社会開発協力部報告書

マレイシア
放射線利用研究プロジェクト
計画打合せ調査団
報告書

平成５年２月

国際協力事業団
社会開発協力部

社協一
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マレイシア
放射線利用研究プロジェクト
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平成5年2月

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序　　文

マレイシア政府は、第５次社会経済開発計画（1986年～1990年）の重点項目に、生産性の向上、産業の多様化及び製品の質的向上に資するための研究開発の促進を掲げ、原子力局（ＵＴＮ）における放射線利用の基礎的研究開発に係る技術協力を我が国に要請してきた。

これを受けて国際協力事業団は、1988年６月に事前調査団、1989年６月に実施協議調査団をそれぞれ派遣し、1989年７月５日にマレイシア側と討議議事録（Ｒ／Ｄ）に署名し、５年間のプロジェクトを開始した。本プロジェクトでは、⑴電子線による表面塗装の硬化、⑵電子線による医療器具の滅菌、⑶電子加速器・保守、及び放射線防護に係る技術協力を実施している。

今般、国際協力事業団は、プロジェクトも残すところ１年半となった現状に鑑み、プロジェクトで行われた研究・技術移転の成果の調査検討、また技術的事項に係る討議などを目的に、計画打合せ調査団を派遣した。

この報告書は本調査団の調査結果を取りまとめたものである。

終わりに、本調査の任にあたられた団員各位、及び本調査団派遣に際してご協力いただいた外務省、科学技術庁、在マレイシア大使館並びに内外関係機関の方々に対し、深甚の謝意を表する次第である。

平成５年２月

国際協力事業団
社会開発協力部
部長　石崎光夫

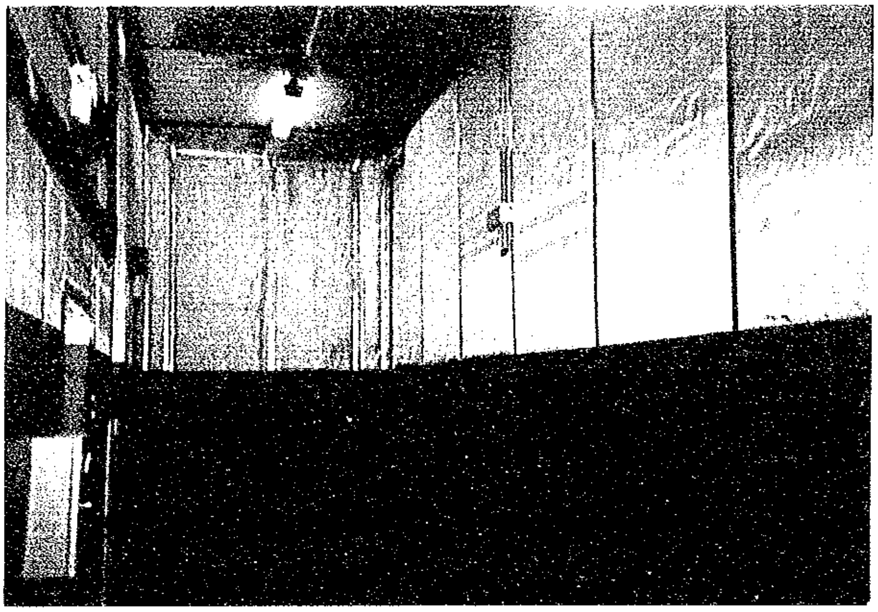
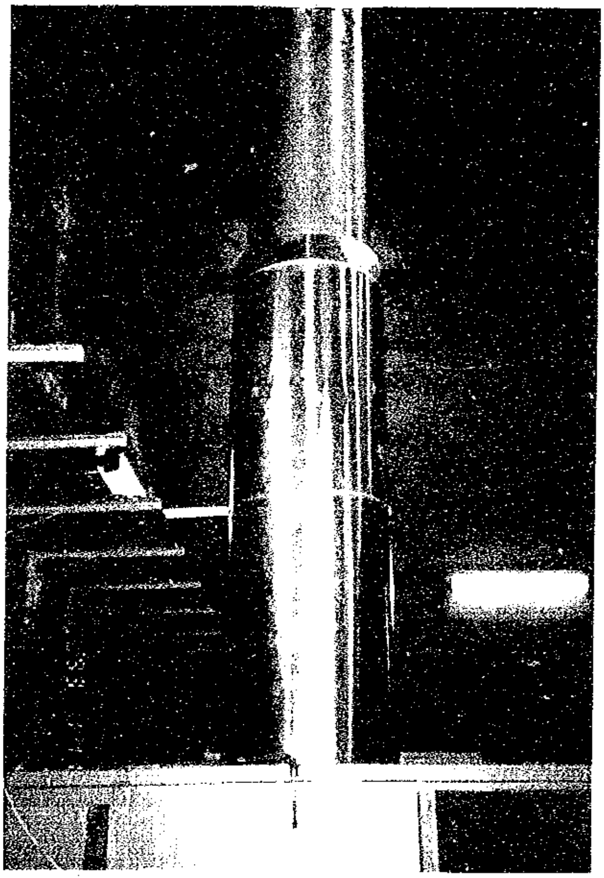


写真１　防音工事結果
（照射室と作業エリアをつなぐ迷路部にグラスウールを貼ったところ）

写真２　防音工事結果
（加速器排気ダクトを
吸音材で包んだ）



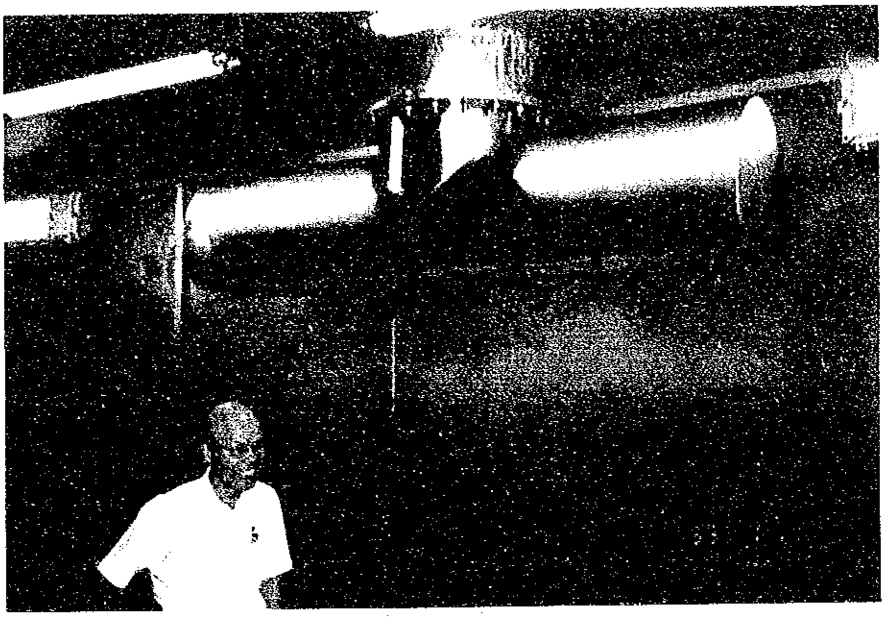


写真３　防音工事結果
（照射室排気吸い込み口を拡げた）

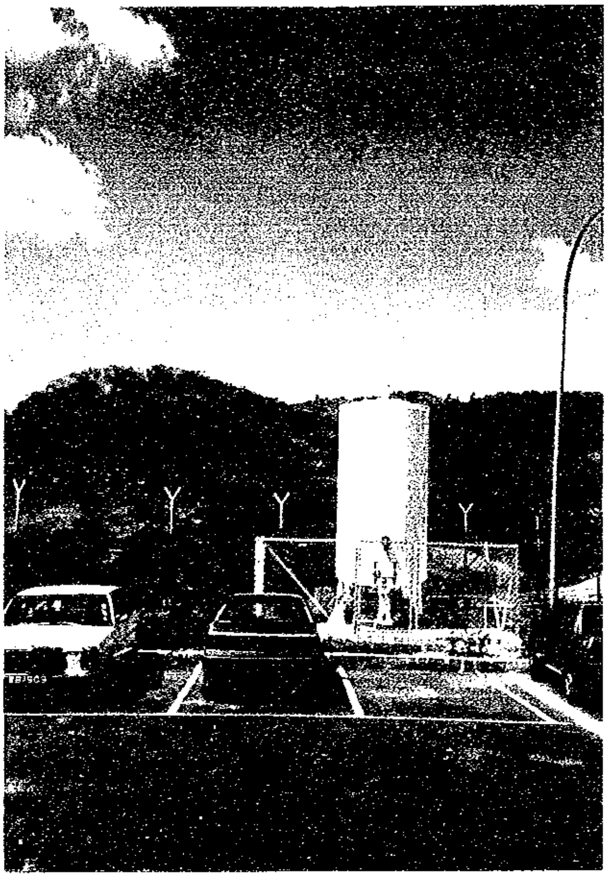


写真４　キュアトロン用
大型液体窒素貯蔵タンク
（マレイシア側が設置）

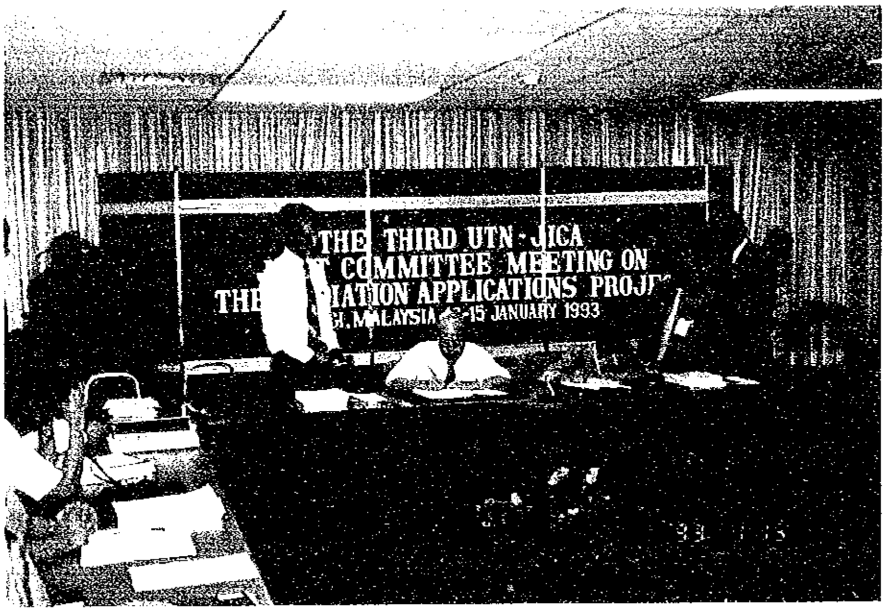


写真５　ミニッツ署名

写真６　関係者で記念撮影

目　　次

1．計画打合せ調査団の派遣

1－1　調査団の構成

佐藤章一

　　担当義務　　総括
　　現職和文　　日本原子力研究所高崎研究所　所長
　　現職英文　　Director-General, Takasaki Radiation Chemistry Research Establishment, Japan Atomic Energy Research Institute

石垣　功

　　担当業務　　放射線利用研究
　　現職和文　　日本原子力研究所高崎研究所　放射線高度利用推進室　室長
　　現職英文　　Director of Department of Advanced Radiation Technology, Takasaki Radiation Chemistry Research Establishment, Japan Atomic Energy Research Institute

岡本次郎

　　担当業務　　照射技術
　　現職和文　　日本原子力研究所高崎研究所　材料開発部照射施設課　課長
　　現職英文　　General-Manager, Irradiation Service Division, Department of Material Development, Takasaki Radiation Chemistry Research Establishment, Japan Atomic Energy Research Institute

四本圭一

　　担当業務　　騒音対策
　　現職和文　　日本原子力研究所高崎研究所　イオンビーム施設課　課長代理
　　現職英文　　Deputy General-Manager of Ion Accelerator Division, Takasaki Radiation Chemistry Research Establishment, Japan Atomic Energy Research Institute

石井利和

　　担当業務　　協力計画
　　現職和文　　科学技術庁原子力局原子力機関監理官室　原子力機関監理官補佐
　　現職英文　　Deputy Director, Institute Administration Division, Atomic Energy Bureau, Science and Technology Agency

涌井純二

　　担当業務　　協力企画
　　現職和文　　国際協力事業団社会開発協力部社会開発協力第一課　職員
　　現職英文　　Staff, First Technical Cooperation Division, Social Development Cooperation Department, ＪＩＣＡ

1－2　調査方針

(1)　プロジェクトの進捗状況を調査し、研究・技術移転の現状と問題点を明らかにする。

(2)　以上を踏まえ、1993年度以降の実施計画、日本側・マレイシア側双方の投入計画について協議を行う。

(3)　1992年度に行われた加速器の防音工事の結果についてチェックし、断続的に不調となった加速器本体についても技術的に検討する。

1－3　調査日程

1993年1月10日～1993年1月16日まで

月日（曜）	行程	調査内容
1／10（日）	東京 ……………………… Ｋ．Ｌ．	移動
1／11（月）		ＵＴＮ表敬、ＥＢＭ施設視察、日本人専門家との打合せ、ＪＩＣＡ事務所打合せ
1／12（火）	佐藤団長　マレイシア訪問	日本人専門家との打合せ マレイシア側とのプレディスカッション
1／13（水）		合同委員会
1／14（木）		合同委員会
1／15（金）		ミニッツ案検討、団内打合せ ミニッツ署名、団長主催晩餐会
1／16（土）	Ｋ．Ｌ． ……………………… 東京	移動

＊宮沢首相（当時）のアセアン歴訪があり、日本大使館多忙のため表敬は取り止めた。
また、ＪＩＣＡ事務所においても所長とは面談不可であった。

1－4　主要面談者

UTN

Y. Bhg. Datuk Dr. Mohd. b. Ghazali Hj. Abd. Rahman	Director General, UTN
Ms. Fatimah bt. Mohd Amin	Acting Deputy Director General, UTN
Dr. Norimah bt. Yusof	Acting Director of Research, UTN
Dr. Khairul Zaman b. Hj. Mohd Dahlan	Head, Radiation Processing Programme, UTN
Dr. Zahrah bt. Abd. Kadir	Radiation Processing Programme, UTN
Mr. Kamarudin b. Bahari	Radiation Processing Programme, UTN
Mr. Nik Ghazali b. Nik Salleh	Radiation Processing Programme, UTN
Mr. Mohd Sidek b. Hj. Othman	Engineering Department, UTN
Ms. Noriah bt. Mod Ali	Health and Radiation Control Department, UTN
Mr. Zulkafli b. Mohd. Nor	Health and Radiation Control Department, UTN
Mr. Raja Abd. Aziz b. Raja Adnan	Planning Unit, UTN
Ms. Zarina bt. Masood	Planning Unit, UTN
Mr. Hilmi b Mahmood	Radiation Processing Programme, UTN
Mr. Mohd. Yusof b. Ibrahim	Health and Radiation Control Department, UTN
Ms. Siti Aiasah bt. Hashim	Radiation Processing Programme, UTN
Ms. Sharifah Hanisah bt. Syed Abd. Aziz	Radiation Processing Programme, UTN
Mr. Kamarudin b. Buyong	Radiation Processing Programme, UTN
Mr. Shari b. Jahar	Radiation Processing Programme, UTN

日本人専門家

吉田健三	チームリーダー
本間　清	業務調整員

2．プロジェクト協力実績

2－1　プロジェクト活動実績

(1)　建設関係

1992年来問題となっていた３ＭＶ加速器施設排気ブロアーの騒音については、12月１日から17日にかけて応急対策費により防音工事を行った。これにより目標としていた騒音レベルが達成された。工事内容は以下のとおり。

①排気ブロアーをグラスウールなどの吸音剤で内張りした鉄板で囲む。

②照射室と作業エリアをつなぐ迷路部の壁・天井にグラスウールを貼る。

③照射室迷路部のコンベアー出入口開口部に鉄板製の垂れ壁を設置する。

④加速器室排気ダクトを吸音材で包む。

⑤照射室排気吸い込み口を拡げる。

⑥照射室排気吸い込み口に穴あきプレート（木製板）を取り付ける。

(2)　加速器関係

３ＭＶ加速器の定期点検を、1992年７月に実施したが、８月に入り加速器の状態が不調になり、定格の３ＭＶを発生できなくなった。

メーカーから技術者が派遣され、また同期間中にデータロガー取付け調整のため派遣された専門家も加わって、高圧発生回路の分解、部品交換、組み立て、調整に当たった結果、今回の不調の原因と思われるコロナシールドと加速器タンク内壁間の異常放電は収まった。

しかし、その後再度故障し、電圧が２ＭＶ以上に上がらなくなったため、1992年度３回目の点検・調整をメーカーの指導のもとに行った。これにより加速器は機能を回復し、最大出力で運転可能となった。その後は順調に運転を続けている。

(3)　その他の機器

キュアトロンの運転は、これまで冷却と酸素除去のために使用する液体窒素の供給が潤滑にいかないため、しばしば停止を余儀なくされていた。そこでＵＴＮは大型の液体窒素屋外貯蔵タンクを購入し、設置した。これによって液体窒素は常時必要に応じて使用できるようになった。

(4)　研究関係

表面塗装の研究開発では、ＧＰＣを用いて塗料用樹脂の分子量調整の研究、塗膜硬化に及ぼす雰囲気中の酸素濃度の影響などが進められた。

医療用具の放射線滅菌では、吉井専門家の指導によりメルトインデックス（ＭＩ）が測定で

るようになり､電子線照射によるＭＩ変化の測定が開始された。また照射された医療用具材料から水に溶け出す成分の分析実験、真空中での微生物の耐放射線性を調べる実験方法の指導、パッケージ入り手術用ゴム手袋の最適照射条件を求めるための照射工学的検討などが進められた。

線量測定では須永専門家の指導によりカロリーメトリーによって、電子線線量の基準測定方法を確立するための測定などが行われた。

2－2　プロジェクト投入実績

2－2－1　日本側投入実績

(1) 専門家派遣

1992年度派遣実績を表２－２－１に示す。

表２－２－１　専門家派遣実績

長期専門家派遣

氏　名	指導科目	所属先	派遣期間（年月日）
吉田　健三	チームリーダー	日本原子力研究所 高崎研究所	900525～940704
本間　　清	業務調整	科学技術庁	900525～930331

短期専門家派遣

No	氏　名	指導科目	所属先	派遣期間（年月日）	備　考
1	三木原和芳	加速器 （データロガー取付調整）	日新ハイボルテージ㈱	920707 ～920726	
2	三木原和芳	加速器 （データロガー取付調整）	日新ハイボルテージ㈱	920909 ～920918	
3	金沢　孝夫	3MeV電子加速器 （データ取扱指導）	日本原子力研究所 高崎研究所	920721 ～920802	
4	須永　博美	基準吸収線量測定	日本原子力研究所 高崎研究所	921111 ～921126	
5	佐々木　隆	表面塗装・樹脂選定・開発	日本原子力研究所	920506 ～920530	
6	庫内　康博	表面塗装	東ソー株式会社	920506 ～920513	
7	山本　芳男	表面塗装	東ソー株式会社	920506 ～920513	
8	梶屋　進一	表面塗装・塗膜物性評価	東ソー株式会社	920506 ～920513	
9	吉井　文男	医療用具滅菌	日本原子力研究所 高崎研究所	920616 ～920710	
10	渡邊　祐平	医療用具滅菌	科学技術政策研究所	920819 ～920905	
11	橘　　宏行	医療用具滅菌（照射技術）	日本原子力研究所 高崎研究所	921020 ～921110	
12	榎本　一郎	表面塗装	都立アイソトープ 総合研究所	930208 ～930307	（予定）

(2) C／P研修員受入れ

1992年度　受入れ実績を表２－２－２に示す。

表２－２－２　1992年度C／P研修員受入れ

研修員氏名	研修科目	主な受入れ先	来日日	帰国日
MOHD. HILMI MAHMOOD	表面塗装および樹脂組成	日本原子力研究所高崎研究所	1992/09/21	1992/12/18
SHARI B. JAHAR	加速器運転保守	日本原子力研究所高崎研究所	1992/09/21	1992/12/18
MEK ZAH BT. SALLEH	表面塗装	日本原子力研究所高崎研究所	1993/03/15	1993/09/12

(3) 機材供与

1992年度供与実績を表２－２－３に示す。

表２－２－３　1992年度供与機材リスト

１．化学発光測定装置
２．接着強度測定装置
３．ミキシングロール（３本ロール）
４．ミキシングロール（２本ロール）
５．タッキネス（粘着度）試験機
６．動的機械特性解析装置
７．紫外可視分光光度計
８．ＣＡＴ線量測定用データ処理装置
９．３MeV電子加速器用交換部品

(4) ローカルコスト負担

1992年度は活動経費（現地業務費）として 1,465千円を支給している。また、前出の防音工事のため 3,605千円を支出した。

２－２－２　マレイシア側投入実績

(1) プロジェクト実施体制

本プロジェクトのマレイシア側の実施体制は、R／D（ＡＮＮＥＸ　Ⅶ）で合意されているように、

① 研究部長

② 研究部ＲＩ放射線産業利用プログラムの放射線加工処理グループ長

をヘッドとして、研究部・運営部（ＯＰＥＲＡＴＩＯＮＳ　ＤＩＶＩＳＩＯＮ<研究炉・加速器などの運転・監理を担当する部門>）の研究者などから構成されることとなっている。実際のプロジェクト実施体制も、概ねこのＲ／Ｄの規定どおりとなっており、日本側のチームリーダー・業務調整員が、それぞれ上記ＵＴＮ側の研究部長・放射線加工処理グループ長のカウンターパートとなって効果的にプロジェクトを推進していた（表２－２－４）。

(2) カウンターパート配置

ＵＴＮ側のカウンターパート配置としては、Ｒ／Ｄ署名当時以降、研究部長の変更があったほかは大きな変更はなく、本プロジェクト実施の核となるカウンターパートの定着状況は良好であった（表２－２－５参照）。近々、加速器運転グループのリーダーがＭｒ．シディックからＭｓ．アイシャに交代する予定である。他の開発途上国の原子力庁に比べ、ＵＴＮの場合、研究者の定着率は比較的良いようであり、今後とも表２－２－５に揚げる研究者が中心となって本プロジェクトを進めていくことが十分に期待できよう。

現在のところ、表面塗装・医療用具滅菌の両プロジェクトに参加するカウンターパートの数はやや少ないが、今年度加速器グループに新規採用者が入る予定となっており、また、３ＭｅＶ加速器（低エネルギー加速器も含めて）が４月から利用可能となることから、それ以降本格的実験が開始されると期待できる。実際のところ、ガザリ長官によると、ＵＴＮは現在200名の人員増加を要求しているところであり（うち約 100名は研究者）、建物の建設が終了し、加速器が利用可能となって研究活動が本格化してくれば、今後、本プロジェクトに携わる人員の数も増加するものと考えられる。

現時点において、カウンターパートの配置について問題点と考えられることとしては、加速器の据付けに携わる運営部のカウンターパートの数、能力が若干不足していることがあげられる。上述のように、本プロジェクトは研究部長が中心となって進められる体制となっているため加速器の据付けに携わる運営部の参加が必ずしも十分ではなく、加速器の利用開始の遅れの一因ともなってしまっている。

また、現時点では、放射線防護などの加速器の安全措置に係る事項が、研究部で担当されるのか、それとも運営部で担当するのかが明確となっておらず、この点も担当を明確にするようＵＮＴ側に要求しておいた。

(3) ローカルコスト

これまでに投入されたローカルコストは、プラスチコーダ2000万円、自動粘度測定装置 270万円、加速器用イオンポンプ 400万円、色差計 250万円、キュアトロン用大型液体窒素貯蔵タンク（予定）他であり、また、施設の整備も進められていることから、マレイシア側のローカルコストの手当はそれなりに実施されていると考えられる。このため、ローカルコストの手当が不足し、本プロジェクトの障害になるとは考えにくい。

表2－2－4　ORGANIZATION CHART FOR THE IMPLEMENTATION OF THE RPOJECT

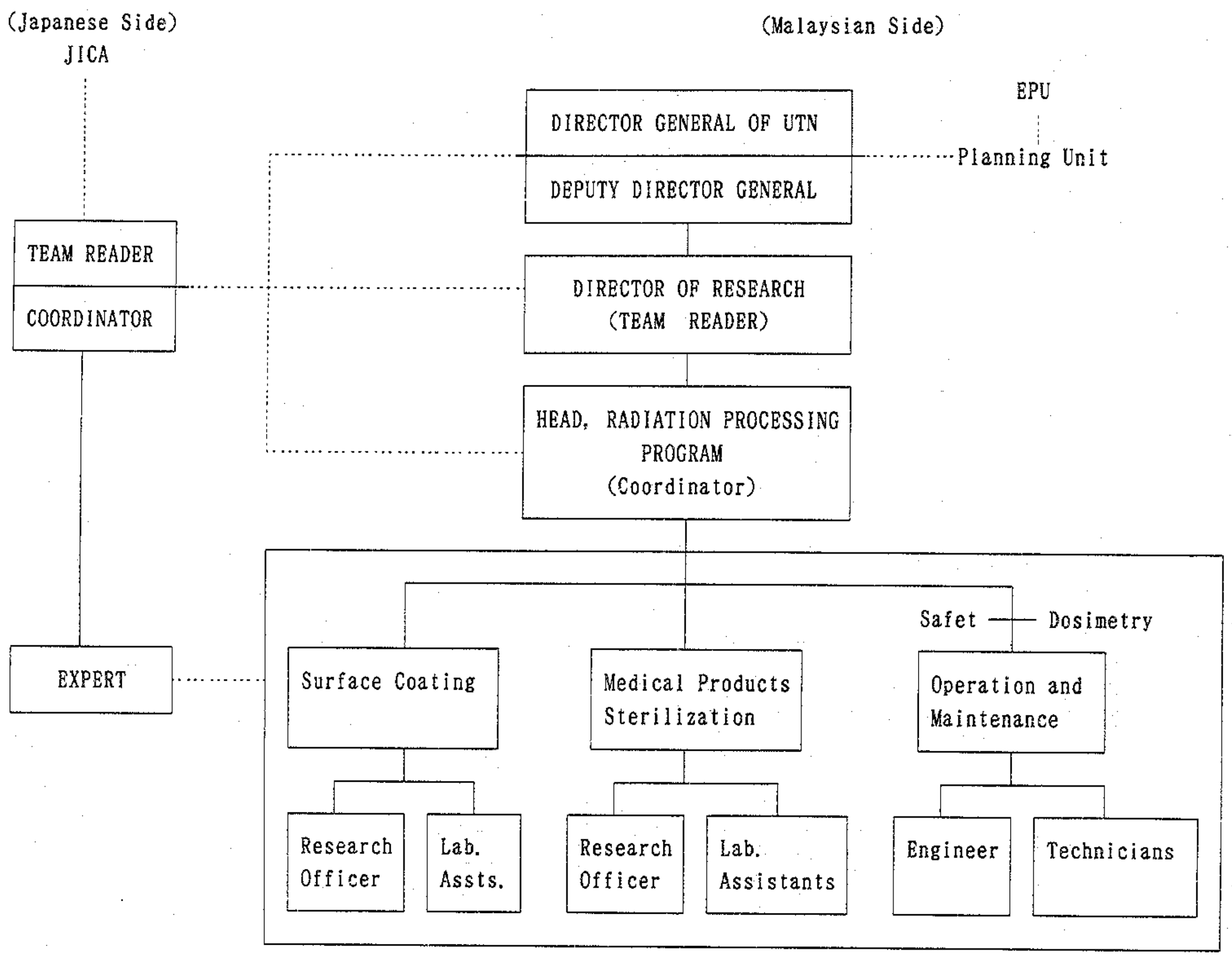


表2－2－5 THE U T N PEROSNNEL FOR THE IMPLEMENTATION OF THE PROJECT

Overall Implemantation:

