3 THIRD PHASE -- Mechanical, Electrical & Testing- 82days
(Jan 22- April 13,1991)

Nissin's Expert: Mr. Mikihara
a) Conveyor system.
b) Wiring works and inspection.
c) Plumbing works.
d) Inspection of tanks.
e) SF6 gas charging.
f) Voltage conditioning.
g) Beam alignment.
h) Beam conditioning.

2.4 FOURTH PHASE -- Mechanical, Electrical & Testing- 33days
(May 20- June 21,1991)

Nissin's Experts: Mr. Kawishagi and Mr. Mikihara
Conveyor's Expert: Mr. Kawata
a) Modification of EBM switchgear.
b) Modification of conveyor system.
c) Voltage and beam conditioning.
d) Depth dose and beam uniformity check.
e) Acceptance test.
f) Training.

*** The installation schedule is as shown in figure in attachment 2(a),2(b),2(c),2(d) and 2(e)

3 Teething problems

* Communication breakdown.
* No demarcation of responsibility.
* Construction.
  - Tight schedule.
  - Bad weather.
  - Variation orders.
    Electrical works.
    Plumbing works.
  - Nominated sub-contractor(NSC) slow response.
* Installation.
  - Accelerator tank.(such as anchor bolt holes too small)
  - Welding set requirement.
  - Incorrect positioning of HF transformers.
  - Additional plumbing works.
    . mismatched flanges.
    . insufficient fittings.
  - oil leakage from HF transformer
  - EBM switchgear does not meet local standard.
  - NHV schedules everchanging.
  - Additional shield ring required for resistor and rectifier at stage 4 and 5 of Cockroft Walton circuit.
  - Power failure caused a loss in vacuuming of accelerator tube.

- Fuses and transistors burn out in scanner power supply.
- SF6 leakage from accelerator tank.
- High noise level.
- Cooling water system.(small pipe size,etc)
- Change of 3.7kW conveyor inverter to 7.5kW conveyor inverter.
- Change of roller chain to roller chain bearing.(conveyor system)
- Tightening of filament cover to stop a small vacuum leak.
- etc.

4 Suggestions to problems

Communication.
- Better command of English.

Variation orders.
- Early work specification from NHV so as to give an ample time for NSC to prepare and finish the works.
- NSC should respond faster and provide additional workers to cater additional works.

Planning.
- Better planning to avoid problems such as anchor bolt hole too small, incorrect positioning of HF transformer, additional shield ring and so forth.

5 Delay

Originally , the machine was supposed to be commisioned by the end of February 1991. However, the actual commisioning was done on June 21,1991. Four months delay was due to both parties, UTN and NHV. Construction schedules were behind time, bad weather and NSC slow response on variation orders were among the factors.
Installation problems such as scanner power supply failure, SF6 leakage from accelerator tank, conveyor operation problems and so forth had consumed some amount of time.
Two breaks between Dec 22,1990 to Jan 21,1991(31days) and April 14,1991 to May 19.1991(26days) also contributed to the delay.

6 Conclusion

This is the first EBM installation in Malaysia. The experience is shared by both the government(UTN) and the private sectors. Although this project finally was completed four months behind schedule, all participating parties, Malaysians and Japanese have given their best to meet the target.

B COMMISSIONING

1. Confirmation of components and the number of accessories, service tools and spare parts. -- okay

2. Interlock test. -- okay

3. Running Test

a)Continous operation test
3MV 30mA for 4hrs(Max operation) Result: okay *
3MV 1mA for 4hrs(UTN decision) Result: okay *

b)Voltage and current stability test
0.5MV 10mA for 1hr Result: okay *
3.0MV 30mA for 1hr Result: okay *
2.5MV 30mA for 1hr Result: okay *
2.0MV 30mA for 1hr Result: okay *
1.5MV 30mA for 1hr Result: okay *
1.0MV 30mA for 1hr Result: okay *
2.0MV 1mA for 10min Result: okay *
2.0MV 0.1mA for 10min Result: okay *
0.5MV 1mA for 10min Result: okay *
For 1hr test, the beam current was increased by 5mA(from 0-30mA) for every 1 or 2min. When it reaches 30mA, the test was run for 1hr. Of course, the pre-beam and pre-voltage conditioning was done before the above stability test.
Results: okay * -- acc voltage +- 2%
beam current +-2%(1-30mA)
+-10%(0.1-1mA)

c)Ramp up and down time for acc voltage and beam current at 3MV 30mA
current ramp up : 30sec(0--30mA) Result: okay
voltage ramp up : 120sec(0--3MV) Result: okay

4. Beam profile check is to allign the beam scan and beam spot
Photosensitive paper was used. Scan width: 120cm,60cm,30cm
3.0MV,2.5MV,2.0MV,1.5MV,1.0MV,0.75MV and 0.5MV
Results: okay

5. Surface dose distribution
CTA film was used.Scan width:120cm(in Y-direction along scanner chamber)
3.0MV,2.5MV,2.0MV,1.5MV,1.0MV and 0.5MV
Results: okay(+-5%)

6. Depth dose curve
   CTA film was used.
   3.ØMV,2.5MV,2.ØMV,1.5MV,1.ØMV and Ø.5MV
   Results: okay

7. Conveyor system
   speed and smoothness of movement   Result: okay

8. Accessories
   Ozone monitor - functioning well
   Radiation monitor - functioning well
   ITV - functioning well

The machine was officially commisioned on June 21,1991.

Please refer to the test report submitted by NISSIN for further information.

C OPERATION

		July 31,91	Jan 6,92
1 High voltage generating hours	:	275.2H	387.3H
Irradiation hours	:	160.3H	222.5H

2 Users

2.1 Mr. Yoshida -- Electron Beam Characteristics
- using Electron Beam Intensity

2.2 Ms. Noriah Md Ali -- Dose measurements
- for all irradiation conditions) JICA Expert: Mr. Haruyama

2.3 Dr. Zaharah Abd Kadir -- Medical sterilisation
- surgical gloves only) JICA Expert: Mr. Tachibana
- packaging materials only
- surgical gloves with packaging materials
- suture and needle caps
- PP samples

2.4 Mrs. Asnah Hasan
- Effect of electron beam on bacteria(spores)) JICA Expert: Dr. Watanabe

2.5 Mr. Mohd Lebai Juri
- Effect of electron beam on bacteria (palm oil sludge)

2.6 Mr. Zulkifli Ghazali -- Crosslinking of cable
- PVC and PE samples

2.7 Mr. Watanuki
- Safety and interlocks check) JICA safety expert

2.8 Dr Zaharah Abd Kadir
- Perspex(gifts)

D MAINTENANCE

1 Maintenance works carried out in 1991.

1.1 Changing of the pulley and belting of exhaust blower
- to reduce noise level

1.2 Bypassing of the purge blower
- to reduce noise level

1.3 Dismantling of a portion of the exhaust duct inside irradiation room
- to reduce noise level

1.4 Rewiring of the irradiation timer
- to rectify incorrect reading

1.5 Bypassing of the flow relay for SF6 cooling system
- to rectify false alarm and interlock

1.6 Leveling of the cooling plate and the floor finish
- to ensure smooth movement of the conveyor system

2 Maintenance works planned for 1992 (apart from the yearly schedule maintenance)

2.1 Column current
- After shorting rod operation, sometimes the column current reading was not indicated at DPM. Suspected to be improper contact of the shorting rod inside DCPS tank.

2.3 Conveyor indicator
- shows incorrect reading. Broken capacitor/component at DPM pcb is suspected.

2.3 Ozone monitor
- Indicates false reading. Possibly needs calibration.

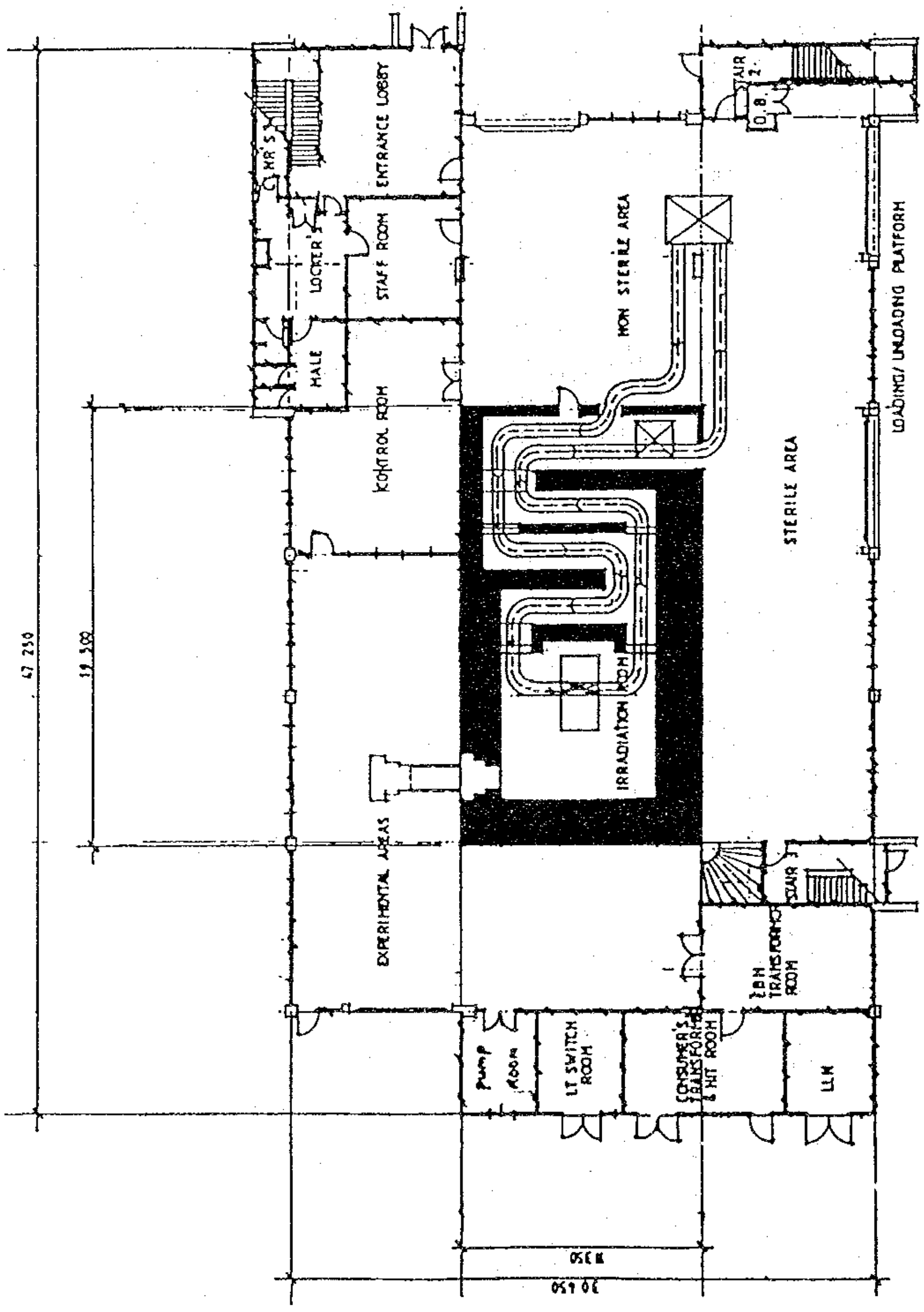
2.4 CTA dosimeter
- Gives a different reading from UV spectrometer. Possibly needs calibration.

2.5 Entrance to the conveyor system
- The present fire resistant wooden door to be replaced with a steel door.

2.6 Sound level
- Follow-up actions to reduce the noise level.

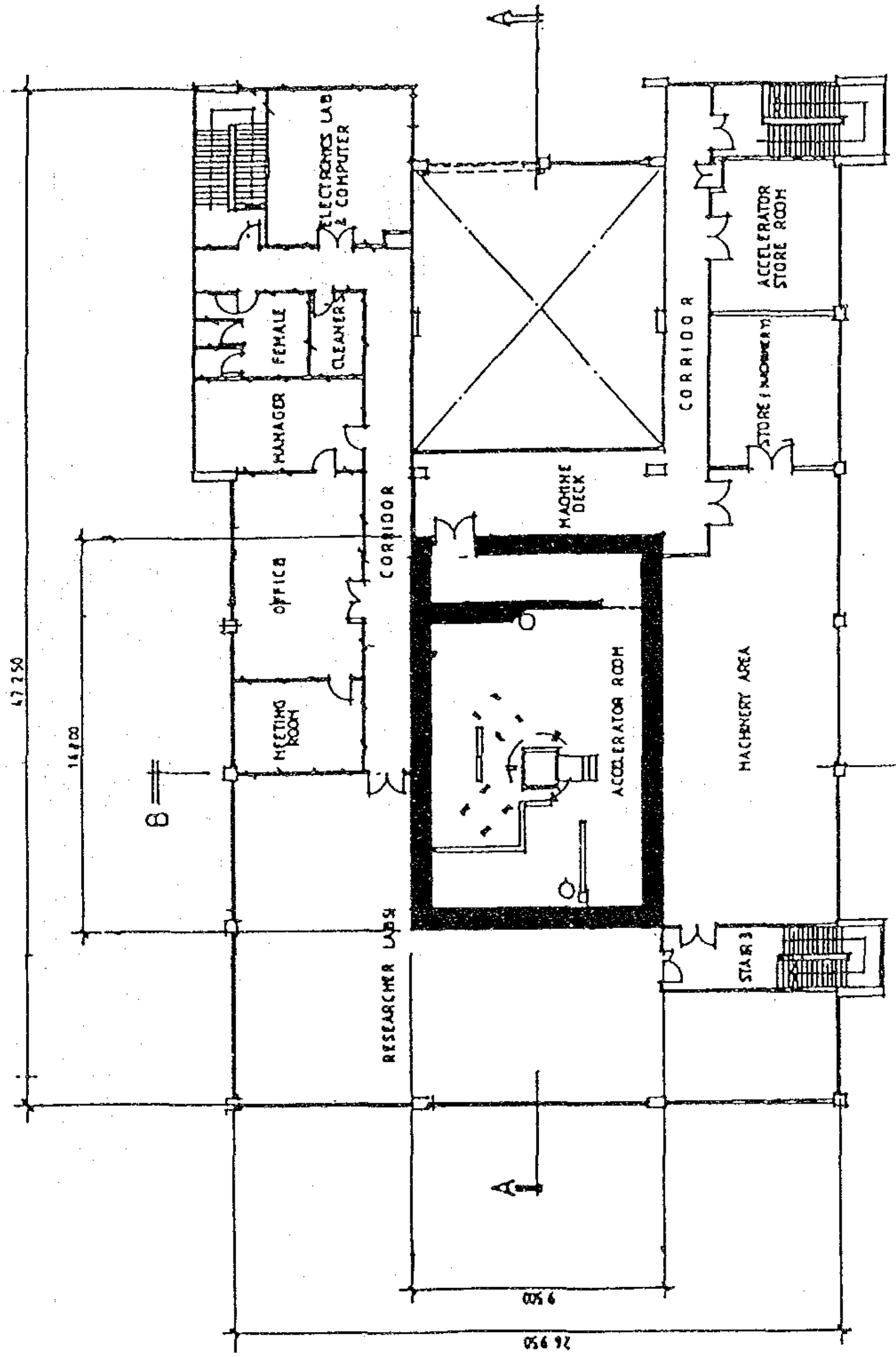
2.7 Safety system
- The accelerator status indicator gives a misleading signal. Proper actions will be taken.

ATTACHMENT 1(a)



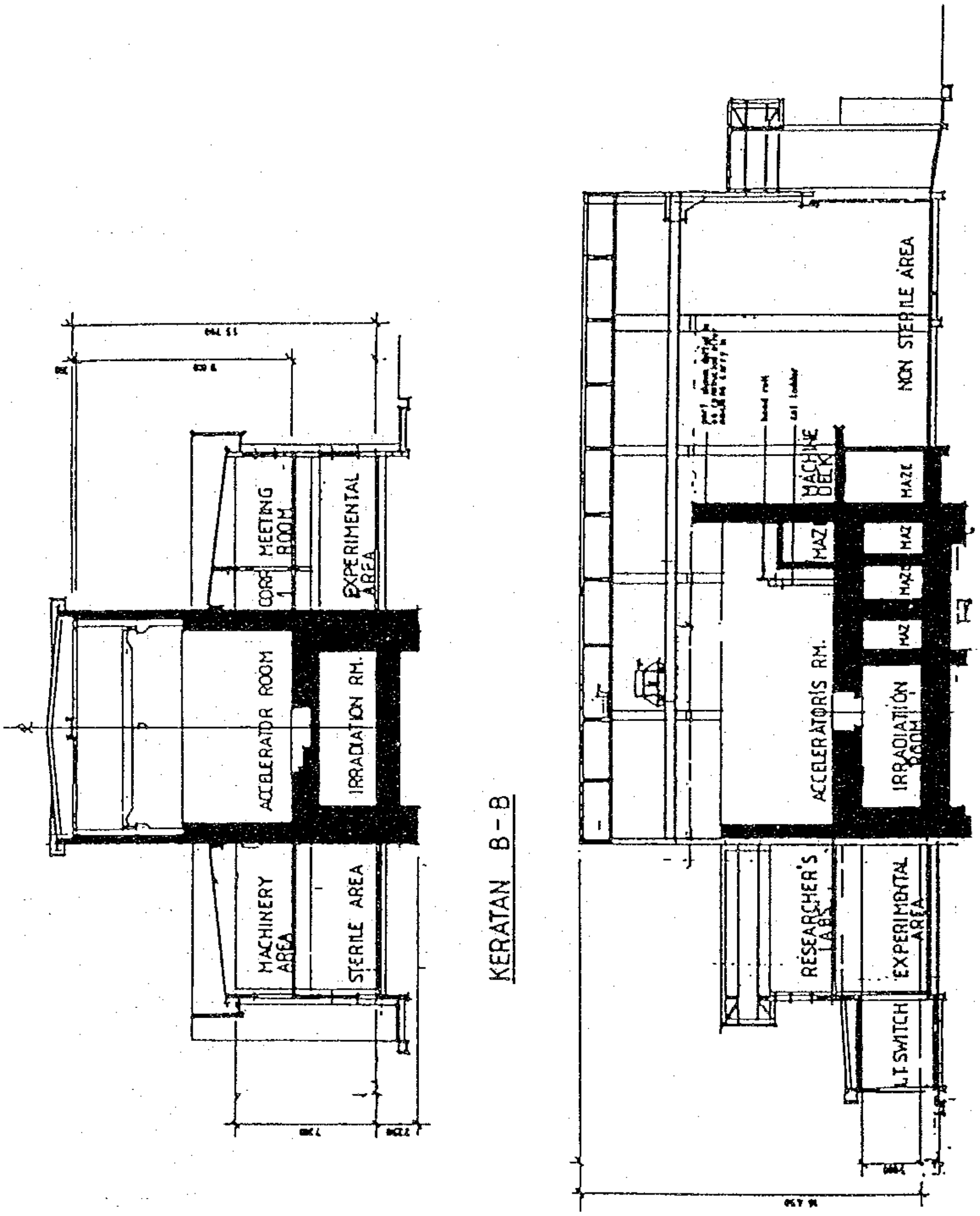
GROUND FLOOR PLAN

ATTACHMENT 1(b)



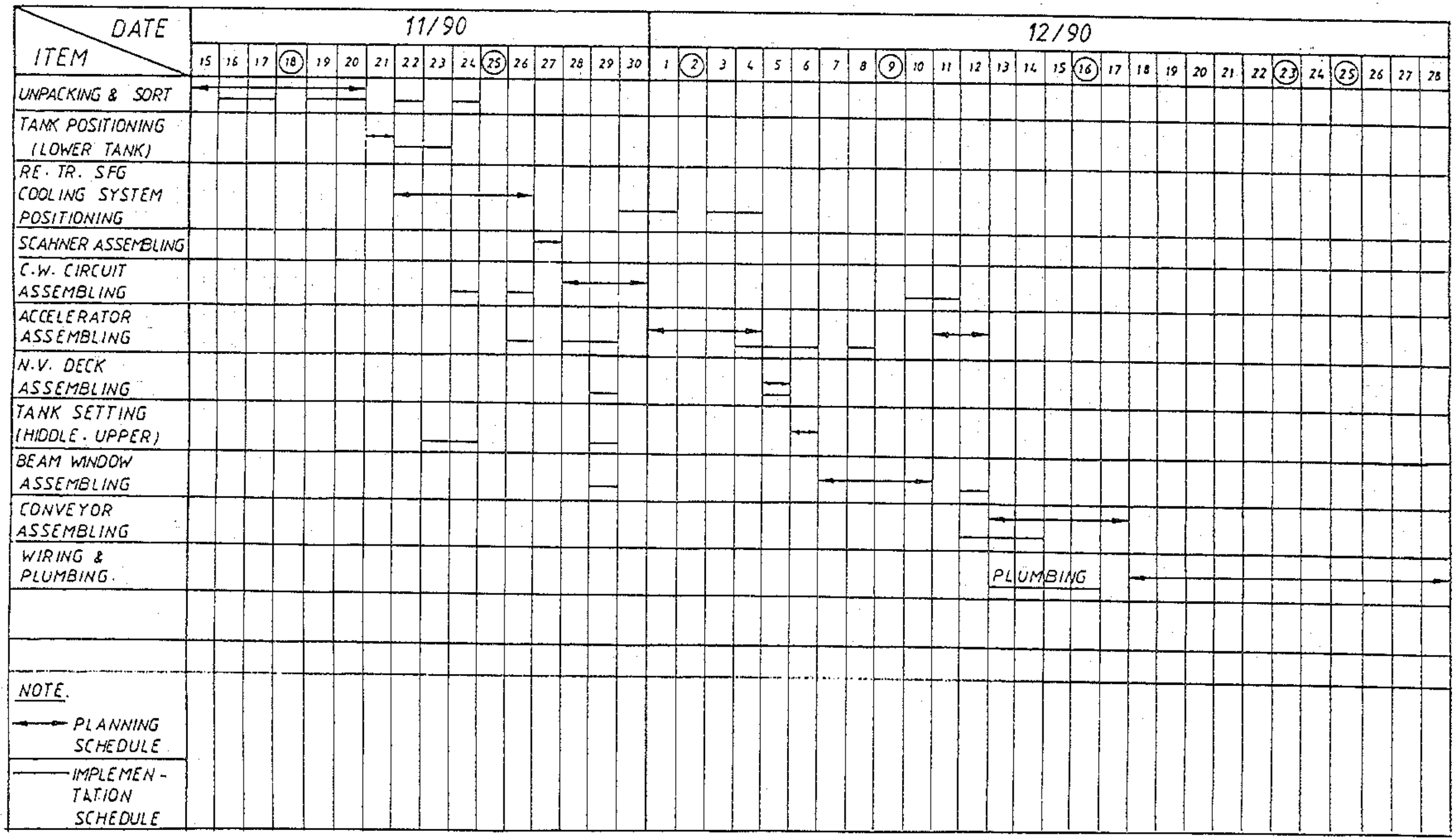
FIRST FLOOR PLAN

ATTACHMENT 1(c)



1/5

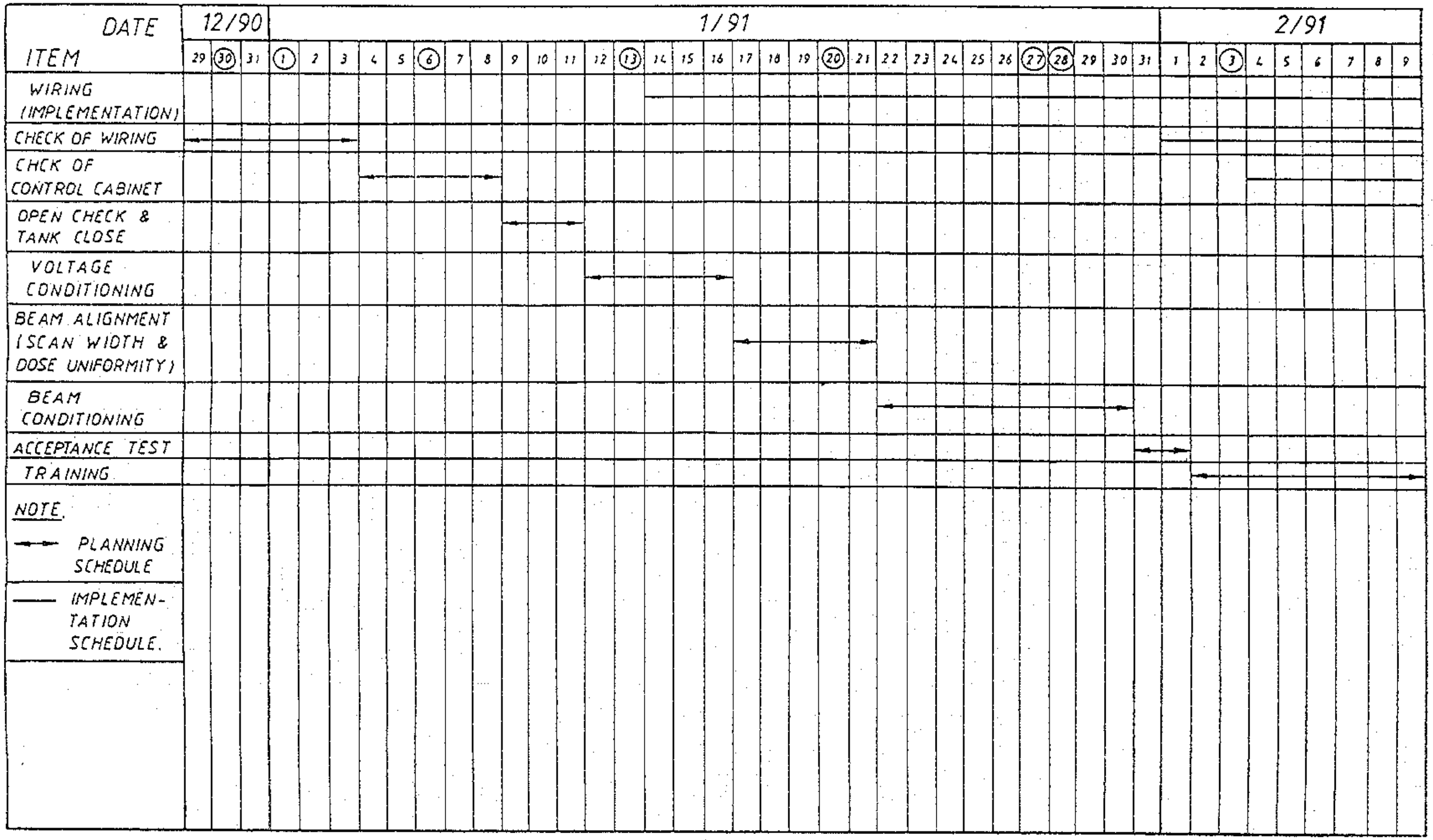
SCHEDULE FOR INSTALLATION AT SITE



ATTACHMENT 2(b)

