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MALAYSIA

RADIOISOTOPE PRODUCTION AT PUSPATI – FIVE YEAR PROGRAMME

Paper Presented at the
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MALAYSIA

RADIOISOTOPE PRODUCTION AT PUSPATI - FIVE YEAR PROGRAMME

Yusof Azuddin Ali and Abd. Rahman Mohd Ali
Isotope Department,
PUSPATI,
MALAYSIA.

Abstract

Most of the basic laboratory facilities for radioisotope production at PUSPATI will be commissioned by September 1983. Work on setting up of production and dispensing facilities is in progress and the nuclides being worked on are those that are commonly used in medical applications, such as Tc-99m, I-131, P-32 and other nuclides such as Na-24 and K-42. Kits for compounds labelled with Tc-99m such as Stannous Pyrophosphate, Sulfur Colloid and Stannous Glucoheptonate are being prepared.

The irradiation facilities available now for radioisotope production at the PUSPATI TRIGA Reactor include a central thimble (flux density 1 x 10^{13} $n.cm^{-2}$ s^{-1}) and a rotary specimen rack (flux density 0.2 x 10^{13} $n.cm^{-1}$ s^{-1}). Irradiation schedules and target handling techniques are discussed.

Plans for radioisotope production at PUSPATI over the period of 1983 - 19[illegible], based on present demand for radioisotope, are also explained.

Introduction

Production of radioisotopes at the Tun Ismail Atomic Research Center (PUSPATI) is about to begin. Emphasis is given on production of medical radioisotopes and other short-lived radioisotopes that require a minimum of chemical processing. Work on setting up of production and dispensing facilities of these radioisotopes and some other radiopharmaceutical kits is in progress.

The paper considers the programme for a 5-year period ending in December 1987 and takes into account the limitation of the facility and assessment of present demand. It also takes into account the guiding principle of production at PUSPATI i.e. production is encouraged where special circumstances exist or where the radioisotopes can be produced economically. Another words, production is encouraged in the following cases:

1) Where the radioisotope has a short half-life and it must be produced locally to satisfy domestic requirements e.g. Na-24, Instant Tc-99m etc.

2) Where production at PUSPATI is necessary in order to ensure continuity and convenience - primarily for medical purposes, e.g. instant Tc-99m and I-131.

3) Labelling of compounds or preparation of a particular radioisotope for labelling purposes. e.g. labelling of hormones with Iodine-131, where special factors are involved such as short half-life, the need to irradiate a local material, or cost.

Present demand for radioisotopes in Malaysia.

The use of radioisotopes and Nuclear Technology has existed in this country long before PUSPATI was formed. In medicine for example, radioiodine and radiophosphorus were used for the investigation and treatment of thyroid and blood disorders as early as in 1960. To get a better picture of the current usage of radioisotopes in this country a market survey was carried out by the Technical Sales Unit of the Isotope Department early this year.

Results of this survey together with the results of other surveys carried out by PUSPATI (1978), the Waste Treatment Unit (1982) and Radiopharmaceutical Unit of the Isotope Department (1980 & Jan. 1983) were combined in order to get more comprehensive data (see tables I, II, III, IV & V).

The results indicate that a wide and varied use of radioisotopes in this country. Many types of radioisotopes are used in the field of research but their usage are in small quantities and there is no indication that they would be ordered regularly. This is expected as their usage would only be for the duration of a particular research project only.

In the medical field, the use of radioisotopes or radiopharmaceuticals in diagnostic studies is still small because there are only 2 Nuclear Medicine Departments are using them. When more Nuclear Medicine centres are opened, then the market for radiopharmaceuticals is bound to increase. Tc-99m compounds is the most used radiopharmaceutical and regularly ordered. The radioiodines are also frequently used. Co-60 and Cs-137 are used in large quantities as sealed sources for teletherapy.

In industry, there is a big need for radioisotopes and the requirements range from low to very high activity, depending on the radioisotopes and its intended use. Mostly, they are of long to very long half-lives and they are used for routine work quite frequently. However, because they are long-lived, they are not ordered regularly. Co-60, Ir-192 and Kr-85 are the top three in terms of radioactivity ordered.

5-year Programme of Radioisotope Production.

Table VI and Figure 1. show a production programme of radioisotopes based on current demand and future predicted demand which is possible with the design of the existing radioisotope production laboratory, blok B at PUSPATI (Figure II). This programme was thought to be flexible enough to cope with variations in quantity and frequency of orders.