Datuk Dr. Mohd. Ghazali Hj. Abd. Rahman - Director General
Ms. Fatimah Mohd. Amin - Deputy Director General

Team Leader/Counterpart

Dr. Norimah Yusof - Director of Research

Coordinator

Dr. Khairul Zaman Hj. Mohd. Dahlan - Heed, Radietion Processing Programme

A. Operation & Maintenance

Ir. Wan Abd. Hadi Wan Abu Baker - Head, Engineering Department
Ir. Mohd. Sidek Othman - Research Officer
Mr. Kamaruddin Hashim - Research Officer
Mr. Shaari Jahar - Technician
Mr. Kamaruddin Buyong - Technician
Mr. Rosli Che Ros - Technician
Mr. Ayub Mohamad - Technician

B. Surface Coating Proiect

Mr. Nik Ghazali Nik Salleh - Research Officer
Mr. Dahlan Hj. Mohd. - Head, Surface Curing Group.
Mr. Mohd. Hilmi Mahmood - Research Officer

4 Research Officers) Research assistant under Research
2 laboratory Assistants) Grant.

C. Medical Product Sterilization Proiect

Dr. Zahrah Abd. Kadir - Head, Effect of Radiation Polymer Group
Mr. Kamaruddin Bahari - Research Officer
Mrs. Sharifah Hanisah S. A. Aziz - Experimental Officer
Mrs. Asnah Hassan - Experimental Officer

2 Research Officers) Research Assistants under
2 Laboratory Assistanta) Research Grant

D. Dosimetry

Ms. Noriah Mod. Ali - Research Officer
Mr. Abdal Halim Md. Ali - Technician

E. Safety

Mr. zulkafli Mohd. Nor - Research Officer

3. プロジェクトの進捗状況

3－1 技術移転状況

加速器棟及び放射線プロセス研究棟の建設遅延、それに伴う約半年間のビーム利用開始遅延の大きい影響もなく技術移転そのものは順調に進展している。

医療用具の放射線滅菌に関しては、マレイシアの主要生産品である手術用ゴム手袋を３ＭｅＶ電子加速器利用のターゲットとして工学的及び微生物学的検討が着実に進展していた。工学的検討では、実用規模の照射を想定し、実用手袋のパッケージを考慮した照射技術についての検討が進められつつある。また、医療用具素材に対する照射効果の研究では、基礎的検討としてのポリプロピレンなどの汎用ポリマー素材の放射線照射効果の他に、ポリプロピレン・ポリ塩化ビニルの耐放射線性配合の研究が継続された。微生物学的検討では、滅菌指標菌のBacillus pumilus、B.megateriumなどの滅菌指標菌を用いて、電子線と Co-60γ線に対する放射線感受性の比較検討がなされた。また、工学的検討として、滅菌のための照射技術では、実用の手術用ゴム手袋を用いて厚さ方向の線量分布測定など行い、実際に包装されたゴム手袋を照射するためのパッケージ方法、またその照射方法の検討が開始された。

表面塗装の電子線硬化技術では、基礎技術としての酸素濃度と硬化皮膜物性の相関及び汎用ポリエステル樹脂をベースに各種単・多官能性モノマーの組み合せによる樹脂配合と物性の相関などが検討された。また、パームオイル及び天然ゴムラテックスから合成されたエポキシ系オリゴマーをベースとした電子線硬化型樹脂の開発も順調に進捗し、その硬化皮膜の物性から剥離紙などの粘・接着剤または下塗り樹脂として有望であることが示された。

3－2 供与機材の活用状況

本プロジェクトに供与された機材は、JFY1989 には3MeV EBM・キュアトロン等大型機器を含む20点、JFY1990には研究用機材４点と研究支援用のプロジェクト車１台、JFY1991には研究用機材４点である。これらの機材のうち、特殊技術を要する機器について、据付調整はメーカーにより行い、取扱方法・保守などに関しては､派遣専門家によりカウンターパートに技術指導を行った。JFY1992年度の供与機材9点は未到着であるが､数種の機器についてはこれまで同様、派遣専門家による指導要請があった。搬入された機器は順調に稼働し、よく利用されている状況であった。前回も指摘したことではあるが、使用頻度の把握、破損原因、交換部品の調達、オーバーホール時期の把握のため使用記録を残すよう指導する必要がある。各機材の利用状況を表３－２－１に示す。

表３－２－１　供与機材の利用・管理状況

マレイシア放射線利用研究プロジェクト

平成４年12月末現在

管理番号	機材名	購入金額（千円）	到着日	引渡日	使用場所	利用状況	備考
A-89-01	キュアトロン (Curetron)	23,900	90.10.01	91.04.11	Curetron Lab. MTS	A	
A-89-02	赤外分光光度計 (IR Spectrophotometer)	3,872	90.10.01	92.02.20	Anal. Lab. Curing	A	
A-89-03	ロールコータ (Roll Coater)	3,729	90.10.01	92.02.20	Curetron Lab. MTS	B	
A-89-04	フローコータ (Flow Coater)	1,260	90.10.01	92.02.20	Curetron Lab. MTS	B	
A-89-05	表面摩擦試験機 (Surface Abrasion Tester)	815	90.10.01	92.02.20	Curetron Lab.	A	
A-89-06	接触角計 (Contact Angle Meter)	1,220	90.10.01	92.02.20	Anal. Lab. Curing	B	
A-89-07	ＣＴＡフイルム線量測定装置 (CTA Film Dose Meter)	2,550	90.10.01	92.02.20	Control Room, EBM	A	
A-89-08	自動塗工機 (Automatic Applicator)	958	90.10.01	92.02.20	Curetron Lab. MTS	A	
A-89-09	ラミネータ (Laminator)	1,987	90.10.01	92.02.20	Curetron Lab. MTS	B	
A-89-10	万能試験機 (Tensile Test Machine)	4,065	90.10.01	92.02.20	Phy. & Mech. Lab.	B	
A-89-11	クリーンベンチ (Clean Bench)	1,150	90.10.01	92.02.20	Animal Cytology Lab.	A	
A-89-12	滅菌用オートクレーブ (SS-Autoclave)	508	90.10.01	92.02.20	Genera Purpose Lab.	A	
A-89-13	ギアオーブンテスター (Gear Type Aging Tester)	1,570	90.10.01	92.02.20	Phy. & Mech. Lab.	A	
A-89-14	高速冷凍遠心分離器 (High Speed Refg. Centrifuge)	2,215	90.10.01	92.02.20	Animal Cytology Lab.	B	
A-89-15	偏光顕微鏡 (Crystalization Rate Analyz)	2,540	90.10.01	92.02.20	Anal. Lab., Rad. Effect group	A	

注）利用状況　Ａ：常時使用されている　Ｃ：その他

管理番号	機材名	購入金額（千円）	到着日	引渡日	使用場所	利用状況	備考
A-89-16	ロックウエル硬度計 (Rockwell Hardness Tester)	1,500	90.10.01	92.02.20	Phy.& Mech.Lab.	B	
A-89-17	アイゾッド衝撃試験機 (IZOD Impact Tester)	1,680	90.10.01	92.02.20	Phy.& Mech.Lab.	B	
A-89-18	ダンベルカッター (Super Dumbbell Cutter)	168	90.10.01	92.02.20	Phy.& Mech.Lab.	A	
A-89-19	サンプル調製装置 (Sampling Machine)	914	90.10.01	92.02.20	Phys & Mech. Lab.	B	
A-89-20	３ＭＶ電子加速器 (3MV Electron Accelerator)	283,113	90.11.15	92.02.20	EBM Building	A	
A-90-01	搬送台車 (Conveyor Cart)	1,660	90.11.15	92.02.20	EBM Building	A	
A-90-02	プロジェクト用車 (MAZDA Bongo1800)	1,911	90.11.20			A	
A-90-03	ゲルパーミエーションクロマト (Gel Permiation Chromatogra.)	4,300	91.01.25	92.02.20	Anal. Lab. Curing	B	
A-90-04	ウエザーテスター (Weather Tester)	12,200	91.01.25	92.02.20	Curetron Lab.	B	
A-90-05	電子流密度分布測定装置 (Current Density Dist. Appa)	6,500	91.01.25	92.02.20	Control Room, EBM	A	
A-91-01	ゲルパークロマトシステム化機材 (GPC Systemization)	4,422	92.04.01		Anal. Lab., Curing	A	
A-91-02	溶解度試験装置 (Dissolution Tester)	9,389	92.05.12		Anal. Lab., Radiation Effect G.	A	
A-91-03	メルトインデクサー (Melt-Indexer)	1,204	92.05.12		Phys & Mech. Lab.	A	
A-91-04	加速器用データロガー (Data Logger for Accelat.)	4,359	92.05.12		EBM Building	A	
A-92-01	ケミルミネッセンスアナライザ (Chemiluminescence Analizer)	予13,000	未到着				
A-92-02	接着強度測定装置 (Adhesion Strength Tester)	予 6,200	未到着				

注）利用状況　Ａ：常時使用されている　Ｃ：その他

管理番号	機材名	購入金額（千円）	到着日	引渡日	使用場所	利用状況	備考
A-92-03	ミキシングロール（３本ロール） (Mixing Roll-3Rolls)	予 6,360	未到着				
A-92-04	ミキシングロール（２本ロール） (Mixing Roll-2Rolls)	予 1,310	未到着				
A-92-05	タッキネス試験機 (Tackiness Tester)	予 2,700	未到着				
A-92-06	動的機械特性解析装置 (Dynamic Mechanical Anzlyzer)	予12,000	未到着				
A-92-07	紫外可視分光光度計 (UV-Visible Spectrophotomete)	予 3,500	未到着				
A-92-08	ＣＴＡ線量計用データ処理装置 (Data Processor for CTA Read)	予 3,600	未到着				
A-92-09	3MV 電子加速器法スペアパーツ (3MV EBM Spare Parts)	予 6,286	未到着				

注）利用状況　Ａ：常時使用されている　Ｃ：その他

3－3　加速器及び施設運転・維持状況

3MeV EBMは初期トラブルのために通常より若干多い30日の保守日を要したが、ほぼ順調に稼働しマレイシア工科大学を含む所内外の利用に供した。医療用具の滅菌、線量測定、高分子の放射線効果などの実験利用に供したビーム発生時間は 108時間であった。また、作業エリアの騒音については、年末に工事が完了し、騒音レベルは80db以下に低減された。

200KeVキュアトロンは液体窒素の補給タンクが整備され順調に稼働し、表面塗装の実験に利用された。

４．長期計画の見直し

「３－１　技術移転状況」で述べたように、ビーム発生の遅れなどがあったにも拘らず、医療用具滅菌技術及び表面塗装硬化技術に関する各研究項目の実施状況は、ほぼ討議議事録（Ｒ／Ｄ）のマスタープランに沿って大きい遅延もなく進展していると認められる。従って、現時点では、計画の延長を考える必要はないように考えられる。

5．今後の日本側投入計画

5－1　専門家派遣

技術移転についてはほぼ実施計画（R／D）通り進展しているため、加速器保守・点検及び照射技術（線量測定）と、医療用具滅菌技術に関する短期専門家派遣は当初の計画通り派遣することにした。ただし、派遣期間に関しては、UTN側から要請のあった期間を満たすのが困難な場合が多いため、個々にその都度実情に合せた期間にするべく確定はしなかった。さらに、キュアリングの長期専門家については、これまで、これまでの努力の結果、92年度に都立アイソトープ総合研究所から1ヵ月の専門家派遣が実現したことから、93年度には、2～3週間の短期専門家2回、都立アイソトープ総合研究所の専門家1回の他に、さらに民間企業から1ヵ月程度の専門家派遣ができるよう要請を受けた。

なお、92年度の実施予定が延期されたUTNでのEBプロセッシング・ナショナルセミナーに講師として短期専門家を3名を派遣することに合意した。

5－2　C／P研修員の受入れ

実施計画（R／D）に基づき、研修期間の長短に拘らず、3人／年度でC／P研修員を受入れることが確認された。

5－3　機材供与

FY1993の研究用機器及び加速器予備品などの供与希望リストが提出されたが、供与機材については、JICAの平成5年度予算が確定してから、各品目の優先度を考慮して供与することで合意した。

６．協議議事録

例年同様、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・署名し、合同委員会のミニッツを調査団のミニッツに添付した。

別々にミニッツを作成するのは署名者が異なるためである。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、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ＵＴＮ長官が署名すべきと考えられる。

THE MINUTES OF MEETING BETWEEN THE JAPANESE CONSULTATION TEAM AND THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF MALAYSIA ON THE RADIATION APPLICATIONS PROJECT.

11 - 15 JANUARY 1993

at
NUCLEAR ENERGY UNIT,
PUSPATI COMPLEX, BANGI

THE MINUTES OF MEETING BETWEEN THE JAPANESE MUTUAL CONSULTATION SURVEY TEAM AND THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF MALAYSIA ON THE RADIATION APPLICATIONS PROJECT

The Japanese Mutual Consultation 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 10 to January 16, 1993, 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, 1993

DR. SHOICHI SATO TEAM LEADER, JAPANESE MUTUAL CONSULTATION SURVEY TEAM	DATUK DR. MOHD. GHAZALI HJ. ABDUL RAHMAN, DIRECTOR GENERAL NUCLEAR ENERGY UNIT (UTN)

THE ATTACHED DOCUMENTS

I. The Team attended the Third UTN-JICA Joint Committee Meeting on the Radiation Applications Project, 13 - 15 January 1993. The list of participants from Malaysia and Japan appears as Annex 1.

II. The progress report of the project in the JFY 1992 was reviewed and evaluated. The significant accomplishments appear as the Minutes of the Third UTN-JICA Joint Committee Meeting.

III. The Team appreciated the progress made by UTN and JICA experts, in the implementation of the Project in JFY 1992. The Team observed that the Project was progressing satisfactorily with a few minor exceptions that need to be addressed.

IV. The project plan for JFY 1993 was discussed in the meetings. The proposed plan is shown in the Minutes of the Third UTN-JICA Joint Committee Meeting.

Annex 1

LIST OF PARTICIPANTS

A. Malaysian Representatives

1. Y.Bhg. Datuk Dr. Mohd. b. Ghazali Hj. Abd. Rahman	Director General, UTN
2. Ms. Fatimah bt. Mohd Amin	Acting Deputy Director General, UTN
3. Dr. Norimah bt. Yusof	Acting Director of Research, UTN
4. Dr. Khairul Zaman b. Hj. Mohd Dahlan	Head,Radiation Processing Programme, UTN
5. Dr. Zahrah bt. Abd. Kadir	Radiation Processing Programme, UTN
6. Mr. Kamarudin b. Bahari	Radiation Processing Programme, UTN
7. Mr. Nik Ghazali b. Nik Salleh	Radiation Processing Programme, UTN
8. Mr. Mohd Sidek b. Hj. Othman	Engineering Department, UTN
9. Ms. Noriah bt. Mod Ali	Health and Radiation Control Department, UTN
10. Mr. Zulkafli b.Mohd. Nor	Health and Radiation Control Department, UTN
11. Mr. Raja Abd. Aziz b. Raja Adnan	Planning Unit, UTN
12. Ms. Zarina bt. Masood	Planning Unit, UTN
13. Mr. Hilmi b Mahmood	Radiation Processing Programme, UTN
14. Mr Mohd. Yusof b. Ibrahim	Health and Radiation Control Department, UTN
15. Ms. Siti Aiasah bt. Hashim	Radiation Processing Programme, UTN
16. Ms. Sharifah Hanisah bt. Syed Abd. Aziz	Radiation Processing Programme, UTN
19. Mr. Kamarudin b. Buyong	Radiation Processing Programme, UTN
20. Mr. Shari b. Jahar	Radiation Processing Programme, UTN

B. Japanese Representatives

1.	Dr. Shoichi Sato	Director General, TRCRE, JAERI
2.	Mr. Kenzo Yoshida	Team Leader, UTN-JICA Project
3.	Mr. Kiyoshi Honma	Coordinator, UTN-JICA Project
4.	Dr. Isao Ishigaki	Director, Advanced Radiation Technology, TRCRE, JAERI
5.	Dr. Jiro Okamoto	Manager, Irradiation Services Division, TRCRE, JAERI
6.	Mr. Keiichi Yotsumoto	Deputy Manager, Ion Accelerator Division, TRCRE, JAERI
7.	Mr. Toshikazu Ishii	Deputy Director, Atomic Energy Bureau, STA
8.	Mr. Junji Wakui	Social Development Cooperation Department, JICA Head Office

**THE THIRD UTN-JICA JOINT COMMITTEE MEETING
ON THE RADIATION APPLICATIONS PROJECT
13 - 15 JANUARY, 1993**

The Third 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 13 - 15 January, 1993 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, 1993

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

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

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

THE THIRD JOINT COMMITTEE MEETING OF UTN-JICA RADIATION APPLICATION PROJECT 13 - 15 JANUARY, 1993

DATE: 13, 14 and 15 January 1993.

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	Acting Deputy Director General, UTN
2. Dr. Norimah bt. Yusof	Acting Director of Research, UTN
3. Dr. Khairul Zaman b. Hj. Mohd Dahlan	Head,Radiation Processing Programme, UTN
4. Dr. Zahrah bt. Abd. Kadir	Radiation Processing Programme, UTN
5. Mr. Kamarudin b. Bahari	Radiation Processing Programme, UTN
6. Mr. Nik Ghazali b. Nik Salleh	Radiation Processing Programme, UTN
7. Mr. Mohd Sidek b. Hj. Othman	Engineering Department, UTN
8. Ms. Noriah bt. Mod Ali	Health and Radiation Control Department, UTN
9. Mr. Zulkafli b. Mohd. Nor	Health and Radiation Control Department, UTN
10. Mr. Raja Abd. Aziz b. Raja Adnan	Planning Unit, UTN

B. JAPAN

1. Mr. Kenzo Yoshida	Team Leader, UTN-JICA Project
2. Mr. Kiyoshi Honma	Coordinator, UTN-JICA Project
3. Dr. Shoichi Sato	Director General, TRCRE, JAERI
4. Dr. Isao Ishigaki	Director, Advanced Radiation Technology, TRCRE, JAERI
5. Dr. Jiro Okamoto	Manager, Irradiation Services Division, TRCRE, JAERI
6. Mr. Keiichi Yotsumoto	Deputy Manager, Ion Accelerator Division, TRCRE, JAERI
7. Mr. Toshikazu Ishii	Deputy Director, Atomic Energy Bureau, STA
8. Mr. Junji Wakui	Social Development Cooperation Department, JICA Head Office

RESOURCE PERSONS:

A. MALAYSIA

1. Ms. Zarina bt. Masood	Planning Unit, UTN
2. Mr. Hilmi b. Mahmood	Radiation Processing Programme, UTN
3. Mr. Mohd. Yusof b. Ibrahim	Health and Radiation Control Department, UTN
4. Ms. Siti Aiasah bt. Hashim	Radiation Processing Programme, UTN
5. Ms. Sharifah Hanisah bt. Syed Abd. Aziz	Radiation Processing Programme, UTN
6. Mr. Kamarudin b. Buyong	Radiation Processing Programme, UTN
7. Mr. Shari b. Jahar	Radiation Processing Programme, UTN

AGENDA OF THE THIRD UTN-JICA JOINT COMMITTEE MEETING ON RADIATION APPLICATION PROJECT
13 - 15 JANUARY, 1993

Wednesday, 13 January 1993

0930	Opening of the Third UTN-JICA Joint Committee Meeting on Radiation Application Project; 1. Welcoming Address by Director General, UTN 2. Opening Remarks by: Director General, TRCRE, JAERI Team Leader JICA - UTN Project.
	Adoption of Agenda
	Adjournment of the Meeting
1015	Tea/Coffee
1045	Presentation of Papers on Review of Progress of Project in Fiscal Year 1992 1. "Operation and Maintenance of EBM" presented by Mr. Mohd Sidek Othman 2. "Dosimetry in Electron Beam Irradiation" presented by Ms. Noriah Mod Ali 3. "Current Safety Status of EB Facility" presented by Mr. Zulkafli Mohd Nor 4. "Sterilization of Medical Products using EBM" presented by Mr. Kamarudin Bahari 5. "Radiation Curing of Surface Coating" presented by Mr. Nik Ghazali Nik Salleh
1245	Lunch
1430	"Review of the Overall Project Implementation in JFY 1992" presented by Dr. Khairul Zaman Hj.Mohd Dahlan
1500	Discussion on the review of the progress and implementation of the project in JFY 1992 a. Counterpart Training b. Expert Visits c. Status of Equipments d. Work Plan
1600	Adjournment of the Meeting
	Tea/Coffee.

Thursday, 14 January 1993

0900	"Planning Schedule for Fiscal Year 1993 and Future Plans" presented by Mr. Kenzo Yoshida
0930	Discussion on planning schedule for JFY 1993 and Future Plans a. Counterpart Training b. Recruitment of Experts c. Requisition of Equipments d. Work Plan
1030	Tea/Coffee
1100	Continue Discussion
	Adjournment of the Meeting
1200	Lunch
1400	Preparation of Minutes

Friday, 15 January 1993

0900	Separate Discussions on Minutes of the Meeting
1000	Tea/Coffee
1030	Confirmation of Minutes of the Meeting
1230	Lunch
1430	Signing of Minutes of the Third UTN-JICA Joint Committee Meeting on the Radiation Applications Project
1500	Closing of the Third UTN-JICA Joint Committee 1. Closing remarks by: Director General, TRCRE, JAERI Team Leader of JICA-UTN Project 2. Closing Address by Director General, UTN
	Tea/Coffee.

MINUTES OF THE MEETING

1. Opening of the Meeting

1.1 The Third UTN-JICA Joint Committee Meeting on "Radiation Applications Project" was chaired by the Director General of the 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 Japanese Consultation 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 provisional agenda of the meeting was adopted without any amendments.

3. Review of the Project Implementation in JFY 1992

3.1 5 papers were presented by UTN

3.1.1 "Operation and Maintenance of EBM" presented by Mr. Mohd Sidek b. Othman (see Appendix 4) reported that JFY 1992 was a very active period whereby 30 working days were spent on machine maintenance. A total of 108 applications for EB irradiation were entertained in 1992.

3.1.2 "Dosimetry in Electron Beam Irradiation" presented by Ms. Noriah bt. Mod Ali (see Appendix 5) disclosed that a thorough study was performed to complete the dose measurement data of the UTN EB machines. Preliminary work was initiated on the use of the graphite calorimeter system to fulfill the requirements for the standardisation and calibration of the 3 MeV EBM.

3.1.3 "Current Safety Status of EB Facility" presented by Mr. Zulkafli b. Mohd. Nor (see Appendix 6) reported that the EB Facility has achieved the safety standards prescribed by the UTN Safety Committee for its safe operation.

Nevertheless, further improvements on safety such as the improvement of the surveillance system through the maze will be considered.

3.1.4 "Sterilization of Medical Products using EBM" was presented by Mr. Kamarudin b. Bahari (see Appendix 7).

In the study of radiation effect on surgical rubber gloves, the tensile strength and elongation at break were not significantly affected by gamma and EB during irradiation and storage. However, tear strength decreased with increasing dose in both EB and gamma irradiation. The degradation is higher with gamma than with EB.

With respect to microbiological studies, the radiosensitivity or D10 value of a biological indicator, *Bacillus pumilus* was studied. *B. pumilus* was slightly more resistant to EB than to gamma irradiation.

In the dose distribution study, packs of eight pairs of gloves were found suitable for EB sterilisation. Eight boxes were selected for the study. In double sided irradiation, rotation along the conveyor direction was more practical and the stacking method was better than the centre method.

3.1.5 "Radiation Curing of Surface Coatings" presented by Mr. Nik Ghazali b. Nik Salleh (see Appendix 8) observed that the effect of oxygen concentrations was significant to formulation containing monofunctional monomer and there was a 10% difference in hardness (maximum) for difunctional monomer at 30 kGy.

In coating formulation using commercially available resins, aromatic urethane was more superior than the aliphatic urethane . Formulation containing monofunctional monomer exhibited excellent properties in adhesion. Prepolymers such as polyester and epoxy acrylates will be studied in the future.

The degree of crosslinking was almost maximum at 40 kGy dose and the gel content of cured films was more than 90%. Further investigation will concentrate on the gathering of basic data before the applications of the newly developed materials are pursued.

3.2 The project implementation for JFY 1992 was presented by Dr. Khairul Zaman b. Hj. Mohd. Dahlan as shown in Appendix 9.

It was reported that the overall project implementation for JFY 1992 was on schedule except for the despatch of several short term experts for radiation curing. The research equipments received, are operating satisfactorily. However, most of the spare-parts for the high energy EBM have all been utilised during the maintenance and repair work. With regards to training, two counterparts successfully completed their training. It is expected that the third counterpart would undergo training in radiation curing in March 1993 for 6 months.

It was noted that in Table 1, Appendix 9, the expert visit of Messrs. Kashiwagi and Hayashi, was funded by Nissin High Voltage. It was also noted that an expert from Tokyo Metropolitan Institute is expected to visit UTN in February 1993, to undertake the task of Surface Coating II.

4. Planning Schedule for JFY 1993 and Future Plans

4.1 "The Planning Schedule of Project Implementation and Future Plans" for JFY 1993 was prepared and presented by Mr. Kenzo Yoshida, the Project Team Leader (See Appendix 10).

4.2 The proposed work plan for JFY 1993 comprised of a survey mission for the evaluation of the Project, national seminars, despatch of short-term experts, long-term experts, training and equipments (to be donated).