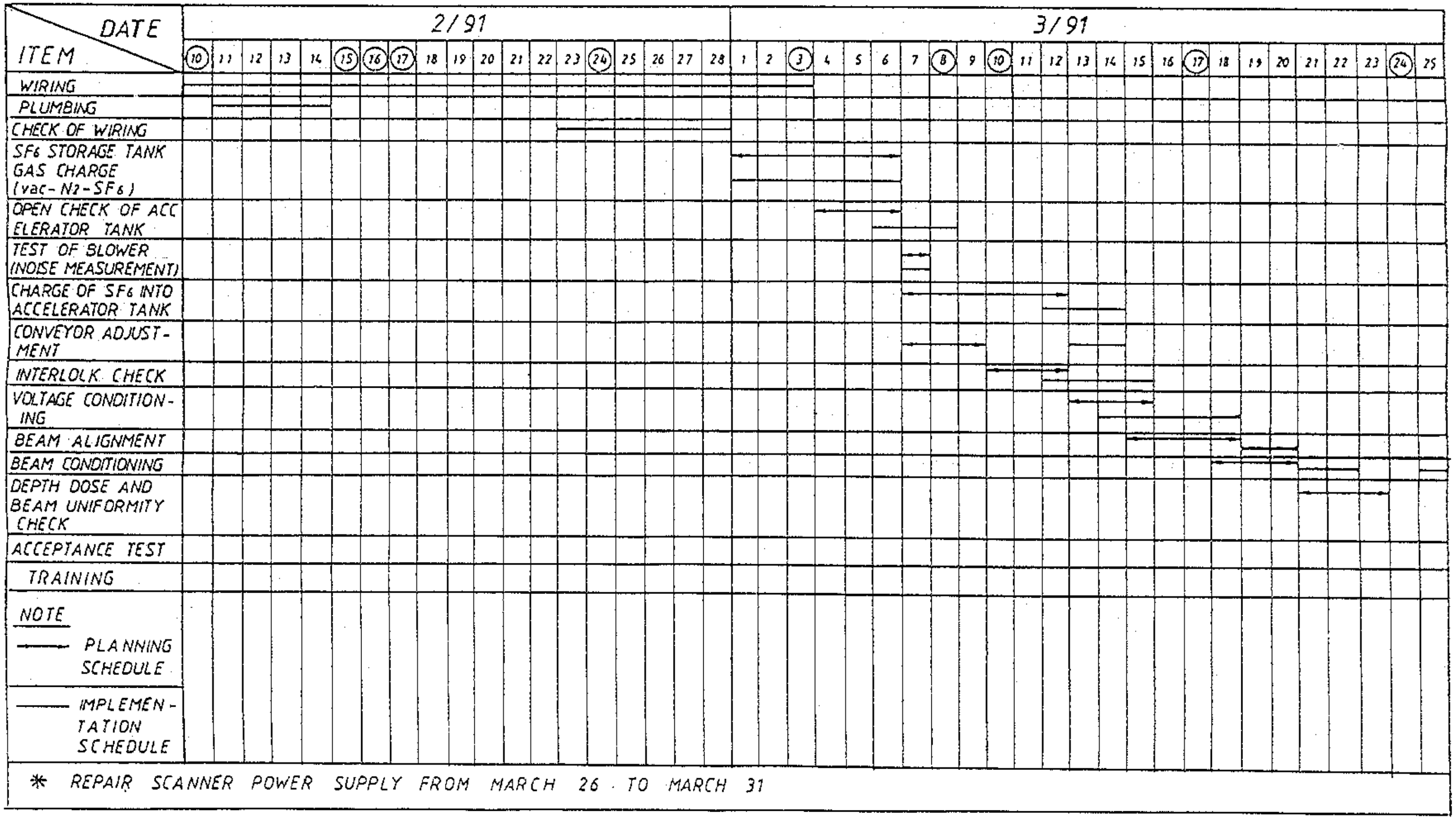
2/5

SCHEDULE FOR INSTALLATION AT SITE



ATTACHMENT 2(c)

SCHEDULE FOR INSTALLATION AT SITE (1st REVISION)



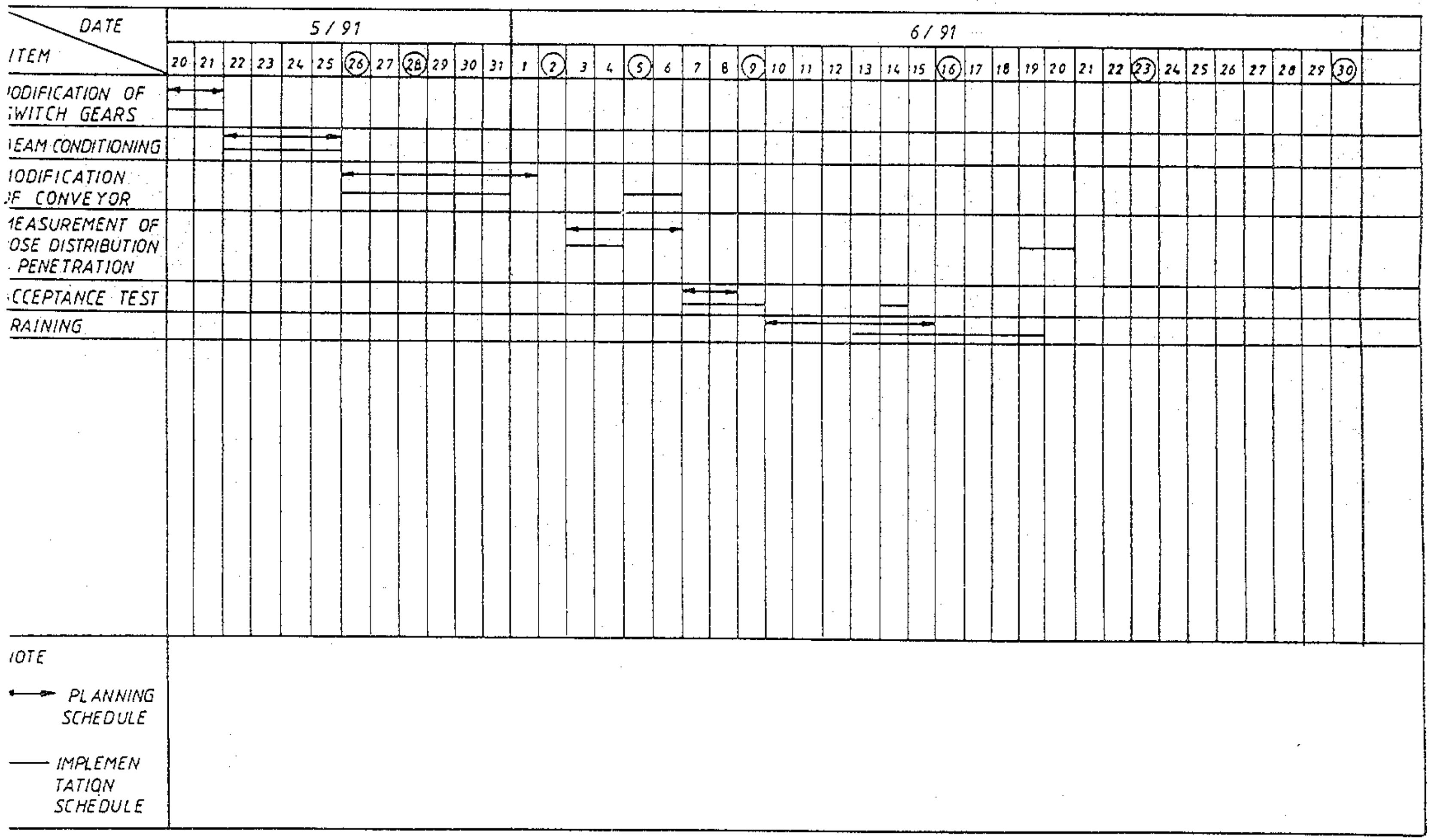
SCHEDULE FOR INSTALLATION AT SITE (2nd REVISION)

ITEM \ DATE	4/91 1	(2)	3	4	5	6	(7)	8	9	10	11	12	13	(14)	(15)	(16)	17	18	19	20	(21)	22	23	24	25	26	27	(28)	29	30
ACCELERATOR TANK FLANGE POLISHING																														
ACCELERATOR TANK ASSEMBLING																														
EVACUATION OF ACCELERATOR TANK																														
CHARGE OF SF INTO ACCELERATOR TANK																														
VOLTAGE CONDITIONING																														
BEAM ALIGNMENT TEST																														
BEAM CONDITIONING																														
CONVEYOR TEST																														
DEPTH DOSE AND BEAM UNIFORMITY CHECK																														
ACCEPTANCE TEST																														
TRAINING																														
VACATION PERIOD															UTN (HARI RAYA HOLIDAYS)													HHV		

NOTA
- —●—● PLANNING SCHEDULE
- ——— IMPLEMENTATION SCHEDULE

5/5

SCHEDULE FOR INSTALLATION AT SITE (3rd REVISION)



DOSIMETRY FOR ELECTRON BEAM MACHINE

Noriah Bt Mod Ali,
SSDL, NEU

*UTN-JICA Joint Committee Meeting for the Radiation Application Project, UTN,
13-15th January 1992.

1. INTRODUCTION

Reliable mastering of the industrial electron irradiation processes is based on the precise knowledge of the characteristic of the irradiation field and the dose absorbed in the product to be irradiated. These parameters are determined mainly using a reliable dosimetry system, used to provide an important starting point for the utilization of the electron beam facilities, by measuring the relation between absorbed dose and the key parameters.

A thorough dose measurement had been carried out by the Secondary Standard Dosimetry Laboratory (SSDL) upon the installation of two electron beam machine, EPS-300 (0.5 MeV to 3 MeV) and EBC-200-AAC (150 keV to 200 keV) at UTN. The SSDL-NEU, which had acquired the status of national standard laboratory, is responsible for maintaining good and reliable dose measurements throughout the country. The role of the SSDL is shown in simplified form in Fig.1.

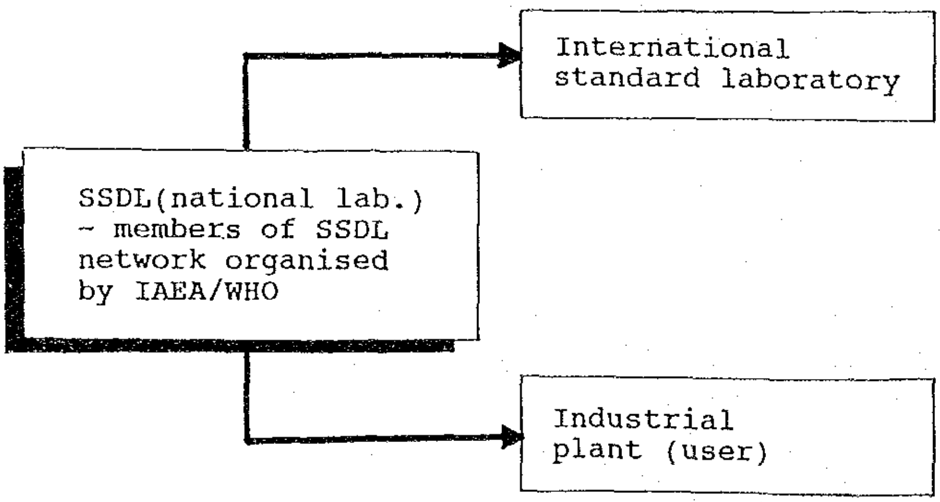


FIG.1. A schematic representation of SSDL-NEU's role as a national standard laboratory in the country.

The information and results obtained play an important role in order to characterize the irradiation facility with regards to the capability to process within the manufacturer's specification. It will also be served as a baseline for the establishment of a good irradiation process with electron beam facilities at UTN.

Radiation process/sterilization can only be carried after the facilities are well characterized. It means that the facility is able to deliver a given dose to the product or sample, and that the parameters that are essential to maintain a given dose are known and can be reproduced within specific limits.

2. STATUS OF DOSIMETRY WORKS

2.1 Dosimeter system:

Dose measurements were performed using several types of film dosimeters that are available at NEU. Presently, we use film dosimeters i.e *Cellulose triacetate(CTA)*, *Radiochromic dye(RCD)* and *Blue cellophane(BC)* as routine dosimeters. Due to their thickness, *RCD* and *BC* are most suitable to measure depth dose for electron with energy below 300 keV. While CTA film dosimeter is used for energy above 500 keV. CTA film dosimeter is also suitable for measuring the beam profile for both EPS and EBC. Electron current densitymeter (developed by JAERI) is used as standard method to measure the beam current density for energy above 0.5 MeV.

TABLE 1. FILM DOSIMETRY SYSTEM AVAILABLE AT NEU

[1] CTA	:	Thickness	~ 125 μm
		Dose range	~ 10 - 160 kGy
[2] RCD	:	Thickness	~ 50 μm
		Dose range	~ 2 - 100 kGy
[3] BC	:	Thickness	~ 25 μm
		Dose range	~ 10 - 100 kGy

Since film dosimeter is sensitive to environmental conditions (i.e light, humidity and temperature) especially for BC and RCD, special precautions had been established in dealing with these dosimeters. All of the film dosimeters were stored in a dessicator and handled in air-conditioned rooms.

2.2 Beam Characterization:

The characterization of a radiation field was done in x, y and z axis of the electron beam. This gives detailed information about the beam and the depth dose profiles, which are known as the output characteristic of the electron machine.

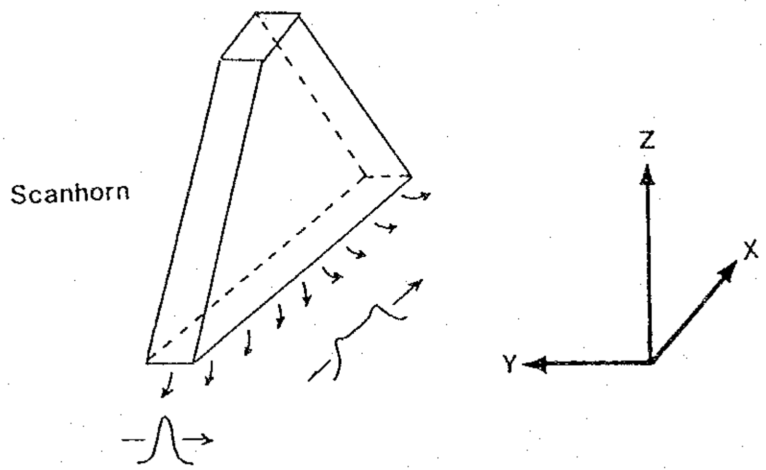


FIG.2. Three dimesional coordinate system characterizing the radiation field of the electron beam machine

Measurement of beam profiles (x-axis) was performed by using a long strip of CTA film dosimeter positioned along the beam window. From the beam profile, a *beam width* can be determined. It can be used to guide the dimension (i.e length) of the product along the beam window, in order to maintain a homogenous irradiation dose.

The electron distribution in y-axis gives a Gaussian shape , and was determined using an electron current density meter. The distribution enables quantification of the radiation beam such as electron current density, electron charge fluence etc. necessary in radiation processing. The shape of this Gaussian distribution depends on the electron energy and on the distance,z from the window to the irradiation plane.

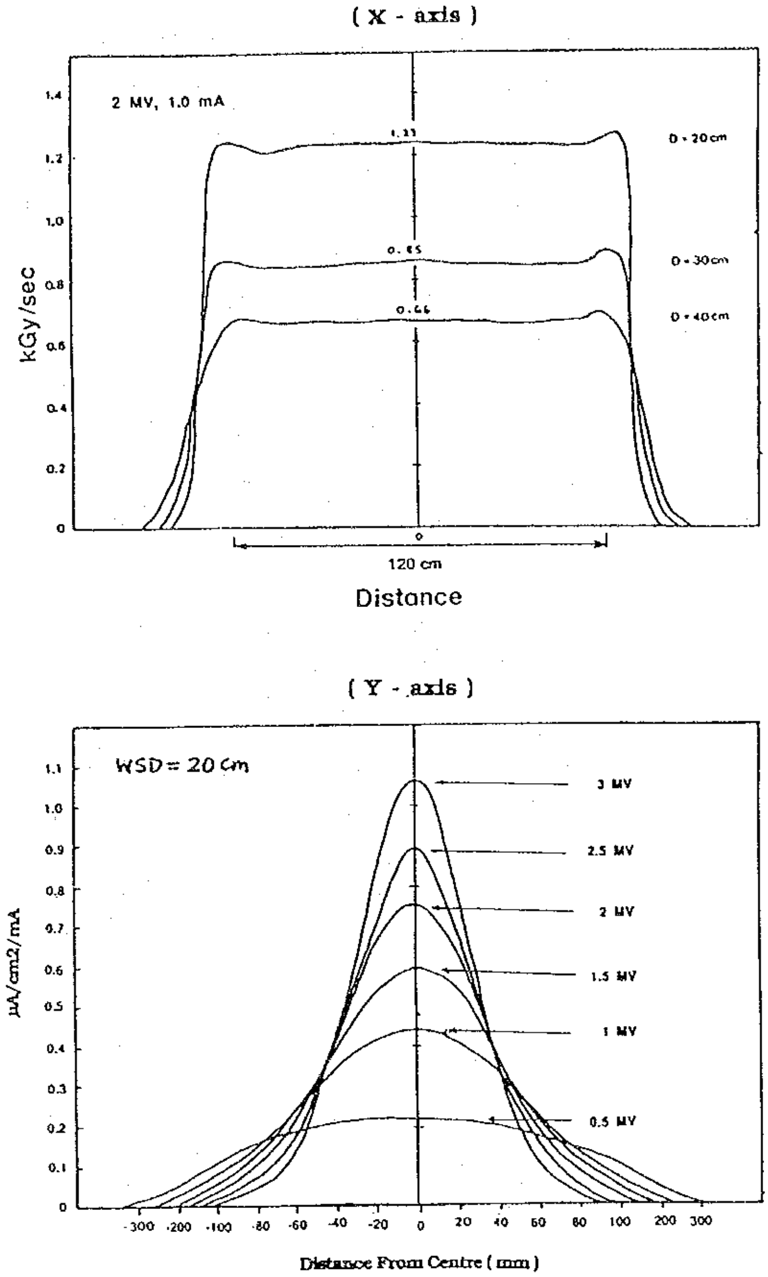


FIG.3. Dose rate and electron current density distribution along x and y-axis, EPS-300

TABLE II. BEAM WIDTH FOR EBC AND EPS

[1]	EBC-200-AAC: 150 - 200 keV Beam width : 15cm Uniformity= ± 10%
[2]	EPS-300 : 0.5 - 3.0 MeV Beam width : 120cm Uniformity : ± 5 %

To plan for an effective radiation process, a depth dose distribution need to be established. It has been identified for all electron energy and at various distance from the beam window. The depth dose distribution was checked using a pile of film dosimeters, arranged in a special holder made from polymethyl methacrylate. The amount of the film dosimeters used will depend on the energy of electron involved. A useful range parameter is determined from these distribution i.e effective range (R_e), maximum range (R_{max}) and peak range (R_p). An irradiation parameter was derived from this parameter in order to minimise overdoses and maximise the beam penetration capability.

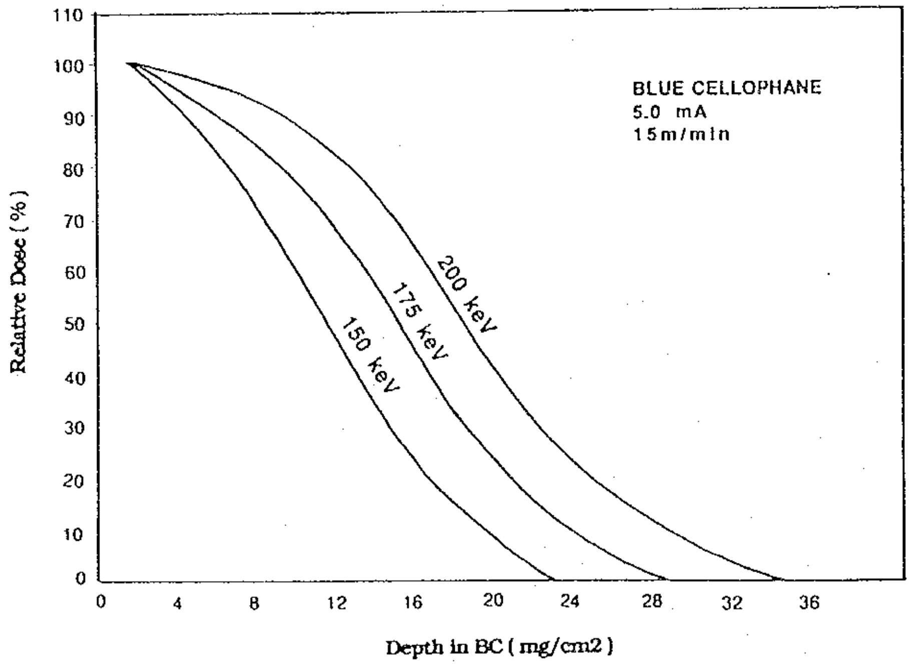


FIG.4. Depth dose profile for EBC-200-AAC, using Blue cellophane

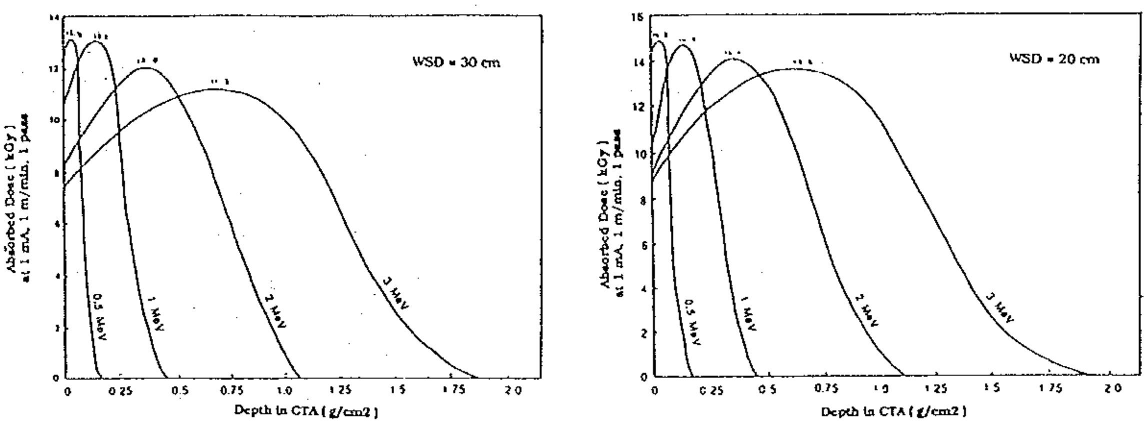


FIG.5. Depth dose profile at 20 and 30cm, EPS-300

These information will provide satisfactory documentation relating to the absorbed dose and physical parameters, to carry out irradiation processes within specifications. For an electron beam facility, the dose depends on several machine parameters such as the electron energy, beam current, scan width and conveyor speed. Under conditions of constant energy, beam geometry and beam current, the dose is inversely related to conveyor speed, or if the conveyor speed is held constant, the dose is proportional to the beam current. The measurement procedure will be repeated at regular intervals, or whenever changes to the irradiation facility are made which may influence the dose or dose distribution.

TABLE III. EBC-200-AAC CHARACTERISTICS

keV	Dose factor,k
150	77.3
175	93.8
200	97.8

* D = k. I/V

TABLE IV. EPS-300 CHARACTERISTICS

[1] WSD=20cm

	MeV					
	0.5	1.0	1.5	2.0	2.5	3.0
Re-CTA (g/cm^2)						
M:	0.04	0.28	0.47	0.69	0.91	1.28
S:	0.09	0.27	0.48	0.70	0.91	1.20
V(m/min),						
Re= 10 kGy	1.47	1.27	1.20	1.18	1.16	1.13
Su= 10 kGy	1.45	1.07	0.96	0.94	0.91	0.90
(1mA)						
D(kGy/s)						
Re:	0.78	1.21	1.45	1.59	1.92	2.82
Su:	0.66	0.93	1.10	1.22	1.54	2.26
FWHM (cm)	18	14	11.0	8.6	6.9	6.6
Peak* (μA/cm2)	0.22	0.45	0.63	0.76	0.91	1.06
n* (μC/cm2)	5.41	6.85	7.35	7.41	7.50	7.60

[2] WSD=30cm

	MeV					
	0.5	1.0	1.5	2.0	2.5	3.0
Re-CTA (g/cm^2)						
M:	0.04	0.23	0.45	0.68	0.92	1.18
S:	0.07	0.27	0.49	0.73	0.94	1.21
V(m/min),						
Re= 10 kGy	1.32	1.20	1.07	1.03	1.00	0.94
Su= 10 kGy	1.27	1.09	0.93	0.85	0.80	0.75
(1mA)						
D(kGy/s)						
Re:	0.51	0.76	0.81	1.08	1.14	1.48
Su:	0.46	0.59	0.61	0.82	0.89	1.17
FWHM (cm)	34	18.6	14.6	12	10.9	7.0
Peak* (μA/cm2)	0.16	0.28	0.39	0.50	0.60	0.7
n* (μC/cm2)	5.41	6.47	6.6	6.83	6.95	7.03

* at 1 mA

3. FURTHER WORK

The task of SSDL-NEU is not only concentrated on the dose measurements, but is also responsible to improve the dosimetry system for making their standard transferable to user through its calibration service. The existing system should also be maintain and be traceable to the International standard. Therefore, further work will be considered in the future to increase confidence in the accuracy of our dosimetry system.

Such work are:

{a} Setting up of the technique for standardization and calibration of the routine dosimeters;

{b} Establish a procedure to maintain a good dosimetry system;

{c} Development of the standard dosimeter system for dose measurement in the use of electron beam i.e calorimeter etc.;and

{d} Participating in the intercomparison programme with reputable institutes i.e NPL, RISO , JAERI etc.

4.CONCLUSION

Dosimetry plays an important role in developing and controlling electron irradiation process. It will ensure that radiation treatment required for the process is correctly applied. For processes related to public health and safety, dosimetric control has implications for regulatory acceptance of irradiated products while in other radiation processes, it is used to confirm the reliablity of the process and the irradiated product.

Appendix :

JICA EXPERTS ON DOSIMETRY FOR EBM :-

(1) Mr. Hiroyuki Tachibana,
23 rd January - 2 nd March, 1991

(2) Mr. Yasuyuki Haruyama,
21 st August - 18 th September, 1991

Appendix 6

EVALUATION OF SAFETY FOR ELECTRON BEAM FACILITIES

1. INTRODUCTION

Radiation processing using electron beam is becoming increasingly popular in the developing countries for improving product quality to ensure its acceptance in the very competitive world markets. Malaysia has for this purpose acquired an electron processing system through bilateral agreement with the Japanese government under the Japan International Cooperation Agency technical cooperation programme. It is located at the Unit Tenaga Nuklear Jalan Dengkil branch. Unit Tenaga Nuklear is the organization responsible for coordinating researches in the field of radiation processing using electron beam. This machine is the first of its kind in Malaysia if not in the South East Asia region. Hence Malaysia can lead this region and share its experiences in the use of this technology for the benefit of the region.

Unit Tenaga Nuklear's policy regarding the establishment of such facility especially when radiation is generated is to ensure its existent and usage will not harm the workers, public and the environment for compliance to the national regulations. Since this specific technology is new for Malaysia, much of the safety requirements had been seek from our expert counterparts and safety documents available from the international organization involving in this field together with our limited experiences.

This paper presents the safety status of the electron beam facility, the ongoing works and also works that will be done in achieving the safety standard laid down by the Malaysian Law.

2. SAFETY STANDARDS

Electron beam processing system presents several known hazards during its operation namely:

a. radiation
b. ozone, noxious and other toxic gases
c. incidental hazard (noise etc.)

The radiation hazard resulted from the generation of X-rays is the utmost important hazard to be given primary attention in safety considerations. Nevertheless safety considerations of other hazards should also be carried out to ensure their present will not significantly increase the health risks to the personnel involved.

2.1 Radiation Protection Standard

For the purpose of radiation protection, UTN follows the Malaysian Atomic Energy Licensing Act (Act 304) and all other regulations and guidelines produced under this act. The Health and Radiation Control Department has the responsibility to carry out all radiation protection activities for Unit Tenaga Nuklear.

2.2 Ozone and other Noxious Gas Protection Standards

At present Unit Tenaga Nuklear has no protection standard for ozone and other noxious gases. Nevertheless for the purpose of ensuring the safety of personnel, the public and environment, the TLV for Chemical Substances in the Work Environment adopted by ACGIH with Intended Change 1988-1989 protection level of 0.1 ppm is being used for protection against ozone. As for other gases their formation are not as significant compare to ozone gas and will not be considered here.

2.3 Noise Protection Standard

In Malaysia the only noise protection standard available is for the working condition in factories set by the Factory and Machinery Department. The noise permissible level is set at a maximum of 80 dB and as prescribed by the PUSPATI Safety Committee as necessary.