The present emphasis is the medical radioisotopes and other short-lived radioisotopes that require a minimum of chemical processing. They are, for example; Tc-99m and its compounds (kits), I-131, P-32, Na-24 and K-42.

Assumptions on which Programme is Based.

The proposed programme assumes that:

1. During the next 5 years the demand in Malaysia for the most commonly used radioisotopes such as Tc-99m, I-131, P-32, Na-24 and K-42 will increase. Justification for this may be found in the increasing development and sophistication of Malaysian industry, research and medicine and the world trend to advancing radioisotope technology.

2. PUSPATI will be able to provide a reliable and efficient service in distributing radioisotopes to domestic users because she will have the necessary expertise and facilities. Other justification for this is the availability of supporting departments in PUSPATI such as Engineering Services, Health & Safety, Instrumentation & Control and Reactor Departments.

3. A development effort by the Isotope Department of PUSPATI will be focused on improving routine products, developing new processes and maintaining a level of technical competence in step with that of other radioisotope producers.

4. 2 or 3 extra irradiation pipes will be made available around the core position of the PUSPATI'S TRIGA Reactor.

5. That the reactor time allocated for radioisotope production will be increased as much as practicable (For the start, 3 continuous day a week).

6. The production programme will make use of the facilities to be available up to 1984 and a few minor extras only.

Radioisotopes Not to be produced by PUSPATI at present.

In general, this includes radioisotopes which cannot be produced in TRIGA MARK II and labelled compounds of long-lived radioisotopes for which the Small Malaysian demand does not at present justify local production (table VII). These radioisotopes wherever possible will be imported from overseas and distributed to local users. PUSPATI will also import in bulk semi-processed products for further processing in its own laboratories. This method may prove to be cheaper and more convenient for PUSPATI.

Facilities for radioisotope production.

The irradiation facilities available now for radioisotope production at the PUSPATI TRIGA Reactor include a central thimble (flux density 1×10^{13} $n.cm^{-2}$ S^{-1}) and a rotary specimen rack (flux density 0.2×10^{13} $n.\ cm^{-2}$ S^{-1}).

At present, the irradiation of target material are carried out only in the specimen rotary rack (Lazy Susan). The rack supports 40 evenly spaced tubular aluminium containers that serve as receptacles for the specimen containers (cans). Each receptacle can hold 2 cans. A standard fishing pole is used for transfering cans into and out of the rotary specimen rack.

The can looks similar to that of the General Atomic type with the exception of the screwed cap, the picking-up tool used at the top cover of the can remain the same. The cans, before irradiation, is cold welded and glued using omniplus plastic-metal glue.

From the Lazy Susan, the can will go into the transfer cask which is wholly built of lead, with a holding capacity of 6 cans at the unloading. It can revolves on its axis so that each hole/slot will hold one can.

...en all the ...ns are in the transfer cask, it will be lowered using ... crane on to the reactor hall where another transport cart (supplied ... the contractor for the Hot-Cell) will be waiting. The cans are ...llowed to fall by gravity into the transport cart by opening the ...ot one at a time. The transport cart will be pushed into the pro-...essing laboratory.

At the hot-cell, the cans will be unloaded from the bottom of the hot-cell. In the hot-cell the cans will be uncapped using an iron ...d and the content processed.

The additional irradiation facilities in the reactor that will ... required for this programme will involve new pipes (dry channels) at ... ...ngs and pneumatic transfer system for irradiated targets.

The laboratory facilities that will be available up to 1984 ...able VIII) are quite adequate for the production of instant Tc-99m, ...-32, Na-24, K-42 and dispensing of I-131. But more in-cell equipment, ...ccessories and spare parts will be needed for the full implementation of the 5 year programme.

...roduction sequence of radioisotopes/radiopharmaceuticals in PUSPATI.

Typical production sequence are graphically illustrated in ...igure 3 where the flow of materials, products and the relevant internal ...ments are shown in a simplified manner.

...radiation scheduling (Initial stage).

The schedule put forward (Figure 4) was devised on its best between ... Reactor Dept and Radioisotope Dept. An ideal irradiation is one that ... continous without long or too many overnight shutdown of the reactor.

This irradiation schedule is based on irradiation of 80g MoO_3 to get enough activity of 300 mCi Tc-99m/week/batch. The schedule will also be used as a basis to fit irradiation of other radionuclides.