5. General Discussion

5.1 Cooling System

It was reported that after more than 1 year of operation of the 3 MeV EBM, the present cooling system was found to be adequate under normal operating conditions. Contrary to what was predicted last year, the construction of a heat sink was unnecessary. It was suggested that UTN considers the installation of an independent cooling system for future experiments when the need arises.

5.2 Safety System

It was acknowledged that the safety system improved with the strengthening of administrative safety procedures. Additional safety devices will be installed in the present system.

5.3 Conveyor System

UTN reported that the locking system of the maze entrance door has been improved.

5.4 Noise levels

The Meeting recognised that steps were taken to reduce the noise levels. These included:

a. an enclosure for the exhaust and window cooling blowers;
b. partial cladding of main ventilation ducts;
c. lining of the walls of the maze; and
d. enlargement of the exhaust duct intake in the irradiation room.

The measured noise levels in the working areas were acceptable, however, efforts to further reduce the working noise level are being taken.

UTN recognises and appreciates JICA's prompt response to rectify the problem of noise in JFY 1992.

The Meeting was informed that Shimizu Corporation will be submitting a technical report that will include the noise measurement data as soon as it becomes available.

5.5 Radiation Curing

It was also noted that the long term expert (Radiation Curing Supervisor) has not been replaced by several short term experts as agreed to in the Second Joint Committee Meeting. However, the meeting was informed that an expert from the Tokyo Metropolitan Institute is expected to be visit UTN in February 1993, to undertake one of the tasks.

5.6 Seminars

The Meeting agreed to the suggestion to include the participation of International Atomic Energy Agency (IAEA) experts to the National Seminar on EB Curing, if the need arises.

The Meeting also agreed to jointly organise a National Seminar on EB Sterilisation in the second quarter of 1994.

5.7 Dosimetry

The meeting was informed that procedures for standardisation and calibration of dosimeters for the electron beam as well as to establish linkage for traceability to a reference laboratory was being initiated. UTN received an expert in this field in JFY 1992.

5.8 Equipments

UTN is requested to prepare the following facilities:

i. a room to locate the Data Processing System for CTA Dosimeter at the EB Facility; and
ii. a dark room at the MTS Block to locate the chemiluminescence analyser (CA).

The meeting noted that it is essential to install and commission the CA before the arrival of the expert on radiation damage.

5.9 Operation & Maintenance of the 200 keV EB Machine (Curetron)

It was noted that there was no necessity to incorporate an exhaust system to the 200 keV EBM. It assumed that the ozone levels are within the permissible limits in the working area as irradiation is performed in a nitrogen environment. This fact was pointed out by the JICA team during the Second UTN-JICA Joint Committee Meeting last year.

It was proposed that the expert from the Tokyo Metropolitan Institute assists in the installation of the Web attachment, if possible.

5.10 Operation & Maintenance of the 3 MeV EB Machine

The Meeting was informed that the Read Only Memory (ROM) of the Programmable Logic Controller (PLC) did not function satisfactorily with each replacement of the ROM. The Meeting agreed that this problem should be rectified. UTN requested that training of UTN counterparts be conducted by Nissin High Voltage to further understand the program structure of the ROM, if possible.

5.11 <u>Manpower and Training</u>

The meeting was informed that four (4) additional permanent staff have been assigned to the Project since the last Joint Committee Meeting.

UTN noted that to secure lodgings at TRCRE for the trainees, the training requests for JFY 1993 should be submitted by February 1993.

6. Implementation and Future Work Plan

6.1 Both parties were generally satisfied with the overall implementation of the Project in JFY 1992. The training component and the assigment of JICA experts were implemented as scheduled. Equipments have been procured and expected to be delivered in April/May 1993.

6.2 The Final Workplan for JFY 1993, incorporating several amendments to the draft, was adopted and agreed by the meeting to be transmitted to JICA for its approval (Appendix 11).

6.3 On JICA's request to review the objectives of the Project and the criteria for Project evaluation, UTN took note of the outline of the Project targets presented by Mr. K. Yoshida (Appendix 12) and agreed to hold further discussions on this matter. The decisions on the Project targets will be transmitted to JICA before the evaluation of the Project.

Organising Sub-Committee

Chair: Ms. Fatimah Mohd. Amin

Members:

Dr. Norimah Yusof

Mr. Iberahim Ali

Mr. Raja Abd. Aziz Raja Adnan

Ms. Hasnah Asma Md. Mosbah

Dr. Khairul Zaman Hj. Dahlan (Secretary)

Technical Sub-Committee

Chair: Dr. Norimah Yusof

Members:

Mr. Kenzo Yoshida

Mr. Kiyoshi Honma

Mr. Kamarudin Bahari

Mr. Nik Ghazali Nik Salleh

Mr. Raja Abd. Aziz Raja Adnan

Dr. Khairul Zaman Hj. Dahlan (Secretary)

Appendix 1

WELCOMING ADDRESS BY THE DIRECTOR-GENERAL
OF THE NUCLEAR ENERGY UNIT AT THE
THIRD JOINT COMMITTEE MEETING OF THE
UTN-JICA PROJECT ON RADIATION APPLICATIONS
13 - 15 JANUARY 1993

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

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

Members of the JICA Mission,

Ladies and Gentlemen

Assalamu'alaikum and good morning.

At the outset, may I wish you, Dr. Sato and members of your mission a very warm welcome.

The Joint Committee Meeting is an annual event to assess the progress of the UTN-JICA project on radiation applications as well as to set out the plan for the following year's activities. This meeting, the Third UTN-JICA Joint Committee Meeting is a very important one since we have only one and the half year remaining before the completion of this project ie in the middle of 1994. This committee has to review thoroughly the progress of the project and to plan carefully for the future so as to ensure the success of the UTN-JICA Technical Cooperation Programme. Moreover this type of cooperation is the first of its kind, ie in radiation field, undertaken by JICA and UTN.

Ladies and Gentleman,

I am happy to note that there has been significant progress made during the fiscal year 1992. The project has been implemented as scheduled and the shortcomings have been overcome successfully. I wish to thank JICA and Nissin High Voltage of their prompt action to send experts to help us in repairing the high voltage electron beam machine recently. Our technical staff have gained considerably experience as a result of this. By now they would been able to maintain the machine and to carry out trouble shooting with minimum supervision from the expert.

With regard to the project, ie the project on radiation sterilization of medical products, a lot of progress has been achieved. The dose maping on rubber golves has also been be done followed by process control and finally to carry out test production of radiation sterilization of surgical rubber gloves. Radiation compatible materials such as PVC and PP constitute another aspect that must be looked into by the research group. I notice that progress has been made on this research and this is one of the area which can really help local medical product manufacturer and at the same time can promote the use of radiation for sterilization.

Radiation curing of surface coating has a great potential to be applied in industry in Malaysia. The group has to enhance their efforts in promoting this technology locally. More promotional activities are required. At the same time the development of resin from indigenous material such as palm oil and natural rubber must continue together with their applications, not only for coating but also for other applications such as pressure sensitive adhesive and printing ink. The lamination of gypsum board is another area which deserve consideration by the group.

Ladies and gentleman,

I am confident that with the training, expert assistance and equipments provided under this programme together with your hard work, we will come out with a meaningful result towards the end of this programme.

Before I end my remark, I wish to take this opportunity to express our gratitude to Mr. Honma who will be leaving us in May of this year. He is such an energetic man, has contributed significantly to the successful implementation of the UTN-JICA programme. We wish him a success in his new job. With this note, I wish a successful delibration of our meeting.

Thank you.

Appendix 2

Opening Remarks by The Director General of
Takasaki Radiation Chemistry Research Establishment, JAERI
for The Third Joint Committee Meeting of
The UTN-JICA Radiations Applications Project

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

It is my great honor and pleasure to participate in this joint committee meeting, again. Since the commencement of this Radiation Applications Project in July, 1989, the Project has been in progress to establish the radiation technology using the electron accelerators. The 3MV accelerator was installed, and commissioned in July, 1991. The smaller 200keV machine was made operable in March, 1991. We are very happy to observe generally smooth implementation of the project, very closely as was scheduled. Research and development of the radiation technology for sterilization of medical products and for curing of surface coating have been undertaken achieving good results.

Within the project, I note that satisfactory technology transfer has been made through the enthusiastic contributions of both Malaysian and Japanese counterparts. This has been realized by the recognition of the importance of this Project at both sides, and on the basis of this recognition, I am confident that we will attain the objective of the Project in time, overcoming a few difficulties which are just as common in a project of this scale.

With mutual understanding which has been and will be developed by the exchange of experts and of information including the presentations and discussions as will be made in this meeting, I believe the concluding phase of this project will be really fruitful.

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

Thank you for your attention.

Appendix 3

THE OPENING REMARKS BY THE TEAM LEADER OF JICA - UTN PROJECT

Datuk Dr. Ghazali b. Hj. Abd. Rahman, Director General of Nuclear Energy Unit, Dr. Shoichi Sato, Director General of Takasaki Radiation Chemistry Research Establishment, distinguish experts and participants, ladies and gentlemen.

It is a great honour for me to address you on the happy occasion of the opening of the Third Joint Committee Meeting, on behalf of Japanese team of JICA-UTN Radiation Applications Project. I never thought to be able to attend this meeting again because my stay would be two year by the initial plan. Therefore, I am delighted all the more.

Looking back on the past one year, we have been made a steady progress in the implementation of the Project in spite of some troubles or difficulties. And now we have arrived at the place from where we can look the goal of the Project and estimate the effort necessary to reach it.

The detailed progress and achievment of the Project in 1992 will be introduced from the counterparts. We can understand the achievment or the progress of the Project through these presentations and discussions. Then, the work plan in Japanese fiscal year 1993 will be formulated through discussions. The work plan should be discussed more carefully and intensively than usual, because it covers almost all period remained for the Project. According to circumstances, the target of each research program written in the original TSI might be allowed to change for the more certainly attainable one.

Finally, I would like to express the 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 Operation and Maintenance Of Electron Beam Facility in 1992

by Mohd Sidek bin Hj. Othman

The Third UTN-JICA Joint Committee Meeting
On Radiation Application Project
13 - 15th January 1993

Introduction

This year (1992) has been a very hectic year for the facility personnels especially in maintenance. The experience gained is invaluable.

Operation

	Jan 6, 1992	Dec 18, 1992
1. High voltage generating hours	387.3H	673.7H
Irradiation hours	222.5H	348.6H

2. A flow chart explaining how the irradiation services are processed is in appendix 1.

3. An electron beam irradiation service form is in appendix 2.

4. A table summarizing the irradiation services by the facility is in appendix 3.

5. A list of personnel involved in the operation and maintenance is in appendix 4.

Users

Several groups have been utilising the radiation services of the electron beam facility. The are the dosimetry groups , effect of radiation on polymer group, plastic crosslinking group,applied radiobiology group, food irradiation group and agro-industry processing. In addition, this facility renders irradiation services to other institutions such as National University of Malaysia and Uniphone.

Maintenance

Maintenance works carried out in 1992 are as the following:

1. Annual maintenance (July 8-25)
   Expert : Mr. Mikihara
   Schedule : The work schedule is in appendix 5.
   Comment : After a few day of operation, we experiened several inverter failures due to overcurrent during voltage conditioning. Therefore, the machine could not generate voltage higher than 2.5MeV. In addition, several undervoltage trips occured.

2. Installation of data acquisition system (July 21 - August 2)

Expert : Mr. Kanazawa

Comment : Mr. Kanazawa could not commission the data logger because the power supply section of the printed circuit board was damaged. However, the system was still under warranty and it was later repaired by Hawlett Packard agent in Kuala Lumpur. Mr. Kanasawa only concentrated on the software parts.

3. First repair works (September 9 -17)

Expert : Mr. Mikihara

: Mr. Kashiwagi (Nissin Expenses)

Schedule : The work schedule is in appendix 6.

Comment : It is suspected that the misallignment of the corona shield causes arcing which leads to inverter failures. However, after a few days of operation, we experienced the same failure as in part 1. Due to that, the machine could not generate a voltage higher than 2.3 MeV.

4. Second repair works (October 6 - 19)

Expert : Mr. Hayashi (Nissin Expenses)

Schedule : The work schedule is in appendix 7.

Comment : There were several arc spots on the wall surface adjacent to the corona shield which has scratches and unevenness. Most probably, these scratches and uneven surfaces were overlooked during the first repair works. It is suspected this is the main reason for the arcing inside the D.C.P.S. tank that leads to overcurrent trip. In addition, we also experienced undervoltage trips. The setting of undervoltage was then adjusted from 12% to 20% to cope with this problem.

5. Noise reduction works (Dec 2 -16)

Three major works were carried out out mainly:-

a. Sound insulation material was install at some portion of
   - the maze area.
   - the ducting for exhaust blower.
   - the ducting for window cooling blower.
b. Steel boxes were installed to enclose the exhaust blower and window cooling blower.
c. The ventilating (exhaust) duct intake was enlarged.

Schedule: The work schedule is in appendix 8.

Comment: The works was done by Shinryo company under direct supervision by Shimizu Company. Generally, the noise level was lower.

6. Other maintenance works (Safety)

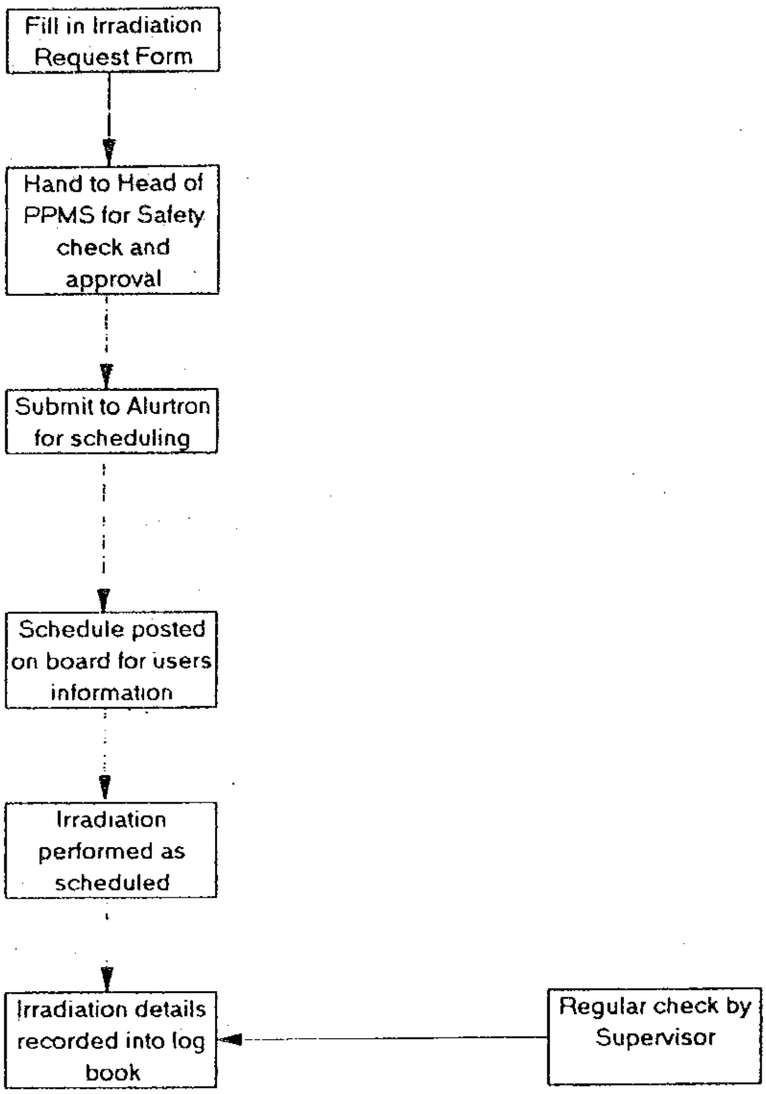
   a. The accelerator operational status indicator were changed to the green for accelerator off and red for accelerator on. Also, wiring for door status indicator and accelerator operational status indicator are independent of each other.
   b. Grille works were installed at the entrance and exit of the maze. Only a small opening merely enough for the sample entrance and exit is left open.
   c. The opening of sheild door must pass through the second limit before stopping in order to prevent the door from automatically close.
   d. The personnel entrance door lock were changed to a self locking type.

Further Works

1. To update the operational procedures.
2. To prepare the maintenance procedures.
3. To study the temperature rise on standard sample.
4. To develop the product handling system, water bath and so forths.

Conclusion

Proper operation and maintenance is important to ensure optimum and safest condition of the facility. Through this fiscal year, we gain a `splendid' experiences for maintaining the machine.



FLOW CHART OF IRRADIATION SERVICES

APPENDIX 2

EBM-1/91

ELECTRON BEAM IRRADIATION SERVICE FORM
RADIATION PROCESSING PROGRAM

Your Ref. :
Our Ref. :

ACCELERATOR: 3.0 MeV / 200 KeV*

A. APPLICANT

Name :

Date :

Department :

Tel. No./Ext. :

B. PROJECT

Title of Research Project :

Purpose of Irradiation :

Date of irradiation :

Time of irradiation :

Equipments to be brought in irradiation room

Name of equipment :

Shape/size :

C. SAMPLE

Name of Sample :

Contents :

Number of samples :

Nature : Solid/Liquid/Gas*

Physical shape/size :

D. IRRADIATION CONDITION

Temperature :

Pressure:

Conveyor : Required/Not required*

Utility : Required/Not Required*

Acc. voltage :	MeV	Beam current :	mA
Dose rate :	kGy/sec	Dose :	kGy/pass
Conveyor speed:	m/min.	Passes :	times
Stationary :	sec.	Distance from window :	cm
Single/double sided*			

Remarks :

Signatures :

.... ( ) Applicant

.... ( ) Head Unit/Group

Table summarizing the irradiation services by the facility
from Jan 1 to Dec 18, 1992

No.	Purpose Of Irradiation	Irradiated Sample	Number of Application	Group
1.	Radiation Effect	PP/PE Blend dumbbell	4	P
2.	Radiation Effect	PP dumbbell	8	P
3.	Radiation Effect	Rubber Glove	3	P
4.	Radiation Effect	PVC dumbbell	3	P
5.	Dose distribution	Rubber Glove	7	P
6.	Dosimetry	CTA film	23	D
7.	Sourvenir	Perspex	5	UTN
8.	Crosslink	PVC sheet	19	X
9.	Crosslink	PVC wire	5	X
10.	Crosslink	HDPE sheet	3	X
11.	Crosslink	LDPE sheet	12	X
12.	Crosslink	PVC tubing	1	X
13.	Crosslink	PE sheet	1	X
14.	Radiation effect	Thermoplastic elastomer	2	S
15.	Sterilization	Fungsi/bacteria	6	F
16.	Sterilization	Empty fruit bunch palm	4	A
17.	Sterilization	Spores	2	B
18.	Radiation effect	Thermoplastic (PP/rubber and PP/HDPE)	2	UKM
			108	

Legend:
- P - effect of radiation on polymer group
- D - dosimetry group
- X - plastic crosslinking group
- S - surface coating group
- F - food Irradiation group
- A - agro industry processing group
- B - applied radiobiology group
- UKM - National University of Malaysia

UTN'S PERSONNEL INVOLVED IN THE OPERATION AND MAINTENANCE

1. Dr. Khairul Zaman bin Hj. Mohd. Dahlan
2. Mr. Mohd. Sidek bin Hj. Othman
3. Mrs. Siti A'iasah bte Hashim
4. Mr. Shari bin Jahar
5. Mr. Kamaruddin bin Buyong
6. Mr. Abd. Basit bin Shafie
7. Mr. Azmi bin Ali
8. Mr. Wan Ali bin Wan Yusof
9. Mr. Noor Khilman bin Sangit

JICA'S Adviser

1. Mr. Kenzo Yoshida

ANNUAL MAINTENANCE

APPENDIX 5

MESSRS: JAPAN INTERNATIONAL COOPERATION AGENCY/NUCLEAR ENERGY UNIT, MALAYSIA

92NHV-4174

SCHEDULE FOR PERIODICAL OVERHAUL OF EPS

NISSIN-HIGH VOLTAGE CO., LTD.

DATE / ITEM	JULY 8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
LEAKAGE CHECK OF SF_6 GAS HANDLING SYSTEM	—																				
TRANSFER SF_6 GAS FROM ACC. TANK	—																				
DISASSEMBLING OF C.W. CIRCUIT		—																			
CHECK THE PARTS OF C.W. CIRCUIT			—	—	—																
CHECK OF SHORTING ROD SYSTEM						—															
CHANGE OF WINDOW FOIL					—	—															
CHECK OF M-G FOR ELECTRON SOURCE							—														
ASSEMBLING OF C.W.CIRCUIT							—	—													
OPEN CHECK									—												
EVACUATION OF ACC. TANK, SF_6 GAS CHARGING									—	—											
CHECK OF CONVEYOR & MODIFICATION LINE SPEED METER									—												
CHECK OF INTERLOCK SYSTEM										—											
WIRING OF DATA LOGGER									—	—	—										
CHECK OF CONTROL CABINET										—											
ACC VOLTAGE CONDITIONING											—	—	—								
CHECK OF BEAM PROFILE														—							
BEAM CONDITIONING														—	—						
TEST REPORT																—	—				
MEETING																		—			

SCHEDULE

(9/10 ~ 9/13)

ITEMS				9/10	9/11	9/12	9/13	SPECIAL		REMARKS
	(Mon.)	(Tue.)	(Wed.)	(Thu.)	(Fri.)	(Sat.)	(Sun.)	TOOLS	EQUIPMENT	
OPERATION CHECK				↔						
TRANSFER SF_6 GAS				↔						
TANK INSIDE CHECK					↔					
DISASSEMBLING C.W.					↔					
CHECKING OF COMPONENTS					↔	↔				
ASSEMBLING C.W.							↔			
OPEN CHECK							↔			

SCHEDULE

(9/14 ~ 9/18)

ITEMS	9/14	9/15	9/16	9/17	9/18			SPECIAL		REMARKS
	(Mon.)	(Tue.)	(Wed.)	(Thu.)	(Fri.)	(Sat.)	(Sun.)	TOOLS	EQUIPMENT	
EVACUATION OF TANK	←→									
CHARGING SF_6 GAS		←→								
OPERATION TEST		←—	—→							
TEST REPORT			←—	—→						

APPENDIX 7

Messrs. NUCLEAR ENERGY UNIT

SECOND REPAIR WORKS

Maintenance Schedule

October *

NISSIN-HIGH VOLTAGE CO., LTD.

		K. Hayashi

ITEM \ DATE	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Operational Check	↔														
Collecting SF_6 Gas	↔														
Open Acc. Tank		↔													
Check Inside of Acc. Tank		↔	↔												
Disassembly			↔												
Check Circuit Element				↔											
Adjustment Circuit Column					↔	↔	↔	↔							
Assembly									↔						
Open Check										↔					
Close Acc. Tank										↔					
Vacuuming Acc. Tank										↔					
Filling SF_6 Gas											↔				
Voltage Conditioning											↔				
Beam Conditioning												↔	↔	↔	

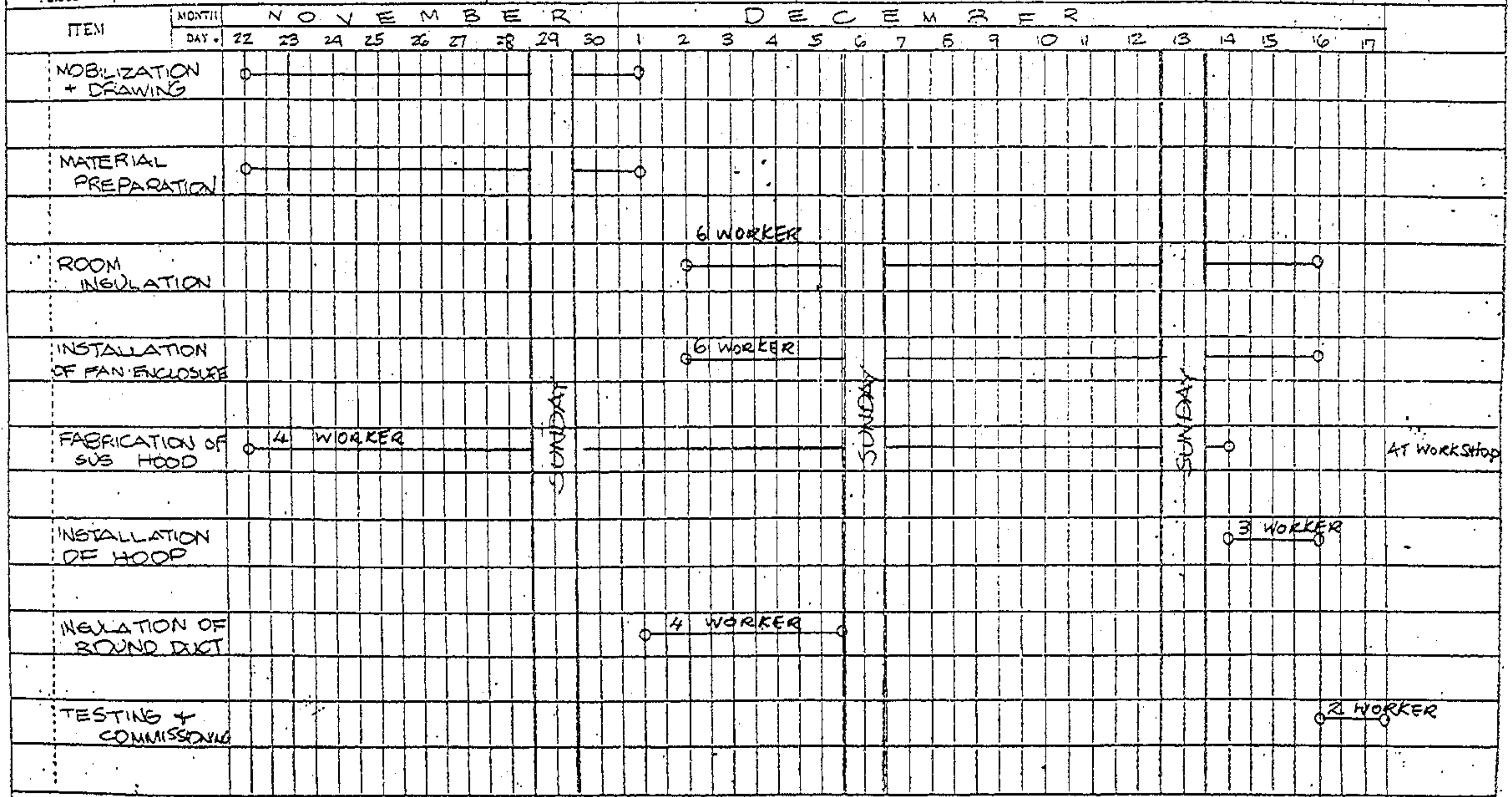
NOISE REDUCTION WORKS

SHIMIZU CORPORATION

MALAYSIA OFFICE
7TH FLOOR, RHB 1, 424 JALAN TUN RAZAK,
50400 KUALA LUMPUR

NAME OF FORM	SCHEDULE	ISSUED NO	
		ISSUED DATE	
NAME OF PROJECT	NUCLEAR R+D FAN ENCLOSURE	JOB NO	
CONSTRUCTION PERIOD	–		

RECEIVED BY	MANAGER	SECTION CHIEF	SITE MANAGER	ENGINEER



DOSIMETRY IN ELECTRON BEAM IRRADIATION

NORIAH MOD ALI
SSDL-NEU

* NEU-JICA Joint Committee Meeting For Radiation Application Project, NEU, 13th - 15th January 1993.