3. SAFETY STATUS

3.1 Radiation Protection

<u>3.1.1 Design Concept</u>

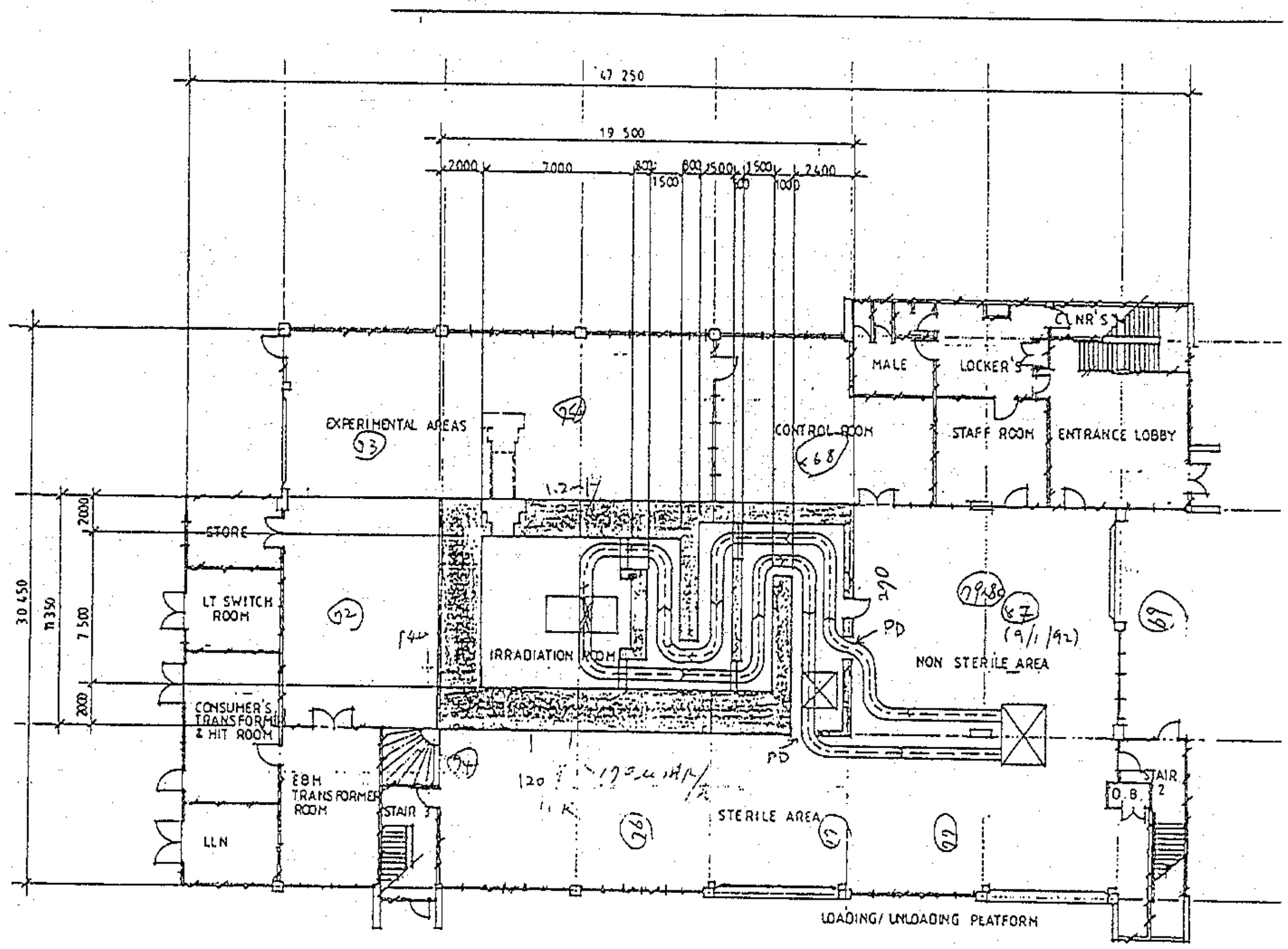
The electron beam facility is designed in such a way that its operation will not present serious radiation hazard to the workers in the building where the machine is housed. Emphasis is given to engineered safety to minimize the need of personnel control and administrative procedures. Therefore the thickness of the shielding of the irradiation and accelerator room is as shown in figure 1.[5,2] With this requirements the classification of the working areas are as will be described in this section below.

The building consist of two floors, ground floor and first floor. The ground floor contains the following rooms/areas;

a. irradiation room

b. rooms/areas bordering the irradiation room
   i. non-sterile area
   ii. sterile area
   iii. experimental areas
   iv. control room

c. rooms/areas which do not border the irradiation room
   i. staff rooms
   ii. transfer room
   iii. LT switch room
   iv. store
   v. toilet and changing room



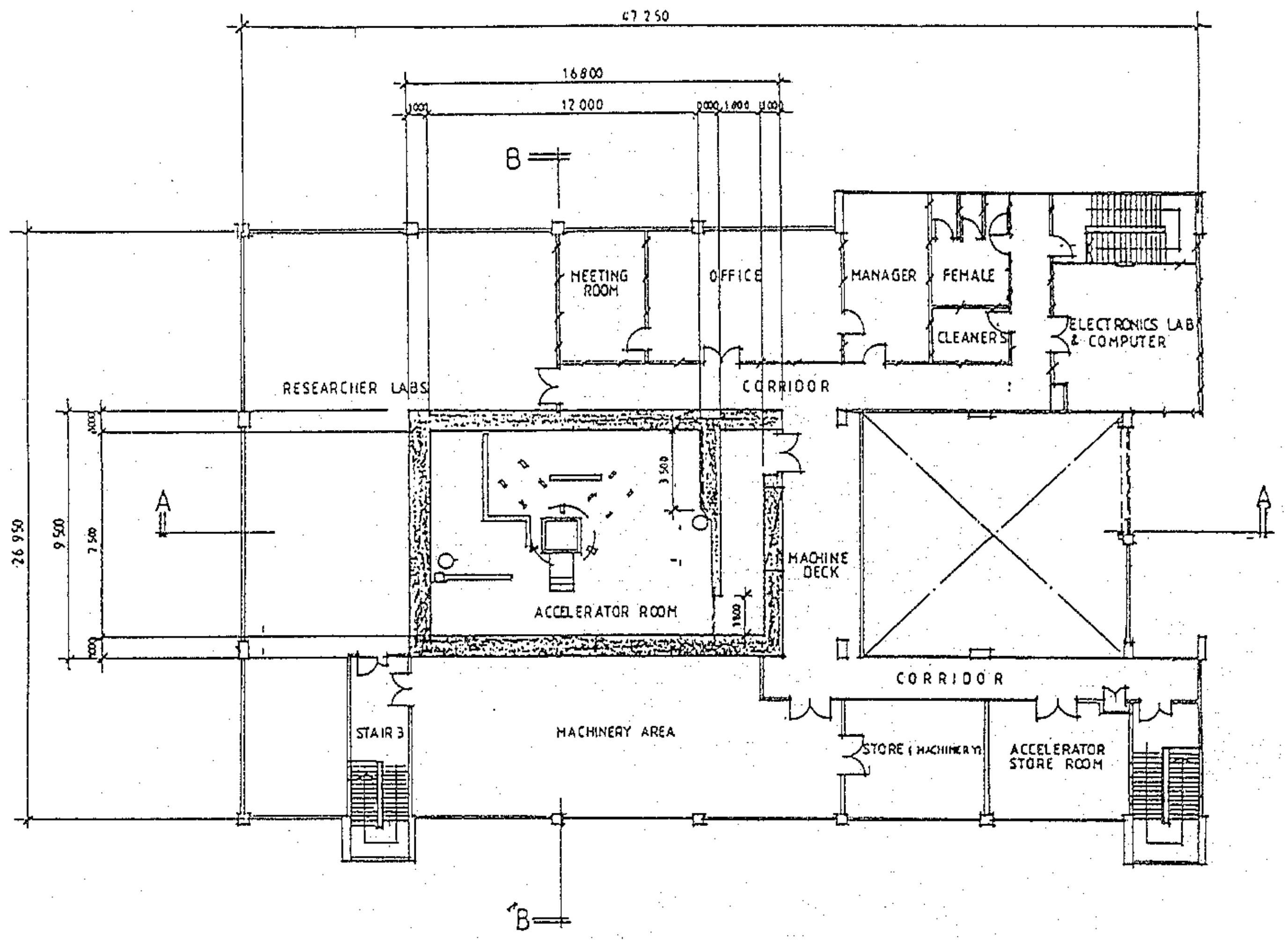
GROUND FLOOR PLAN

Figure 1. Shielding of EBM

Legend:

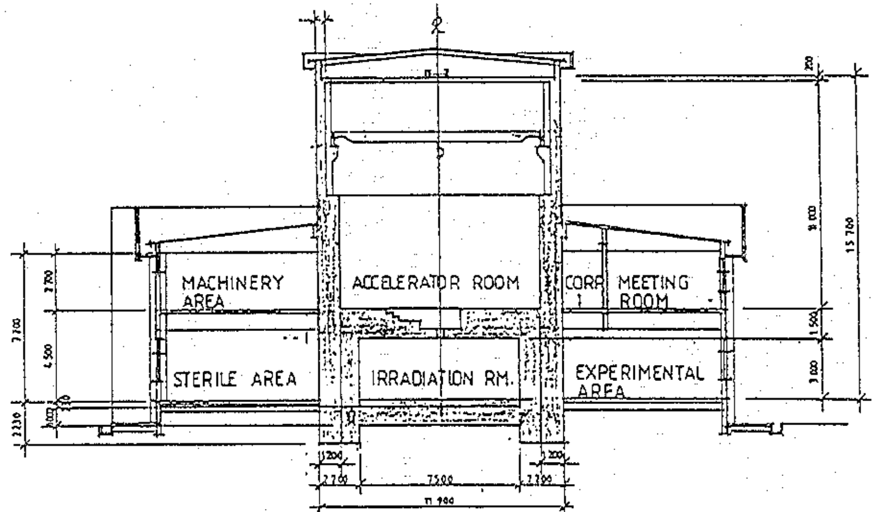
(79) Noise level (Aug 91)

PD Photodetector



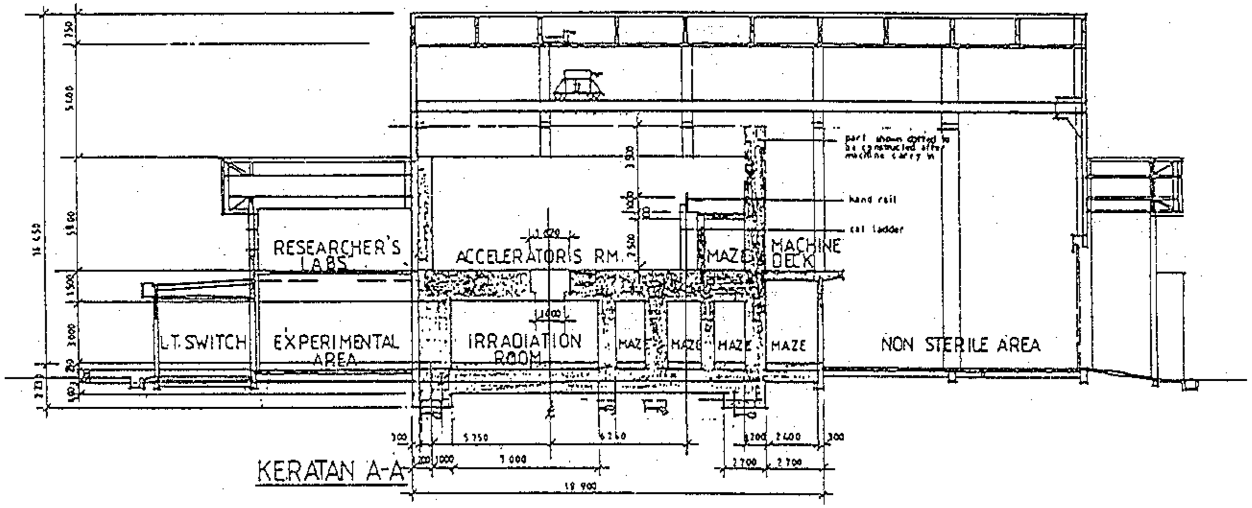
FIRST FLOOR PLAN

Figure 2a. Shielding for EBM.



KERATAN B-B

Figure 2b. Shielding for EBM



KERATAN A-A

The first floor on the other hand contains the following rooms/areas

a. accelerator room

b. rooms/areas bordering the accelerator room
   i. machinery area
   ii. experimental areas
   iii. corridor
   iv. machine deck

c. rooms/areas which do not border the accelerator room
   i. store
   ii. accelerator store
   iii. office
   iv. meeting room
   v. manager's room
   vi. computer lab.
   vii. toilet

For the purpose of radiation protection, the thickness of shielding is chosen so that the rooms/areas in this building follow the radiation area classification as described below (figure 1 and 2);

A. IRRADIATION AND ACCELERATOR ROOMS

These rooms are not permitted for entrance during operation of EBM because of the existence of very high radiation level.

B. GROUND FLOOR

i. all rooms/areas bordering the irradiation room are designated as working area Class A as defined in the Act 304 Atomic Energy Licensing Act (Basic Safety Standard for Radiation Protection) P.U (A) 61.
ii. all areas other than A.i above are classified as uncontrolled area

C. FIRST FLOOR

i. all rooms/areas bordering the accelerator room are classified as Working condition Class B as defined in the Act 304 Atomic Energy Licensing Act (Basic Safety Standard for Radiation Protection) P.U (A) 61.

ii. all areas other than B.i above are classified as uncontrolled areas

D. AREAS OUTSIDE THE EBM BUILDING

The areas outside the building were also considered because of the skyshine effect. These areas are classified as uncontrolled areas.

Measurement of radiation level in these areas were carried out to confirm that the radiation levels do not exceed the level for each classification. The measurements were made when the accelerator was operated at maximum power. The results (figure 3 and 4) shows that the radiation levels are within the prescribe levels for the classification of these areas.

Radiation leakage were detected at the certain sleeves particularly the small diameter sleeves (Figure 3). The leakage is in the form of very fine beam of X-radiation as a result of a big gap between the plug and the sleeves. To overcome this problem, the diameter of the plug were increased and subsequent measurement (Figure 5) shows that the radiation level has reduced the desired levels.

In general the shielding for the building is adequate and no significant radiation leakage were detected.

3.1.2 <u>Interlock System</u>

The Electron Beam Irradiation Facility is also equipped with interlocks system to ensure that no personnel or individuals can enter the irradiation or accelerator room during irradiation. There are five (5) opening for entry to these high radiation level areas during operation namely;

a. shielding door from the experimental area
b. maze door from the non-sterile area. The key system of the maze door is not acceptable for safety reason because it can be opened by turning the knob without the need of a key when it is not locked.
c. product entry port form the non-sterile area
d. product exit port from the sterile area
e. accelerator door on the first floor

3.1.2.1 <u>Door Interlocks</u>

All the three doors that lead to the irradiation room (shielding and maze door) and accelerator room (accelerator door) are provided with limit switch that are interlocked with the accelerator starting sequence. The accelerator starting procedures is disabled when one or more of these switch is open (no current flow). If this is the case the operator must resets the interlocks and ensure that the affected doors is fully close to enable the starting sequence.

3.1.2.2 <u>Safety Switch Interlocks</u>

In the inside section of these three doors are provided with safety selector switches (OPERATION-MAINTENANCE switch) which are also interlocked to the accelerator starting sequence. As a safety measures, any personnel who enters any one of these areas is required to change the selector switch from OPERATION to the MAINTENANCE position. This procedure renders the machine inoperable thus preventing the possibility of accident when personnel or individual is still present in these highly dangerous radiation areas.

PEMONITORAN KAWASAN E B M PADA TAHAP 3MV / 30mA

24-5-91

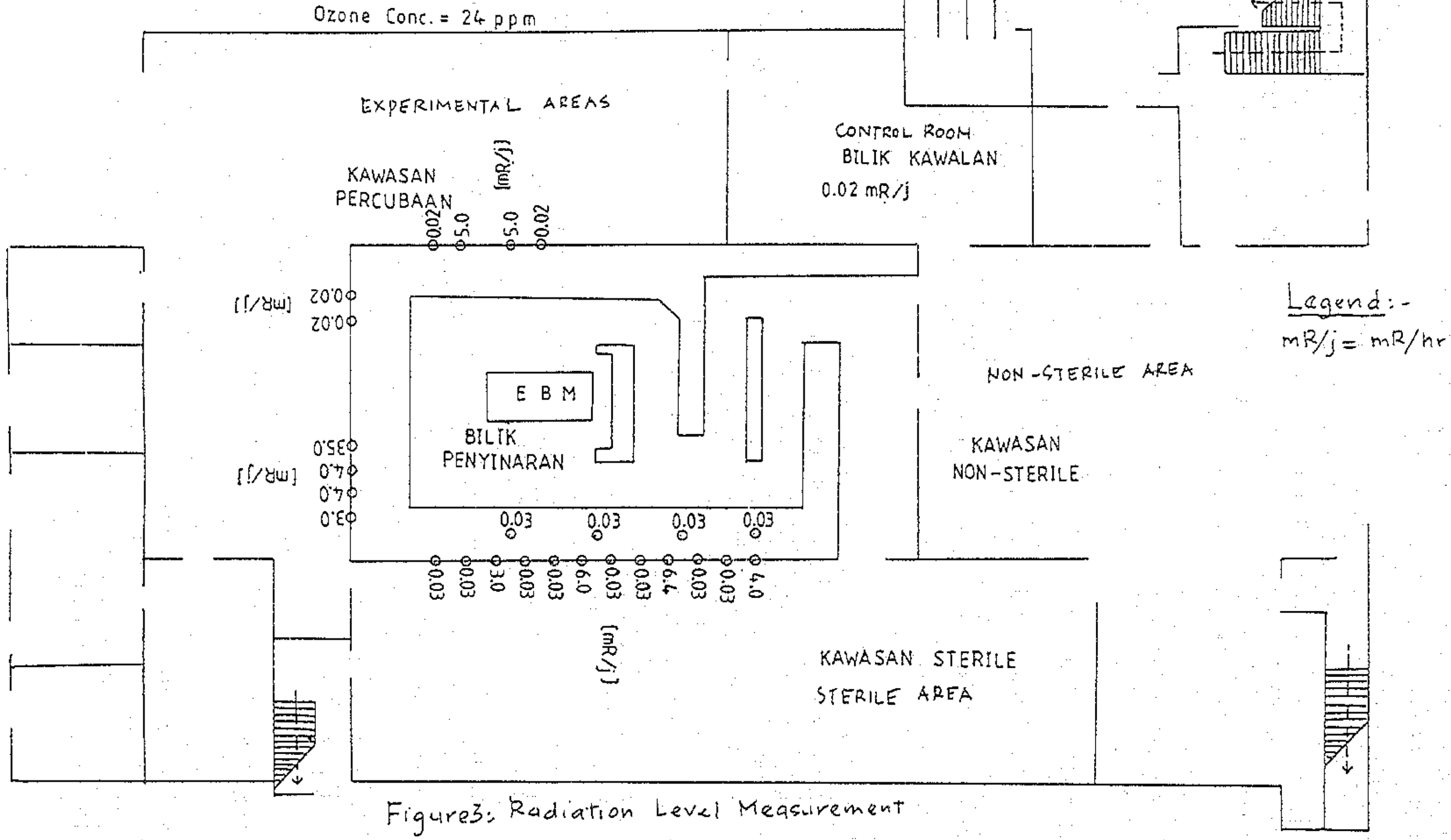


Figure3: Radiation Level Measurement

LANTAI BAWAH
GROUND FLOOR

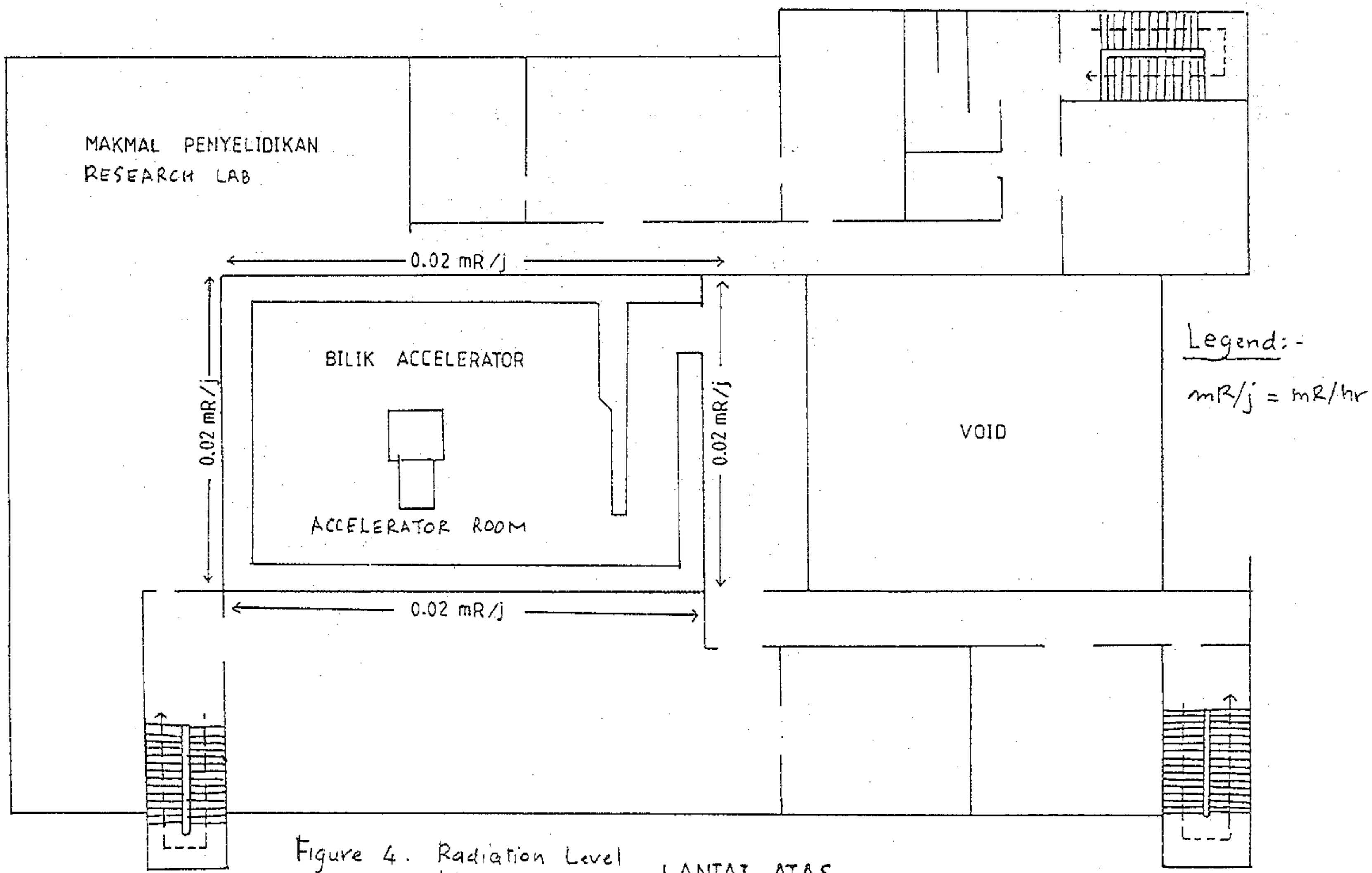


Figure 4. Radiation Level Measurement

LANTAI ATAS
FIRST FLOOR

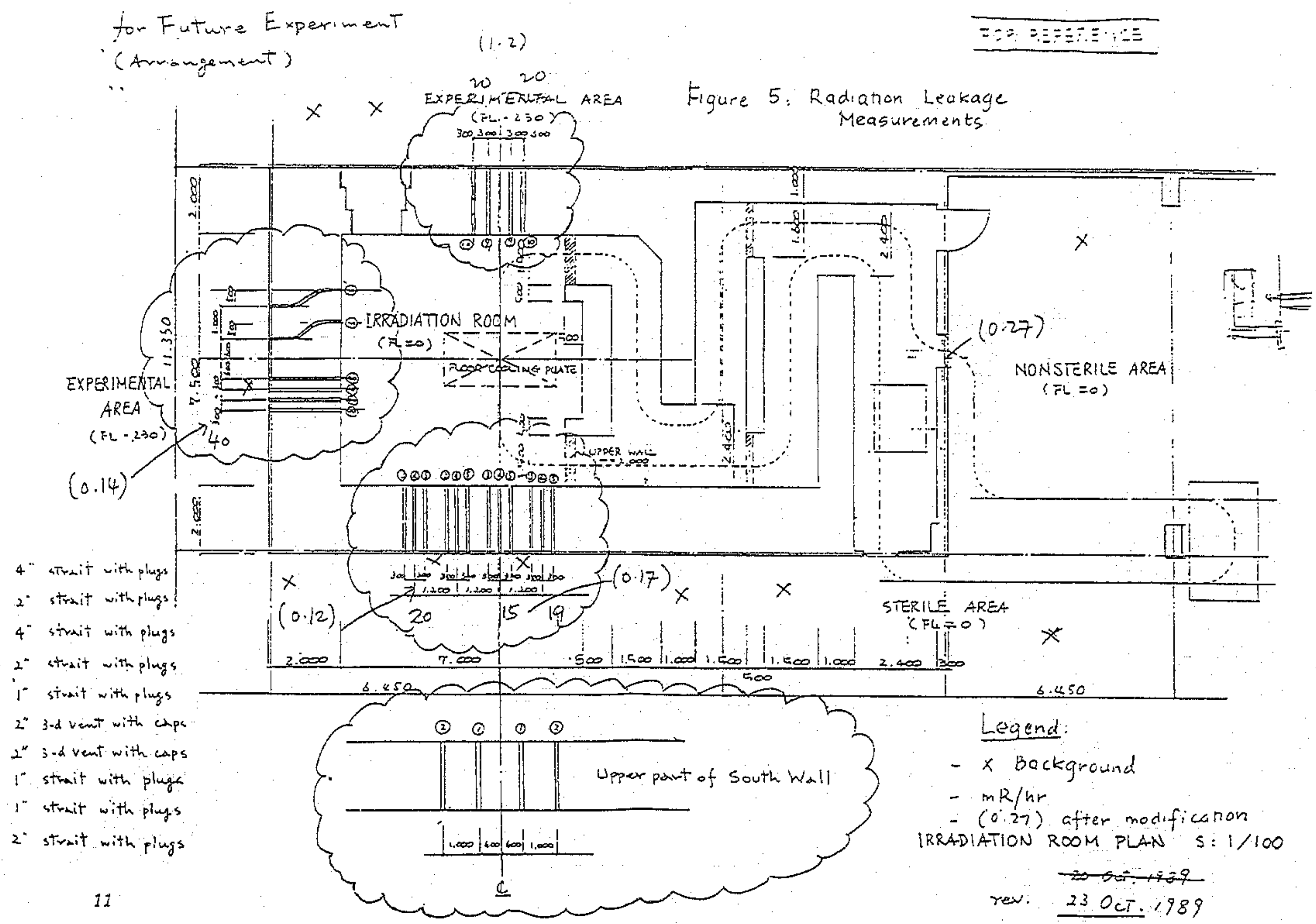


Figure 5: Radiation Leakage Measurements

3.1.2.3 Photodetector Interlocks

Photodetector system are installed at both the product entry and exit ports. These system are also interlocked to the accelerator starting sequence. Triggering the photodetector system will cause the irradiation to be stopped immediately and any attempt to restart the operation sequence without first resetting the the photodetector at the location where it is triggered will be useless.

All these interlocks position are as shown in figure 1 and 2.

3.1.3 Warning Lights

Warning lights are installed selectively at strategic location in the building. There are two kinds of warning light provided (figure 6a and 6b) namely;

a. Door Status

There are many doors that lead to potentially hazardous areas. These areas include irradiation room, maze areas accelerator room and the route to the accelerator and machinery room. The safety concept adopted here is to warn the operator of the action that one or more of these doors are opened. These signal lights are shown as DIL# in figure 6a and 6b where # denotes a number. When the any one of these doors are opened the light on top of the door shows "RED" giving a high pitch beeping sound sufficiently warning the individual of the situation.This warning is also indicated at the indicator console in the control room. Thus, the operator will be aware of these situation and can take proper safety actions deem necessary any accident.

b. Electron Processing System (EPS) Operational Status

The normal practices is to indicate the EPS when in operation and not in operation with a "RED" and "GREEN" light respectively and denoted by the word EBM# in figure 6a and 6b where # denotes a number. The current situation in the EBM building is just the reverse. This is because these warning lights are connected to the door status indicator lights. Since during operation it is required that all doors remain close showing a "GREEN" light on the door hence to avoid confusion the EBM status lights made to show "GREEN" to mean a safe condition because all the doors are closed.
This is a dangerous situation because it could mislead personnel to thinking that during operation is a safe condition.

3.1.4 Operation of Shielding Door

3.1.4.1 Operation Switch

There are two set of operation switches provided for the shielding doors. One each at the outside and inside wall of the irradiation room.