Loading and unloading will be carried out on two specific days i.e. on Monday morning 0600 and Wednesday morning 0600 hrs.

The total irradiation time for the Monday unloading can will be . [illegible] hours.

The total irradiation time for the Wednesday unloading can will 48 + 69 hours.

Irradiation begins at 0900 hrs on Sundays and on other weekdays it begins at 0600 hours.

Current Activities and Achievements.

Current activities are focused on the trial preparation of [illegible] radiopharmaceutical kits and setting up of in-cell equipment for production of Tc-99m & P-32 and dispensing of I-131.

Trial Preparation of Standard Radiopharmaceutical kits (Table IX).

The aim of this activity is to finally produce certain kits which meet the requirements and needs of the local nuclear medicine departments. From the survey carried our last year (1982), four Tc-99m labelled kits have been identified viz. Sulfur Colloid, Macroaggregated Albumin (MAA), Glucoheptonate and Pyrophosphate. These agents are used [illegible] liver, lung, kidney & brain and bone scanning respectively.

To date, Sn-pyrophosphate, sulfur colloid & sn-glucoheptonate kits have been prepared and labelled to Tc-99m (sodium pertechnetate Tc-99m obtained from depleted Tc-99m/Mo99 generators from the local hospitals.

Results from their labelling efficiencies are satisfactory. Nonetheless further tests ought to be carried out to ensure that they are stable on storage.

Besides that, Tc-99m-Sn-Pyrophosphate has been tested at biological distribution level. The results seem not to be very reproducible from statistical point of view. It is unknown whether the discrepancies in the data accumulated is a result of instrument instability as shown by the erratic chi-squared test, or due to problems inherent to the kits themselves. It is hoped that further test and studies would throw light to this effect and to better the quality of the products.

[illegible] Setting up of in-cell equipment for the productions of Tc-99m P-32 and dispensing of I-131.

At present the in-cell equipment for the production of Tc-99m (Figure 4) has been completed. Although the production cells had been installed, work with regard to installation of in-cell equipment will only be completed by the end of November 1983.

The first complete irradiation of target MoO_3 (molybdenum trioxide) will be carried out by early Dec. 1983 and by the end of 1983 the first Technetium 99m will hopefully be produced.

With regard to the production of phosphorus 32, everything is completed; the glassware, the blank run and the glove-boxes (Figure 5). The only problem hindering the production is the target handling section in the glove-box i.e. the shielding and the can cutting machine. Hopefully these will be overcome before the end of 1983. On the dispensing of imported radioiodine, the purchasing of the items for dispensing are vigorously carried out. This project is expected to be completed early next year.

References

1. Technical Sales Unit, Isotope Department PUSPATI;
   A Report on The Extent of Radioisotope Usage in Malaysia, PUSPATI PTA/T11 (April, 1983).

2. Unit Pengurusan Sisa, Jabatan Kawalan Sinaran dan Kesihatan PUSPATI;
   Laporan Soal-Selidik Penggunaan dan Pembuangan Bahan-bahan Radioaktif 1982, PUSPATI PTA-T8 (1983).

1: RADIOISOTOPES DEPARTMENT PROGRAM FROM 1982 - 1987 (PROJECTS)