1. INTRODUCTION

In all radiation processes, accurate dosimetry measurement ensures that radiation treatment required for the process is correctly applied. The installation of an electron beam machine at the Nuclear Energy Unit had led to a demand to expand the dosimetry activities including the electron beam application.

A thorough dose measurement had been carried out by the Secondary Standard Dosimetry Laboratory (SSDL) to complete the dose measurements with the NEU electron beam machines. Irradiation parameters are determined mainly using a reliable dosimetry system for the utilization of the electron beam facilities. These informations will provide satisfactory documentation relating to the absorbed dose and as an important step to ensure that irradiation treatment had been carried out in accordance with regulations.

Standardization of the dose measurements has become an acceptable means of quality control of the irradiation process. Through periodic calibration of the routine dosimeter to the primary measurement systems, confidence is reached. Reasonable, accurate and precise routine dosimetry can be maintained from day to day as well as over long term use in a radiation plant.

The graphite calorimeter that has been set-up recently will fulfill the requirement needed for the standardization and calibration of the NEU 3 MeV electron beam machine. Their dissemination will also be established to cover the low energy electron beam.

2. STATUS OF DOSIMETRY WORK

2.1 Dosimeter system:

Film dosimeters are the most effective system used for dose measurement in processing electron accelerator. Several steps have been taken in order to ensure a good dose measurement is obtained from time to time. It does not only cover the dosimeter system itself but also the measuring equipment involved (Table 1). Implementation of such procedure will help in initiating good dosimetry with the NEU electron beam facilities.

Table 1 Several steps implemented for maintaining a good dosimetry practice at NEU

1. Dosimeter system	* CTA film dosimeter - the thickness and background readings are checked/ recorded for every batch received. The response is also checked against the gamma rays (Appendix II and III).
	* Calibration of Blue cellophane against the CTA film dosimeter (Appendix IV).
2. Measuring instrument	* Calibration of the CTA reader against the UV spectrophotometer (Appendix V).

2.2 Irradiation Parameter:

The irradiation parameter related to the nominal dose measured with CTA film dosimeter had been completed for distances from 20cm to 50cm. 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 result of the machine parameters as related to the electron beam characteristics are summarised in Fig.1. The dose measurement performed after the machine maintenance confirms that the beam parameter and beam profile have not changed.

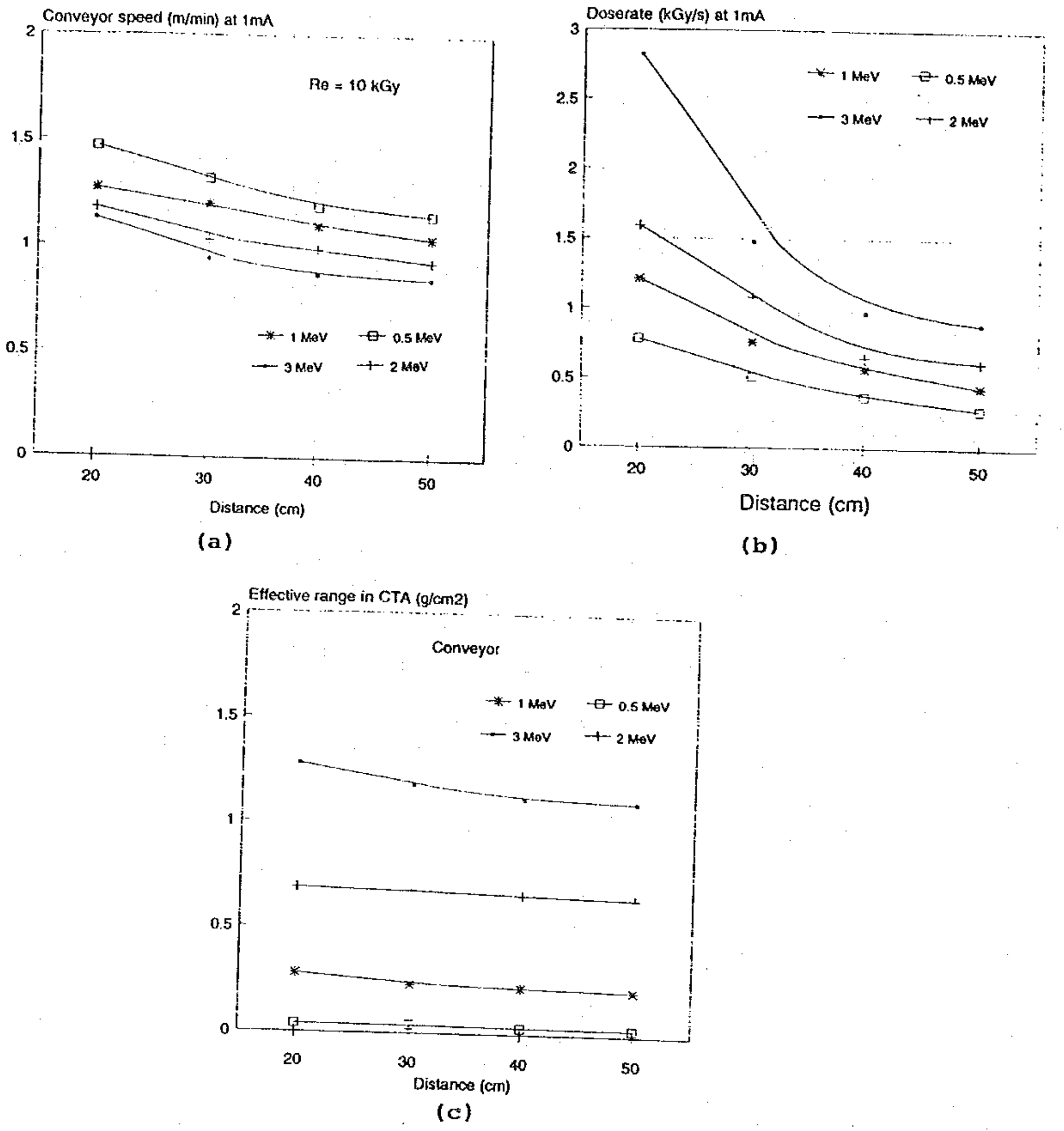


FIG.1. EPS-300 beam parameter versus distance:
a) Conveyor speed; b) Dose-rate; and
c) Effective range in CTA dosimeter.

Compared with electron beam facilities at JAERI, Takasaki, we found that NEU facilities give similiar paremeters pattern as the dual beam type machine (Appendix VI). This is due to the same thickness and material used for the window of the scanhorn of both accelerator .

2.3 Preliminary study on the beam standardization :

2.3.1 Setting up of the graphite calorimeter system:

The construction of the electron beam calorimeter was based upon that of the existing JAERI Takasaki calorimeter. A set components comprising an absorber, thermocouple and other items which had been brought from JAERI are assembled to make a total absorption calorimeter. The system will be introduced for the standardization and calibration activities with the NEU 3 MeV electron beam accelerator.

2.3.1a Construction details:

The calorimeter core (absorber) is a graphite disc, 20.5mm in diameter and 12mm in thickness. A hole is drilled into the mid plane of the absorber to accomodate a glass bead thermistor. Thermal contact with graphite is improved by using a small amount of graphite compound (Hitazol AB-1) around the thermistor bead.

The absorber is surrounded by a graphite guard ring, having the same thickness and is thermally isolated from the absorber block by a nominal 0.25 mm air gap. Small piece of CTA film was chosen to separate the guard ring from the absorber . The ring is adjusted so that the absorber is exactly at its centre.

The cross-sectional view of the total absorption calorimeter was shown in Fig.2. A thin vaporised Al- PET film (6 μm) is used to cover the calorimeter core during irradiation process, in order to protect an influence of the cooling wind from the accelerator window into the absorber.

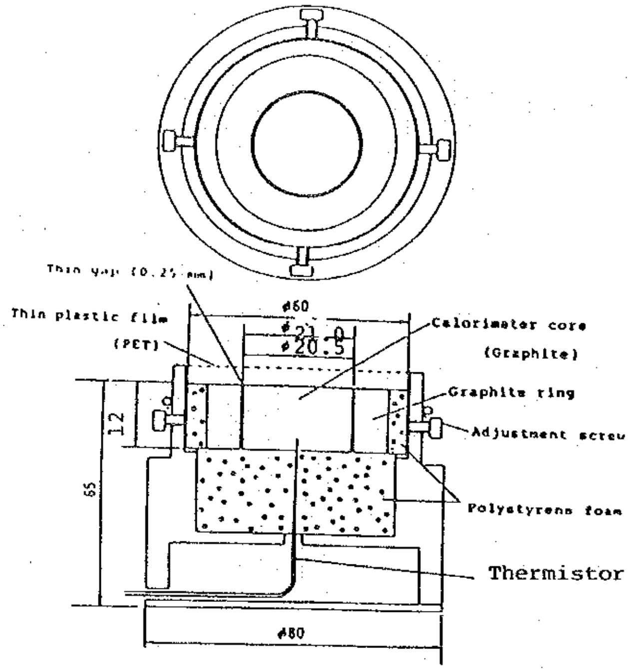


FIG.2. Front and cross-sectional views ot a total absorption calorimeter, fabricated by JAERI.

2.3.1b Temperature measurement system:

The calorimeter is designed to be simple and flexible in use. Temperature rise measured by the thermistor is read by a reader meter, Takara Thermistor Instruments Co.Ltd, D641. Extrapolation is applied in order to determine the actual temperature rise (Fig.3)

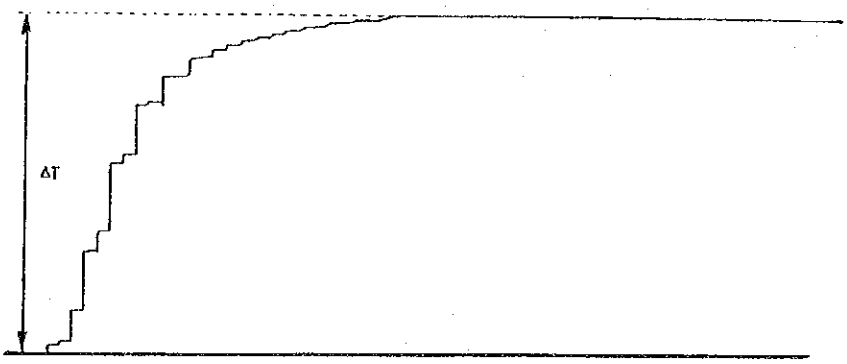


FIG.3. The change of temperature in a graphite calorimeter following irradiation.

2.3.1c Specific heat of calorimeter:

The specific heat capacity of the graphite has been measured by the manufacturer, Agune Technology Centre, Japan. The data are best fitted over the range 10°C - 40°C by the linear equation:

$$C_g = 0.1532 + 0.0008\ T_o \quad \sim \quad \text{cal } g^{-1o}\ C^{-1}$$

where T_o is the initial temperature in degree celcius.

2.3.2 Simultaneous Irradiation:

2.3.2a Calibration of electron energy:

A simultaneous irradiation of calorimeter and electron current densitymeter (ECD) system are necessary to give a detail information about the energy fluence ($J.cm^{-2}$) and the electron fluence (cm^{-2}), which are needed for the standardization of the beam. Unfortunately, such work could not be done because UTN's ECD did not function well. The ampere meter of the ECD system keeps on `blinking' and cannot register any reading. We had tried to contact the supplier of the ECD in Japan, and the simultaneous irradiation will be proceeded after the system has been repaired.

2.3.2b Calibration of the routine dosimeter:

Calibration of a routine dosimeter was performed by irradiating a stack of such dosimeters at the same condition as the total absorption calorimeter. Typical model for stacked cellulose triacetate (CTA) film dosimeter for depth dose measurements is shown in Fig.4. Each column of the histogram is plotted in terms of their measured optical density with the depth of the film dosimeter. By normalizing the irradiation condition: the energy fluence, P measured by calorimeter is the same as the total absorbed dose measured by a stacked CTA film dosimeter.

$$10^{-3}.\ \Psi = \frac{\Sigma OD_i.\ \Delta t}{K} \qquad \ldots\ldots\ldots\ldots[1]$$

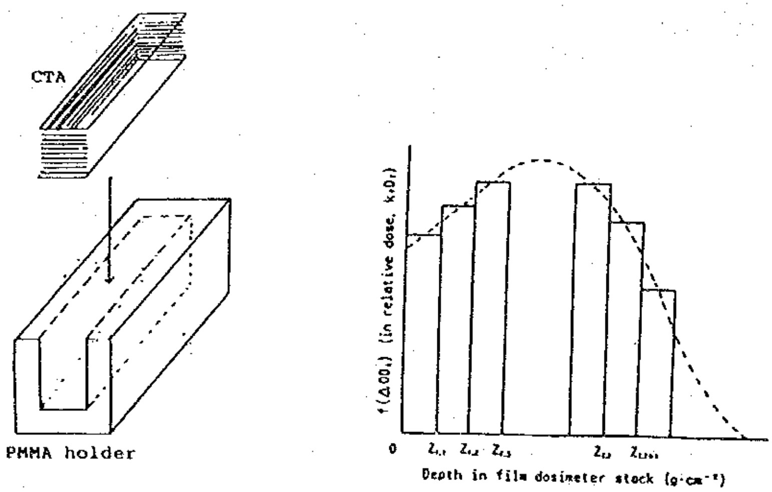
where K : calibration factor (kGy^{-1})
t : thickness (g/cm^2) ~ 16.10^{-3} g/cm^2
OD_i: optical density at ith position
Ψ : energy fluence (J/cm^2)

From [1];

$$10^{-3}.\Psi = \frac{\Delta t}{K} \sum OD_i \,.10^{-3}$$

Therefore,

$$K = \frac{\Delta t \sum OD_i}{\Psi}$$



(a) (b)

FIG.4. Calibration of CTA film dosimeter;
(a) set-up of the film stack
(b) a typical model of measured depth dose profile in the film stacked

2.3.3 Experimental results:

The calorimeter system had shown a good response for measuring temperature rise with electrons of 1 - 3 MeV (Fig.5). The system takes almost 90 minutes for thermal equillibrium after the irradiation. The cooling rate will increase with the help of an external fan (Fig.6)

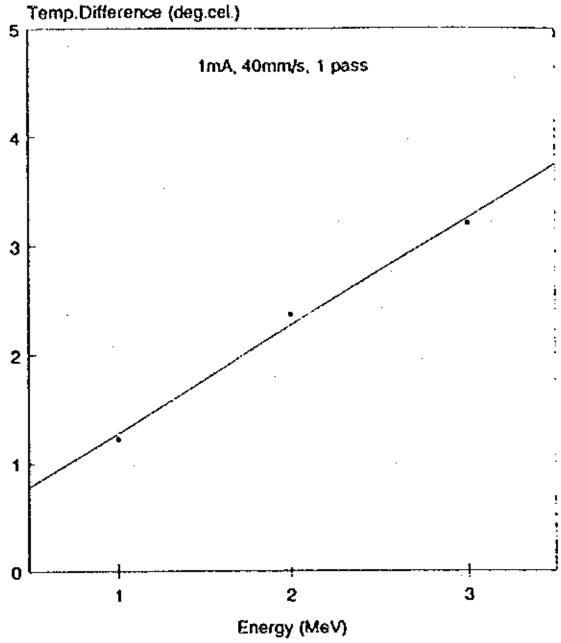


FIG.5. Temperature difference versus beam energy (Graphite calorimeter)

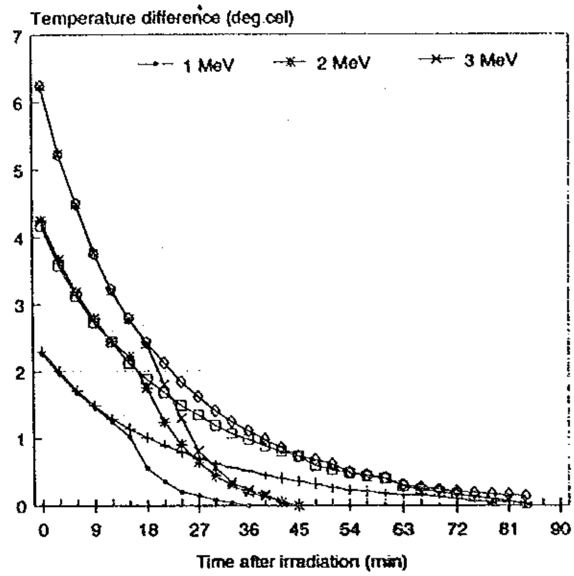


FIG.6. Cooling-rate after irradiation (Graphite calorimeter)

It is found that k-value keeps increasing with the energy involved (Table 2). The value is also found to be +/- 26% as compared with the value given by the manufacturer.
The source of error which might influence the accuracy in calibration of film dosimeters using the combined system can be listed as follows:
[a] Uncertainties in calorimeter system (i.e specific heat, air gap etc.);
[b] Difference in irradiation condition to obtain the response curve and the calibration constant. Both irradiation conditions must be unified as close as possible, but it may be difficult to unify completely the change of environmental conditions, including the temperature rise of the dosimeters during irradiation.

Table 2 : Calibration of CTA against the graphite calorimeter

Irradiation parameter : Window surface distance (WSD) = 20cm
a) Calorimeter : 1-3 MeV, 40mm/s, 1 pass, 2 mA

E (MeV)	To(°C)	T(°C)	Cp ($calg^{-1}{}^oC^{-1}$)	P (Joule)
1	2.44	2.44	0.1764	11.85
2	4.78	4.78	0.1770	23.29
3	6.40	6.40	0.1769	31.16

b) Stacked CTA film dosimeter :
Expected dose : 80 kGy
i. 1 MeV, 4 mA, 0.56m/min, 4pass
ii. 2 MeV, 1 mA, 0.59m/min, 4pass
iii. 3 MeV, 1 mA, 0.57m/min, 4pass

E(MeV)	K value (kGy^{-1}) UTN	Manufacturer	Dev.(%)
1	0.0057	0.0065	-12.3
2	0.0071	0.0065	7.8
3	0.0081	0.0065	26.2

3. FURTHER WORK:

Further work will be considered to improved on the accuracy and confidence dealing with our existing dosimetry system . Work will be focused on :
{1} Improvement of the dose measurement with the graphite calorimeter. The reliability of the dose measurement need to be established before the system could be adopted as a standard tool;
{2} Dissemination of the standard through the calibration service;
{3} Collaboration with other international institutes such as JAERI (Japan), Riso National Laboratory (Denmark) and NPL (United Kingdom) will be foreseen as an important step to increase confidence on the established system.

4. CONCLUSION

Preliminary work on the setting up of the calorimeter system had run smoothly. Beam standardization and calibration of dosimeter using simultaneous technique had also been introduced as an important tool to improve the existing dosimetry system at the NEU electron beam accelerator. More work will be done to improve the calorimeter system and to eliminate the source of error in order to establish a good standard measuring system.

ACKNOWLEDGEMENT

The author is grateful for the valuable help of the SSDL staff in carrying out the dose measurements and preparation of graphs in this paper.

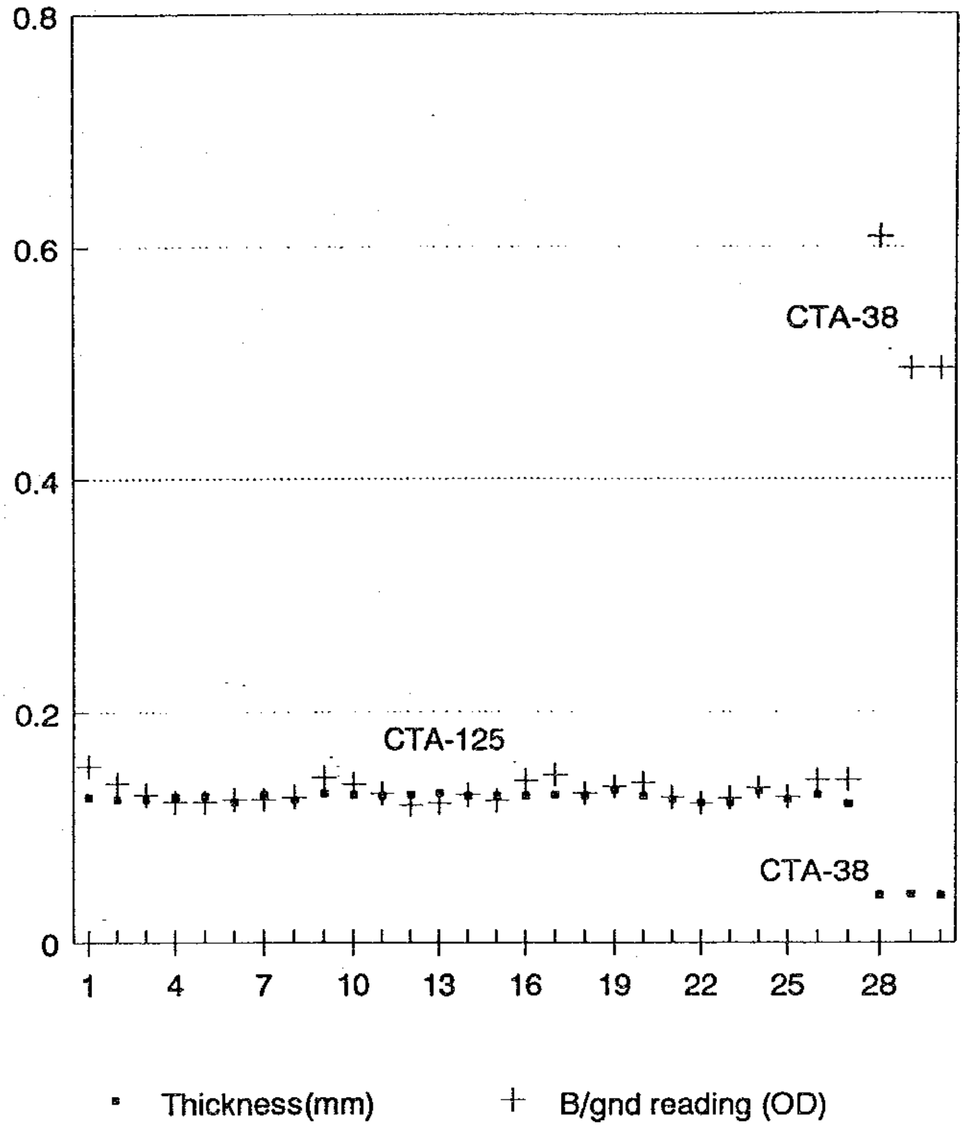
Appendix I :

JICA Expert On Dosimetry for EBM:

Mr. HIROMI SUNAGA (2 weeks)
11th - 26th November 1992

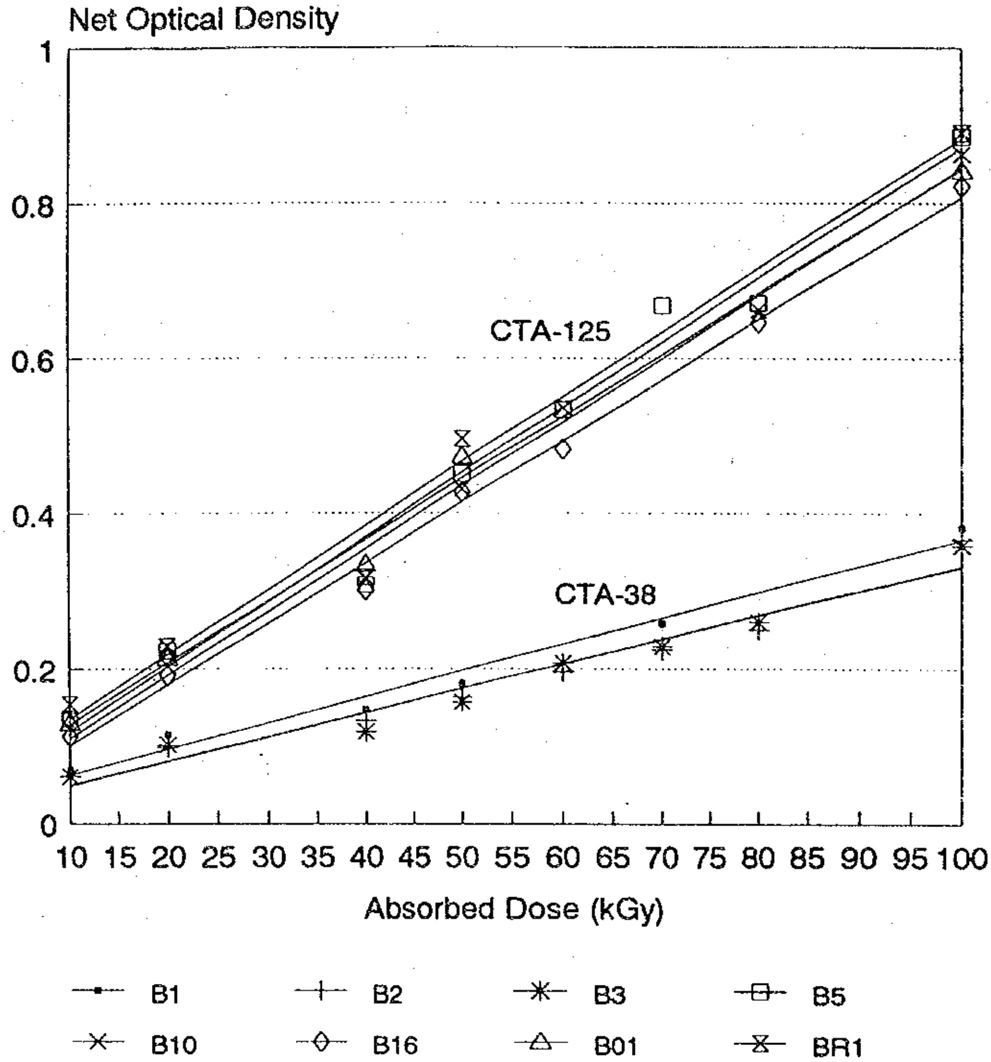
Appendix II :