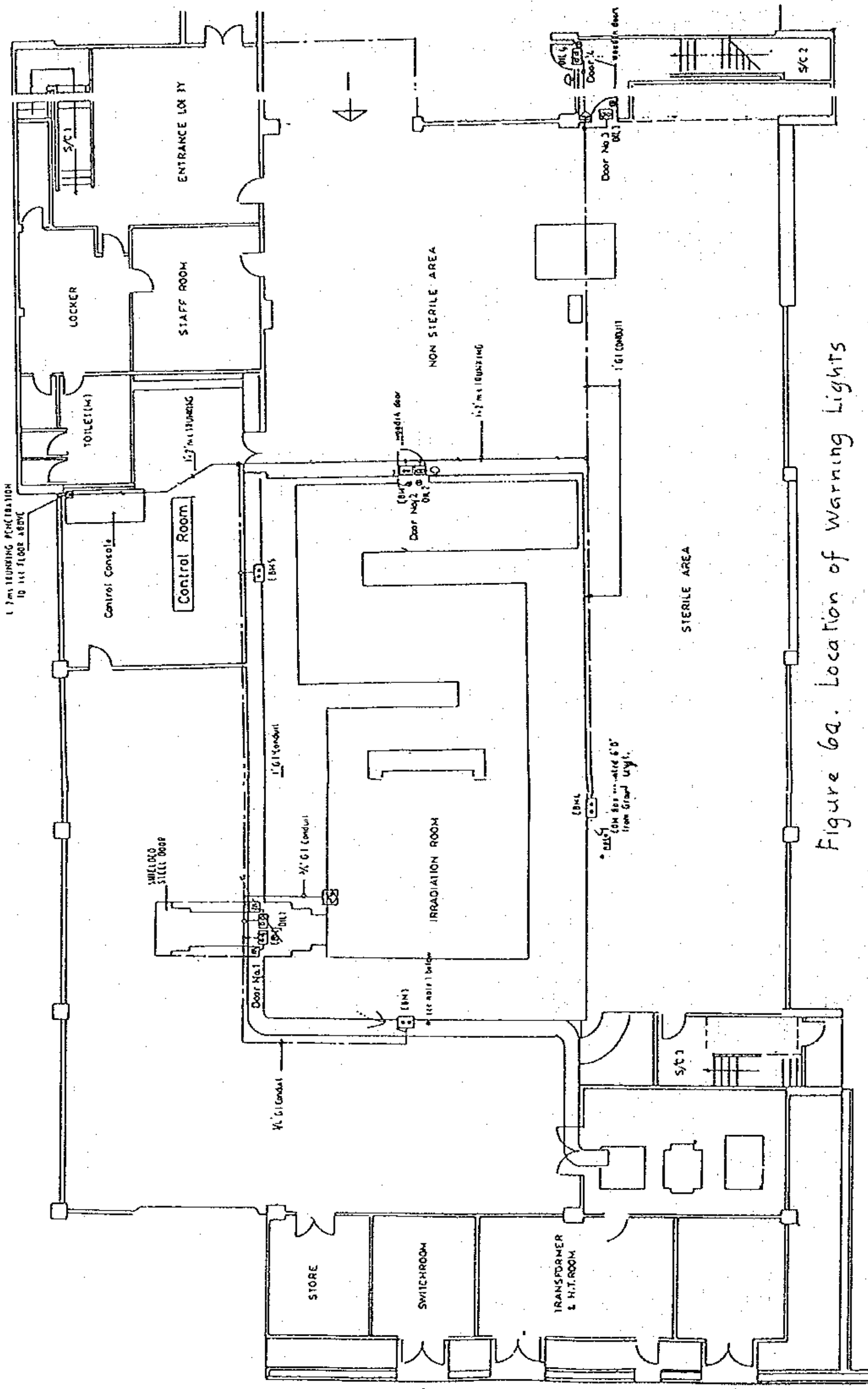


Figure 6a. Location of Warning Lights

Ground Floor

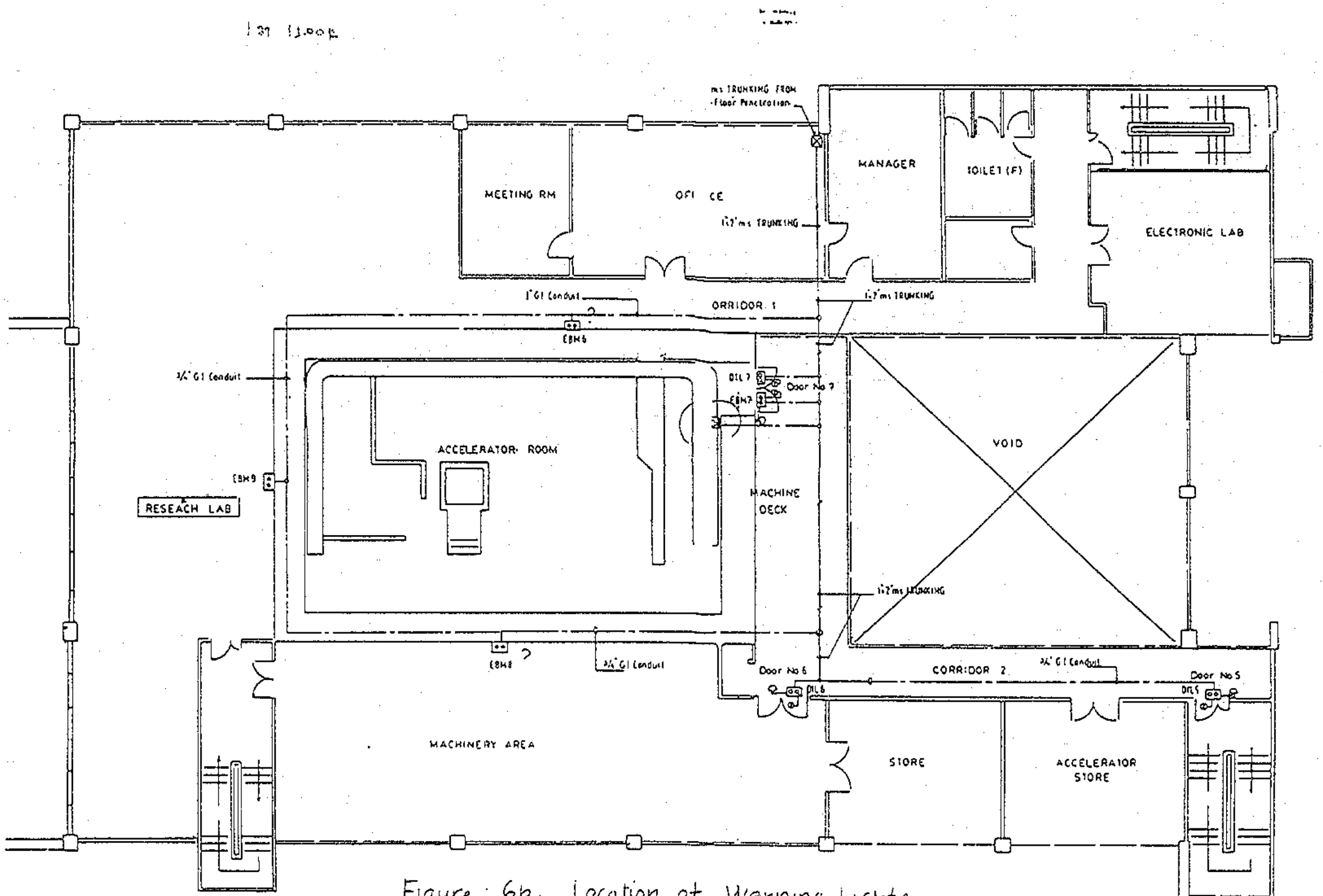


Figure · 66. Location of Warning Lights

At tho switch outside the irradiation room, there are two set of "RED" and "GREEN" button arranged side by side. The left side buttons are for opening while the right side is for closing. These buttons will only be operable when the key switch located at the bottom right is turned to "ON" position.

At the switch inside the irradiation room there is only one set of "RED" and "GREEN" buttons below a big "RESET" button. These "RED" and "GREEN" button can only be used to close the shielding door from inside provided that the isolator switch which is also provided is at the "ON" position. This isolator switch functions like the key switch outside the irradiation room. The "RESET" button is provided as an "EMERGENCY" button to open the door from inside.

3.1.4.2 Audible Warning Signals

There are three types of audible warning signal pertaining to the operation of the shielding door i.e;

a. Intermittent buzzer - to show that the door is moving either during closing or opening. This sound stops when the door stop moving

b. Beeping sounds - to show that the door status (open). This is similar to the warning sound described in section 3.1.3

c. One Minute Siren - to show that the door is fully closed and to warn people that the EPS will be operable after the one minute siren. This time relay is connected to the EPS reset button in the control room.

3.1.4.3 Current Status of the Shielding Door Operation

When the EPS is going to be operated, the following items pertaining to shielding door should be ensured;

a. "MAINTENANCE-OPERATION" selector switch is at the "OPERATION" position
b. Isolator switch is at the "ON" position
c. Safety key switch is at the "OFF" position

Nevertheless, the items (b) and (c) are not pre-requisites for EPS starting sequence regardless of the position of these switches.

Below is the current status of the shielding door operation;

a. Before opening the personnel must first put the safety key switch to "ON" position

b. To open the door, push the left "GREEN" button. The door will open thus triggering the BEEPING and BUZZER alarm. The door will stop when it reaches the contact switch at the end of the track consequently stopping the "BUZZER" alarm as well. The movement of the door can be stopped at any time by pushing the "RED" button beneath the left "GREEN" button

c. The doors has two movement speed, slow and fast. It is open initially at a slow speed then changes to a higher speed when the door past the limit switch provided at the ceiling on top of the door's track.

d. Any personnel going into the irradiation switch is needed to change the "MAINTENANCE-OPERATION" switch to MAINTENANCE and the isolator switch to "OFF" position for safety reasons.

A few points can be made from the operation of this shielding door i.e;

a. It can be seen that the door can be closed from the inside of the irradiation room using the inside "GREEN" button. This is a dangerous situation that must be avoided and the action is unnecessary.

b. When the door is opened the beeping alarm sounds continuously presenting a noise hazard to personnel.

c. The person who enters the irradiation room may forget to change the "MAINTENANCE-OPERATION" selector switch. This is so because in other similar facilities an alarm signal is connected to this switch which can only be turned off when the switch is turned to MAINTENANCE position.

The current system need to be rectified so that its operation does not pose any hazard to the personnel involved.

3.2 Ozone and other noxious gases

Ozone and other toxic gases are other incidental hazards resulted from the operation of the electron beam machine. For the time being only the aspect of ozone safety has been considered because of its higher production rate compare to other toxic gases.

In order to keep the concentration of ozone to minimum inside the irradiation room, the room air is exhausted using high capacity blower installed in the accelerator room on the first floor. The exhaust blower is designed to provides sixty air change per hour for the irradiation room. The maximum ozone concentration in the exhaust duct permitted so that the environmental ozone concentration does not exceed 0.1 ppm is 50 ppm. The operational experience has shown that ozone concentration in the exhaust duct under full power operation of the EPS had rarely exceed an average value of 20 ppm. Nevertheless, the concentration of ozone in the environment outside the building has not yet been carried out to confirm with the design criteria. It will be done when the equipments necessary for this measurement is purchased.

3.3 Noise

Noise hazard is also present due to it generation when the EPS and its auxiliary equipments are operated. The aspects of noise were not considered seriously in the planning stage because perhaps this was not expected would give serious problem. The noise levels inside the facility could reach more than 80 dB in certain areas as revealed by measurements made during full power operation (figure 7).

Investigation on this matter shows that the source of the noise are from;

a. mechanical vibration from the three blowers, ducting and motor operation

b. high speed air jet directed toward the accelerator window used for cooling

c. high speed air jet at the exhaust outlet (environment noise)

d. accelerator noise

The problem would not be as serious if all the blowers (sources of noise) are installed in the machinery room which is fully enclosed. The accelerator room is not suitable because the noise escapes through the opening above the shielding wall facing the non-sterile area.

Nevertheless, some actions had been taken to rectify the problem by;

a. not operating the purge blower that supply fresh air into the irradiation room because it is thought that the product entry-exit opening is adequate in letting the vacuum created by the operation of exhaust blower to feed fresh air to the irradiation room. The safety aspect of this action has not been investigated further.

b. reducing the exhaust blower speed by changing to a bigger diameter pulley

c. removing the duct projection in the irradiation room

The noise level were reduced when these actions were carried out but the levels are still unacceptable. Measurement made on 9th. Jan 1992 shows that the noise level at the non-sterile area was 87 dB on the C selector switch.

4. CONCLUSION

As regard to the safety of the EBM facility, it can be concluded from this analysis that;

a. the shielding for the facility is adequate

b. interlocks system is functioning as designed

c. the light warning signals are not proper

d. noise level is above the permissible limit is certain areas

e. the ozone concentration release through exhaust stack is below the design limit

In general, this electron beam facility is not yet ready to be fully operated safely because certain engineered safety aspect are not adequate to warrant minimum personnel and administrative control.

5. SAFETY RECOMMENDATIONS

The followings are recommendation to raise the current safety level to achieve a minimum safety requirements for the operation of the facility;

a. shielding door operation and controls should be rectified;

i. method should be made available to ensure that the personnel opening the door is aware of the conditions that he must turn the 'MAINTENANCE-OPERATION" selector switch to MAINTENANCE position. Administrative method is not acceptable.

ii. the door close buttons inside the irradiation room is removed

iii. the control of shielding door movement is corrected

b. the warning lights for the EPS status should be corrected to suit normal practice, GREEN for NOT-IN-OPERATION condition and RED for IN-OPERATION condition

c. the noise levels should be reduced to the protection level. This can be done <u>PERHAPS</u> by the following methods;

i. installing flexible bellows between the blower fans and the ducts

ii. insulating the source of vibration with noise insulator

iii. containing and isolating the noise sources

d. the maze door key system should be changed to self locking key system but can be opened from inside

Real and committed efforts should be geared to solving these problems and as soon as possible to ensure that the operation of this facility will ensure safety of personnel.

STERILIZATION OF MEDICAL PRODUCTS USING EBM

INTRODUCTION

Radiation sterilization has been introduced in Malaysia in 1976 with the setting up of the first gamma irradiation plant by Ansell Sdn. Bhd. This irradiation plant, however, is used for the sterilization of in-house manufactured products, the bulk of which are for export.

Recently, UTN has set up another gamma irradiation facility which was commissioned in January 1989 with initial capacity of 200,000 Ci. In order to cope with the demand of the local medical device industry, the source strength was increased to 1.24 MCi. The production rate of this facility is 50 m3 per day or 250,000 pairs of gloves per day. Most of the medical products sterilized in UTN are gloves. Other products sterilized are bottles and catheters.

UTN received a 3 MeV electron beam machine (EBM) from JICA in early 1991. The project to be carried out in this bilateral cooperation is radiation sterilization of medical products using EBM. Although this technology is new, there is the potential of sterilizing medical products such as surgical gloves, catheters, syringes and pharmaceuticals. Before this can be ascertain however, a thorough study on the dose distribution, dose requirement and radiation compatibility of the products have to be carried out.

STATUS OF THE MEDICAL DEVICE INDUSTRY

The medical device industry in Malaysia can be classified as follows:
-medical, surgical, dental, veterinary instruments, equipment.
-latex dipped products such as surgical gloves, examination gloves, catheters and condoms.
-plastic products for medical and veterinary use.
-non-woven surgical and related products.

In Malaysia, medical devices are among the group of products which is promoted for further development in view of the benefits they generate (skills development, value added and export earnings)

The medical devices industry is largely an export oriented industry. Over the last two years, exports of some of the major medical devices have expanded considerably. Within the medical device industry, the rubber-based medical products, particularly gloves have emerged as the largest sector. Output of gloves increased from 397 million pairs in 1987 to 1.3 billion pairs in 1988. By 1989, production reached 1.6 million pairs.

The growth of the plastic-based medical products is slower compared to the rubber-based medical products. A total of 7 companies have been approved to manufacture disposable plastic syringe and hypodermic needles, out of which 3 are already in production. One other company manufactures disposable vein puncture sets, disposable infusion administration sets, disposable blood transfusion sets and surgical sutures.

CURRENT RESEARCH AND DEVELOPMENT ACTIVITY

The discussion on current research and development activity will be divided into three parts, namely:

-Materials compatibility
-Microbiology
-Radiation technology

1. Materials compatibility

We have carried out research on the compatibility of plastic raw materials such as PP, CP, and PVC. The research work that we are doing at the moment are as follows:

On going projects on material compatibility:

1.1 The effects of irradiation on PP/CP blends.
1.2 The effects of irradiation on PP/PE blends.
1.3 Formulation of radiation compatible PVC.
1.4 The effects of irradiation on surgical rubber gloves.
1.5 The effects of irradiation on sutures.
1.6 The effects of irradiation on hab and cap.

1.1 The effects of irradiation on PP/CP blends

Experimental

Sample preparation

Samples with and without nucleating agent (NA) are provided by Toyoshoda and the nucleating agent used in PP and CP is NC-4 (0.1%). The composition of the blends is shown in table. The sample (40 g) was blended using Brabender Plasti-corder PL 2000 belong to RRIM and SIRIM respectively. The blend was prepared at speed of 70 rpm for 5 min at 190 C.

CP sheets were prepared by using blended material under pressure of 150 kg/cm2 for 5 min at 190 C using spacer of 0.5 mm after preheating for 3 min at the same temperature. The sheets were then immediately cooled between two plates of cold press at 25 C, under pressure of 100 kg/cm2 for 5 min. Dumbbell-shaped pieces for tensile test were cut from these sheets.

Irradiation

The samples were irradiated by gamma ray and electron beam at doses of 10, 25, 50 and 80 kGy. The dose rate for gamma is 2.9 kGy/h. The acceleration energy and the current used for E.B irradiation were 3 MeV and 1 mA respectively. The dose rate is 10 kGy for one pass.

Estimation of degradation

The degradation of irradiated PP/CP blends were estimated by determining the elongation at break from Tester Sangyo Tensile Strength Machine, the tension speed used is 100 mm/min and the range is 10.

2. Microbiology

Experimental

The first experiment was the depth dose measurement of the polypropylene. The second experiment is to determine the E.B sensitivity of B. Pumilus dry spore in air.

3. Radiation technology

Experimental

1. Depth dose distribution of packaging materials.
2. Calibration of CTA dose reader.
3. Effect of rubber sheets on CTA film.
4. Depth dose distribution of rubber sheets
5. Dose distribution measurement of loosely pack surgical rubber gloves.
6. Dose distribution measurement of surgical rubber gloves in a box.

EXPERTS (FY 1991)

1. Material compatibility

JICA Expert: Dr. Fumio Yoshii

Duration: 21 August-14 September 1991

Job description:

1. Adjustment of equipments to measure the physical properties of irradiated polymer material.
2. Heat moulding of test pieces for evaluation of radiation stability.
3. Evaluation of radiation stability of polymer materials.
4. Classification of medical devices for E.B sterilization.

2. Microbiology

JICA Expert: Mr. Yuhei Watanabe

Duration : 28 October - 16 November 1991

Job description:

1. Depth dose measurement of PP.
2. Determination of E.B sensitivity of B. Pumilus dry spore in air.
3. Relationship between the survival fraction and absorbed dose.

3. Radiation technology

JICA Expert: Mr. Hiroyuki Tachibana

Duration : 7 November - 4 December 1991

Job description:

1. Survey of adequate packaging method for surgical rubber gloves.
2. Optimization of irradiation conditions using conveyor system.

RADIATION STERILIZATION OF MEDICAL PRODUCTS

- DR. ZAHRAH A. KADIR
- MR. KAMARUDDIN BAHARI
- MRS. SHARIFAH HANISAH S. A. AZIZ .
- MRS. ASNAH HASAN
- MS. NORAISHAH OSMAN
- MS. ZALIHA MOHAMAD
- MR. NOOR KHILMAN SANGIT
- MS. KHUZAIMAH HASSAN

EXPERTS(FY 1991)

1. MATERIAL COMPATIBILITY

JICA EXPERT : DR. FUMIO YOSHII

DURATION : 21 AUGUST - 14 SEPTEMBER 1991

JOB DISCRIPTION :

1.1 ADJUSTMENT OF EQUIPMENTS TO MEASURE THE PHYSICAL PROPERTIES OF IRRADIATED POLYMER MATERIAL.

1.2 HEAT MOULDING OF TEST PIECES FOR EVALUATION OF RADIATION STABILITY.

1.3 EVALUATION OF RADIATION STABILITY OF POLYMER MATERIALS.

1.4 CLASSIFICATION OF MEDICAL DEVICES FOR EB STERILIZATION.

2. MICROBIOLOGY

JICA EXPERT : MR. YUHEI WATANABE

DURATION : 28 OCTOBER - 16 NOVEMBER 1991

JOB DESCRIPTION

2.1 DEPTH DOSE MEASUREMENT OF PP

2.2 DETERMINATION OF EB SENSITIVITY OF *B. PUMILUS* DRY SPORE IN AIR.

2.3 RELATIONSHIP BETWEEN THE SURVIVAL FRACTION AND ABSORBED DOSE

3. RADIATION TECHNOLOGY

JICA EXPERT : MR. HIROYUKI TACHIBANA

PURATION : 7 NOVEMBER - 4 DECEMBER 1991

JOB DESCRIPTION :

3.1 SURVEY OF ADEQUATE PACKAGING METHOD FOR SURGICAL RUBBER GLOVES.

3.2 OPTIMIZATION OF IRRADIATION CONDITIONS USING CONVEYER SYSTEM.

RADIATION STERILIZATION OF MEDICAL PRODUCTS USING ELECTRON BEAM MACHINE (EBM)

RESEARCH AND DEVELOPMENT ACTIVITY

1. MATERIALS COMPATIBILITY
2. MICROBIOLOGY
3. RADIATION TECHNOLOGY

ON GOING PROJECTS (MATERIAL COMPATIBILITY)

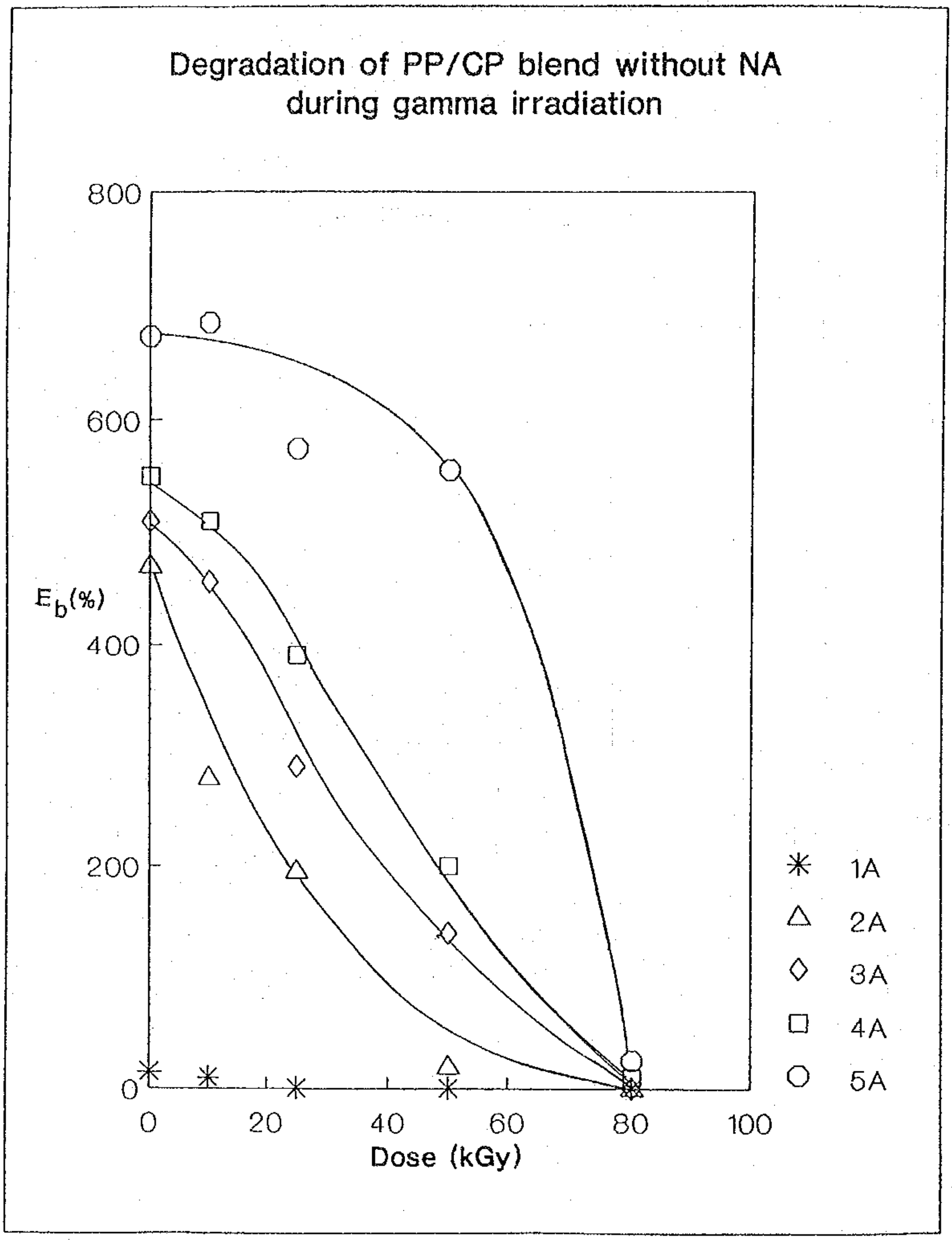
1. THE EFFECTS OF IRRADIATION ON PP AND CP BLENDS.
2. THE EFFECTS OF IRRADIATION ON PP/PE BLENDS.
3. FORMULATION OF RADIATION COMPATIBLE POLYVINYL CHLORIDE (PVC).
4. THE EFFECTS OF IRRADITION ON SURGICAL RUBBER GLOVES.
5. THE EFFECTS OF IRRADIATION ON SUTURES.
6. THE EFFECTS OF IRRADIATION ON HAB AND CAP.