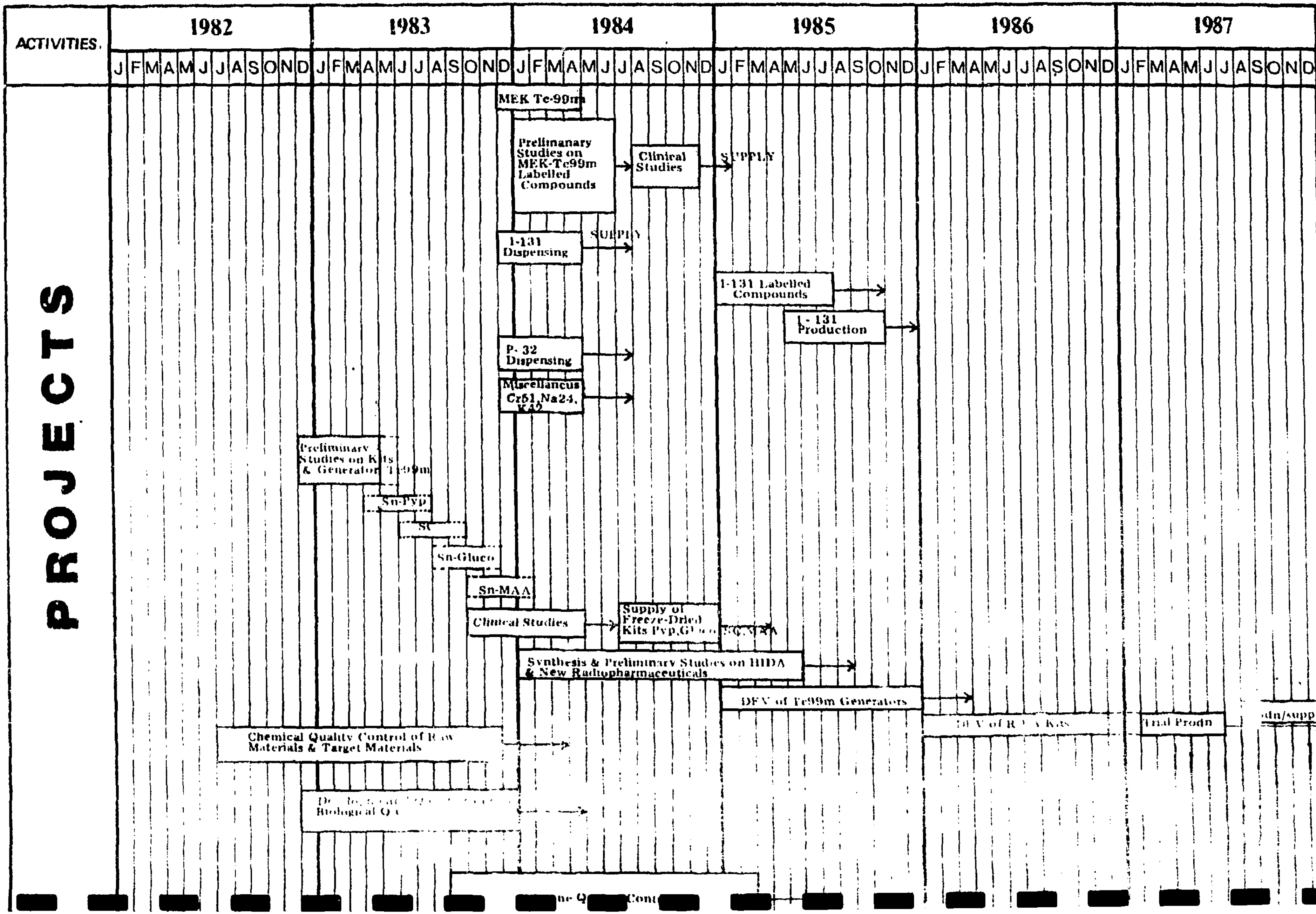
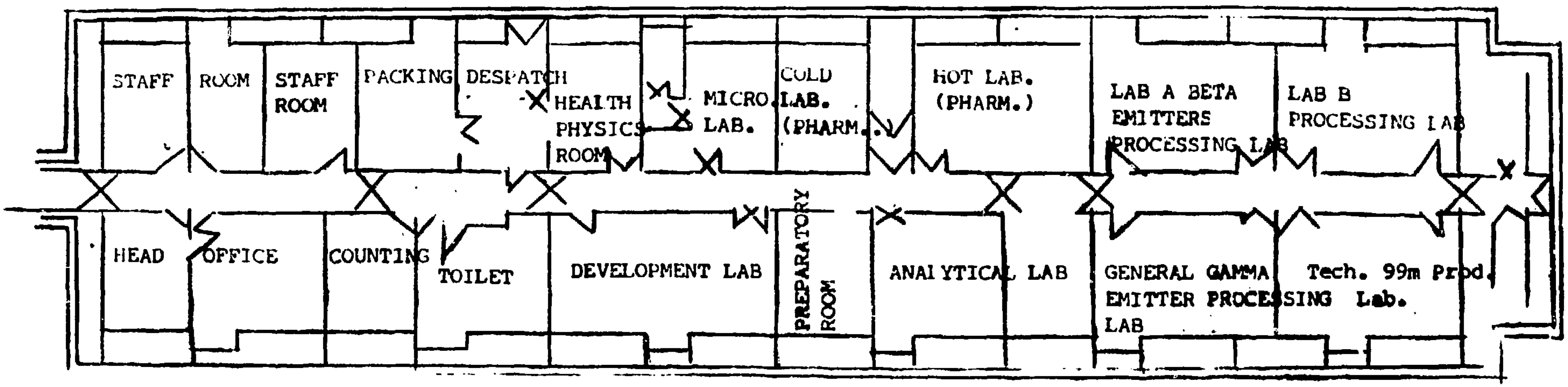