Thickness and background reading for CTA film dosimeter



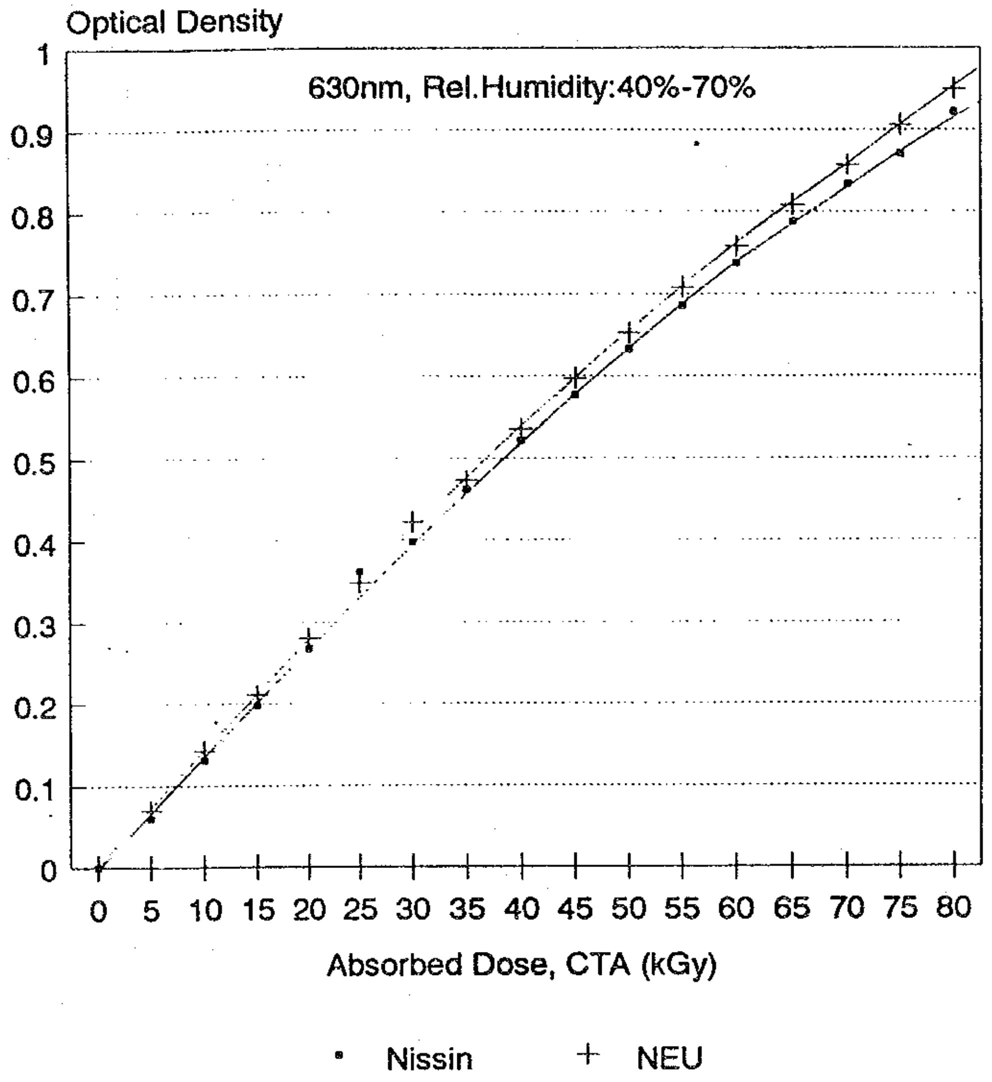
Appendix III:

Response of CTA film dosimeter to the gamma rays



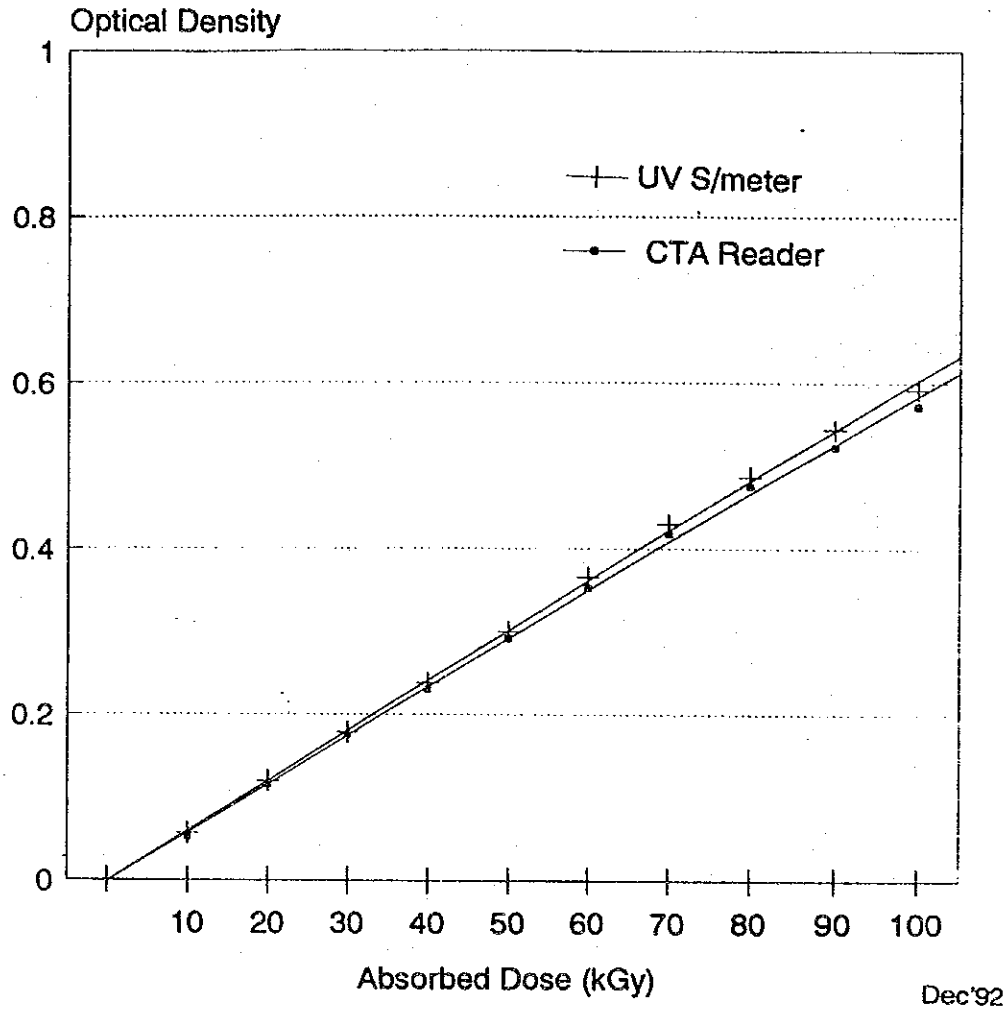
Appendix IV:

Calibration of Blue cellophane against the CTA film



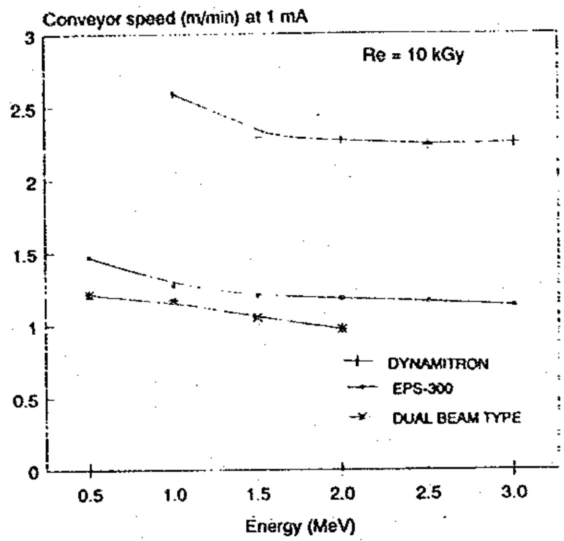
Appendix V:

Calibration of the CTA reader against the UV spectrophotometer

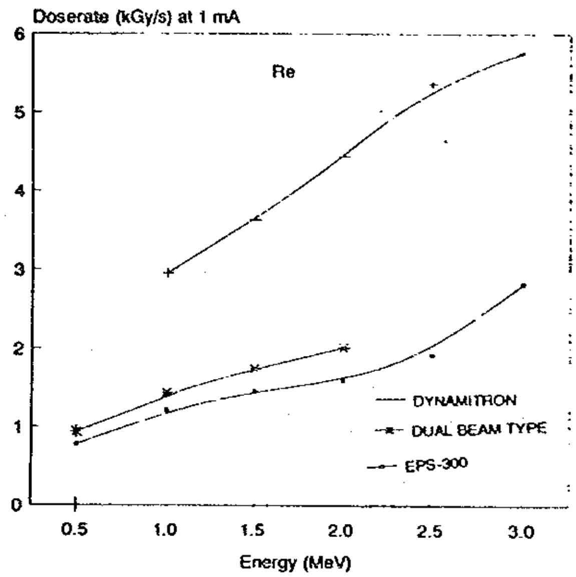


Appendix VI:

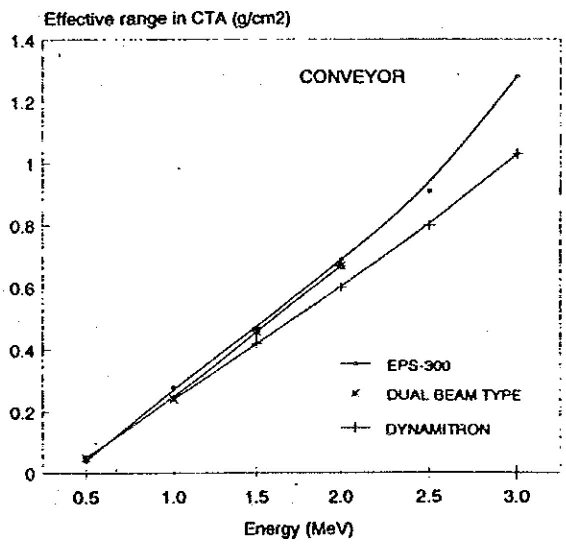
Comparison of NEU and JAERI's machine parameter
(WSD = 20cm)



(a)



(b)



(c)

APPENDIX 6

CURRENT SAFETY STATUS OF ELECTRON BEAM FACILITY

by

Mohd Yusof Ibrahim and Zulkafli Mohd Nor

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1. INTRODUCTION

The first Electron Beam Machine in Malaysia was commissioned in the late 1991. It is intended for use in research in the field of radiation processing. 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. 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.

The safety aspects of the electron beam facility were evaluated by the UTN Safety Committee from the submission of Electron Beam Safety Analysis Report. Inspection of the various design specifications and measurement of safety operating parameters were made during commissioning and the results were reported in during the Second UTN-JICA Joint Committee Meeting in early 1992. There were some issues related to safety highlighted in the report and recommendations to rectify the problem were also given. This paper reports the current safety status of the EB facility after a year of operation especially with regards to the actions that had been taken to coorect the safety related problems highlighted in the previous report.

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 0.1ppm 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

3.1.1 Design Concept

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. The radiation levels in the areas around the irradiation and the accelerator room are kept below the design levels with the provision of adequate shielding. The results of measurements were reported in the previous report.

The classification of areas in the EB building remain as before and are listed below;

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 are 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 since it is open to the non-radiation workers and the public.

During the year 1992, fixed TLD monitors were installed around the irradiation as well as the accelerator room to measure the dose during operation of Electron Beam Machine. The location of these TLD monitors are shown in figure 1. The results of these measurements are given in table 1 and figure 2.

The results clearly show that the yearly radiation dosage at these locations are below the limits for supervise areas including at the supposedly the Control Areas.

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

3.1.2 Interlock System

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) openings 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.
c. product entry port from the non-sterile area
d. product exit port form the sterile area
e. accelerator door on the first floor

3.1.2.1 Door Interlocks

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 Safety Switch Interlocks

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.

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 photodetector at the location where it is triggered will be useless.

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 3) 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 mere of these doors are opened. These signal lights are shown as DIL# in figure 3 where # denotes a number. When any one of these doors is 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 during any accident.

b. Electron Processing System (EPS) Operational Status

In the previous repert, it was reported that the colour indicating the operational status of EPS was not in accordance with international norms. Since then, actions had been taken to rectify the problem by reversing the colour code. However, the lights are right now are not bright enough because of low current supplied to the bulb used. The signals are denoted by the word EBM# in figure 3 where # denotes a number. The warning light which shows the status of the EPS had been separated from the door status indicator lights.

3.1.4 Operation of Shielding Door

3.1.4.1 Operation Switch

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

At the switch outside the irradiation room, there are two sets of "RED" and "GREEN" buttons arranged side by side. The left side buttons are for opening while the right side buttons are for closing. These buttons will only be operable when the key witch 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" buttons. These "RED" and :GREEN" buttons 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 signals 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 audible warning signal stops when the door stop moving

b. beeping sound - 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 to warn the people that the EPS will be operable after the one minute siren expires. This time relay ius 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 the 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 item b. and c. are not prerequisites for EPS starting sequence regardless of the position of the switches.

Below is the current status of the shielding door operation:

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

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

c. The door has two movement speed, slow and fast. It opened at initially a slow speed then changes to a higher speed after the door moves past the limit switch located at the ceiling on top of the door track,

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

A few safety points regarding the operation of the shielding door were raised in the previous report. Some actions had been taken to correct the situation namely;

a. the situation where the door can be closed from the inside of the irradiation room using the inside "GREEN" button was eliminated. This button can now only be used to open the shielding door from inside instead of the originally to close it,

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

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 the switch which can only be turned off when the switch is turned to "MAINTENANCE" position. The alarm signal to remind the entering personnel has until now not yet been installed.

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 the other toxic gases.

In order to keep the ozone concentration to a minimum level inside the irradiation room, the room air is exhausted using a high capacity blower installed in the accelerator room on the first floor. The exhaust blower is designed to provide 60 air change per hour for the irradiation room. The maximum ozone concentration in the exhaust ducts permitted so that the environmental ozone concentration does not exceed 0.1 ppm is 50 ppm. The operation experience has shown that ozone concentration in the exhaust ducts under full power operation of the EPS had rarely exceeds an average value of 20 ppm as reported in the EPS operational log book data. Measurements for concentration of ozone in the environment outside the building were made on several occasions without any detection.. The measurements data for ozone concentration inside the building are shown in figure 4.

3.3 Noise

Noise hazard is also present when the EPS and its auxiliary equipments are operated. The aspects of noise were not considered seriously at the planning stage because perhaps this was not expected would give serious problems. The noise level inside the facility could reach more than 80 dB(A) in certain areas by measurement made during full power operation (Fig. 1 see previous report).

The sources of the noise were identified to originate from;

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

b. high speed air jets 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 are installed in the machinery room next to the accelerator room. 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 in 1991 by:

a. Not operating the purge blower which supplies fresh air to the irradiation room. The irradiation room gets its supply of fresh air by normal ventilation condition created when exhaust blower is in operation. The fresh air gets into the irradiation room through the entry-exit openings,

b. Reducing the exhaust blower speed by increasing the diameter of the pulley,

c. Removing the duct projection in the irradiation room.

The noise level were reduced when these actions had been taken but the levels are still unacceptable in some areas. Measurements made on 9-Jan.-1992 shows that the noise level in the non-sterile area was 87 dB(C).

Subsequent to the safety recommendations, JICA had sent mission from Japan to identify the problems and to find its solutions in the Fiscal year 1992. As a result of this mission a report and suggestions on methods to reduce the noise level was submitted to the UTN-JICA Joint Committee. Modifications were carried out in the early months of Dec. 1992 by Shimizu Corporation. We are still waiting for the report of the effect of the modifications that have been taken. However, UTN's Safety Department had conducted noise measurement on 9-Jan.-1993 and the results are shown in figure 5.

4. CONCLUSION

With regard to the safety of the EBM Facility, it can be concluded from these analysis that;

a. the shielding of the facility is adequate,

b. interlocks system is functioning as required,

c. the lights warning signals are now installed according to the international convention though not bright enough. This is only a minor problem which can be overcome easily.

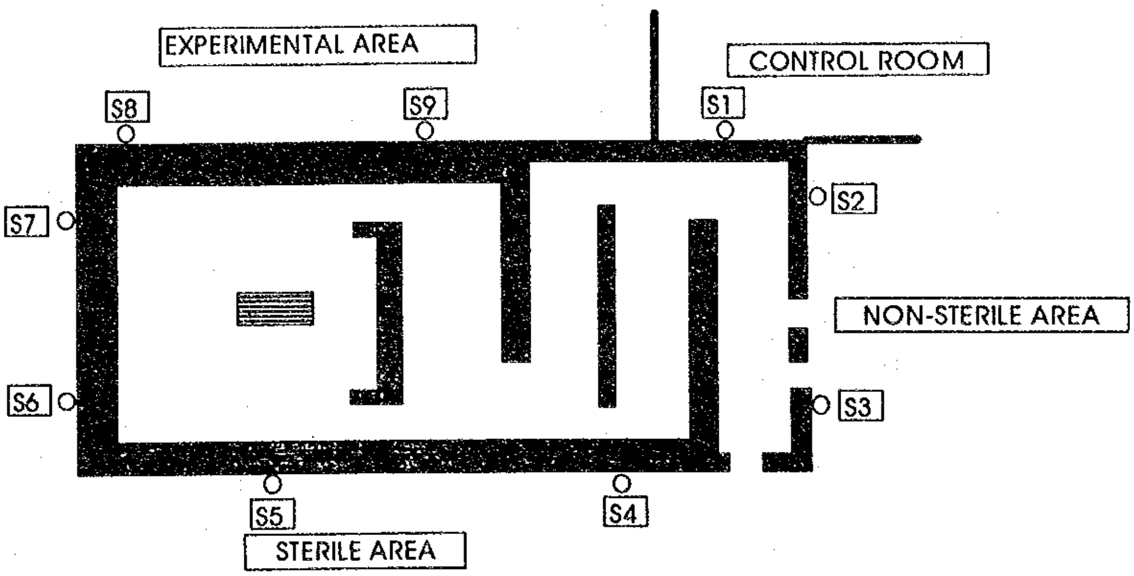
d. the noise levels at all measured locations are below 80dB(A) but in some areas are above than the intended level of 75dB(A),

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

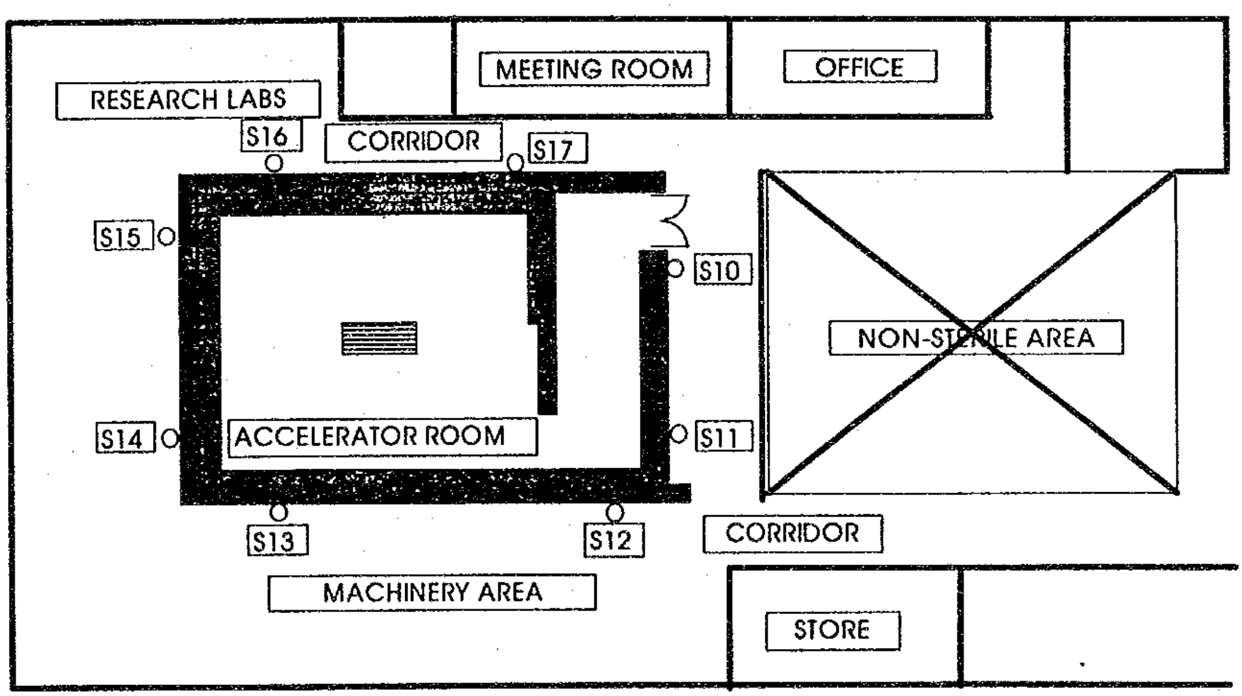
At this moment with regard to safety requirements, the EBM has achieved the minimum requirement of safety to ensure the safe operation.

5. SAFETY RECOMMENDATIONS

Even though the EBM has achieved a minimum safety requirement to warrant its full operation without relying on administrative controls and procedures to ensure safety in operation, there are still rooms for improvement especially with regards to the operation of safety switch when entering the irradiation room. It is recommended that the methods 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 the "MAINTENANCE" position.



a. Layout of the ground floor



b. Layout of the first floor

Figure 1. Location of TLD monitors on the ground and first floor of EB Facility

RESULTS OF AREA MONITORING OF ELECTRON BEAM FACILITY
USING TLD FOR THE YEAR 1992 COMPARED WITH POWER USAGE OF EPS

MONTH	kW-hr	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13	ST14	ST15	ST16	ST17
JAN FEB	37.23	0.90	0.70	0.80	0.81	0.83	0.86	1.26	0.98	0.73	0.64	0.67	0.57	0.54	0.61	0.79	0.80	0.61
MAR APR	85.56	0.52	0.50	0.44	0.50	0.46	0.54	0.40	0.44	0.43	0.39	0.54	0.35	0.33	0.41	0.57	0.70	0.58
MAY JUN	55.69	0.63	0.82	0.92	0.42	0.53	0.73	0.45	0.64	0.82	0.46	0.48	0.46	0.65	0.58	0.71	0.32	1.29
JUL AUG	149.98	0.98	0.94	0.92	0.79	0.49	0.82	0.87	0.42	0.74	1.05	0.81	0.52	0.87	1.20	1.31	1.95	1.38
SEP OCT	1042.31	1.29	1.10	0.48	1.61	0.86	0.71	0.75	0.67	1.06	0.94	1.12	0.65	0.60	1.02	0.82	0.93	1.25
NOV DEC	42.44	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	1413.21	4.32	4.06	3.56	4.13	3.17	3.66	3.73	3.15	3.78	3.48	3.62	2.55	2.99	3.82	4.20	4.70	5.11

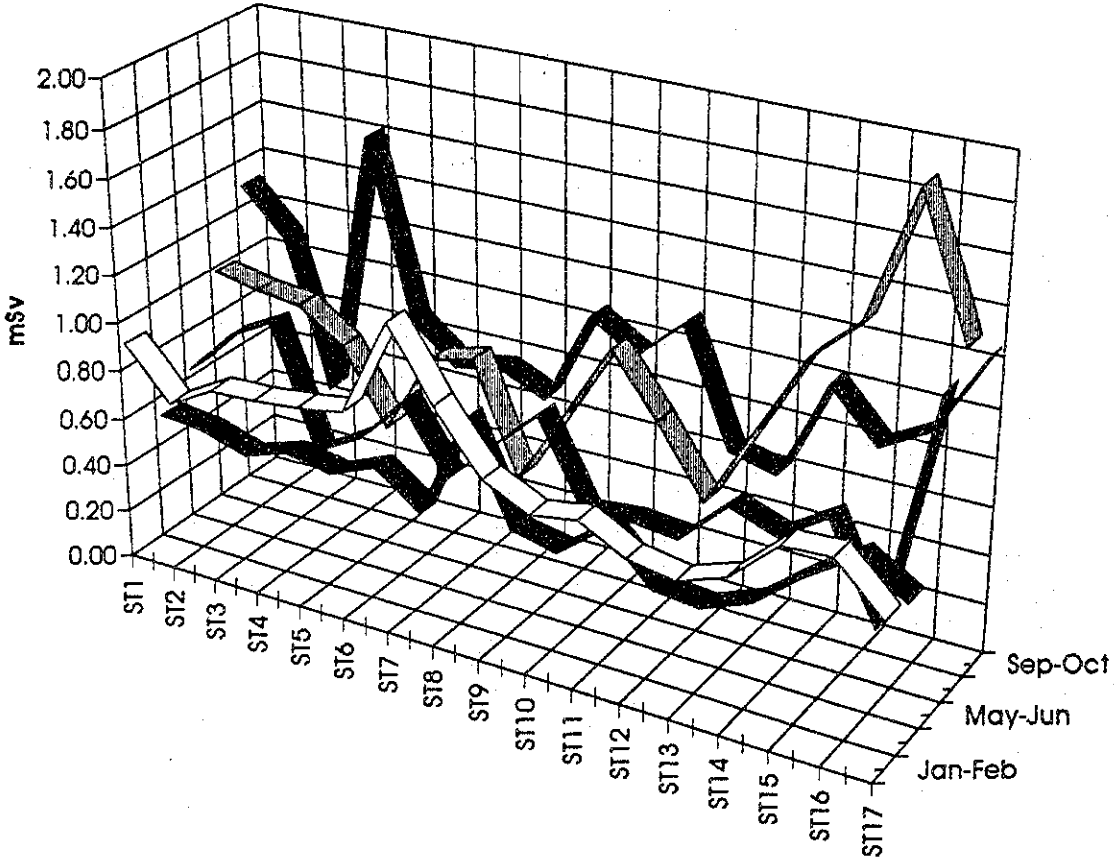
Notes:

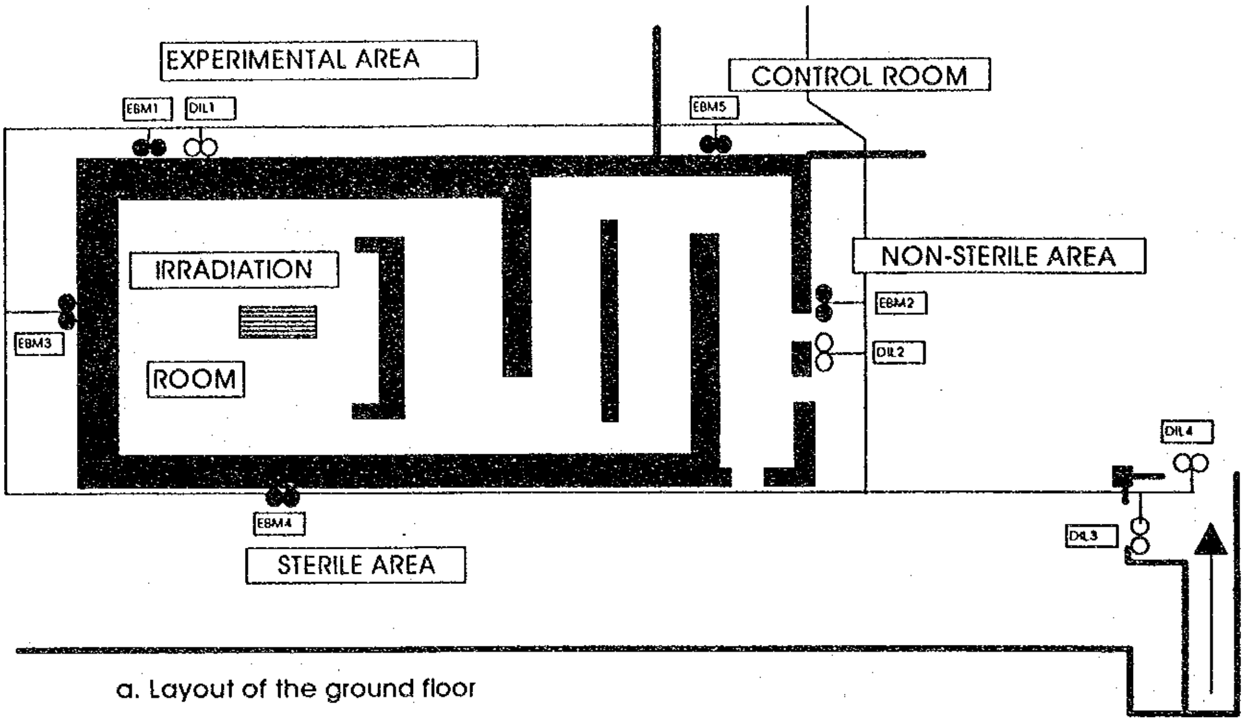
1. All dose data are in mSv.