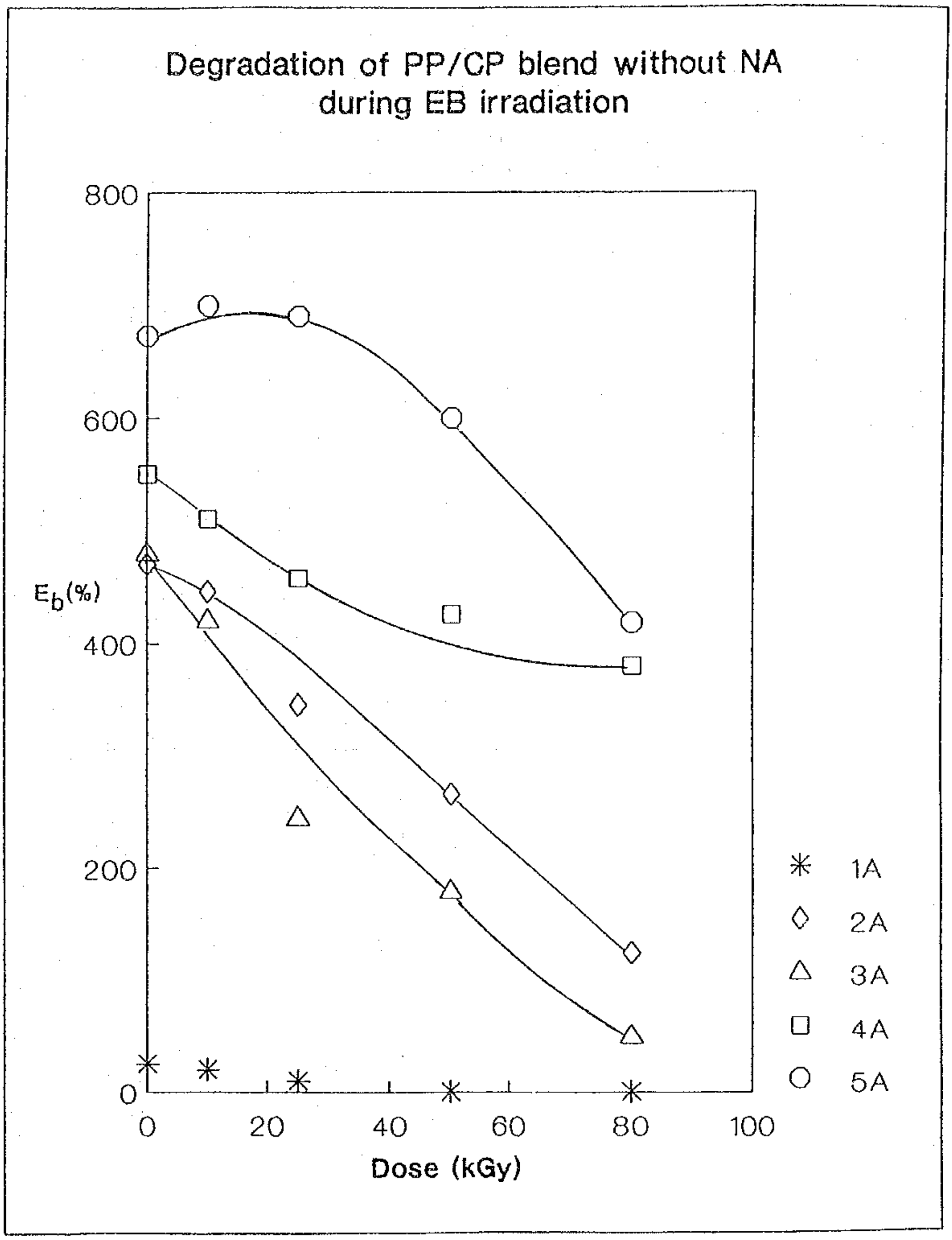
THE EFFECTS OF IRRADIATION ON PP/CP BLENDS

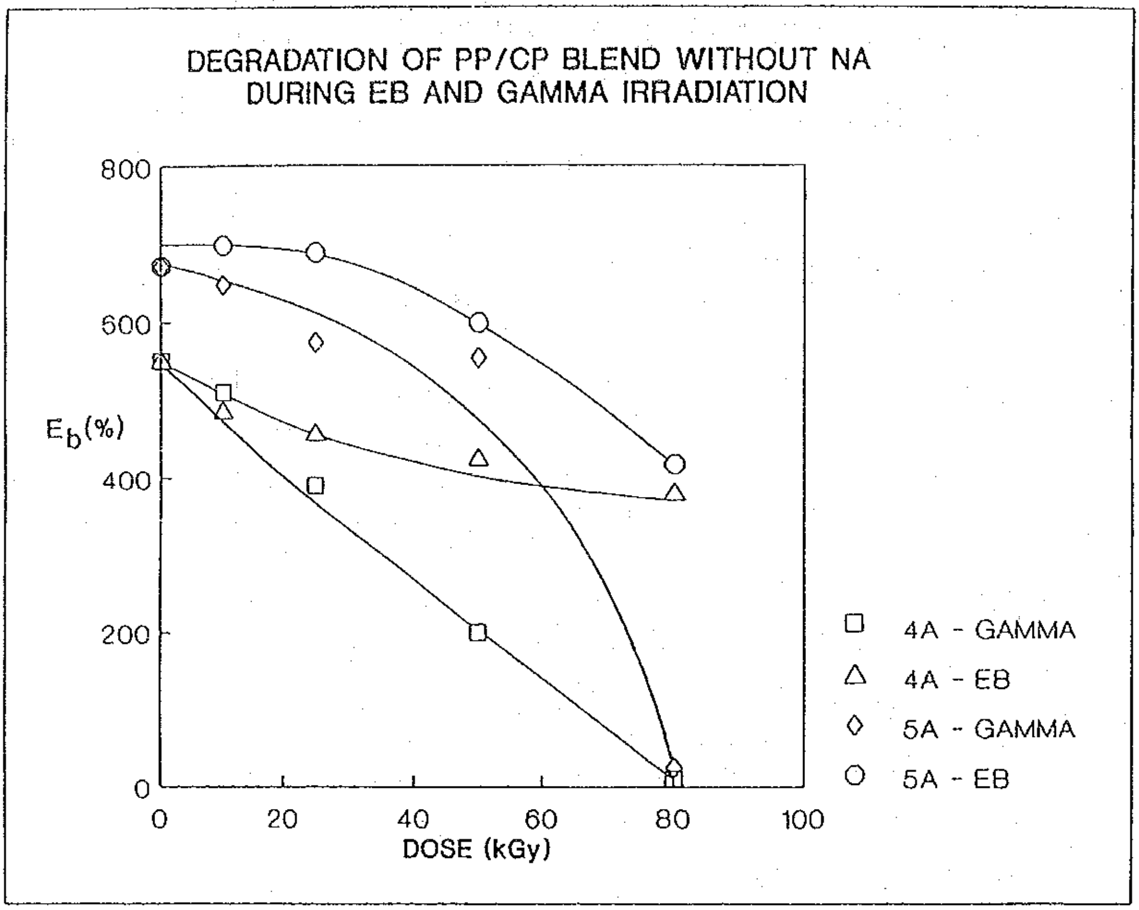
COMPOSITION OF THE BLENDS

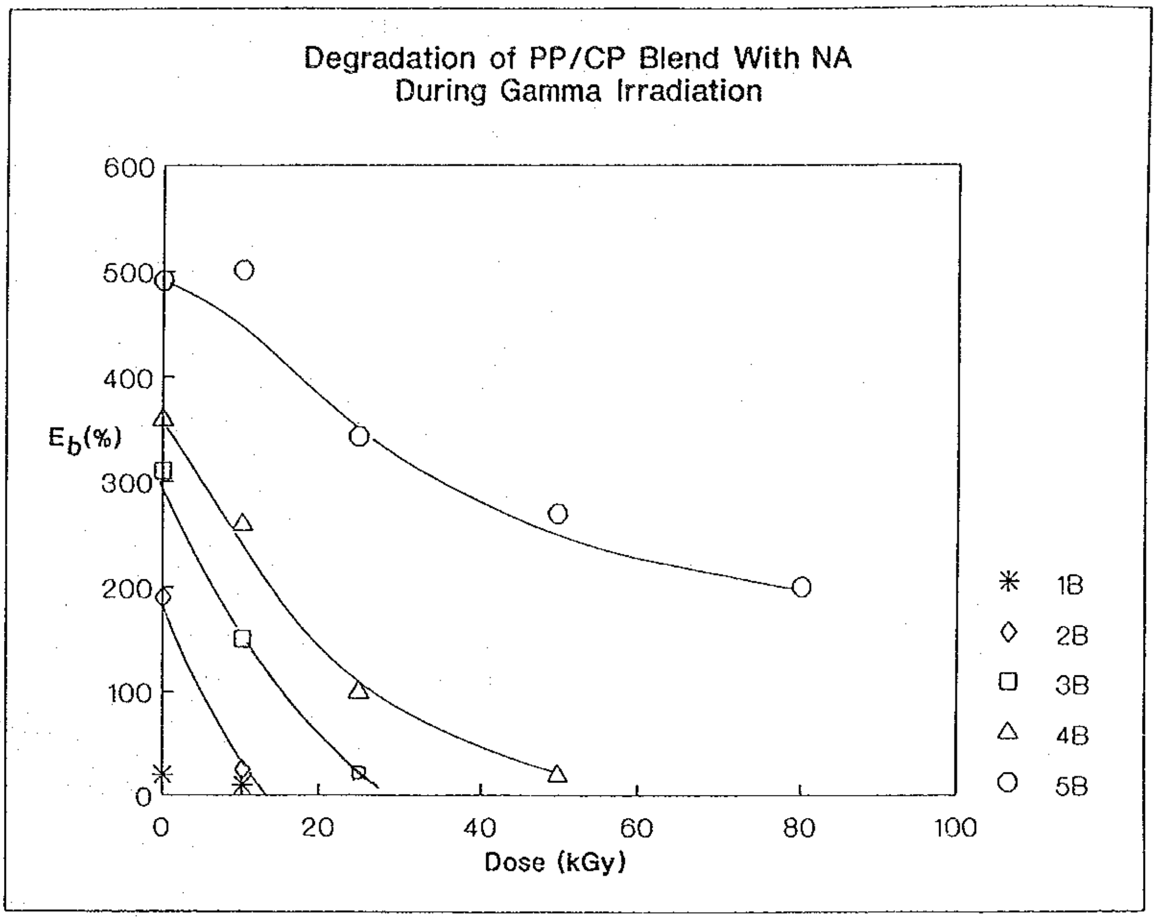
Samples	PP (%)	CP (%)
1A 1B	100	0
2A 2B	70	30
3A 3B	50	50
4A 4B	30	70
5A 5B	0	100

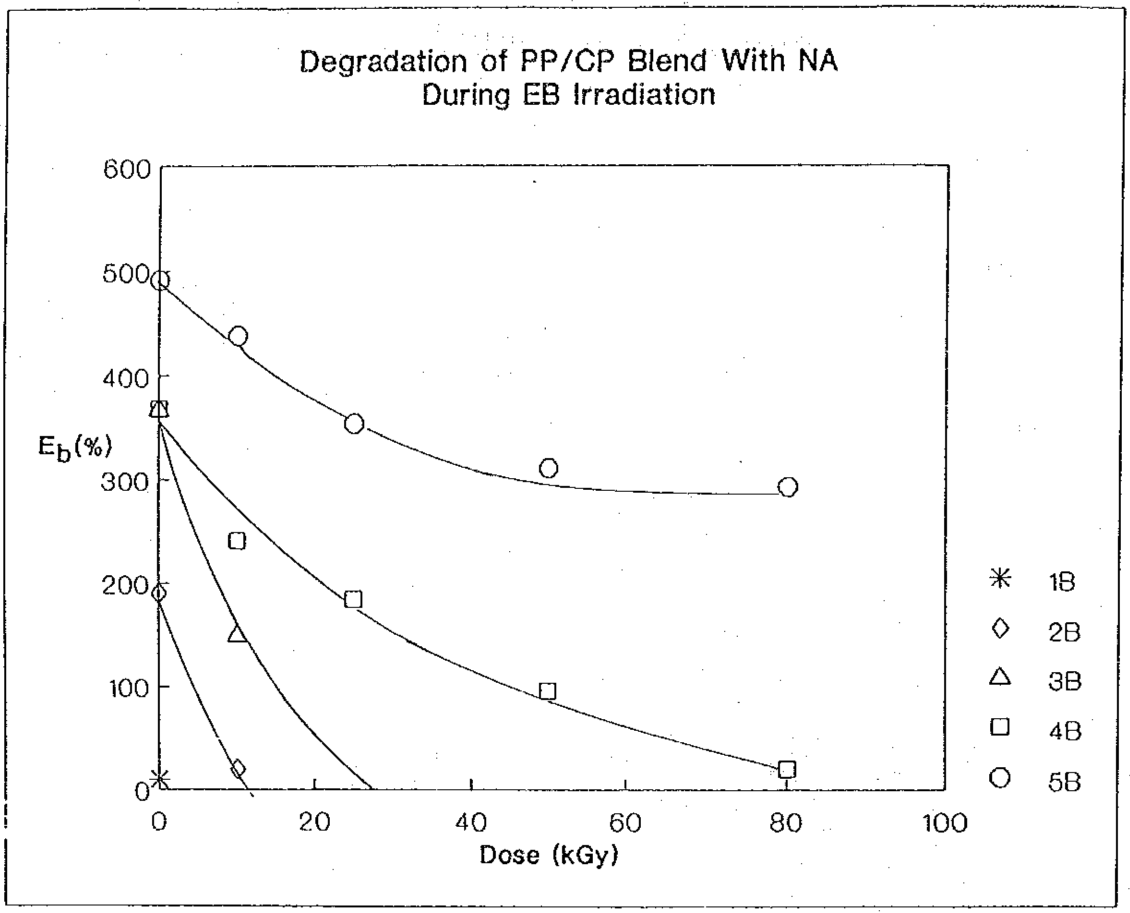
Note : A - Without NA
B - With NA (NC-4, 0.1 %)
NC-4 1.3, 2.4-di (p-ethylbenzyldine) sorbitol

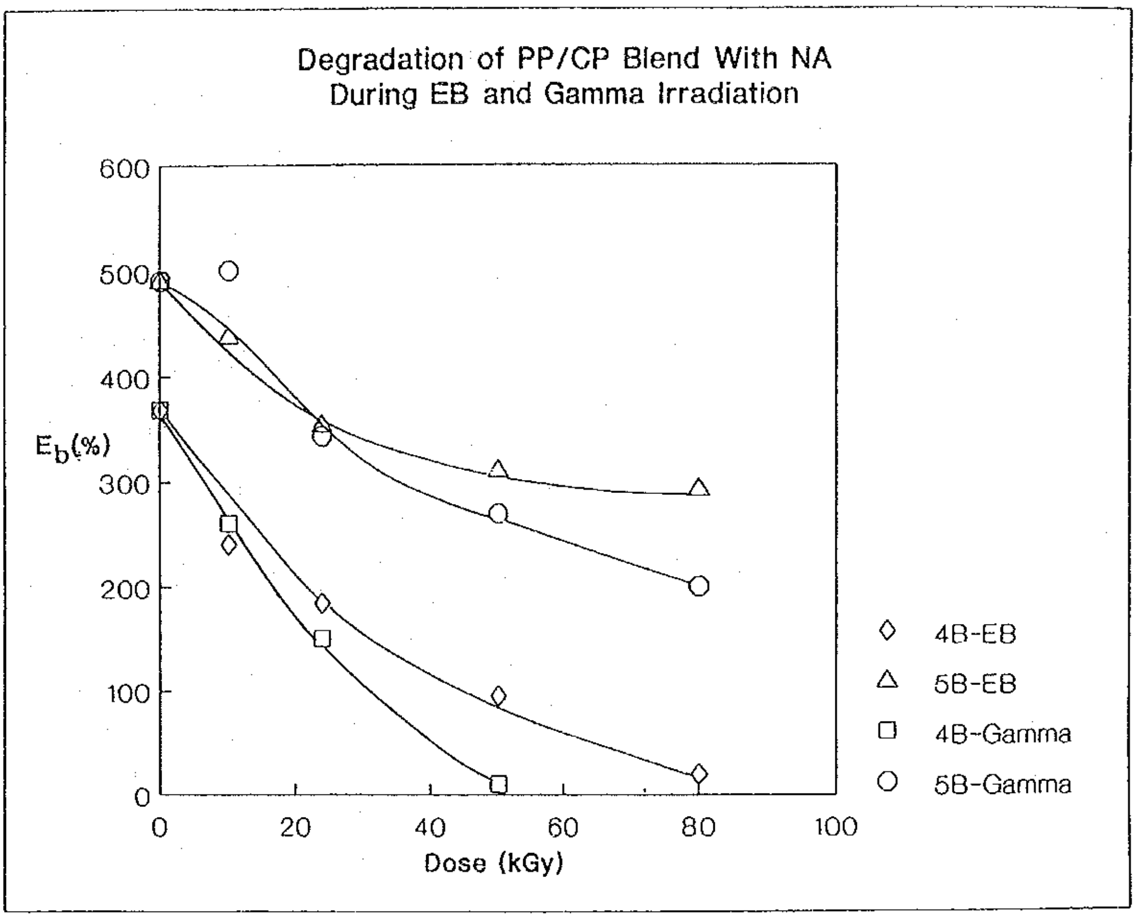

Degradation of PP/CP blend without NA
during gamma irradiation
800
600
400
200
0
Eb(%)
0
20
40
60
80
100
Dose (kGy)
1A
2A
3A
4A
5A


Degradation of PP/CP blend without NA
during EB irradiation
800
600
400
200
0
Eb(%)
0
20
40
60
80
100
Dose (kGy)
1A
2A
3A
4A
5A


DEGRADATION OF PP/CP BLEND WITHOUT NA
DURING EB AND GAMMA IRRADIATION
800
600
400
200
0
Eb(%)
0
20
40
60
80
100
DOSE (kGy)
4A - GAMMA
4A - EB
5A - GAMMA
5A - EB

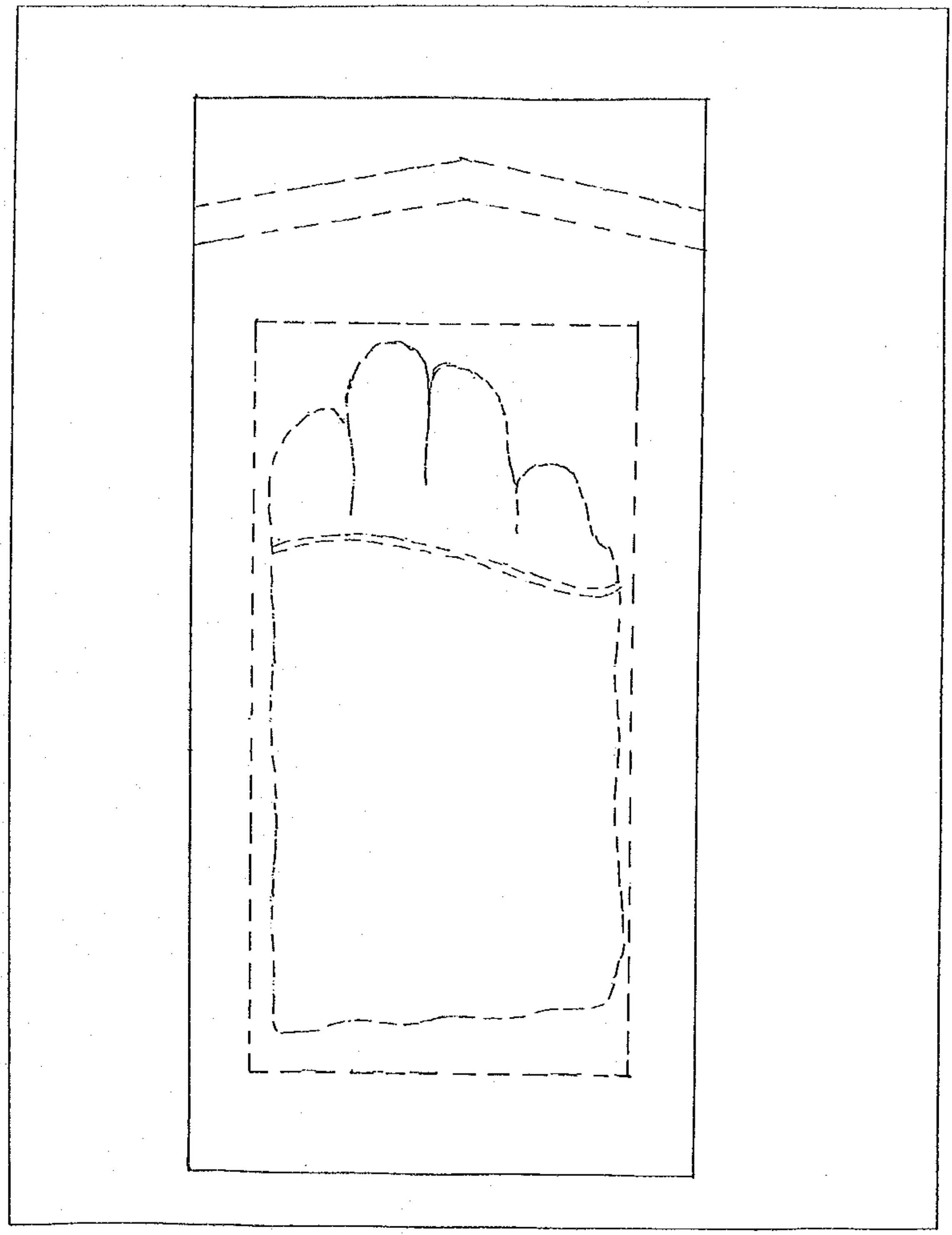

Degradation of PP/CP Blend With NA
During Gamma Irradiation
600
500
400
300
200
100
0
Eb(%)
0
20
40
60
80
100
Dose (kGy)
1B
2B
3B
4B
5B

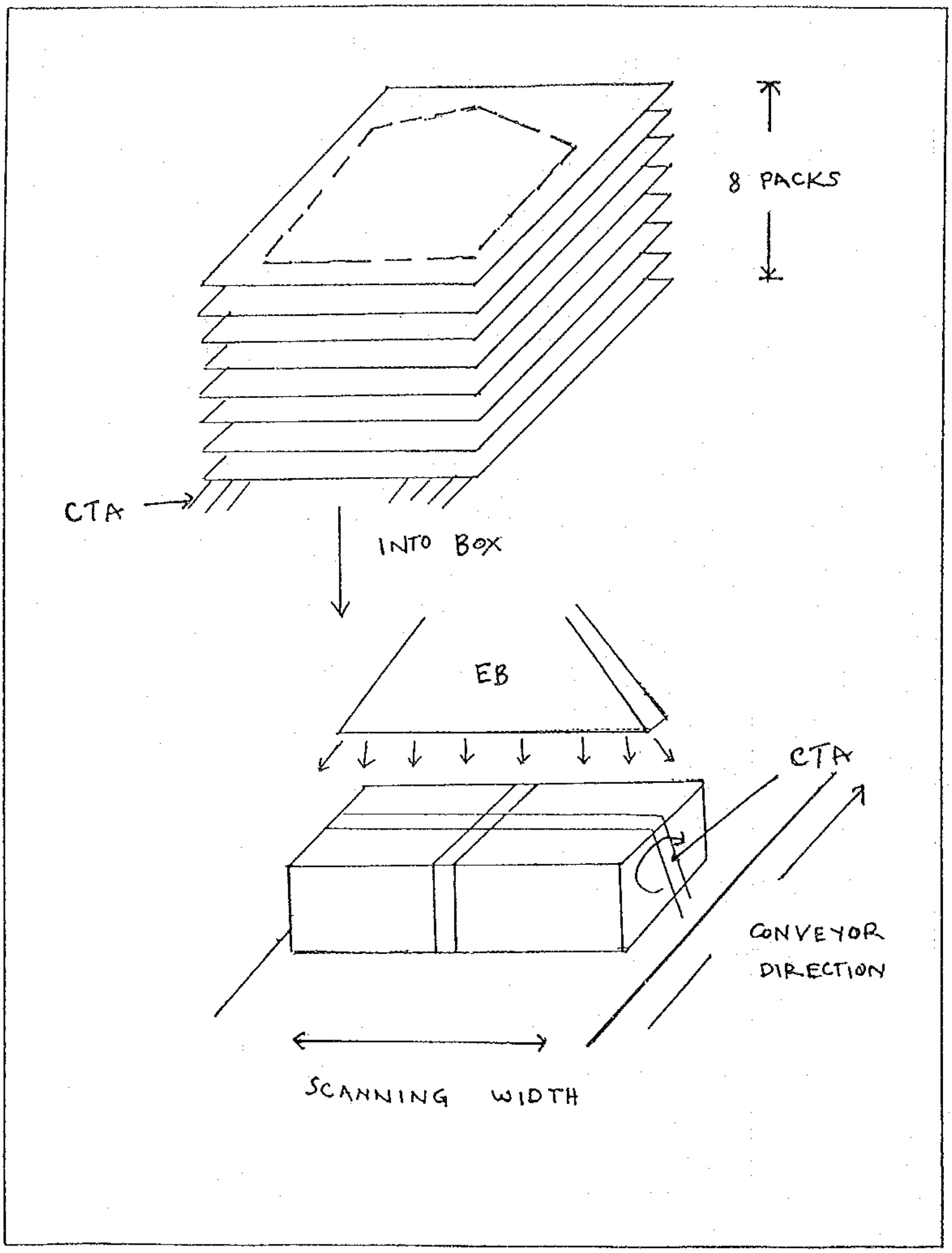

Degradation of PP/CP Blend With NA
During EB Irradiation
600
500
400
300
200
100
0
Eb(%)
0
20
40
60
80
100
Dose (kGy)
1B
2B
3B
4B
5B



Degradation of PP/CP Blend With NA
During EB and Gamma Irradiation
600
500
400
300
200
100
0
E_b(%)
0
20
40
60
80
100
Dose (kGy)
4B-EB
5B-EB
4B-Gamma
5B-Gamma