2.

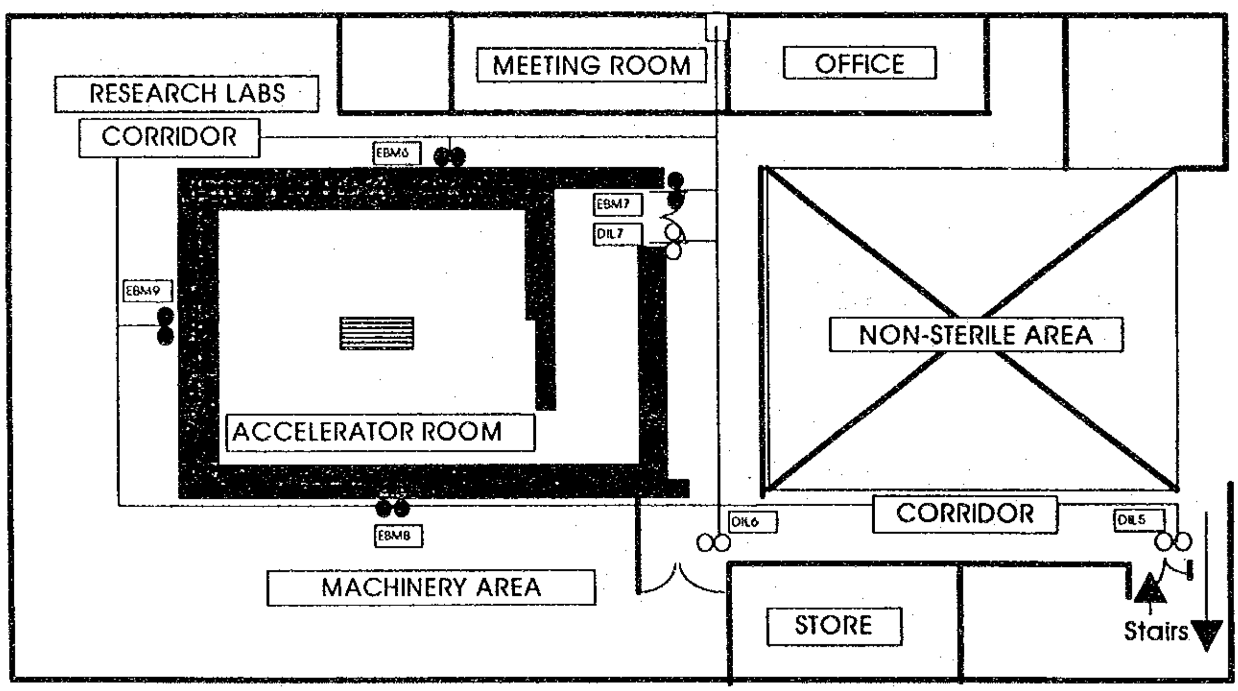
Area Class	Yearly Likely Dose
Control Area	> 15 mSv
Supervise Area	5 mSv < Dose < 15 mSv

Fig. 2 Area monitoring in EBM (TLD)





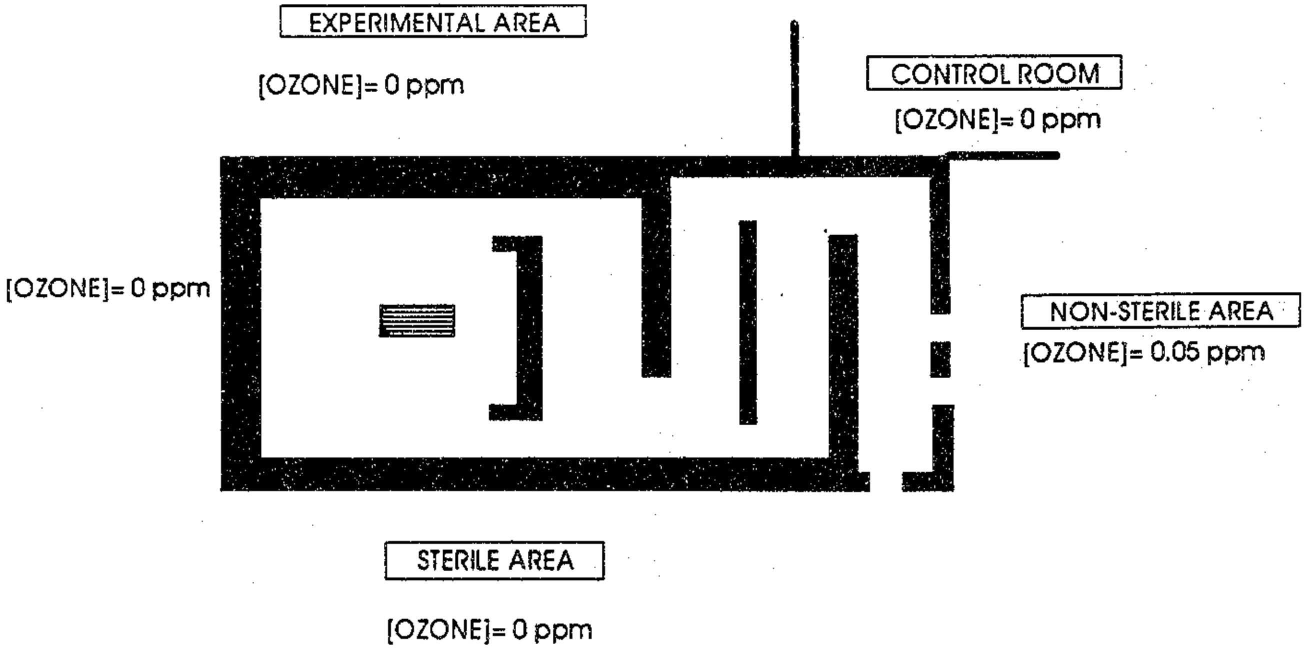
a. Layout of the ground floor



b. Layout of the first floor

Figure 3. Locations of warning lights and signals

FIG. 4 OZONE CONCENTRATION LEVEL MEASUREMENTS
AT ELECTRON BEAM FACILITY,
UTN COMPLEX, DENGKIL BRANCH



EPS OPERATIONAL PARAMETERS:

ACC. VOLTAGE:	3 MV
BEAM CURRENT:	30 mA
OZONE METER:	QUANTIMETER 1000 (DRAGER TUBE)

NOISE LEVEL MEASUREMENTS
AT ELECTRON BEAM FACILITY

DATE: 9-Jan-93
NOISE METER: SOUND LEVEL METER TYPE 3604
MANUFACTURE: YOKOGAWA ELECTRIC WORKS

STATION	BLOWER OPERATION "ON"								
	WINDOW COOLING			EXHAUST			WINDOW COOLING+EXHAUST		
	A	B	C	A	B	C	A	B	C
ST1	72	69	71	75	78	82	77	79	82
ST2	61	66	68	75	78	80	78	79	82
ST3	62	66	68	72	76	78	74	76	78
ST4	62	65	68	70	73	76	70	74	77
ST5	67	68	71	69	73	75	7	74	76
ST6	67	69	70	69	73	76	70	74	76
ST7	70	71	71	71	76	78	74	76	78
ST8	70	70	71	71	75	77	73	76	77

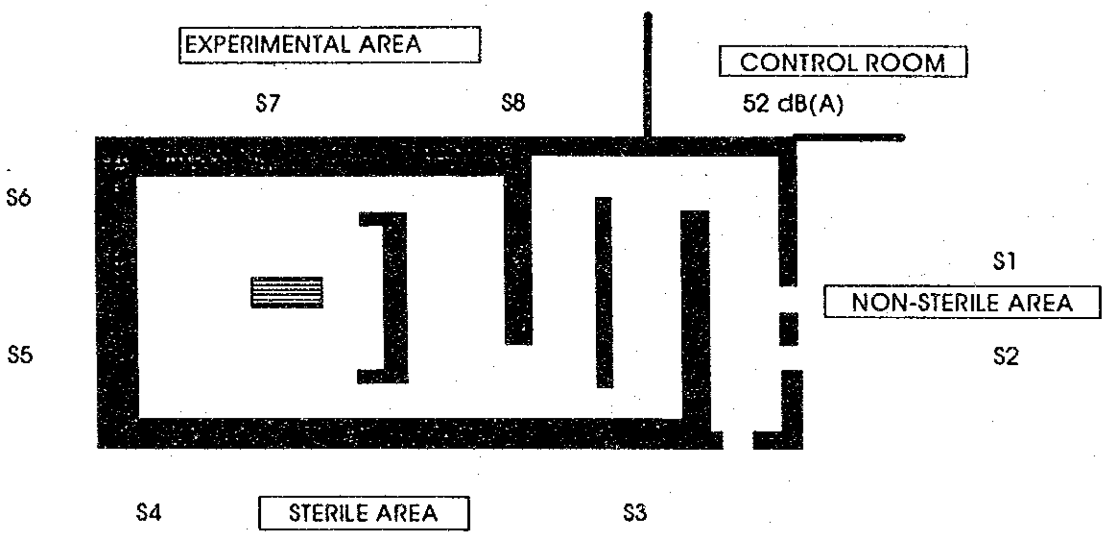


FIG. 5 NOISE MEASUREMENTS AROUND THE IRRADIATION ROOM

APPENDIX 7

THIRD JOINT COMMITTEE MEETING ON THE RADIATION APPLICATIONS PROJECT BETWEEN UTN AND JICA.

13th - 15th JANUARY 1993.

PROGRESS REPORT ON STERILIZATION OF MEDICAL PRODUCTS USING ELECTRON BEAM MACHINE.

RESEARCHERS & SUPPORTING STAFF

DR. ZAHRAH ABDUL KADIR

MR. KAMARUDIN BAHARI

MRS. SHARIFAH HANISAH S. A. AZIZ

MRS. ASNAH HASSAN

MS. NOORLIDA ISMAIL

MS. MASSITA MOHD SANI

MR. AZMI OTHMAN

MR. NOOR KHILMAN SANGIT

MS. KHUZAIMAH HASSAN

RADIATION STERILIZATION OF MEDICAL PRODUCTS USING ELECTRON BEAM MACHINE

RESEARCH AND DEVELOPMENT ACTIVITY

1. MATERIALS COMPATIBILITY
2. MICROBIOLOGY
3. RADIATION TECHNOLOGY

ON GOING PROJECTS
(MATERIAL COMPATIBILITY)

1. **THE EFFECTS OF IRRADIATION ON SURGICAL GLOVES**
2. **THE EFFECTS OF IRRADIATION ON SUTURES**
3. **THE EFFECTS OF IRRADIATION ON PVC MEDICAL SUPPLIES**
4. **THE EFFECTS OF VARIOUS NUCLEATING AGENTS ON THE OXIDATIVE DEGRADATION OF POLYPROPYLENE**
5. **THE EFFECTS OF IRRADIATION ON PP AND CP BLENDS**
6. **THE EFFECTS OF IRRADIATION ON PP AND PE BLENDS**
7. **FOMULATION OF IRRADIATION COMPATIBLE POLYVINYLCHLORIDE (PVC)**

PROGRESS REPORT OF RESEARCH PROJECTS (FY 1992)

STERILIZATION OF MEDICAL PRODUCTS USING ELECTRON BEAM MACHINE

Research Activities

1. Material Compatibility

We have carried out research on the compatibility of plastic raw materials such as PP, CP, PVC and PE.

The research works are as follows:

1.1 The effects of irradiation on surgical rubber gloves.

1.2 The effects of irradiation on sutures.

1.3 The effects of irradiation on Polyvinyl Chloride (PVC) medical supplies.

1.4 The effects of various nucleating agents on the oxidative degradation of Polypropylene.

1.5 The effects of irradiation on PP and CP blends.

1.6 The effects of irradiation on PP and PE blends.

1.7 Formulation of radiation compatible PVC.

EFFECTS OF IRRADIATION ON SURGICAL RUBBER GLOVES

INTRODUCTION

Medical products can be sterilized by steam, autoclave, ethylene oxide gas and radiations (gamma rays and electron beam) . In this article we report on the effects of irradiation on rubber gloves. The gloves used are examination glove (Dental) and surgical rubber gloves.

From the previous work[1], we found that the tensile strength and elongation at break (E_b) were not significantly affected during irradiation and storage after irradiation in gamma-ray and electron beam . However, the degradation was found to be higher in gamma compared to electron beam radiation.

EXPERIMENTAL

Materials

Five commercial rubber gloves used were:

1. Guanti : Sample A
2. Profeel with powder : Sample B
3. Profeel without powder : Sample C
4. Dental : Sample D
5. Safeskin : Sample E

Irradiation

All rubber gloves were irradiated in both gamma and electron beam radiation with doses of 10, 25, 50 and 100 kGy. For gamma radiation, the dose rate used was 2.5 kGy/h. For electron beam radiation , the beam and voltage used were 1 mA and 2.5 MeV. The dose rate used was 10 kGy/pass.

Measurement After Irradiation

The tensile properties such as tensile strength (T_b) ,Elongation at break (E_b) , modulus at 100% elongation (M_{100}) and tear strength (T_r) of the samples were determined in accordance with the ASTM standard D3577 and using an Instron Tensile Machine 4301. Six pieces of dumbbell-shaped glove were used and the average value was taken.

RESULTS AND DISCUSSION

Effect of Gamma Radiation on the Surgical Rubber Gloves.

Figure 1 shows the change of T_b, E_b, T_r and M_{100} with dose after irradiated in gamma-ray for rubber gloves. From figure 1a, the slope for Sample A is the steepest . This show that degradation occurs more in Sample A than the other gloves. From Figure 1c, it can be seen that E_b is hardly affected with increasing dose. Figures 1b and 1d, show that M_{100} and T_r decrease with increasing dose for all rubber gloves. The experiment concludes that degradation from gamma irradiation occurs most in Sample A, followed by Sample C, Sample B, Sample D and Sample E.

Effect of Electron Beam Radiation on the Surgical Rubber Gloves

The effect of electron beam on the degradation of rubber gloves has also been studied. Figure 2 shows the effect of electron beam radiation on the T_b, T_r, E_b and M_{100} for rubber gloves at different doses. From Figure 2a, it can be observed that T_b decreases with increasing dose. There is no significant change in E_b for all rubber gloves (Figure 2c). Figures 2b and 2d show that M_{100} and T_r decrease slightly with increasing dose after irradiated in electron beam. Comparing Figures 3 and 4, it can be seen that T_b and T_r decreased more in gamma than electron beam, indicating that degradation is higher in gamma than in electron beam radiation.

Effect of Storage on the Surgical Rubber Gloves

According to previous work[1], degradation of rubber gloves occured during storage.For confirmation , physical properties on irradiated rubber gloves in gamma-ray and electron beam were measured.

Figures 5 and 6 show that the T_b and E_b for the rubber gloves during storage at 25 and 50 kGy in gamma-ray and electron beam. There is no significant change in T_b and E_b for the rubber gloves during storage. However, by comparing the effects of gamma-ray and electron beam on the gloves during storage , it can be seen that T_b (Figure 5) decreases more in gamma-ray than in electron beam , especially at 50 kGy . This indicates that degradation is higher in gamma than electron beam radiation.

CONCLUSION

From the data obtained,it was found that the tensile strength and elongation at break for rubber gloves were not significantly affected during irradiation either in gamma ray or electron beam and also during storage. On the other hand, modulus at 100% elongation and tear strength decreases with increasing dose for all the rubber gloves. From this data, it was found that degradation is higher in gamma ray than electron beam radiation.In gamma radiation , the irradiation time is longer for oxygen to diffuse into the sample.

REFERENCE

1. Zahrah A. Kadir et al. ,Durability of Radiation-sterilized Polymers, IX. The Effect of Irradiation on Rubber Gloves (1990). Journal of Applied Polymer Science, 40, 799-810.

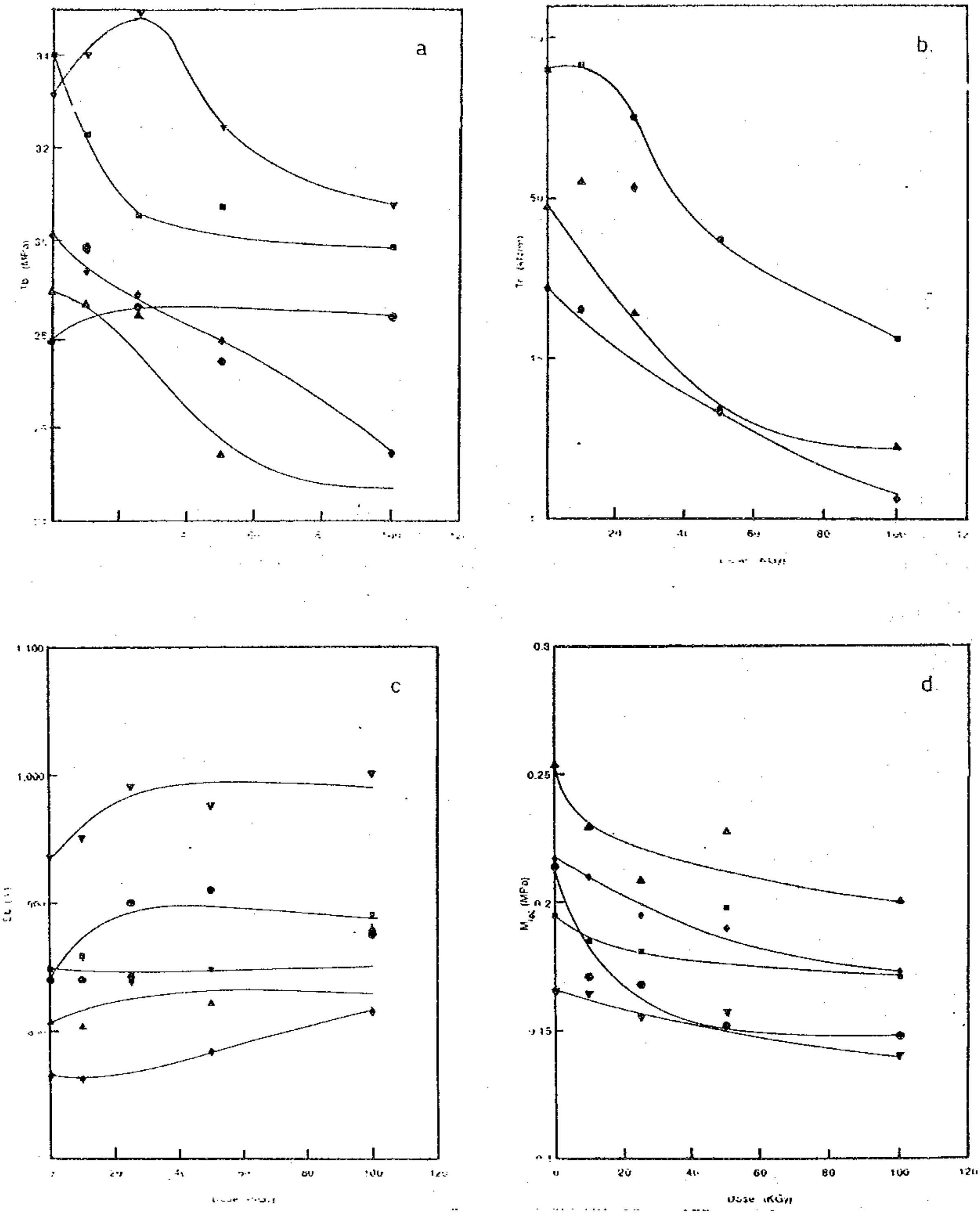


Fig.1. The change of (a) tensile strength.Tb: (b) tear strength, Tr ; (c) elongation at break .Eb;and (d) modulus at 100% elongation,M_{100} ; with dose after irradiation in gamma ray for rubber gloves : (■) Sample A; (◆) Sample B; (▲) Sample C; (●) Sample D; (▼)Sample E.

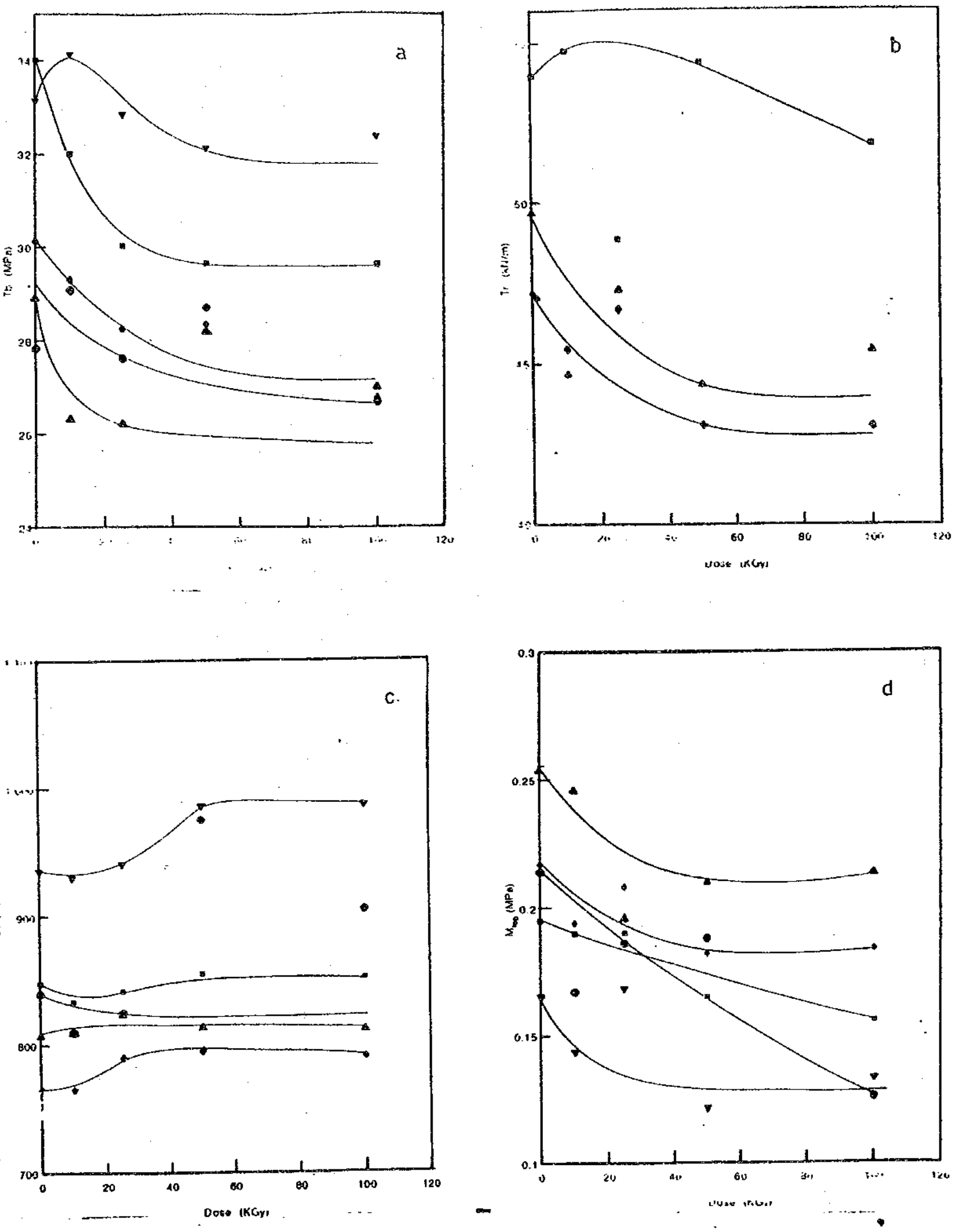


Fig.2. The change of (a) tensile strength,Tb; (b) tear strength, Tr; (c) elongation at break,Eb ;(d) modulus at 100% elongation ,M100; with dose after irradiation in electron beam for rubber gloves: (■) Sample A; (◆) Sample B; (▲) Sample C; (●) Sample D; (▼) Sample E.

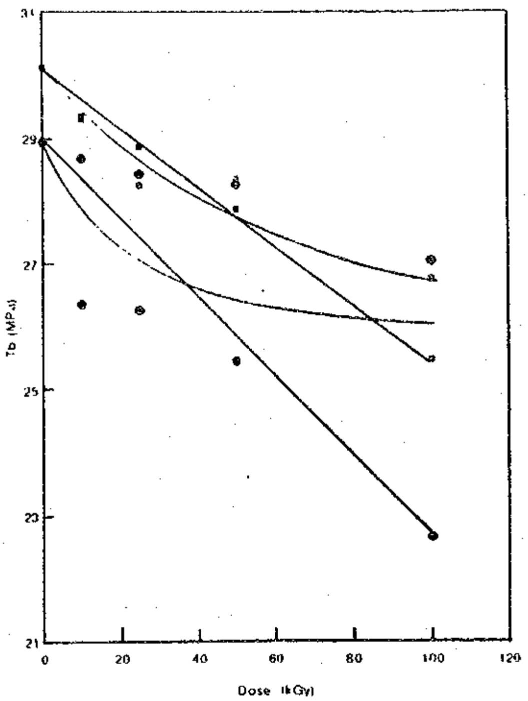


Fig.3. The change in Tb of the two rubber gloves with dose after irradiation in gamma ray and electron beam; (■) Sample B and (●) Sample C in gamma ray; (□) Sample B and (○) Sample C in electron beam.

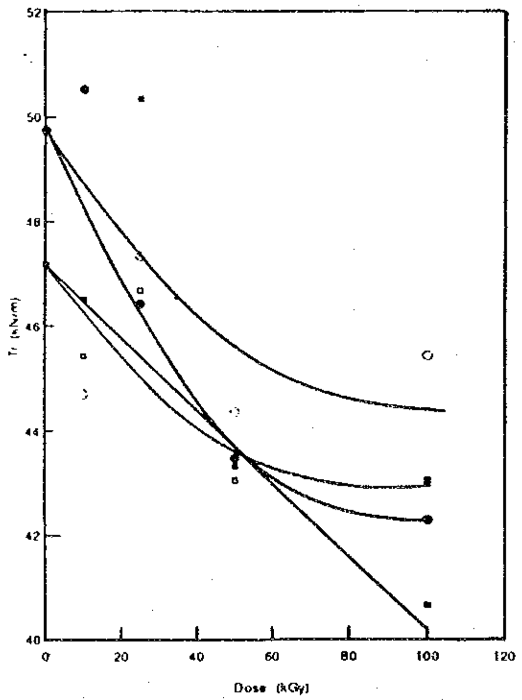


Fig.4. The change in Tr of the two rubber gloves with dose after irradiation in gamma ray and electron beam; (■) Sample B and (●) Sample C in gamma ray ; (□) Sample B and (○) Sample C in electron beam.

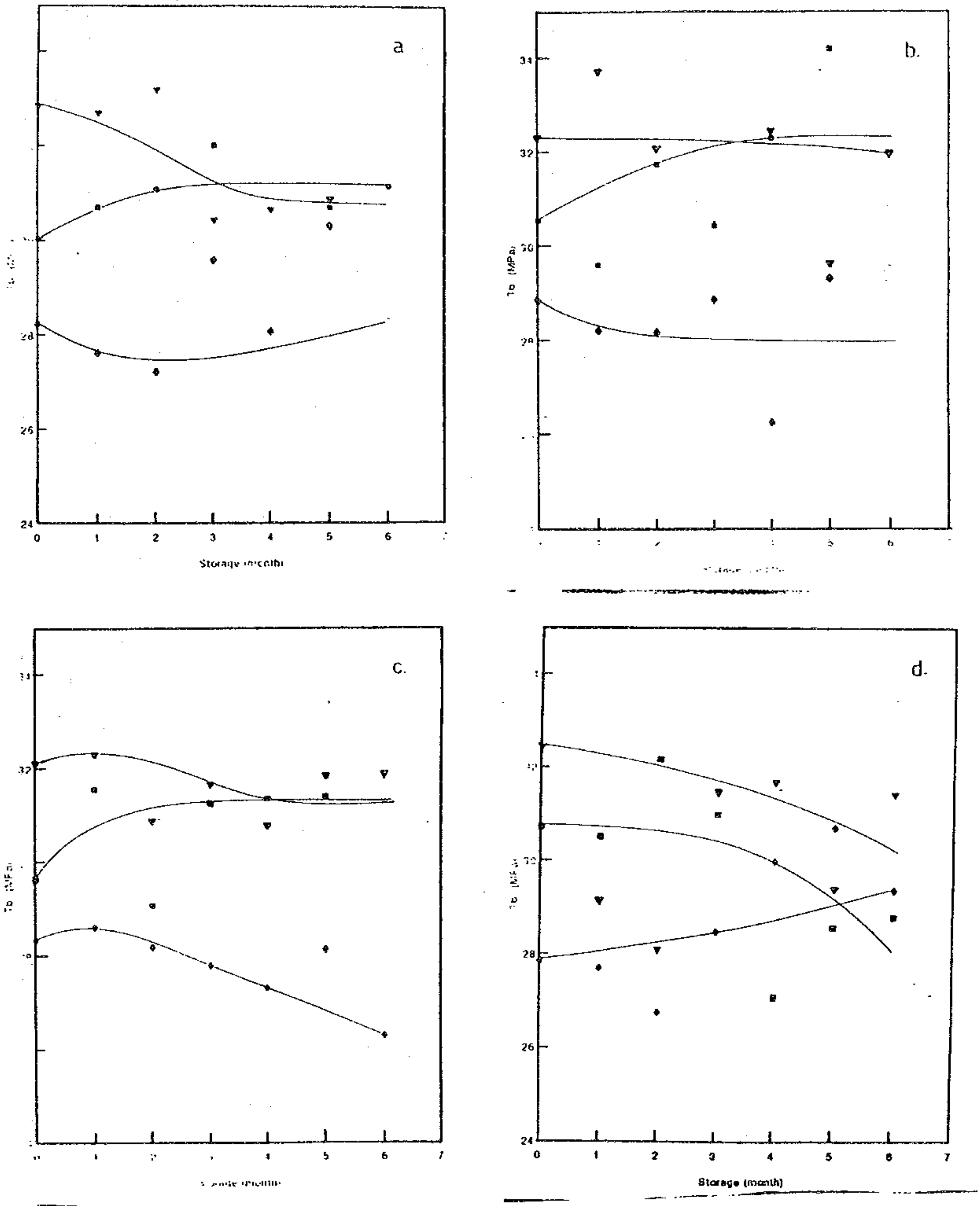


Fig.5. The change in Tb of the three rubber gloves during storage; (a) 25 kGy in electron beam ; (b) 25 kGy in gamma ray; (c) 50 kGy in electron beam; (d) 50 kGy in gamma ray; (■) Sample A; (♦) Sample B; (▼) Sample E.

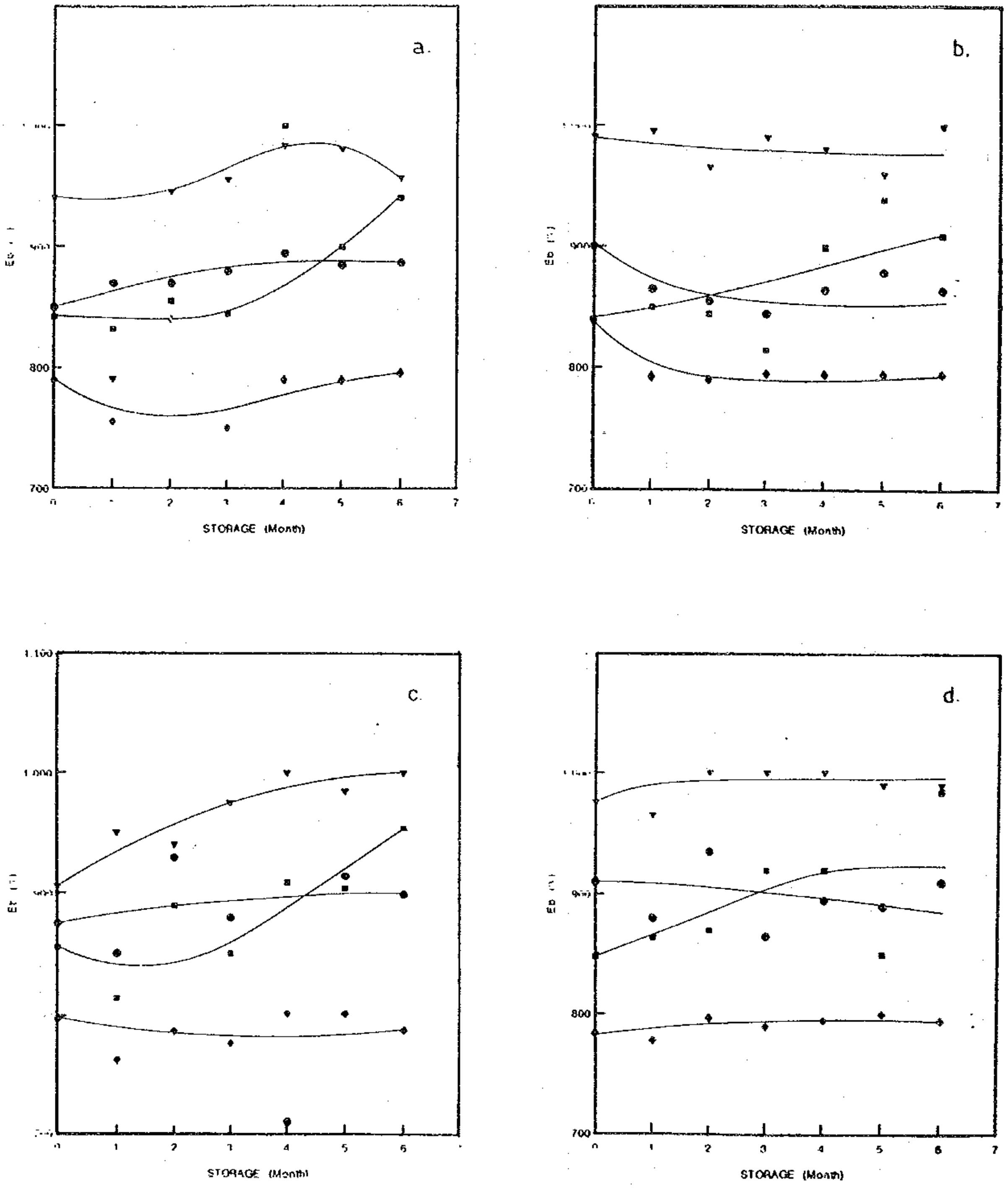


Fig.6. The change in Eb of the four rubber gloves during storage ; (a) 25 kGy in electron beam; (b) 25 kGy in gamma ray; (c) 50 kGy in electron beam; (d) 50 kGy in gamma ray; (■) Sample A; (♦) Sample B; (●) Sample D; (▼) Sample E.

2. Microbiology

The experiments carried out were as follows:

2.1 Dose rate measurements in glass vials and plastic bags.

2.2 Depth dose measurement of glass plates.

2.3 Effects of vacuum on B. Pumilus.

2.4 Effects of vacuum and moisture on B. Pumilus.

2.5 Sterilization doses determination using gamma radiation on gloves, cotton and gauze.

2.6 Radiation sensitivities of biological indicator using gamma and EB radiation.

SUMMARY OF MICROBIOLOGY REPORT

Sterilization doses determination by using gamma radiation were carried out using sample of gloves, cotton and gauze. AAMI method i.e the pre-sterilization dose of items and the resistance of the residual bioburden of items, was employed. From these tests the sterilization dose were found to be 1.7 kGy for cotton, 16 kGy for both gloves and gauze.

Radiation sensitivities of biological indicator e.g B. pumilus and B. megaterium were carried out using gamma and electron beam (EB) radiation. It was found that the D_{10} values of B. pumilus differ when irradiated in gamma and eletron beam radiation. D_{10} value of B. pumilus is 1.6 kGy in gamma and 1.7 kGy in EB radiation. The D_{10} values of B. megaterium is 2.3 kGy in gamma and 2.4 kGy in EB radiation. Both micro-organisms became more resistant in EB irradiation.

In order increase the monitoring dose range, investigations were carried out to increase the D_{10} value of the biological indicators by adding additives such as peptone and glycerin. Results showed that these additives increased the D_{10} value of B. pumilus from 1.6 to 1.9 kGy in gamma and 1.7 to 2.3 kGy in EB radiation. For B. megaterium the D_{10} value increase from 2.3 to 2.6 kGy in gamma and 2.4 kGy to 3.1 kGy in EB radiation. The presence or the absence of oxygen, moisture and dose rate might influent the inactivation of the micro-organisms, studies were also carried out by irradiating the biological indicator by EB in these conditions. It showed that D_{10} value is high for irradiated biological indicator in vacuum and moisturised vacuum. The D_{10} value of B. pumilus irradiated under these conditions increase from 1.7 kGy in air to 3.0 kGy in vacuum and 3.2 kGy in moisturised vacuum. Thus this will help to increase the monitoring dose range of biological indicator.

In EB radiation, many factors had to be considered such as density and thickness of the materials. Sterility test carried out on higher density material eg. a box of needles, a result shown is positive only to certain depth.

Table 8 : Some data of the preparation of LENRA.

No.	Sample	Source	$\bar{M}w$	$\bar{M}n$	DRC,%	OOC,%	Epoxy:AA ratio	Cat. %	Inh. %	Reaction time(hr)	Initial AN	Final AN	% AN reduction
1.	LENR-25	UKM	380,000	82.000	27.6	5.04	1:1.2	1	1	61	166	64.0	61.4
2.	LENR-25	UKM	380,000	82,000	27.6	5.04	1:1.2	1	1	116	166	55.4	66.6
3.	LENR-25	UKM	380,000	82,000	27.6	5.04	1:1.2	1	1	16	166	48.1	71.0
4.	LENR-50	UKM	232,000	62,000	21.9	5.26	1:1.2	1	1	7	172	153.9	10.5
5.	LENR-50	UKM	232,000	62,000	21.9	5.26	1:1.2	1	1	15	172	141.5	17.7
6.	LENR-50	UKM	232,000	62,000	21.9	5.26	1:1.2	1	1	27	172	115.7	32.7
7.	LENR-50	UKM	232,000	62,000	21.9	5.26	1:1.2	1	1	41.5	172	103.5	39.8
8.	LENR-50	RRIM	19,478	5,847	50	7.43	1:0.2	1	1	20	65.1	49.4	24.1
9.	LENR-50	RRIM	19,478	5,847	50	7.43	1:0.1	1	0.5	13	24	14.9	37.9
10.	LENR-50	RRIM	19,478	5,847	50	7.43	1:0.1	1	0.5	11	25	17.2	31.2
11.	LENR-50	RRIM	19,478	5,847	50	7.43	1:0.1	1	0.5	22	24	12.0	50.0
12.	LENR-50	RRIM	19,478	5,847	50	7.43	1:0.2	1	0.5	28	72	49.0	31.9

Notes :- DRC = Dried Rubber Content
OOC = Oxirane Oxygen Content (before reaction)
AN = Acid Number
Cat = Catalyst
Inh = Inhibitor
AA = Acrylic acid.

Table 1 : Target Material

Target Name	PROFEEL Surgical Rubber Gloves
Company Name	Wembley Rubber Products Malaysia
Size	6.5
Type	Powder Free
Lot Number	440990
Number of Glove	1 Pair

Table 2 : EB Irradiation Conditions

Energy	3 MeV
Current	1 mA
Speed	1.13 m/min
Distance from window	20 cm
Total number of passes	5 (1 Pass=10 kGy)
Type of irradiation	Both side

Table 3 : EB Irradiation Conditions

Energy	3 MeV
Current	1 mA
Speed	1.13 m/min
Distance from window	20 cm
Total number of passes	2 (1 Pass=10 kGy)
Type of irradiation	Both side

DOSE DISTRIBUTION STUDY ON SURGICAL RUBBER GLOVES USING EBM

INTRODUCTION

Radiation sterilization of medical products using gamma radiation is a well established technique. On the other hand, for electron beam sterilization of medical products, there are only few facilities in the world which are dedicated for this purpose. Most of these facilities are either 5 MeV or higher energy EBM.

UTN has commissioned a 3 MeV electron beam machine (EBM) in middle 1991. Thorough study on the selected medical products has to be carried out in order to find out the best packaging methods. Unlike the gamma facility, the quality control of EBM is very difficult. There are so many factors and parameters to be considered. In this report, the dose distribution on surgical rubber gloves using EBM is being studied.

EXPERIMENTAL

The target materials for this experiment is the surgical rubber gloves supplied by Wembley Rubber Products, Malaysia (Table 1). The diagram of the surgical rubber gloves are shown in Figures 1 and 2. The experiment was carried out on 6, 8 and 10 packs of gloves.

The original box was used (Figure 3) and dummy packs were added to remove the side and backscattering of the electron. CTA dosimeter film were placed at the centre of the stack (the centre tively. From the results, it shows that eight packs has DUR value of 3.06, thus eight packs is the best for this experiment.

In Figure 9, shows the surface dose of box number 6, the Optical Density (O.D) is lower for the position number 5, 6 and 7 cm. These positions are the high density area where the gloves are folded into several layers. Figure 10 and 11 show the centre dose of the gloves. O.D is found to be decreased at position numbers 17 and 18 cm.

Table 4, shows that the DUR obtained when four boxes were rotated along scanning direction. DUR for these boxes were found to be 3.0 and 2.95. The DUR obtained when four boxes were rotated along the conveyor direction were found to be 3.05 and 3.15 (Table 5). Although in both rotation the DUR were not uniform but it is still below 4. DUR for six boxes gave the same pattern. Thus, eight boxes were found to be the best arrangement and the rotation method selected was along the conveyor direction since it was convenient and practical.

The stacking method gave a better result compared to the centre method since the overall DUR is real.

CONCLUSION

From the above results, it can be concluded that eight packs are suitable for EB irradiation. For the irradiation field, eight boxes are selected rather than six boxes since O.D is similar to six boxes, and it is the maximum number of boxes that can be placed under the scan horn.

method). The EB irradiation conditions were shown in Table 2.

For the experiment to determine the irradiation field, eight (Figure 5) and six boxes (Figure 6) were used. Eight packs of gloves were placed inside the modified box (Figure 4). Three pieces of CTA film were placed on top of the box and fourteen pieces at the centre of the stacks. They were arranged side by side under the scan horn. The EB irradiation conditions were shown in Table 3. Four boxes were rotated along the conveyor direction and the other four boxes were rotated along scanning direction.

For the confirmation of dose distribution and DUR by stacking method, eight boxes were arranged as before. Two boxes were placed at the edge and the centre, whilst the other four boxes used as a dummy (Figure 7). The arrangement of the CTA films were as in stacking method.

Fourteen pieces were placed on the top of the box and the first pack. In the other two boxes, fourteen pieces CTA were placed on the second and the third pack. CTA films were not arranged on all packs at one time as to avoid the additional thickness.

RESULTS AND DISCUSSION

Figure 8 shows the graph of Dose Uniformity Ratio (DUR) against the Number of packs. DUR for the pack of gloves in a box for double sided irradiation is found below the value of 4. DUR for six , eight and ten packs are 3.65, 3.06 and 3.12 respec-

3. Radiation Technology

The experiments carried out were as follows:

3.1 Dose distribution measurement of surgical rubber gloves in a box (centre method).

3.2 Dose distribution measurement of surgical rubber gloves to determine the irradiation field.

3.3 Confirmation of dose distribution and Dose Uniformity Ratio (DUR) by varying the arrangement of CTA dosimeter (Stacking Method).

Table 4 : DUR using the Centre Method
(Rotate along Scanning Direction)

Number of Box	DUR		
	8 Boxes	6 Boxes	
1	3.00		Experimental Data
2	2.95	2.90	
3	2.95	3.00	
4	3.00	2.86	
5	3.00	2.86	Expected Data
6	2.95	3.00	
7	2.95	2.90	
8	3.00		

Table 5 : DUR using Centre Method
(Rotate along Conveyor Direction)

Number of Boxes	DUR		
	8 Boxes	6 Boxes	
1	3.05		Expected Data
2	3.05	3.15	
3	3.10	3.75	
4	3.15	3.15	
5	3.15	3.15	Experimental Data
6	3.10	3.75	
7	3.05	3.15	
8	3.05		