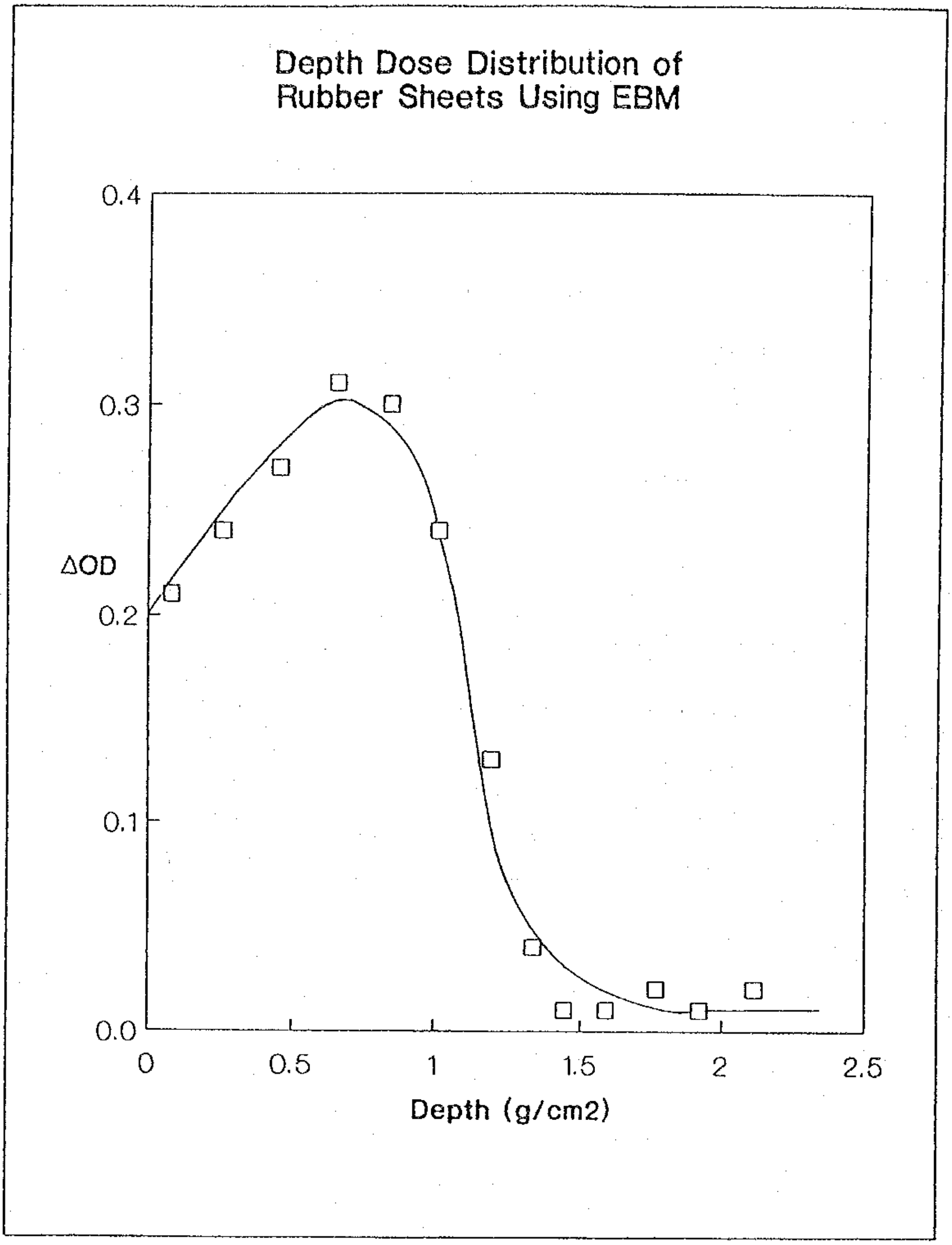
RADIATION TECHNOLOGY

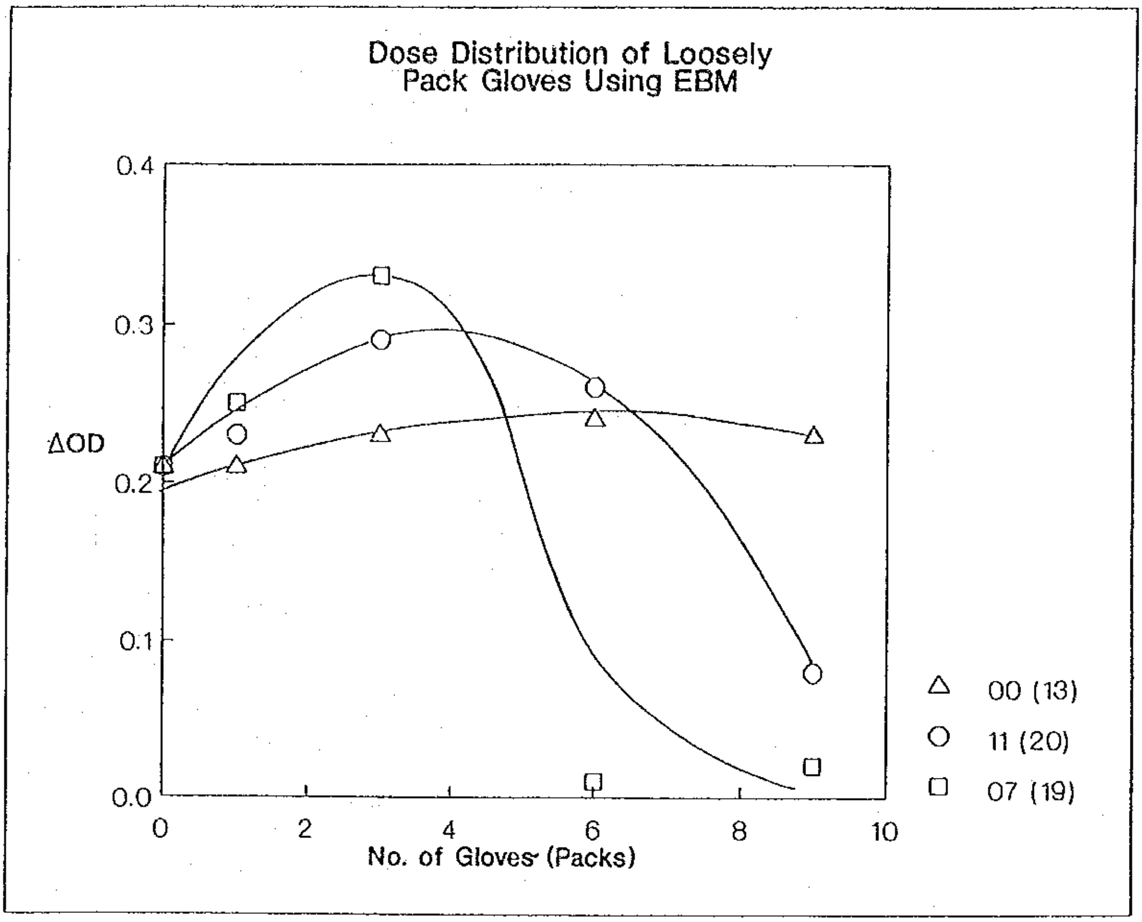


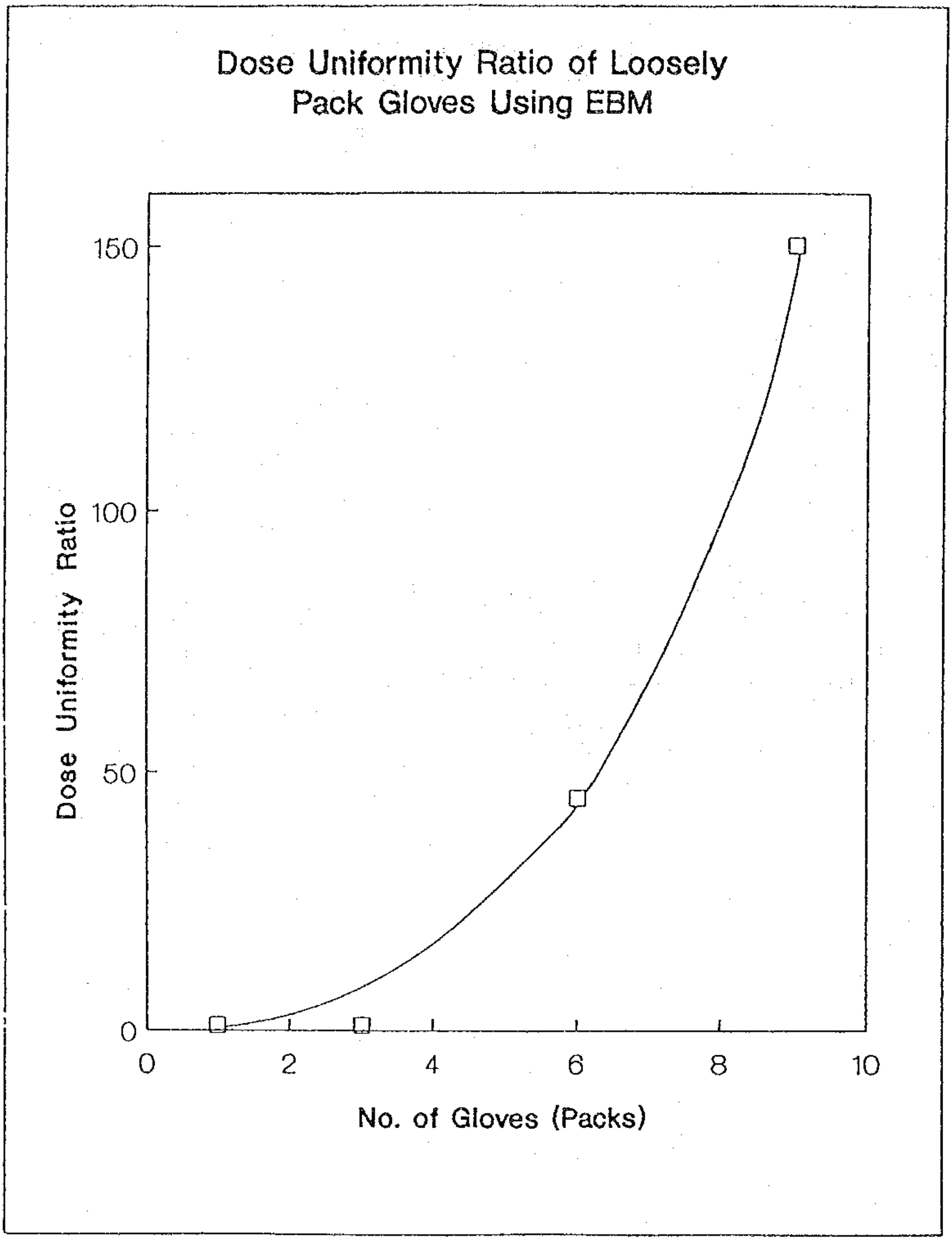

8 PACKS
CTA
INTO BOX
EB
CTA
CONVEYOR
DIRECTION
SCANNING WIDTH

EB IRRADIATION CONDITIONS

VOLTAGE	: 3 MeV
CURRENT	: 1 mA
SPEED	: 1.16 m/min
1 PASS	: 10 kGy
TOTAL NO OF PASS	: 5 PASSES
ABSORBED DOSE	: 50 kGy
IRRADIATION POSITION	: 1 SIDE
DOSIMETER USED	: CTA FILM


Depth Dose Distribution of
Rubber Sheets Using EBM
0.4
0.3
ΔOD
0.2
0.1
0.0
0
0.5
1
1.5
2
2.5
Depth (g/cm2)


Dose Distribution of Loosely
Pack Gloves Using EBM
0.4
0.3
0.2
0.1
0.0
ΔOD
0
2
4
6
8
10
No. of Gloves (Packs)
00 (13)
11 (20)
07 (19)


Dose Uniformity Ratio of Loosely
Pack Gloves Using EBM
Dose Uniformity Ratio
150
100
50
0
0
2
4
6
8
10
No. of Gloves (Packs)

SURGICAL RUBBER GLOVES (4 PAIRS)

ONE-SIDE IRRADIATION (4 PAIRS)				DOUBLE-SIDED IRRADIATION (4 PAIRS)			
CTA NO.	ΔO.D(MIN)	ΔO.D(MAX)	DUR	CTA NO.	ΔO.D(MIN)	ΔO.D(MAX)	DUR
LT1	0.210	0.225	1.07	MT1	0.150	0.320	2.13
LT2	0.110	0.230	2.09	MT2	0.210	0.325	1.55
LB1	0.110	0.315	2.86	MB1	0.155	0.325	2.09
LB2	0.275	0.310	1.13	MB2	0.235	0.330	1.40
L00	0.230	0.250	1.08	M00	0.290	0.300	1.03
L01	0.230	0.260	1.13	M01	0.280	0.310	1.11
L02	0.230	0.275	1.19	M02	0.280	0.325	1.16
L03	0.225	0.320	1.42	M03	0.280	0.355	1.27
L04	0.230	0.315	1.37	M04	0.285	0.365	1.28
L05	0.235	0.320	1.36	M05	0.290	0.390	1.34
L06	0.230	0.340	1.48	M06	0.290	0.400	1.38
L07	0.230	0.345	1.50	M07	0.280	0.405	1.45
L08	0.235	0.340	1.45	M08	0.300	0.310	1.03
L09	0.230	0.330	1.43	M09	0.280	0.390	1.39
L10	0.240	0.315	1.31	M10	0.290	0.380	1.31
L11	0.235	0.300	1.28	M11	0.285	0.360	1.26
L12	0.240	0.295	1.23	M12	0.280	0.335	1.19
L13	0.230	0.285	1.24	M13	0.285	0.325	1.14

Second Joint Committee Meeting of
UTN - JICA Technical Cooperation on
Radiation Applications Project.

Review of Project Implementation in FY 1991.
Radiation Curing of Surface Coatings.
Nik Ghazali Nik Salleh.

INTRODUCTION

Radiation curing using the low energy electron beam is relatively high technology to Malaysia. This equipment (Curetron) was provided by Japan International Cooperation Agency (JICA) under the UTN - JICA Technical Cooperation on Radiation Applications Project. This is the first EB machine available in this country for radiation curing especially in surface coatings. However, ultraviolet (UV) curing has already been employed in local industries for printing and coating mainly wood base materials. In view of its great potential for industrial applications, Unit Tenaga Nuklear (UTN) has embarked on this project with the assistance of JICA.

RESEARCH ACTIVITIES IN RADIATION CURING

A great variety of solventless electron beam coating materials is offered on the market nowadays. In preparing the radiation curable coating materials, the Radiation Curing Group at the Nuclear Energy Unit (UTN) studied the main technological parameters of coating formulation and curing such as:

i. the effect of monomer functionality
ii. the effect of monomer reactivity
iii. the effect of dose requirement
iv. the effect of inerting atmosphere

The main components used in the coating formulation of radiation curable coating materials are:

1. **Oligomers/prepolymers**
    i. Aromatic urethane acrylate
    ii. Aliphatic urethane acrylate
    iii. Epoxidized palm oil acrylate
    iv. Liquid epoxidized natural rubber acrylate

2. **Monomers/reactive diluents**
    i. Monofunctional monomers
    ii. Difunctional monomers
    iii. Trifunctional monomers.
    iv. Hexafunctional monomer

3. Additives

i. 2-Hydroxyethyl acrylate

Since the above oligomers are very viscous, there is a need to mix them with reactive diluents or monomers in order to achieve the required viscosity of the resin for the desired coating. Selection of the diluent monomers is made in such a way that it can help enhance the process of crosslinking during the curing period.

The resins used in our research project are mainly commercial resin easily available in the market except epoxidized palm oil acrylate (EPOLA) and liquid epoxidized natural rubber (LENRA). These two epoxy resins are synthesized in our laboratory. In the formulation of EB coating materials, these oligomers were dissolved in several reactive diluents and the composition ratio is as listed in Table 1 and 2. The setting time of the coating prior to electron beam irradiation is also very important for surface tension i.e during coating and irradiation process. Therefore, 2-hydroxyethyl acrylate (HEA) was added into the above formulations i.e about 10 percent of the total weight.

In the case of using reactive diluents in the coating formulations, we are now introducing more monofunctional monomers than other multifunctional monomers. This is because the former have better properties especially in viscosity, adhesion and physical properties. At early stage, the Radiation Curing Group used mostly multifunctional monomers in order to obtain fast curing and also hard films.

For monitoring the curing progress of the coating materials, a series of Standard Mitsubishi Pencil (JIS 5400) which is approved by the Japan Paint Inspecting Association or pendulum hardness tester (Labotron-Byk) and the non-extractible gel content (soxhlet extraction) have been tested. It should be noted that pendulum hardness is more sensitive as testing method than the solvent extraction to follow crosslinking conversion (see Figures 1 to 4). Before that, we have to measure the viscosity of the resins by using viscometer (Brookfield).

At the same time, the Radiation Curing Group is also working on the development of resins from indigenous materials such as palm oil and natural rubber. It is a great progress that epoxidized palm oil products (produced by PORIM) and epoxidized natural rubber of lower molecular weights (produced by RRIM and UKM) are now available, which enable our scientists to synthesize these products by acrylation process. More work will be needed to accumulate basic data for these newly developed materials (such as curing behaviour, physico-chemical properties of oligomer-monomer mixture and also cured films) before these can be applied into practical processing. Potential applications of these materials could be in printing and adhesives (lamination or pressure sensitive).

Since epoxy compounds are directly polymerizable through cationic mechanism, investigation on cationic polymerization of liquid epoxidized natural rubber (ENR) and epoxidized palm oil products (EPOLA) has been initiated. The iodonium salt was dissolved in ethylene divinyl ether. A mixture of liquid ENR and ethylene divinyl ether added with the catalyst solution required higher dose (about 170 kGy) to be cured by EB irradiation. This cure systems can also be sensitive to moisture and humidity. However, the cationic polymerization systems (cationic curing) have advantages compared to radicals systems in that:

i. Epoxy compounds can be directly utilized without acrylation process.
ii. Reduced coating shrinkage and better adhesion on some substrates like metals.

We have also overcome the high level of background noise (trouble shooting) caused by the infrared spectrophotometer Model IR-700 (JASCO). After measuring 100 percent transmittance, single beam (SB) energy level and using standard film of the polystyrene, we sent these spectrum to the manufacturer in Japan (see Figures 5 to 7).

Later, it was found that both the thermocouples of the light source in the infrared spectrophotometer and the spare one given by a manufacturer were damaged (may be due to humid/moisture). We ordered another unit of the thermocouple through a local agent in

Malaysia i.e Research Instrument Sdn. Bhd. Now, this equipment is able to operate and analyze the samples correctly (see Figure 8).

For the past few months, the Radiation Curing Group were also involved in the parquet project. We produced more than three thousands pieces of parquet and five hundreds pieces of souveniers (handycraft and gypsum tiles) which were cured by the low energy electron beam (Curetron). These parquet are made from rubberwood timber. We also used between 20 to 30 percent of epoxidized palm oil acrylate or liquid epoxidized natural rubber acrylate in the coating formulations. These parquet were installed at the control room of EBM building.

Now, we are in the process of modifying the valves of the low energy electron beam machine (piping system) so that air can be introduced into the irradiation chamber. From this modification, we can control the amount of air/oxygen in the chamber. In future, the Radiation Curing Group can study the effect of oxygen content (ppm) in the inerting atmosphere on the hardness of EB cured coatings. Inertization is required at the zone of EB curing where the radical chain-reaction of complete hardening occurs within a second.

EXPERTS IN FISCAL YEAR 1991

1. Long Term Expert

   i. Curing Supervisor (None)

      Duration: 1 - 1.5 years

2. Short Term Experts

   i. Mr. Takashi Sasaki

      Field : Product Characterization

      Duration: 3 weeks

      (18 Sept. - 10 Oct. 1991)

   ii. Mr. Y. Haruyama

      Field : Dosimetry for Curetron

      Duration: 4 weeks

      (21 Aug. - 18 Sept. 1991)

   iii. Instruction of Coatings Machine (None)

      Duration: 1 week

During Mr. T. Sasaki stayed at UTN for the short period of time in September last year, the expert did contribute or recommend certain aspect related to radiation curing such as:

   i. To use commercial coating materials for practical applications (at early stage).

ii. Extensive work should be continued to collect/get more data basic data regarding the development of new materials.

iii. Synthesized iodonium salt.

iv. Explain the principles and operation methods of the reverse roller coater and the curtain (flow) coater.

v. To move weather meter tester (Suga) to suitable place i.e Heavy machine laboratory at the MTS building.

TRAINING PROGRAMME IN FY 1991

In this fiscal year, there is no personnel from the Radiation Curing Group trained in Japan except Mr. Nik Ghazali Nik Salleh. He went to Takasaki Radiation Chemistry Research Establishment (JAERI) under FY 1990 (21 Mar. - 29 Sep.1991) and carried out research in the field of coating formulations.

RESEARCH EQUIPMENTS IN FY 1991

Research Equipments Received From JICA

1. Washability Tester (Toyo Seiki)
2. Du Pont Type Paint-film Impact Tester (Toyo Seiki)
3. Accessories for High Performance Gel Permeation Chromatography System Model HLC-8020 (Tosoh):
   i. System Controller
   ii. Color Monitor
   iii. Printer
   iv. Degasser
   v. Columns
   vi. Data Processor Software etc.

Note:
The Radiation Curing Group requested wet abrasion tester instead of washability tester. The later is used mainly for testing clothes). Accessories No. 3 is supposed to arrive UTN in December, 1991.

Research Equipments Available IN UTN Until 1991

1. Cone Plate Viscometer (Brookfield)
2. Penhulum Hardness Tester (Labotron-Byk)
3. Pencil Hardness Tester (Ueshima)
4. Ultraviolet Machine (IST)
5. Vacuum Oven System (Eyela)
6. Reflected and Transmitted Optical Microscope (Olympus)
7. Tristimulus Colorimeter (Hunterlab)
8. Glossmeter (Sheen)
9. Ultraviolet Spectrophotometer (Hitachi)
10. TLC Densitometer (CAMAG)
11. Coating Thickness Gauge (Sheen)
12. Rotary Evaporator System (Eyela)
13. Pendulum Hardness Tester (Sheen)
14. Analytical/Semi-micro Balance (Mettler)
15. Hot/Plate Stirrer (Cole Palmer)
16. Ultrsonic Cleaner (Elma)

PERSONNEL INVOLVED IN THE RADIATION APPLICATIONS PROJECT

Project Coordinator:

Dr. Khairul Zaman Hj. Mohd Dahlan

(Head of Radiation Processing Programme)

Personnel Involved In The Radiation Curing:

A. Research Officers

1. Mr. Nik Ghazali Nik Salleh
2. Mr. Dahlan Hj. Mohd
3. Mr. Mohd Hilmi Mahmood
4. Ms. Mek Zah Salleh
5. Mr. Abdul Ghani Harun
6. Ms. Rafidah Rafi
7. Ms. Noraziah Ismail

B. Supporting Staff

1. Mr. Roslan Ismail
2. Mr. Mohd Rosli Mohd Radzi

Sample No.	OLIGOMER ARONIX M-1100	MONOMERS HEA	FA 513A	VISCOAT 155	FA 513M	ARONIX M-220	NK ESTER A-TMPT	NK ESTER A-TMM-3	KAYARAD DPCA-60	tBA
M-1	50	10	40							
M-2	50	10	-	40						
M-3	50	10	-	-	40					
M-4	50	10	-	-	-	40				
M-6	50	10	-	-	-	-	40			
M-7	50	10	-	-	-	-	-	40		
M-8	50	10	-	-	-	-	-	-	40	
M-9	50	10	-	-	-	-	-	-	-	40

Table 1 Composition ratio of radiation curable coatings (Aromatic urethane acrylate system).

Sample No.	OLIGOMER ARONIX M-1200	MONOMERS								
		HEA	FA 513A	VISCOAT 155	FA 513M	ARONIX M-220	NK ESTER A-TMPT	NK ESTER A-TMM-3	KAYARAD DPCA-60	tBA
F-1	50	10	40							
F-2	50	10	-	40						
F-3	50	10	-	-	40					
F-4	50	10	-	-	-	40				
F-6	50	10	-	-	-	-	40			
F-7	50	10	-	-	-	-	-	40		
F-8	50	10	-	-	-	-	-	-	40	
F-9	50	10	-	-	-	-	-	-	-	40

Table 2 Composition ratio of radiation curable coatings (Aliphatic urethane acrylate system).

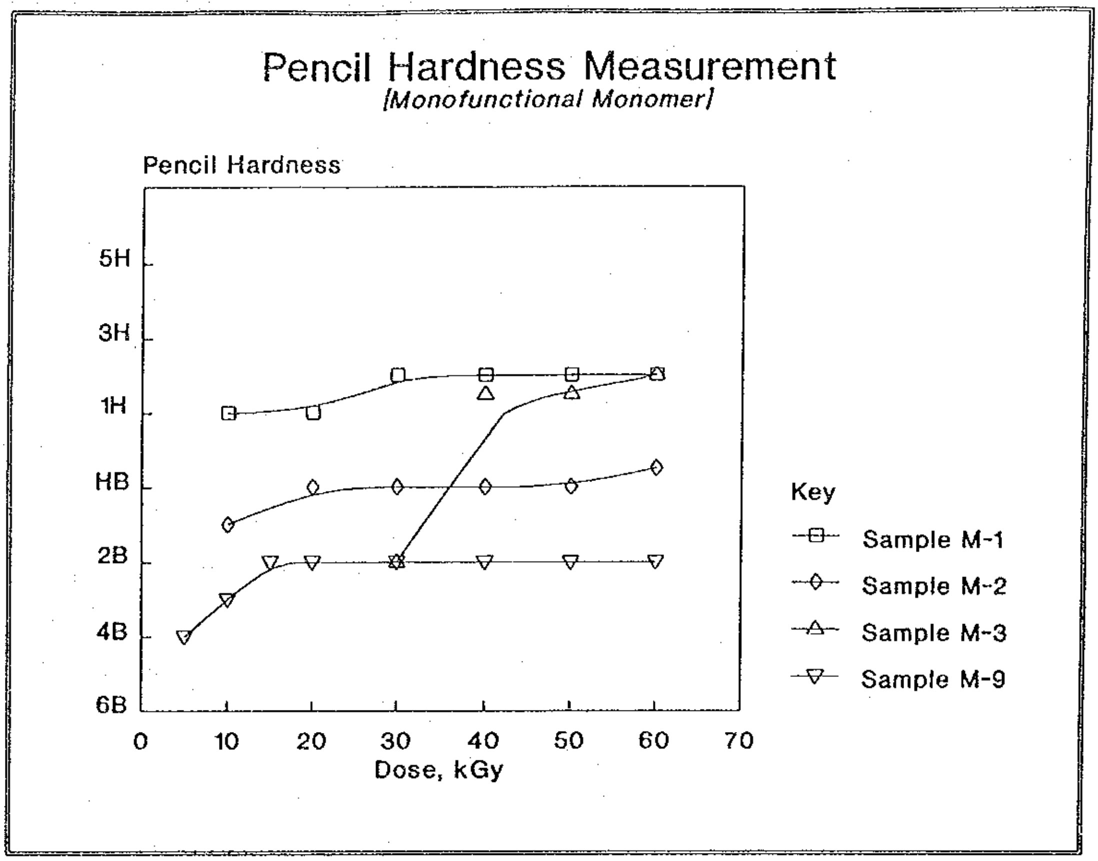


Fig. 1 Pencil hardness measurement of aromatic urethane acrylate formulations.

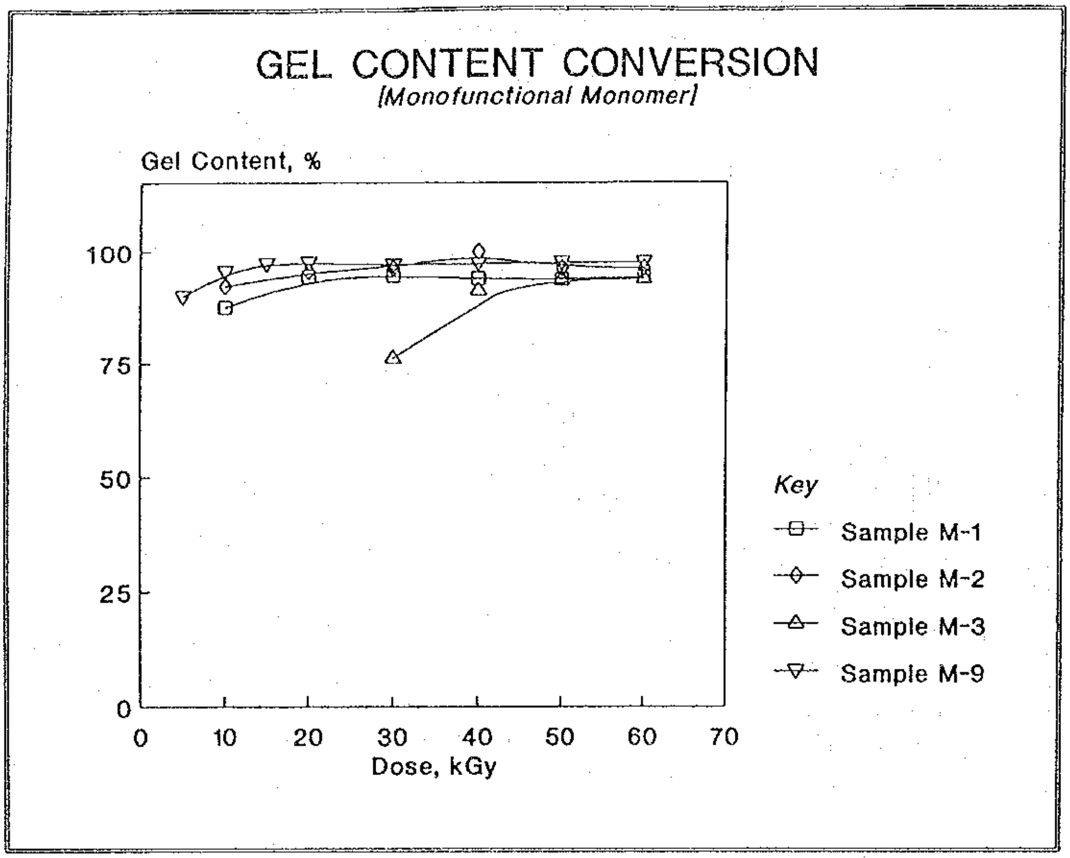


Fig. 2 Gel content conversion of aromatic urethane acrylate formulations.

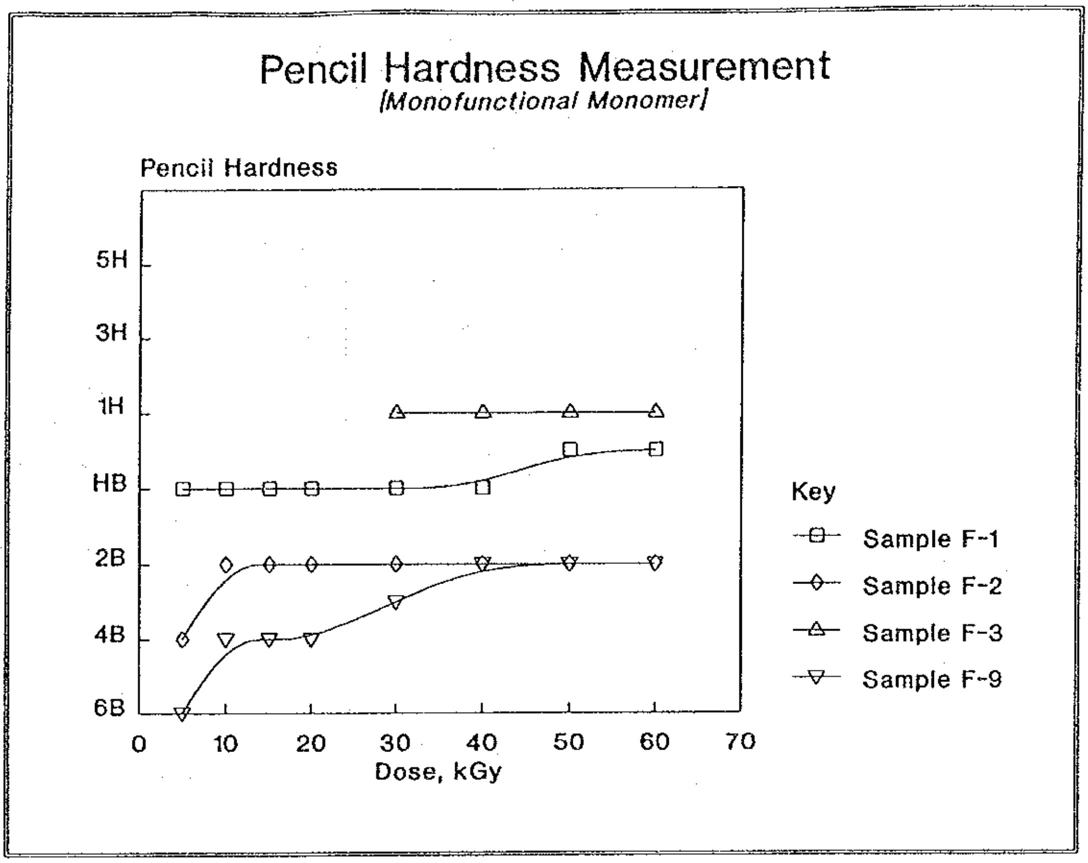


Fig. 3 Pencil hardness measurement of aliphatic urethane acrylate formulations.

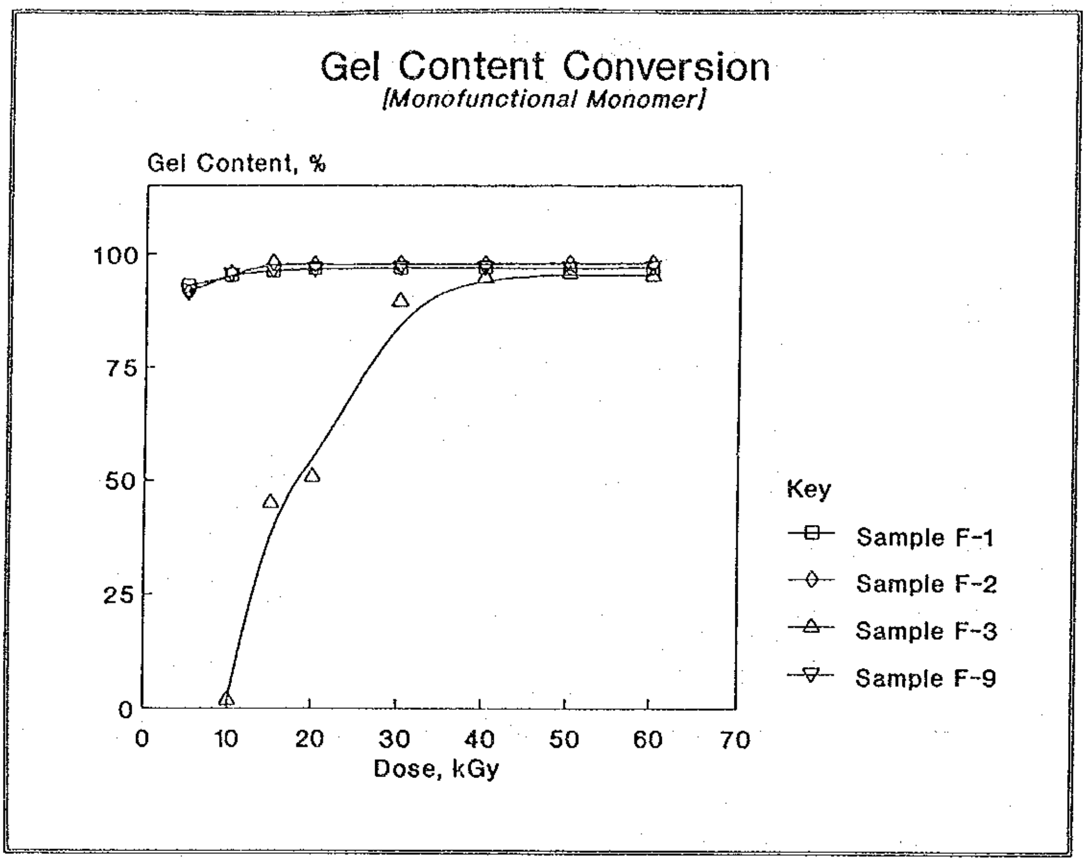


Fig. 4 Gel content conversion of aliphatic urethane acrylate formulations.

Figure 5 100 Percent Transmittance

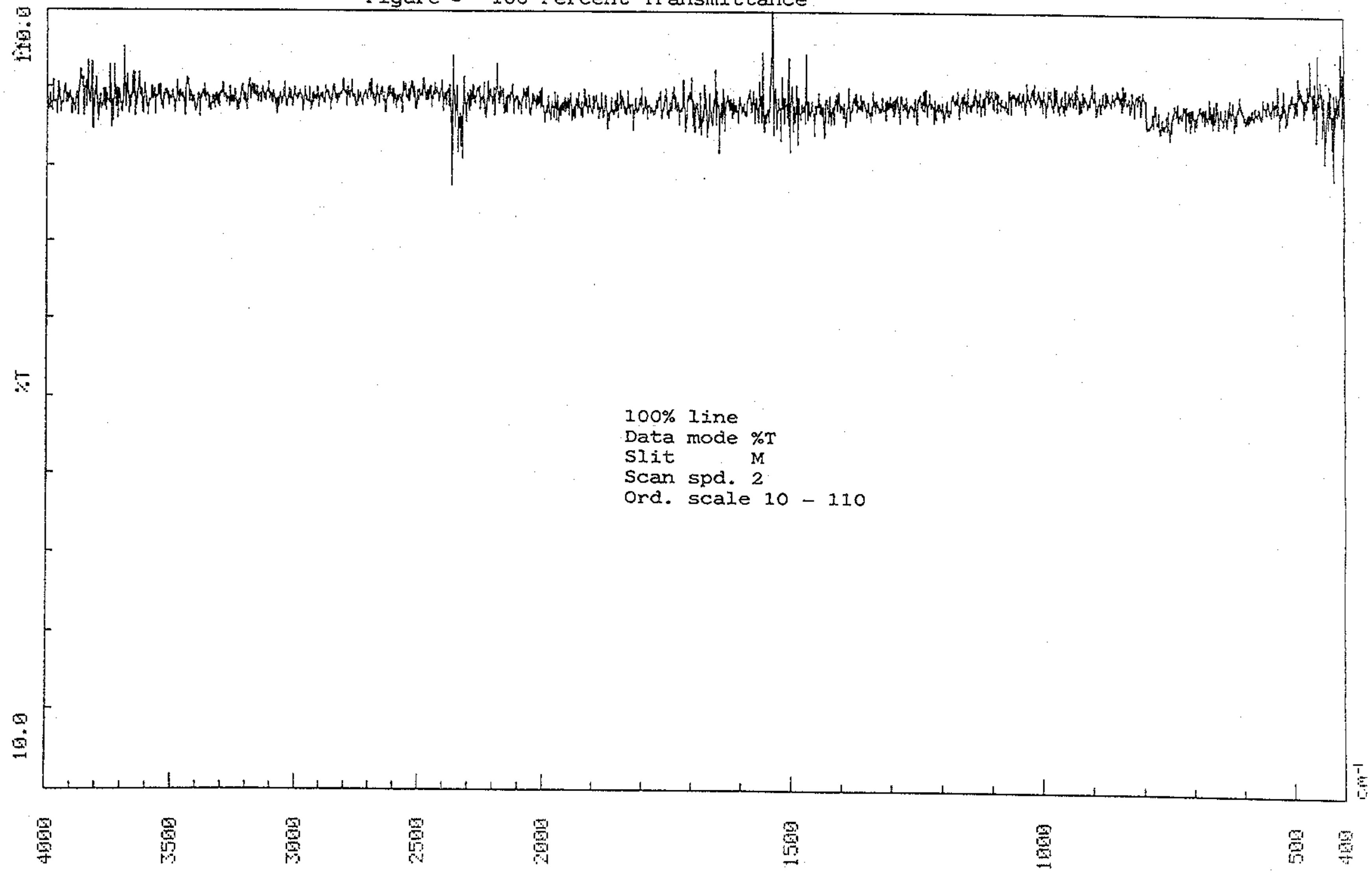


Figure 6 Single Beam (SB) Energy Level

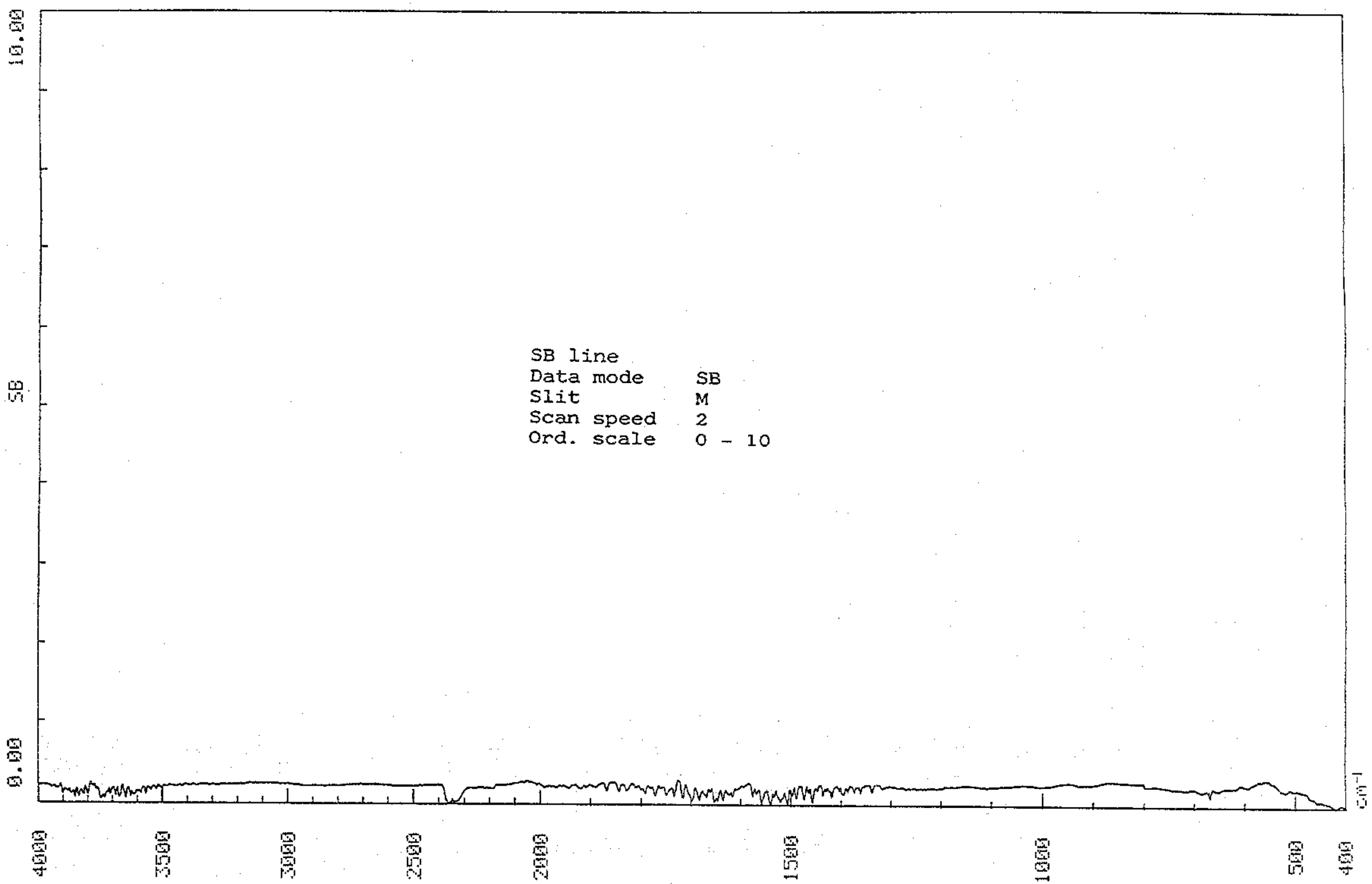


Figure 7 Standard film of the Polystyrene (with background noise).

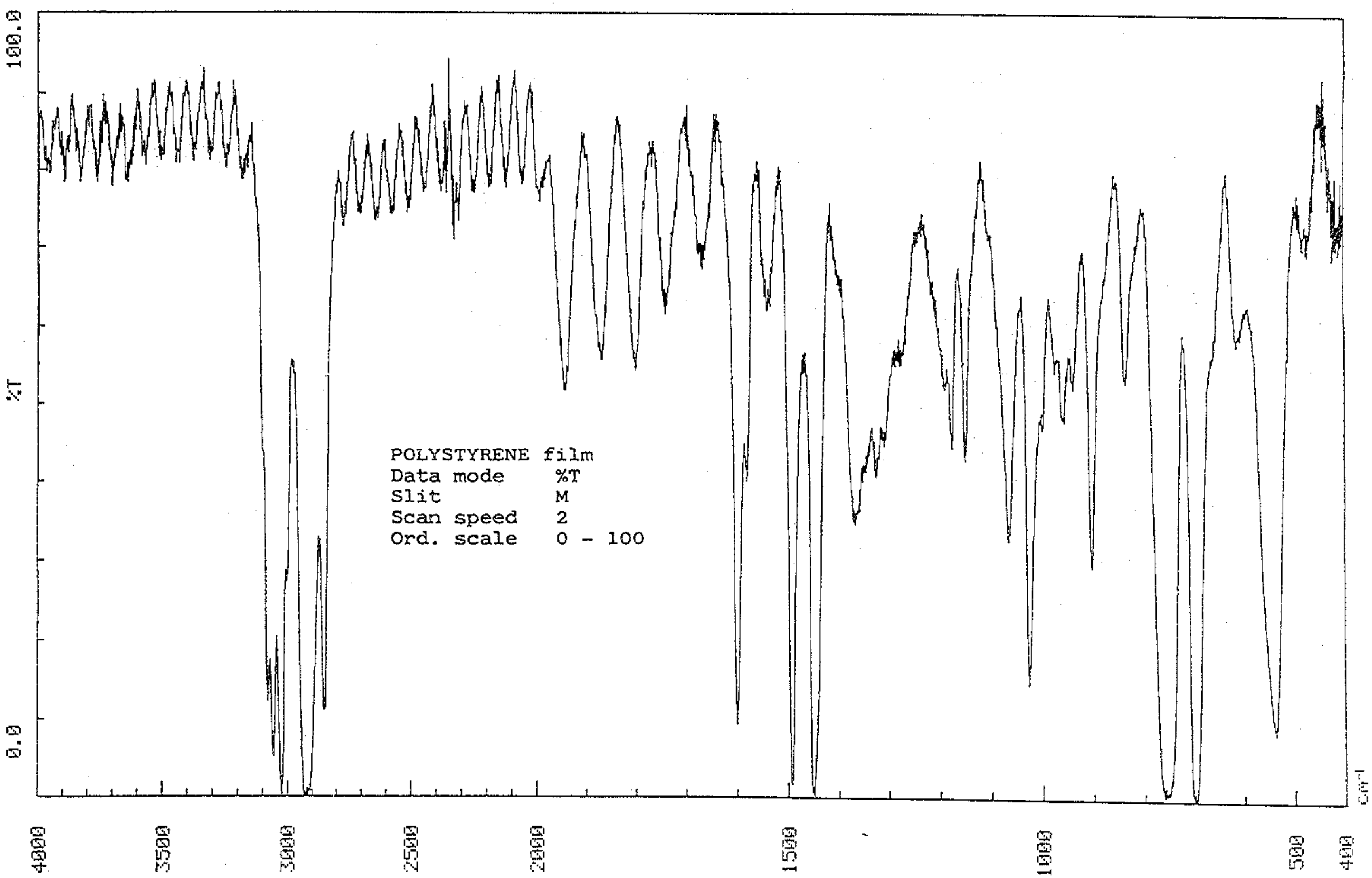


Figure 8 Standard film of the Polystyrene.

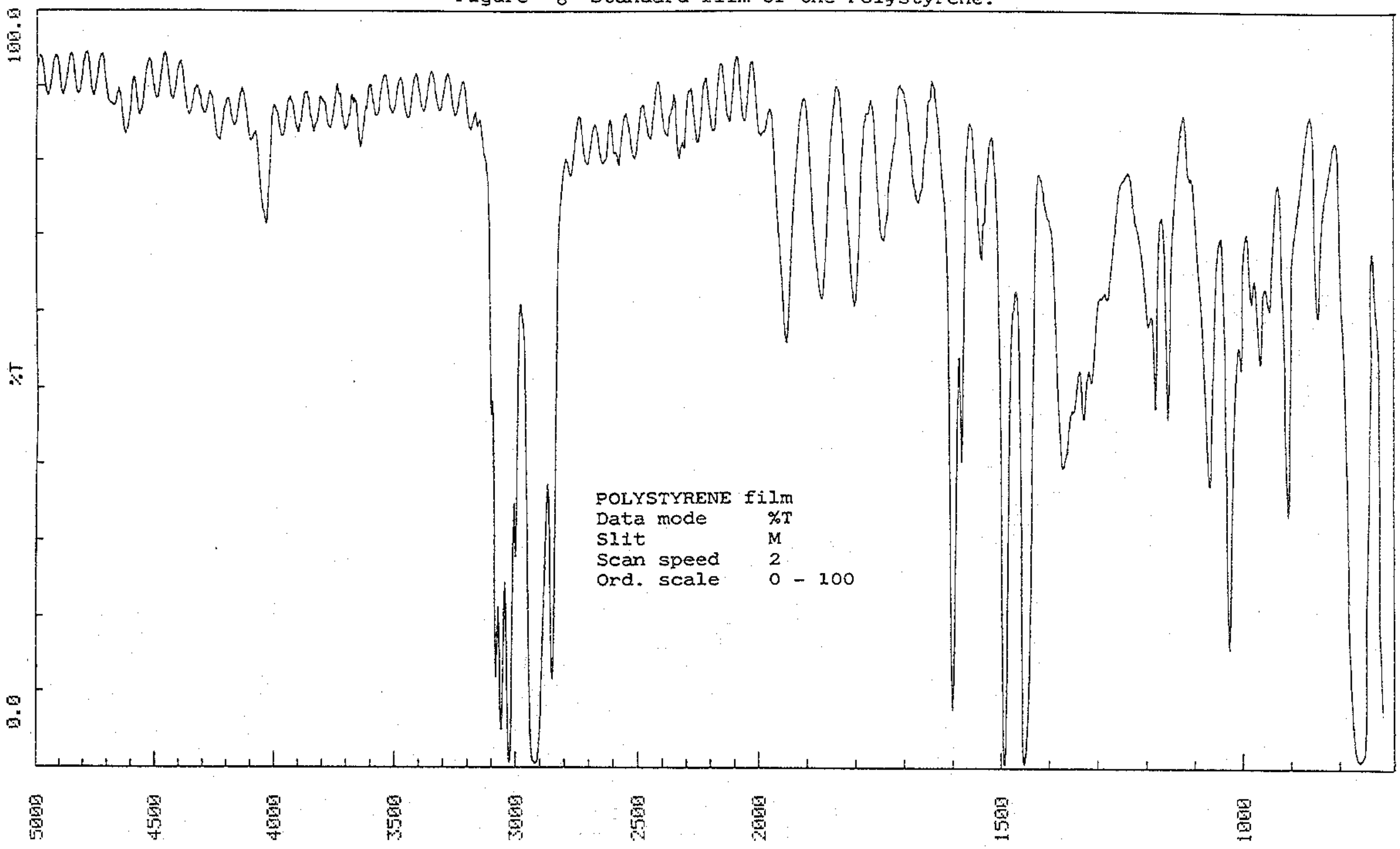


Figure 9 Single Beam (SB) Energy Level (without noise)

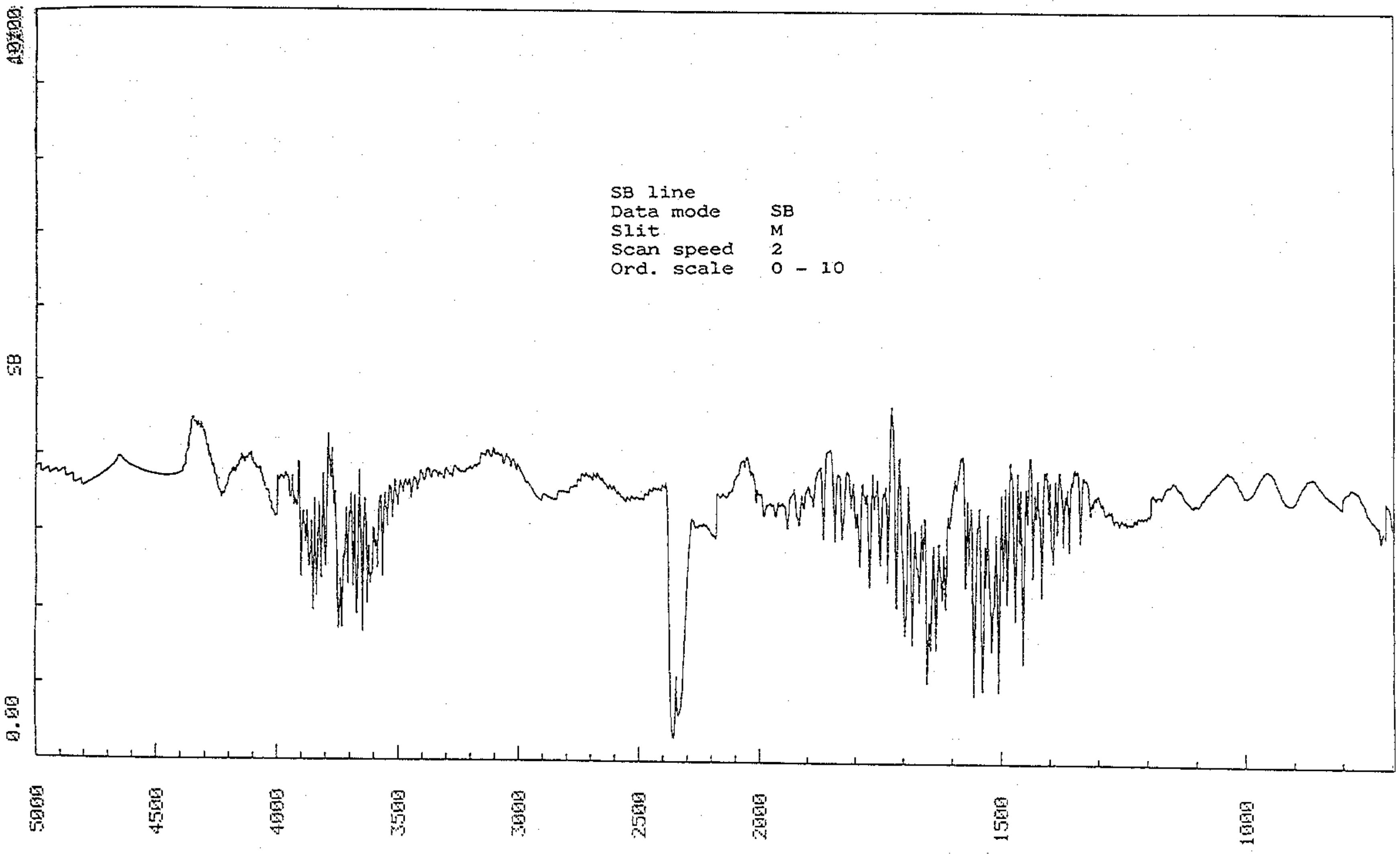


Table 1 List of Experts in FY 91

Name	Organiz.	Period	Purpose
YoshiKazu Kasahara	Tester Sangyo	19.05.91 - 25.05.91	Commi. Res. Equi
Sadaaki Tomizawa	Tester Sangyo	19.05.91 - 25.05.91	Comm. Res. Equip
Kazuyoshi Hikihara	NHV	20.05.91 - 23.06.91	EBM Test Operat.
Masayuki Kashiwagi	NHV	03.06.91 - 23.06.91	EBM Training
kouji Watanuki	JAERI	21.08.91 - 03.09.91	Radiat. Safety
Yasuyuki Haruyama	JAERI	21.08.91 - 18.09.91	EBM Dosimetry
Humio Yoshii	JAERI	21.08.91 - 14.09.91	Radiat. Damagess
Takashi Sasaki	JAERI	18.09.91 - 10.10.91	Product Charactn
Yuhei Watanabe	JAERI	28.10.91 - 16.11.91	Biological Study
Hiroyuki Tachibana	JAERI	07.11.91 - 04.12.91	Rad. Technology
Takashi Sasaki	JAERI	Feb. - Mar. 3 weeks	Product Charactn
Takao Kanazawa	JAERI	Postpone to FY92	Data Logger Inst

Table 1. A List of Experts in FY 91(Continued)

Name	Organiz.	Period	Purpose
Not Fixed	NHV	Postpone to FY 92	Data Logger Inst
Not Fixed	NHV	Postpone to Fy 92	EBH Haintenance

Table 2. List of Trainee in FY 89 to FY 91

Name	Period	Field
Dr. Khairul Zaman Hj Mohd Dahlan	23.01.90 - 24.04.90	Curing
Dr. Zahrah Abd. Kadir	13.03.90 - 14.06.90	Sterilizatn.
Ms. Noriah Mod Ali	13.03.90 - 13.08.90	Dosimetry
Mr. Wan Abd. Hadi Wan Abu Bakar	14.08.90 - 18.09.90	Acc.Operatn.
Mr. Shari Jahar	14.08.90 - 28.09.90	Acc.Operatn.
Mr. Nik Ghazali Nik Salleh	21.03.91 - 21.09.91	Curing
Mr. Kamarudin Hj. Buyong	24.09.91 - 17.12.91	Acc.Operatn.
Mr. Zulkafli Mohd Nor	22.10.91 - 17.12.91	Rad. Safety
Ms. Asnah Hasan	02.03.92 - 01.06.92	Microbiology

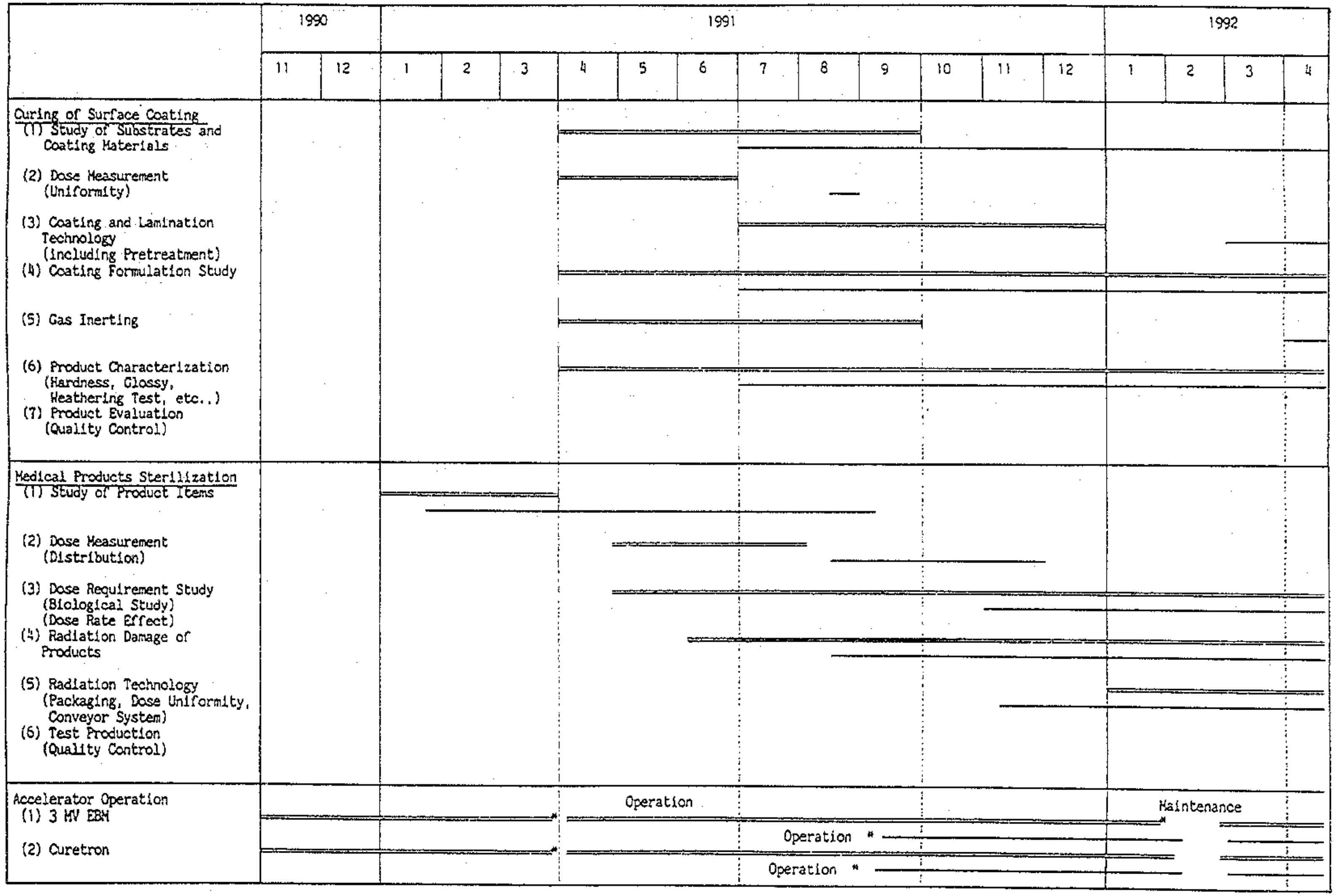
Table 3. A list of Donated equipment in FY 91

Equipment	Approx. Price (10^3yen)	Purpose
GPC Systemization Accessor	4,422	Curing
Dissolusion Tester (with HPLC)	9,389	Sterilization
Melt Indexer	1,204	Sterilization
Data Logger for 3MV EBM	4,359	EBM Operation