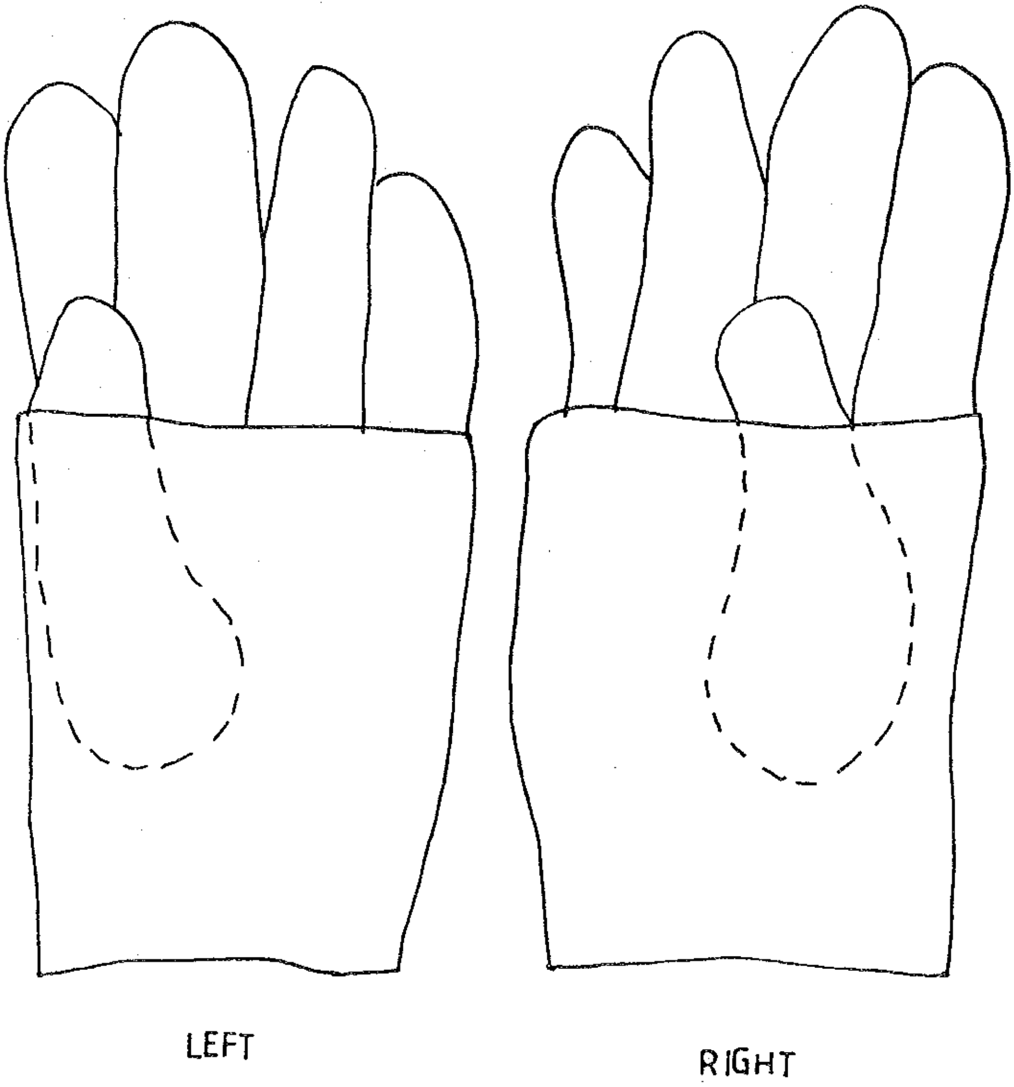


Figure 1 : **Diagram of the surgical gloves**

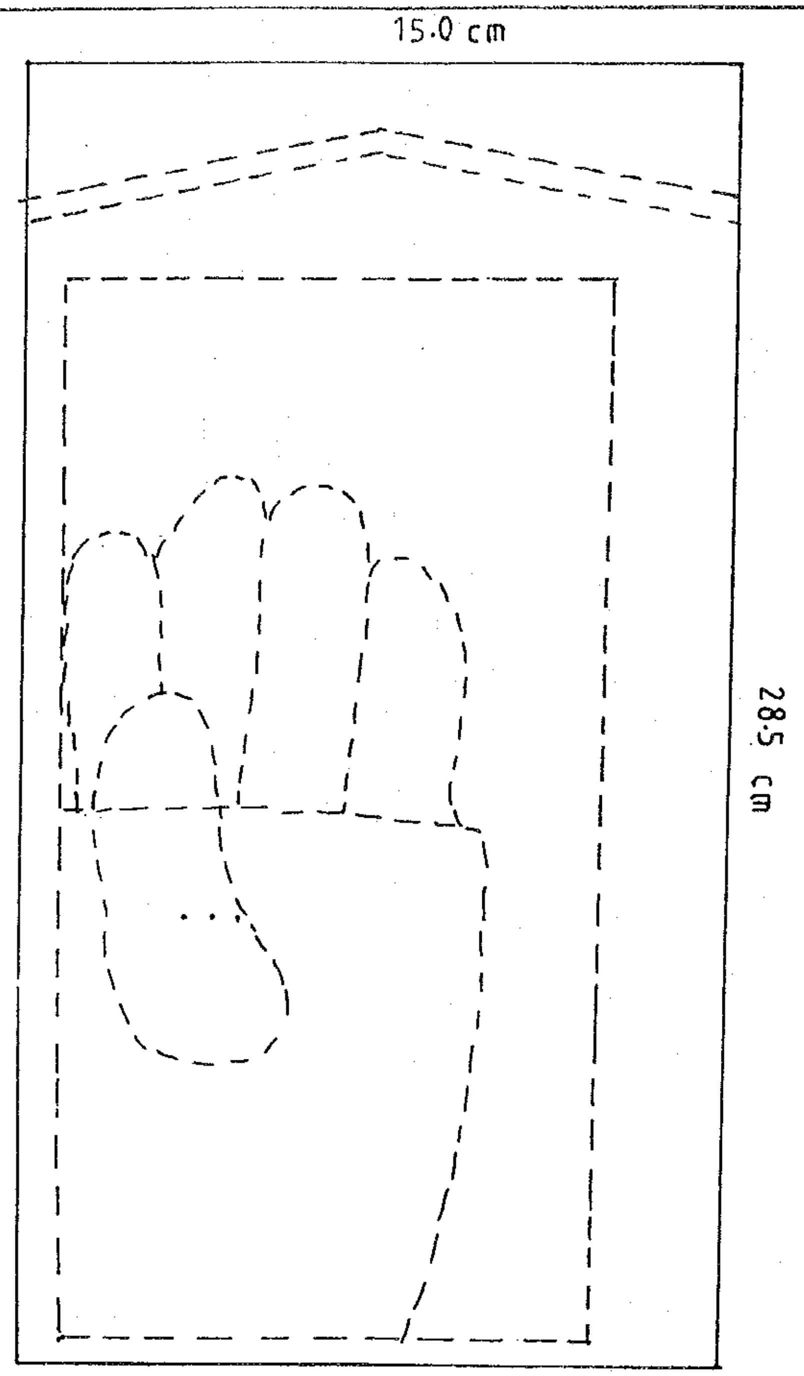


Figure 2 : Position of glove in the pouch and package

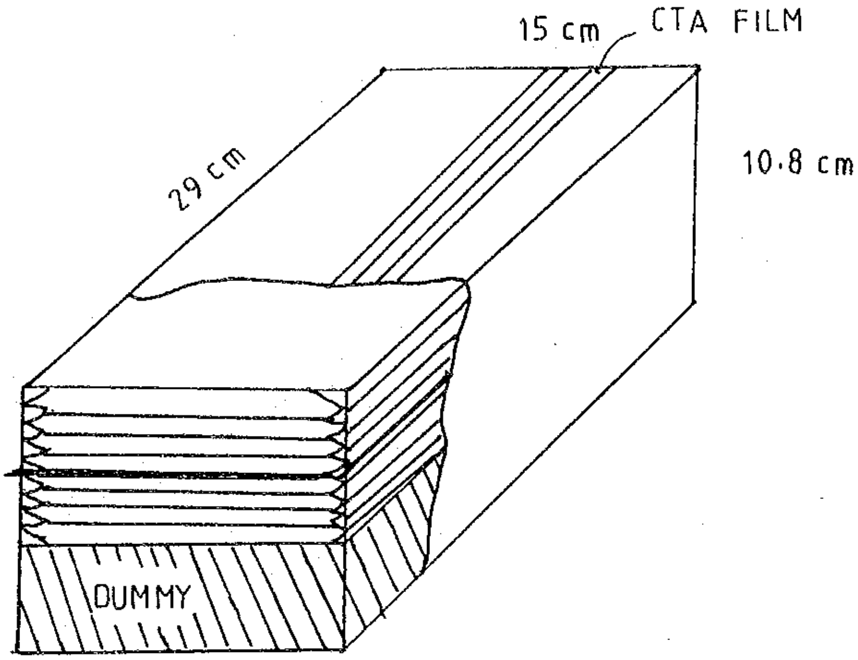


Figure 3 : 8 packs and dummy packs in original box

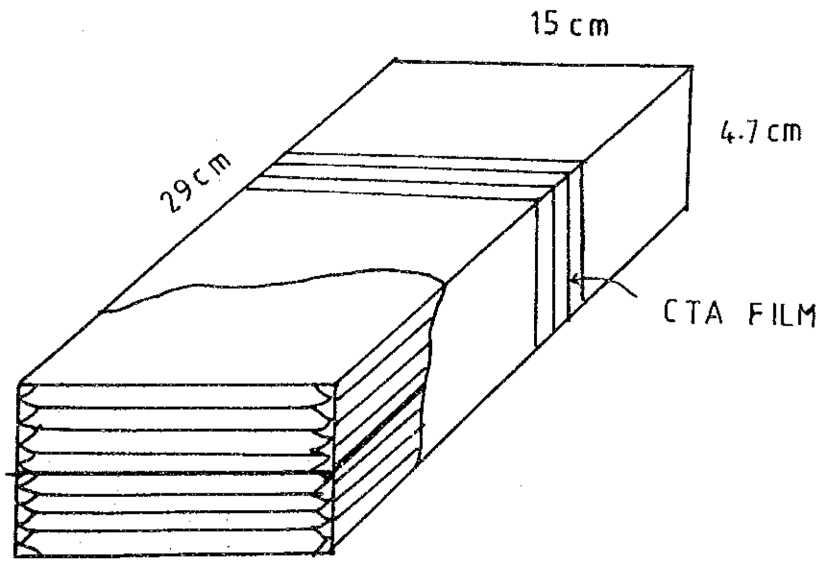


Figure 4 : 8 packs in a modified box

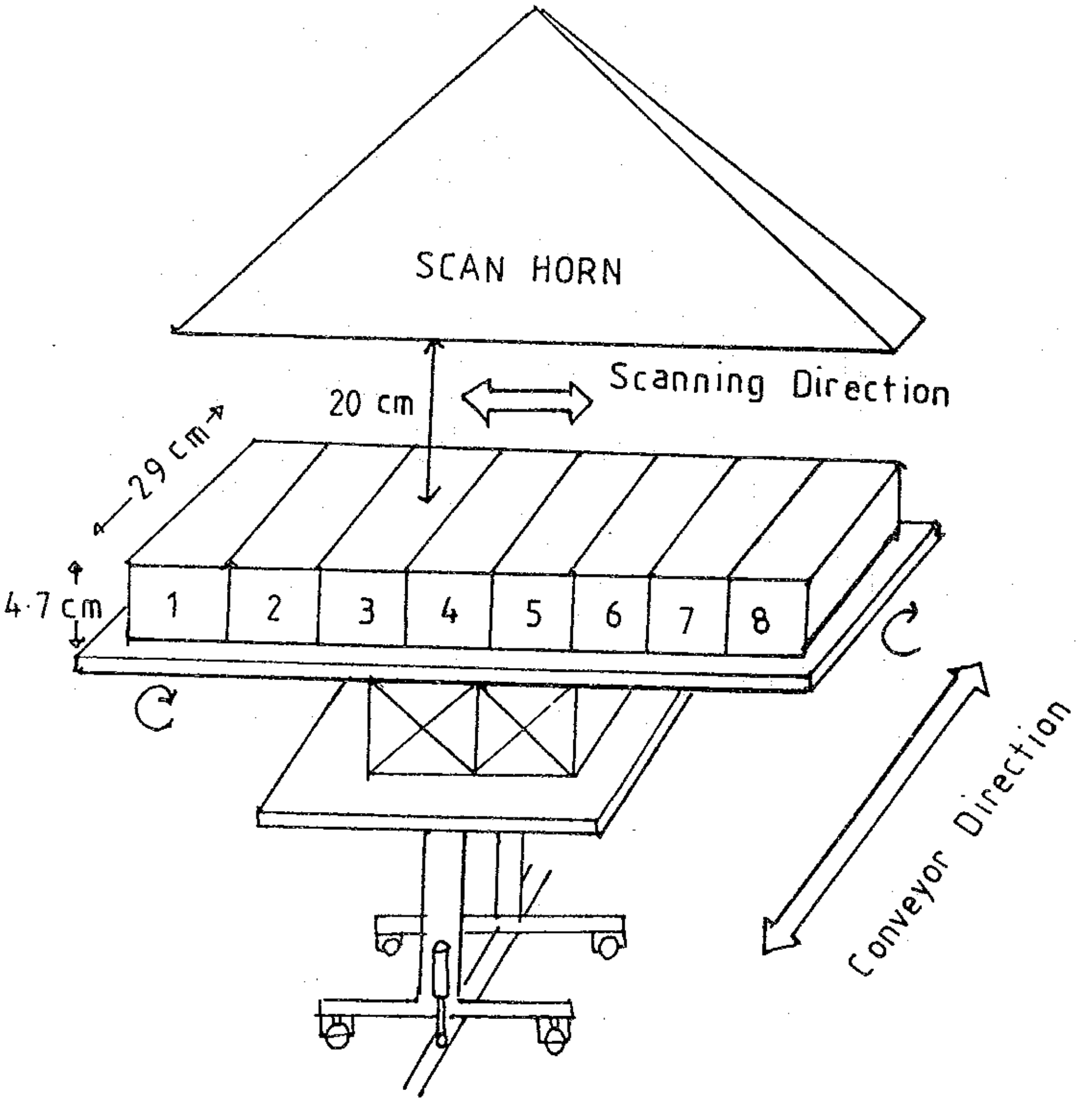


Figure 5 : **Arrangement of 8 boxes of glove on the cart**

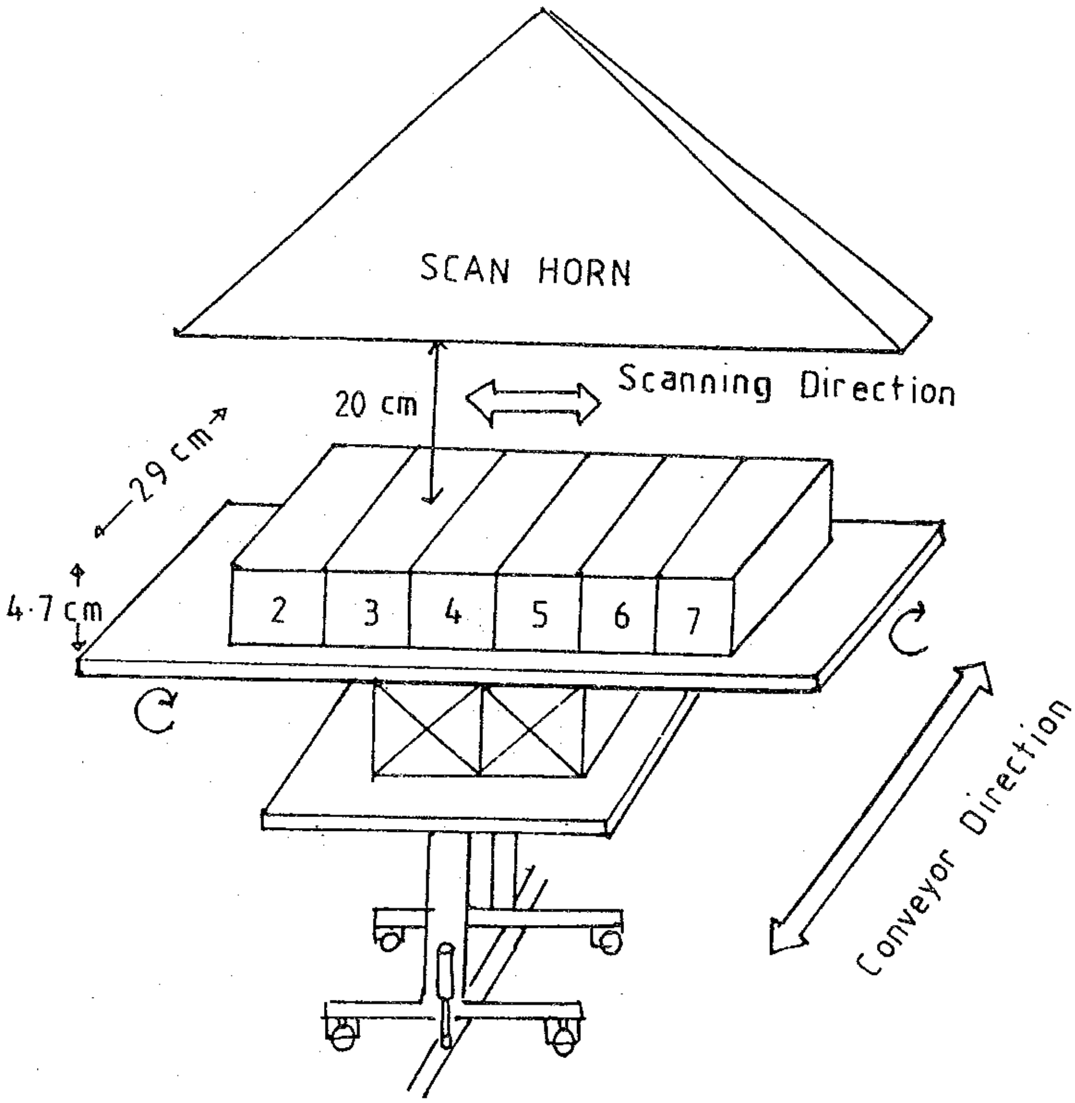


Figure 6: **Arrangement of 6 boxes of glove on the cart**

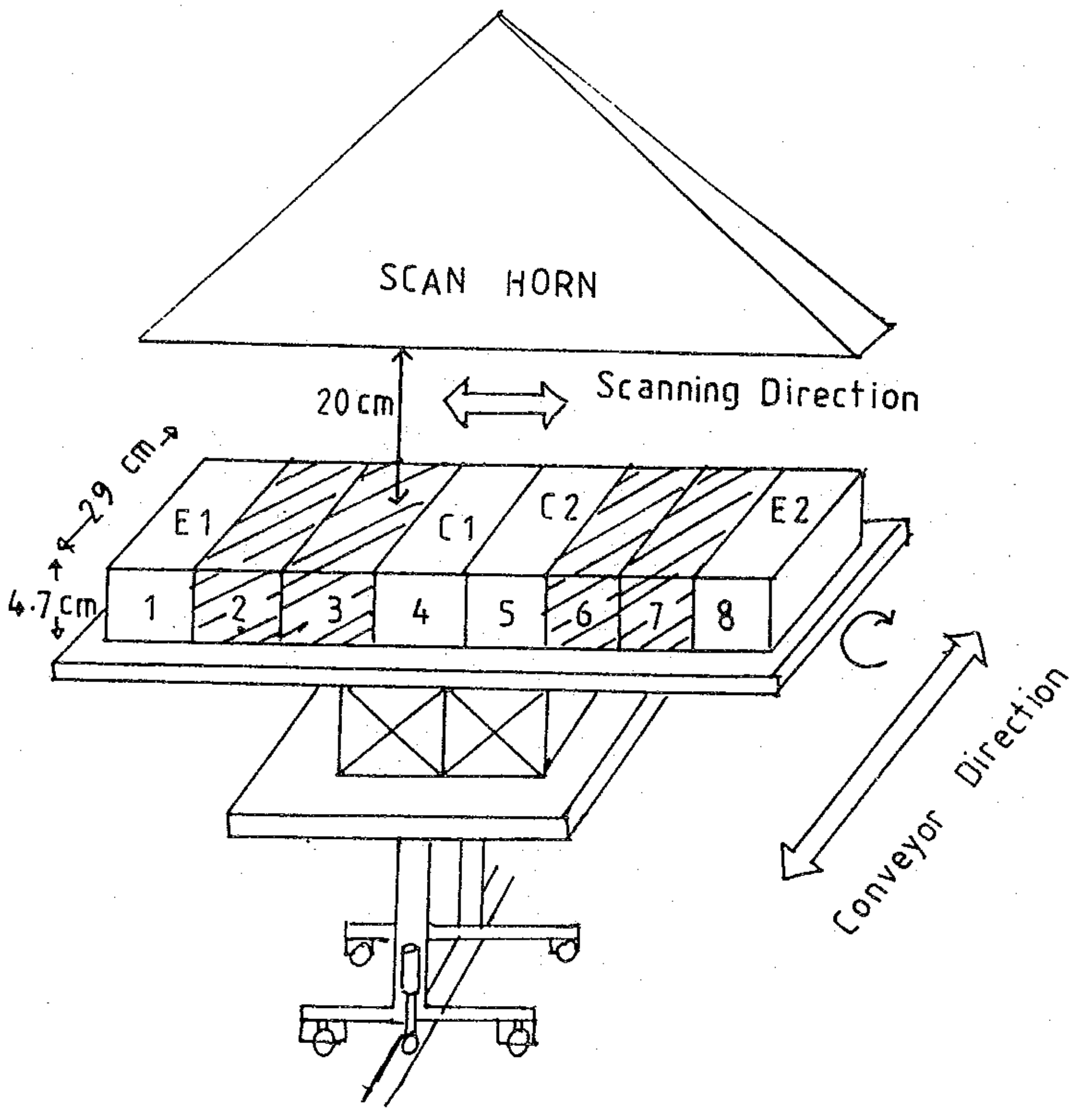


Figure 7 **:Arrangement of 8 boxes of glove on the cart**

Figure 8 : Dose Uniformity Ratio (DUR) of pack gloves in a box (Double Side)

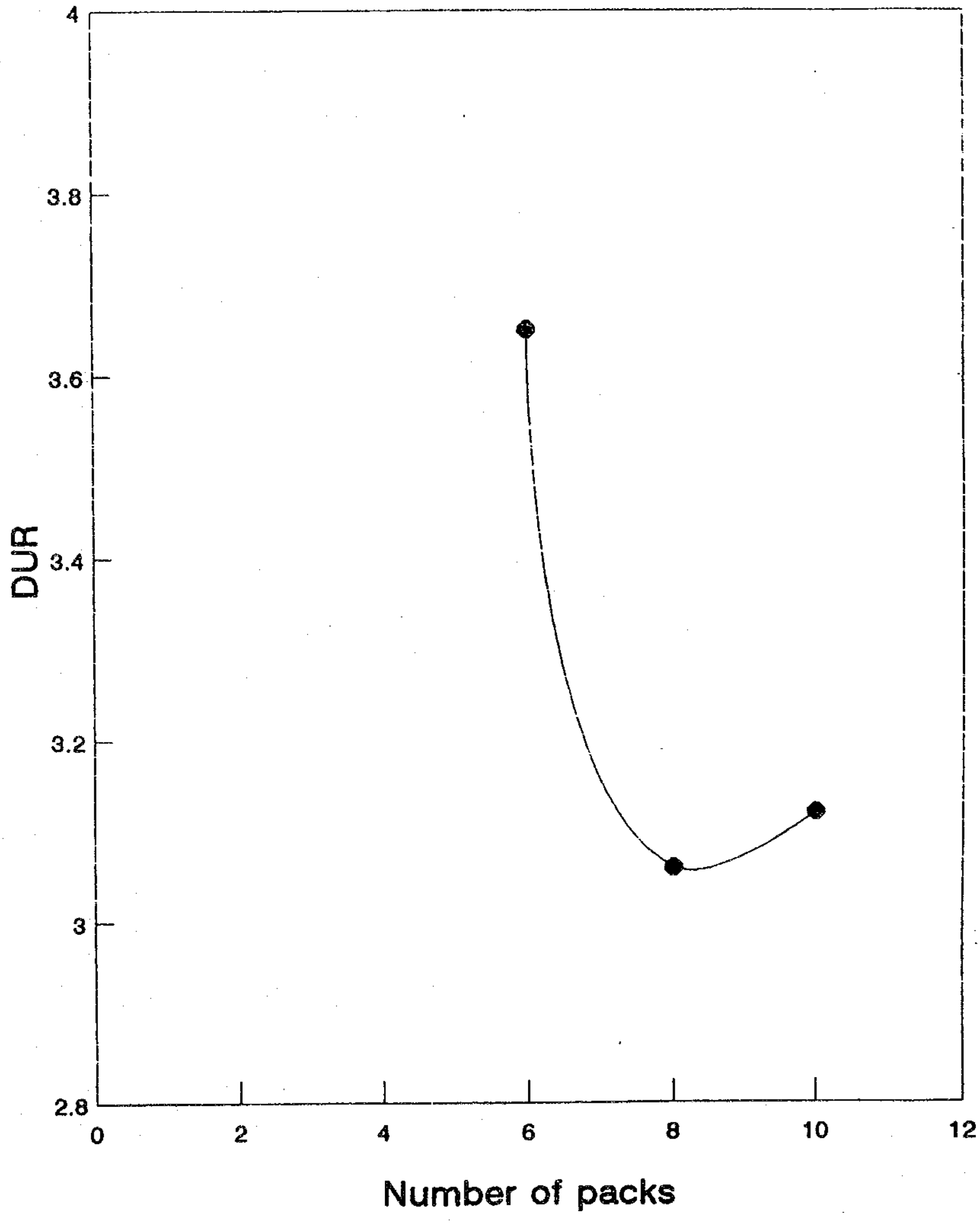


Figure 9 : Surface Dose of Box Number 6
(Top and Bottom)

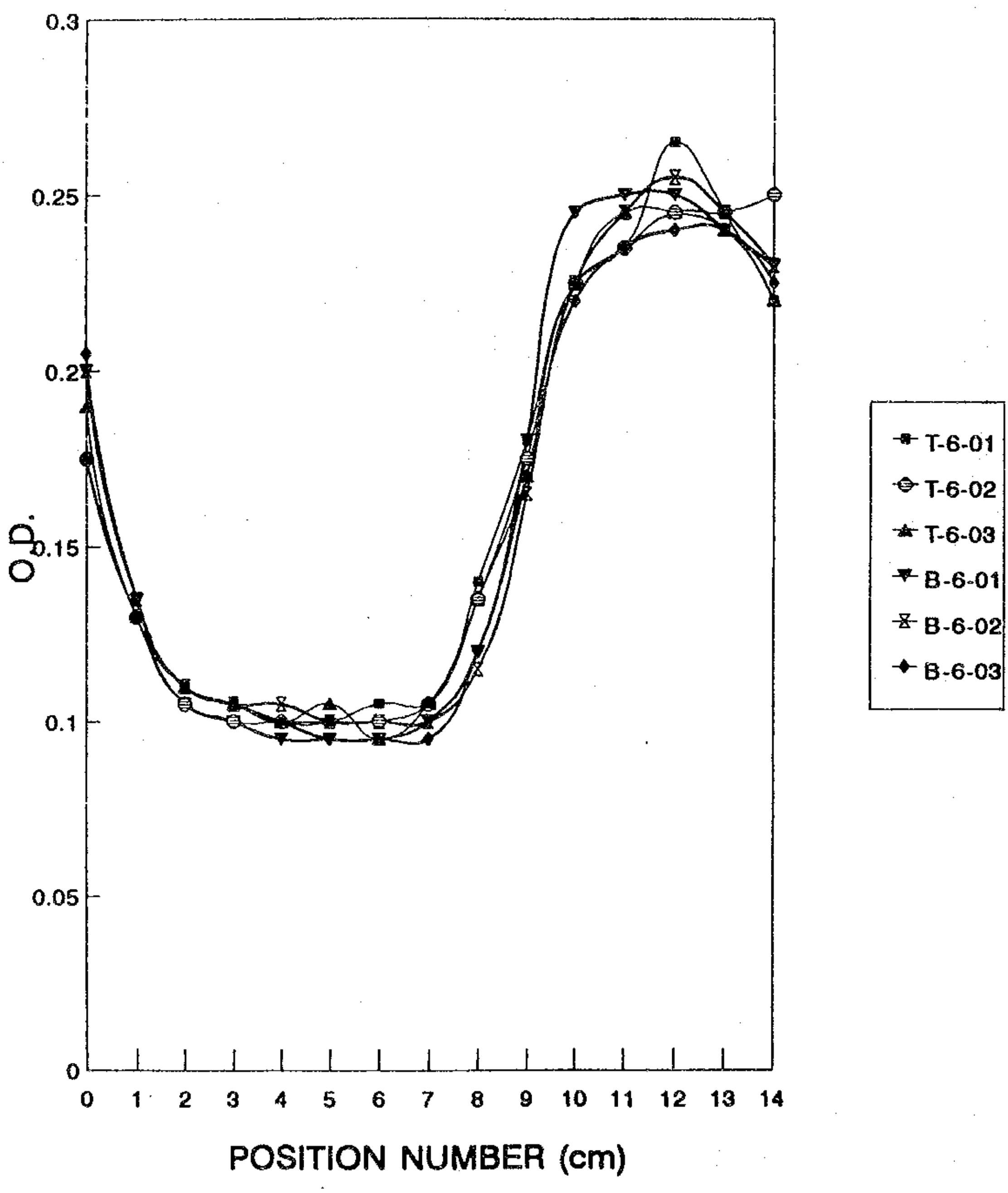


Figure 10 : Centre Dose of Box Number 6
(01 to 06)

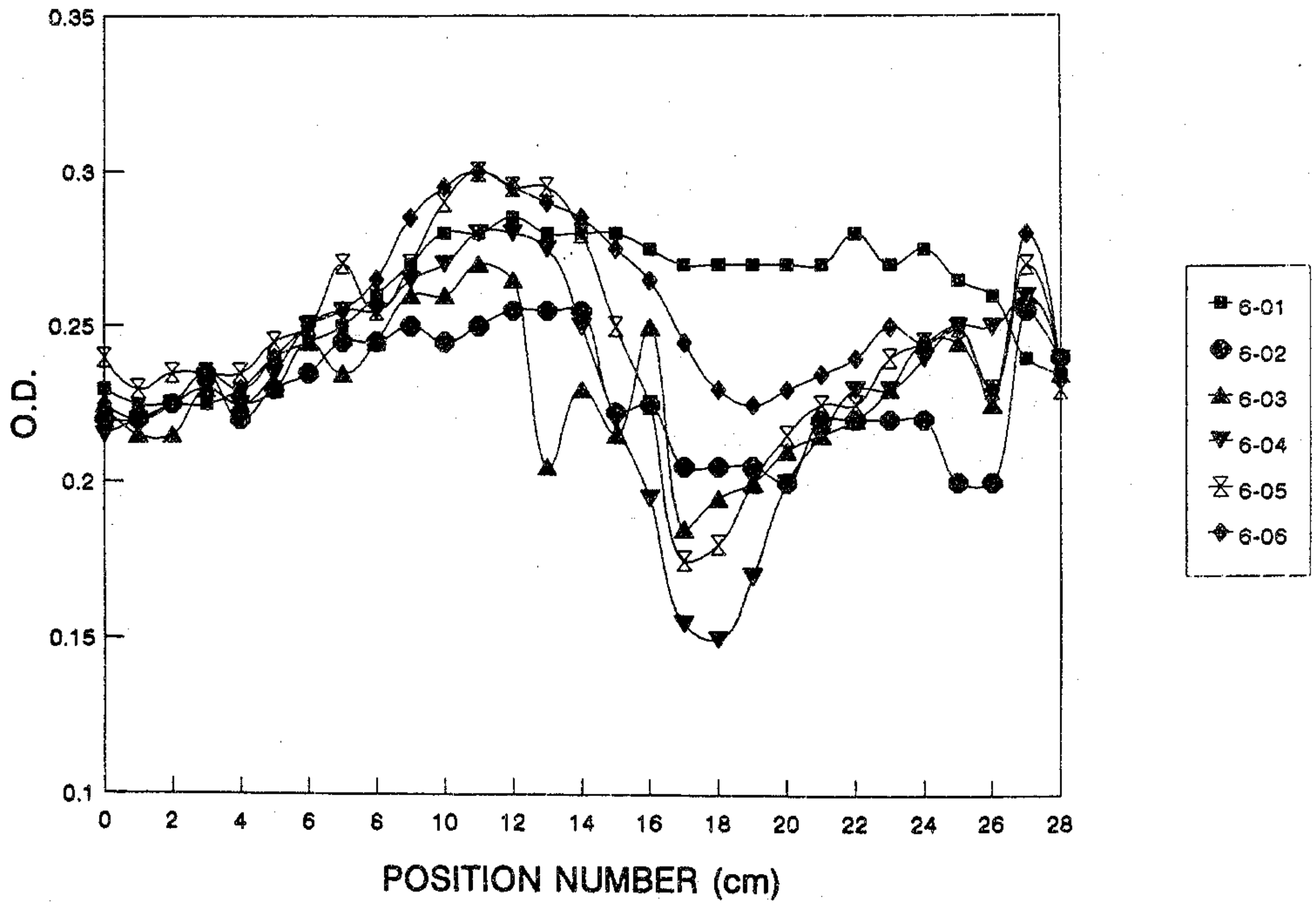


Figure 11 : Centre Dose of Box Number 6
(07 to 12)