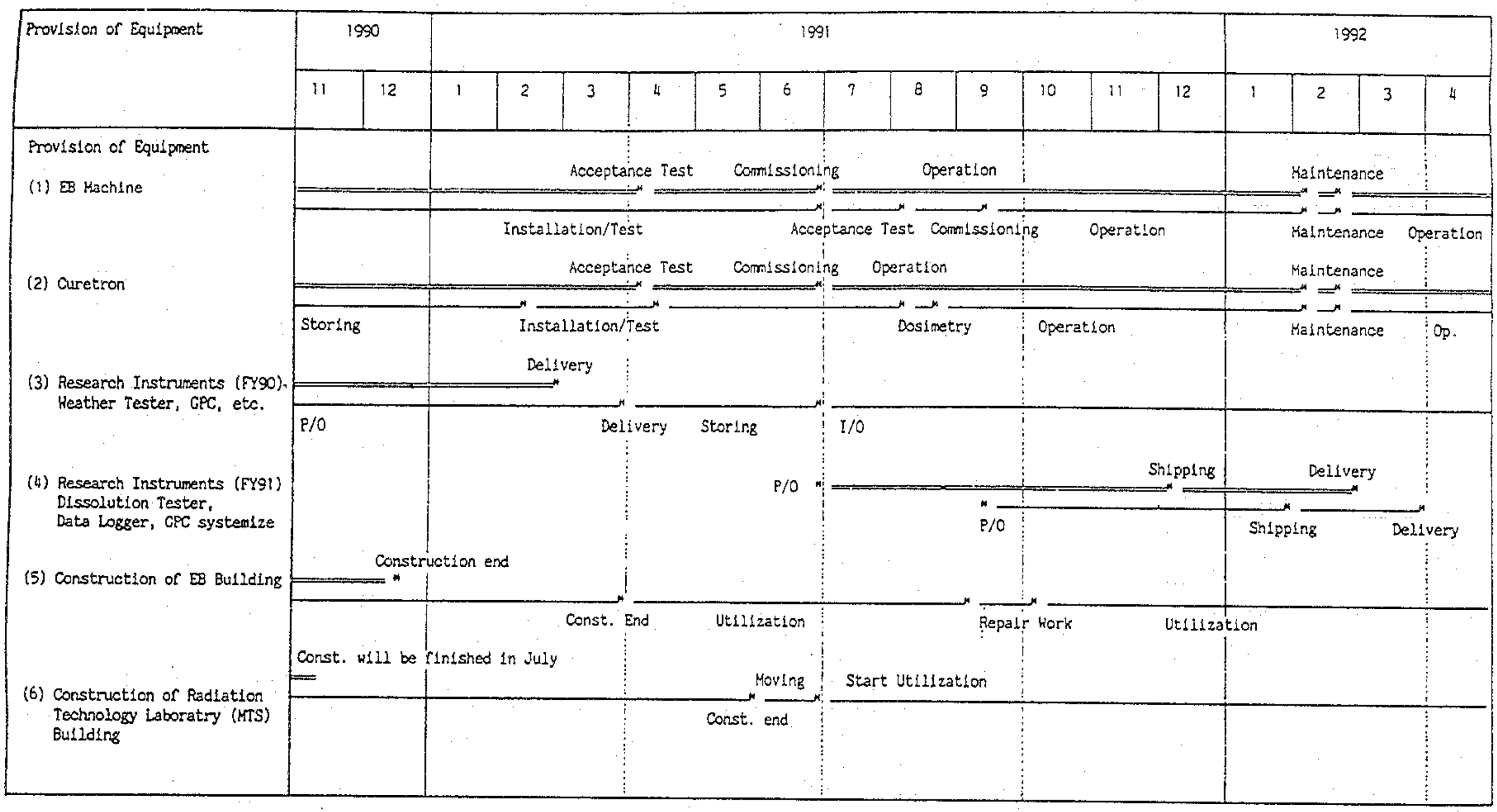
Table 4. A list of Keiko-Kizai in FY 91

Equipment	Approx. Price (10^3yen)	Purpose
Desicator	164	Dosimetry
Accessories for Tensile M	914	Sterilization
Handy Humidity Meter	126	Common
Word Processor (Desk-top)	274	Common
Word Processor (Lap-top)	232	Common
Digital Temperature Record	439	Common
Load Cell	Not delivered	Sterilization
Thickness checker	Not delivered yet	Dosimetry

Progress of the Project in FY 91 (Research Activities)



Progress of the Project in FY 91 (Provision of Equipment & construction)



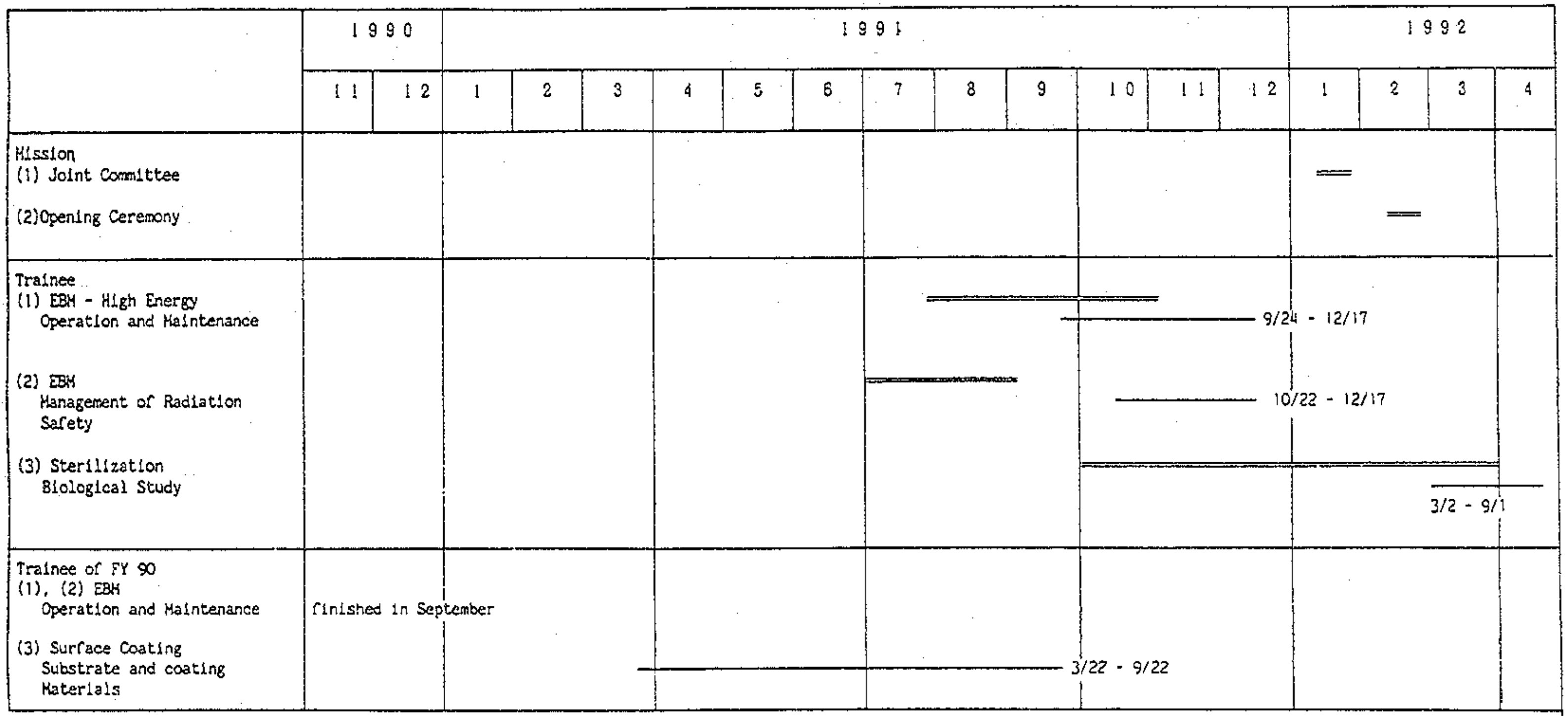
Progress of the Project in 1991 (Experts)

	1990		1991												1992			
	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
Long Term Expert																		
(1) Project Leader									Home Leave (6/24 - 7/25)								(to 24 May'92)	
(2) Coodinator												Home Leave (10/21 - 11/12)					(to 24 May'92)	
(3) Curing Supervisor								1 - 1.5 year	(not realized)									
Short Term Expert																		
(1) Surface Coating Product Characterization												9/18 - 10/10		3 Months			3 [illegible]	
(2) EBM - High Energy Test Operation and Training									5/20 - 6/23 (2 persons)									
(3) EBM - High Energy Radiation Safety											8/21 - 9/3							
(4) EBM - High Energy Commissioning Dose Maping												8/21 - 9/18 (Common with (5))						
(5) EBM - Curetron Dosimetry																		
(6) Surface Coating Instruction of Coating Machine							(not realized)											
(7) Sterilization Instruction of Research Equipments							5/19 - 5/25 (2 persons)											

Progress of the Project in 1991 (Exp... ...)

	1990		1991												1992			
	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
Short Term Expert (Continued) (8) Sterilization Dose Reqirement (Biological Study)													10/28 - 11/16					
(9) Sterilization Radiation Damage of Mterials										8/21 - 9/14								
(10) Sterilization Process Control													11/7 - 12/4					
(11) EBM-High and Curetron Priventive Maintenance																——		
(12) EBM - High Energy Data Logger Installation																——		
Short Term Experts in FY 90 (1) EBM - High Energy Assembling and Installation	(2) 11/14 - 12/22		(1) 1/22 - 4/16															
(2) EBM - Curetron Installation and Test				2/25 - 4/13														
(3) EBM - High Energy Radiation Saferty			1/23 - 2/19															
(4) EBM - High Energy Commissioning			(2) 1/23 - 3/2															
(5) Sterilization Selection of Product Items			1/21 - 2/16															
(6) Surface Coating Study on Substrate				2/20 - 3/14														

Progress of the Project in 1991 (Mission & Trainee)



Proposed Workplan FY 1992

1. The mission and seminar
   (1) Regional Seminar on EB Processing: August 1992
   (2) Mission : December, 1992

2. Despatch of the short-term experts
   (1) Accelerator (Preventive maintenance), 3 weeks (December, 92)
   (2) 〃 (Standardization of Dosimetry), 4 weeks (August, 92)
   (3) Surface coating (Resin Formulation Study), 3 months (April - June, 92)
   (4) 〃 (Characterization of Products), 4 weeks (January -, 93)
   (5) Sterilization (Radiation Technology), 3 weeks (May - , 92)
   (6) 〃 (Radiation Damage of Materials), 4 weeks (June, 92)
   (7) Instruction of Equipment (Commis. of GPC), 1 week (April, 92)
   (8) 〃 (Chemiluminescence), 1 week (March, 93)
   (9) Sterilization (Test Production, Quality Control), 4 weeks (Feburuary, 93)
   (10) 〃 (Biological Study), 3 weeks (July, 92)

3. Equipments to be donated
   Total request: 75.00 MYen

4. Keiko-Kizai
   Total budget: 5.0 MYen

5. Long-term expert
   (1) Team Leader: Kenzo Yoshida or Succssor (2 years)
   (2) Coodinator : Kiyoshi Honma or Successor (2 years)
   (3) Surface Coating Supervisor: Not Fixed (upto 1 year)

6. Acceptance of trainee
   (1) Surface Coating(Formulation Study), 6 months (September-, 92)
   (2) 〃 (Product Characterization), 6 months (March-, 93)
   (3) Accelerator (Operation, service and dosimetry), 3 months, (March-,93)

7. Local cost

(1) Seminar: 1.2 MYen

(2) Payment for Official car driver

8. List of research equipments requested (75.0 MYen)

(1) Chemiluminesence Analyzer	20,000
(2) Dynamic Mechanical Analyzer	10,000
(3) Universal Scratching Tester	2,500
(4) Adhesion Endurance Tester	5,500
(5) ESR	15,000
(6) Panel Sprayer	1,000
(7) Accelerator accessories and supplies	10,000
(8) UV-Visible Spectrophotometer	2,000
(9) Colour Indexer	2,500
(10)Tackiness Meter	5,000
(11)Data Processor for CTA Reader	1,500
Total	75,000

9. list of equipment to be requested in FY 1993 (39.5 MYen)

(1) 3MV Accelerator Tube	33,000
(2) Weather Tester Supplies	500
(3) GPC and HPLC Spare Parts	1,000
(4) Maintenance Cost for research equipments	5,000
Total	39,500

ANNUAL RESEARCH WORK PLAN - FY 1992 (DRAFT rev.3)

I. Research Subjects

1. Accelerator Operation	2. Curing of Surface Coating	3. Sterilization of Medical Product
1) Operation 2) Maintenance 3) Dosimetry	1) Substrate, Material 2) Dose Measurement 3) Coating, Lamination 4) Coating Formulation 5) Gas Inerting 6) Product Characterization 7) Product Evaluation	1) Product Item Study 2) Dose Measurement 3) Dose Requiement(Biological)Study 4) Radiation Damage of Product 5) Radiation Technology 6) Test Production

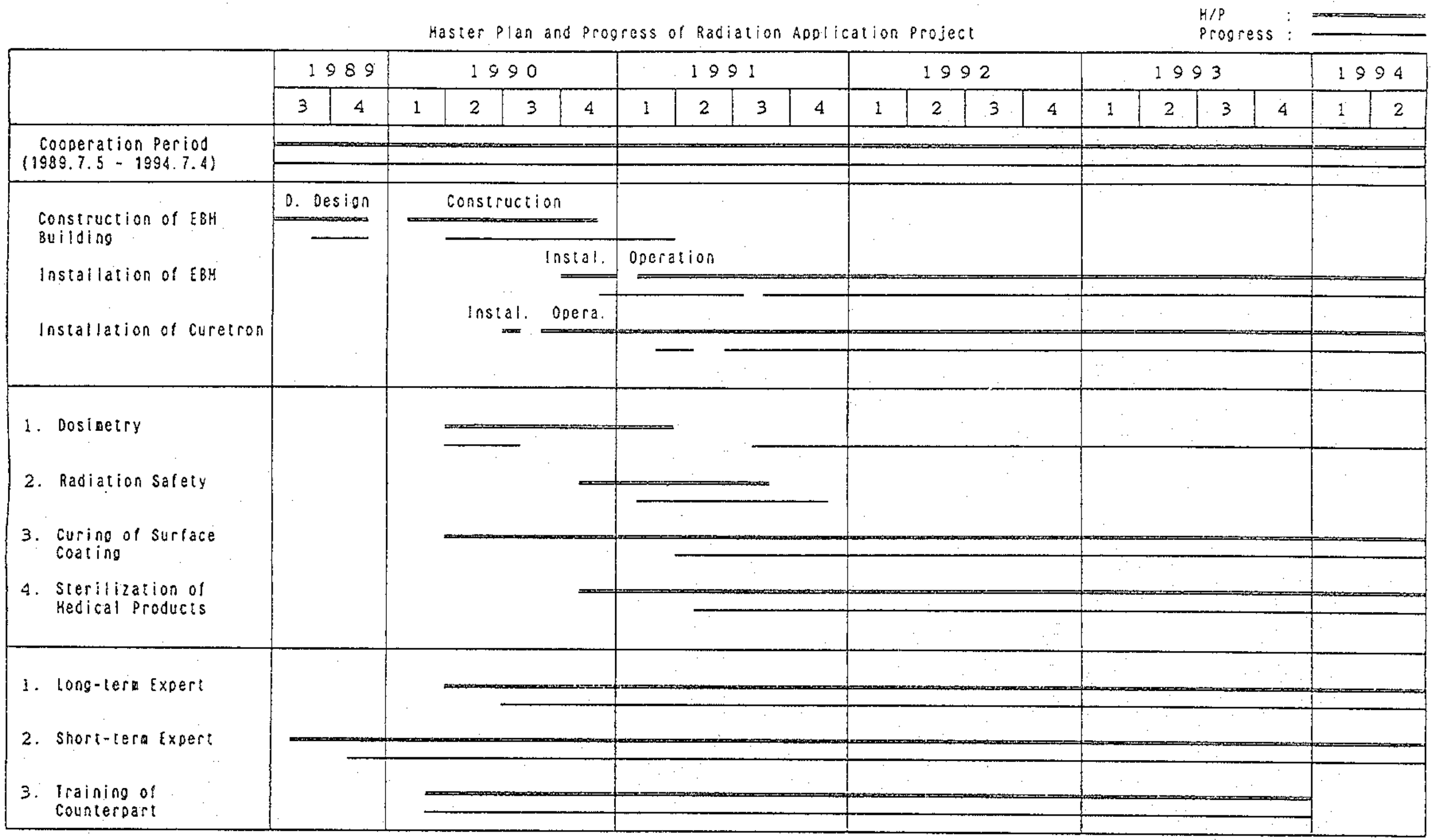
II. Schedule

	FY 1991			FY 1992											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1. Accelerator H.V. Operation	Maintenance											Maintenance			
L.V. Operation	Maintenance											Maintenance			
Dosimetry															
2. Curing 1) Substrate															
2) Dose Measr.															
3) Coat.& Lam.															
4) Formulation															
5) Gas Inert.															
6) Prd. Chara.															
7) Prd. Evalu.															
8)															
3. Steriliztn. 1) Prod. Item															
2) Dose Meas.															
3) Dose Requir															
4) Rad. Damage															
5) Rad. Tech.															
6) Test Prodn.															
7)															

Implementation Schedule in FY 92 (Draft rev.3)

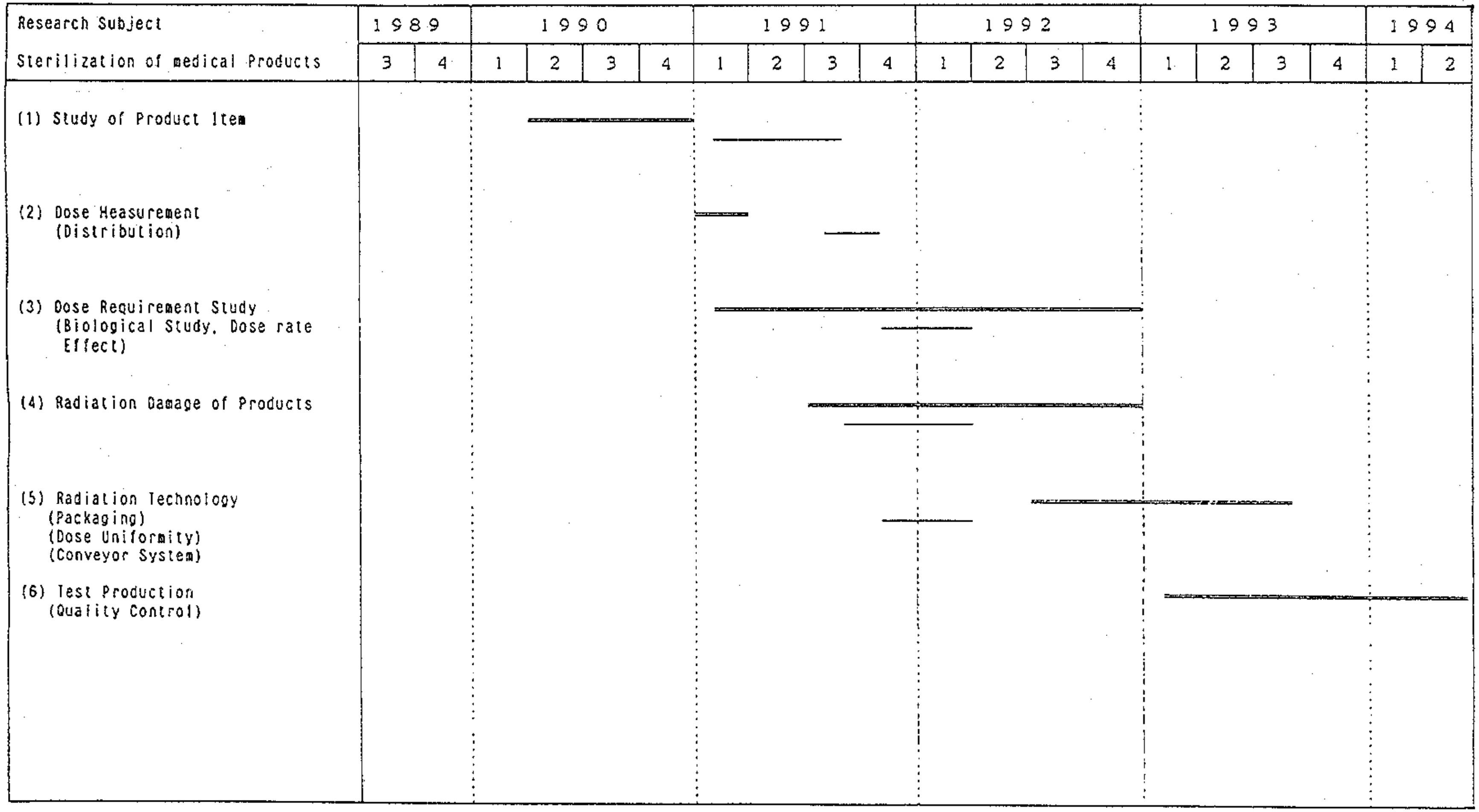
		FY 1992 (4, 5, 6, 7, 8, 9, 10, 11, 12, 1, 2, 3)
Mission	Joint Committee	— 1 week
Seminor	Domestic & Regional	— 1 week
Expert	Long Term	replace or continue?
	1. Leader	———— ———————— 2 years
	2. Coordinator	———— ———————— 2 years
	3. Curing Supervisor	Unpromissive, might be replaced by several short term experts
	Short Term	both EBM
	1. Acc. Maintenance	——
	2. Standard Dosimet.	—— both EBM
	3. Coating Formulat.	———— from Industry (or JAERI's expert 3 weeks)
	4. Product Charact.	—— 4 weeks
	5. Radiation Techn.	—— 3 weeks
	6 Radiation Damage	—— 4 weeks
	7. Equip. Comm. GPC	—
	8. Equip. Comm.	—
	9. Test Production	——
	10.Biological Study	—— 3 weeks; 4 weeks
Trainee	1. Coating Formulat.	6 months ————
	2. Product Charact.	6 months ——
	3. Acc. Operation	3 months ——
	4.	

Master Plan and Progress of Radiation Application Project



Progress and TSI of Sterilization of Medical Products

TSI :
Progress in '91:



Progress and TSI of Curing of Surface Coating

TSI :
Progress in '91:

Research Subject	1989		1990				1991				1992				1993				1994	
Curing of Surface Coating	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
(1) Study of Substrates and Coating Materials																				
(2) Dose Measurement (Uniformity)																				
(3) Coating, Lamination Technology (Including Pretreatment)																				
(4) Coating Formulation Study																				
(5) Gas Inerting																				
(6) Product Characterization (Hardnes, Glossy, Weatering Test etc..)																				
(7) Product Evaluation (Quality Control)																				

APPENDIX 13

Proposed Workplan FY 1992

1. The mission and seminar
   (1) National Seminar on EB Processing: August or September 1992 , 1 week
   (2) Mission (Mutual Consultation): December, 1992

2. Despatch of the short-term experts
   (1) Accelerator (Preventive maintenance), 3 weeks (December, 92)
   (2) 〃 (Standardization of Dosimetry), 4 weeks (August, 92)
   (3) Surface coating (Resin Formulation Study), 1 month (2 ~3 times in FY 92)
   (4) 〃 (Characterization of Products), 2 - 3 weeks (January, 93)
   (5) Sterilization (Radiation Technology), 3 - 4 weeks (September, 92)
   (6) 〃 (Radiation Damage of Materials), 4 weeks (May, 92)
   (7) Instruction of Equipment (Commis. of GPC), 1 week (April, 92)
   (8) 〃 (Chemiluminescence), 1 week (March, 93)
   (9) Sterilization (Test Production, Quality Control), 4 weeks (Feburuary, 93)
   (10) 〃 (Biological Study), 3 weeks (October, 92)
   (11)Accelerator (Noise Control), 1 - 2 weeks (May, 92)
   (12)Four Seminar Lecturers, 1 week (August or September, 92)

3. Equipments to be donated
   Total request: 75.00 MYen

4. Keiko-Kizai
   Total budget: 5.0 MYen

5. Long-term expert
   (1) Team Leader: Kenzo Yoshida (2 years)
   (2) Coodinator : Kiyoshi Honma or Successor (2 years)

6. Acceptance of trainee
   (1) Surface Coating(Formulation Study), 6 months (September-, 92)
   (2) 〃 (Product Characterization), 6 months (March-, 93)
   (3) Accelerator (Operation, service and dosimetry), 3 months, (March-,93)

7. Local cost

(1) Seminar

(2) Payment for Official car driver

8. List of research equipments requested (75.0 MYen)

(1) Chemiluminesence Analyzer	20,000
(2) Dynamic Mechanical Analyzer	10,000
(3) Adhesion Strength Tester	6,500
(4) ESR	15,000
(5) Accelerator accessories and supplies	10,000
(6) UV-Visible Spectrophotometer	2,000
(7) Colour Indexer	2,500
(8) Tackiness Meter	5,000
(9) Data Processor for CTA Reader	1,500
(10)Mixing roll	2,500
Total	75,000

9. list of equipment to be requested in FY 1993 (39.5 MYen)

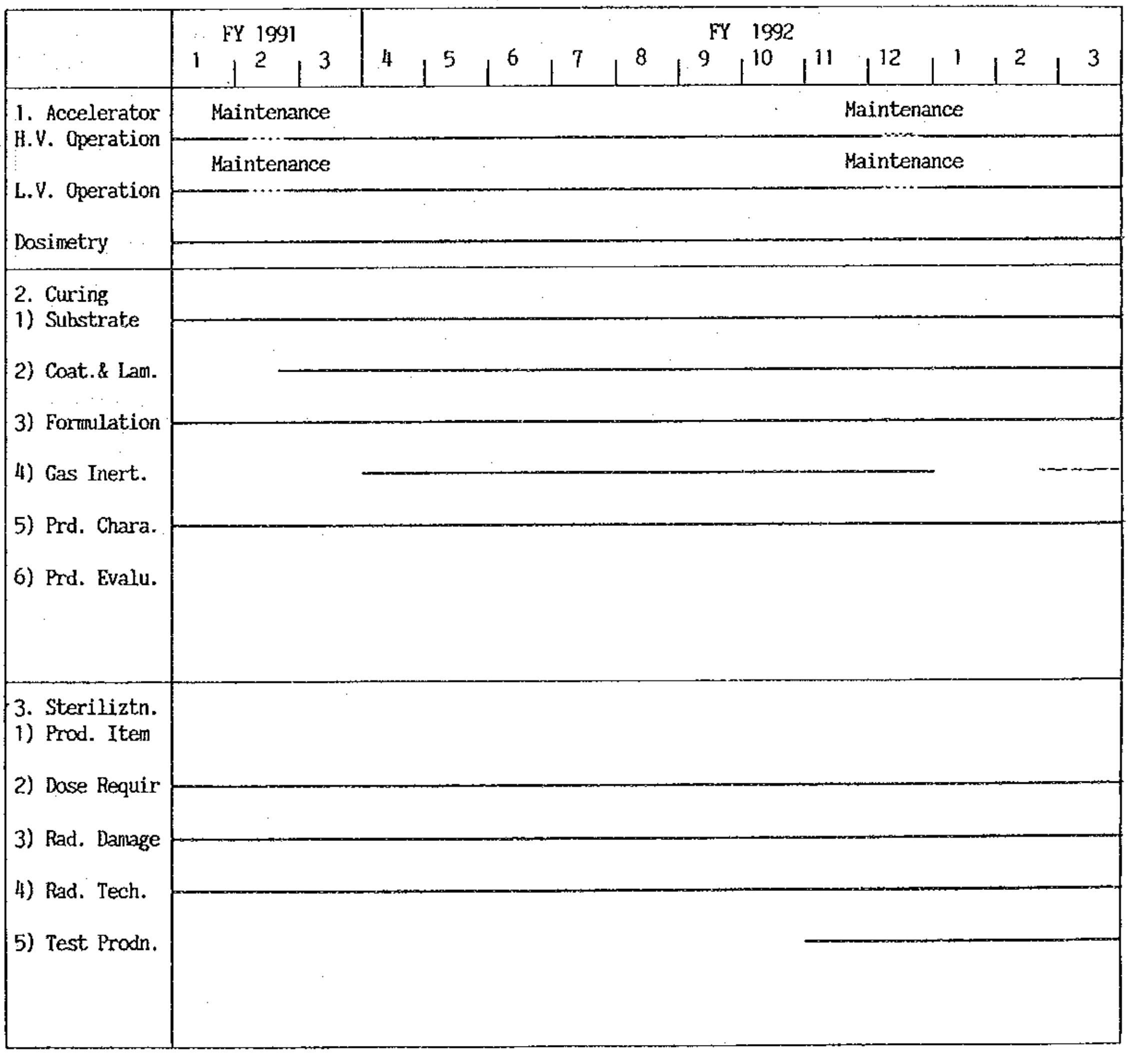
(1) 3MV Accelerator Tube	33,000
(2) Weather Tester Supplies	500
(3) GPC and HPLC Spare Parts	1,000
(4) Spare parts for research equipments	5,000
Total	39,500

ANNUAL RESEARCH WORK PLAN - FY 1992

I. Research Subjects

1. Accelerator Operation	2. Curing of Surface Coating	3. Sterilization of Medical Product
1) Operation 2) Maintenance 3) Dosimetry	1) Substrate, Material 2) Coating, Lamination 3) Coating Formulation 4) Gas Inerting 5) Product Characterization 6) Product Evaluation	1) Product Item Study 2) Dose Requiement(Biological)Study 3) Radiation Damage of Product 4) Radiation Technology 5) Test Production

II. Schedule



Implementation Schedule in FY 92

		FY 1992 (4, 5, 6, 7, 8, 9, 10, 11, 12, 1, 2, 3)
Mission	Joint Committee	— 1 week
Seminor	National	— 1 week
Expert	Long Term	
	1. Leader	2 years
	2. Coordinator	2 years
	Short Term	
	1. Acc. Maintenance	both EBM
	2. Standard Dosimet.	both EBM
	3. Coating Formulat.	from Company (2 - 3 times per a year)
	4. Product Charact.	2 - 3 weeks
	5. Radiation Techn.	3 - 4 weeks
	6 Radiation Damage	4 weeks
	7. Equip. Comm. GPC	1 week
	8. Equip. Comm.	1 week
	9. Test Production	
	10.Biological Study	3 weeks; 4 weeks
	11 Noise Control	1 week
	12 Seminar Lecturer	1 week
	13 〃	〃
	14 〃	〃
	15 〃	〃
Trainee	1. Coating Formulat.	6 months
	2. Product Charact.	6 months
	3. Acc. Operation	3 months

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