FIGURE 2.: RADIOISOTOPE PRODUCTION LABORATORY



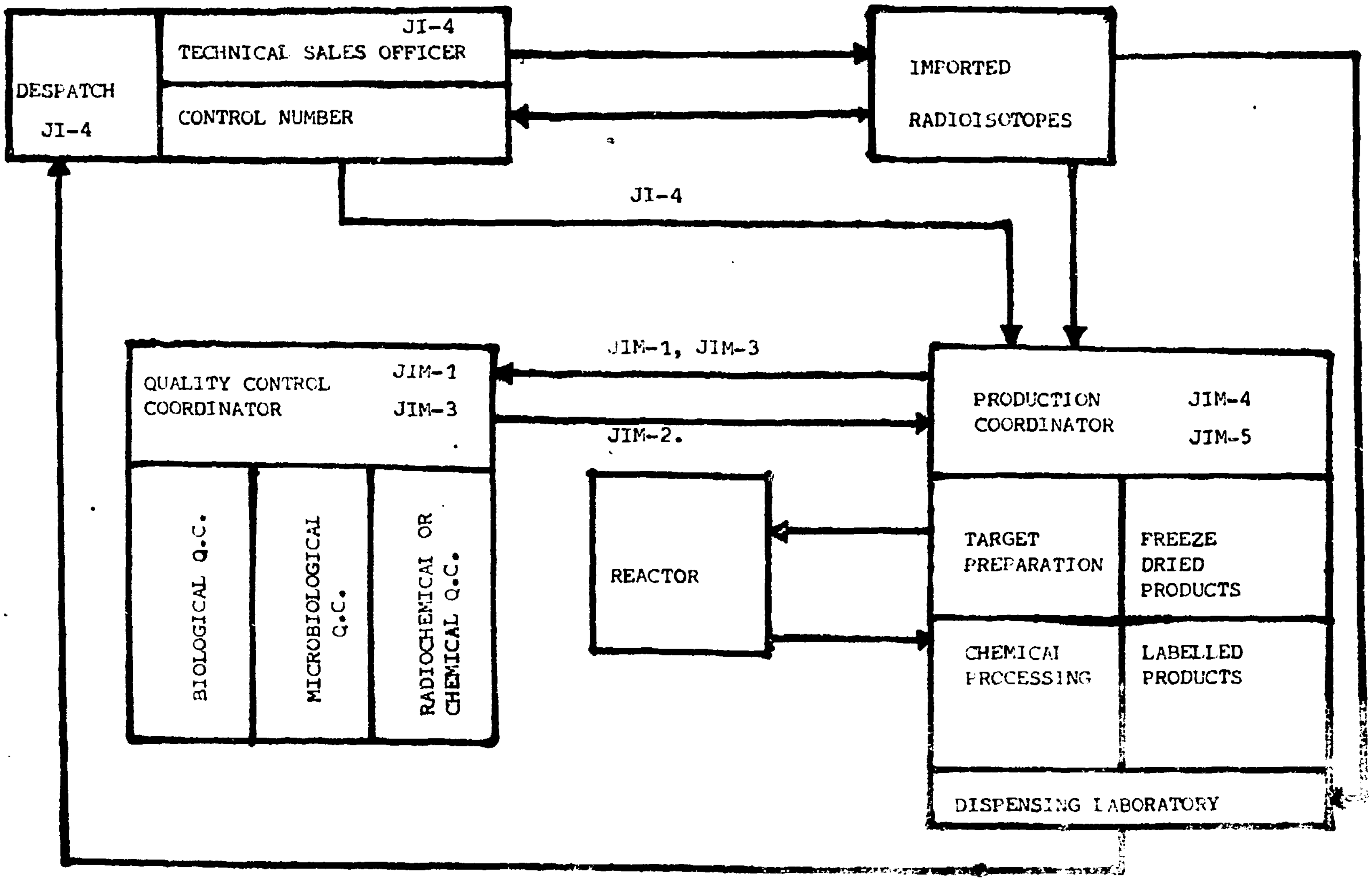
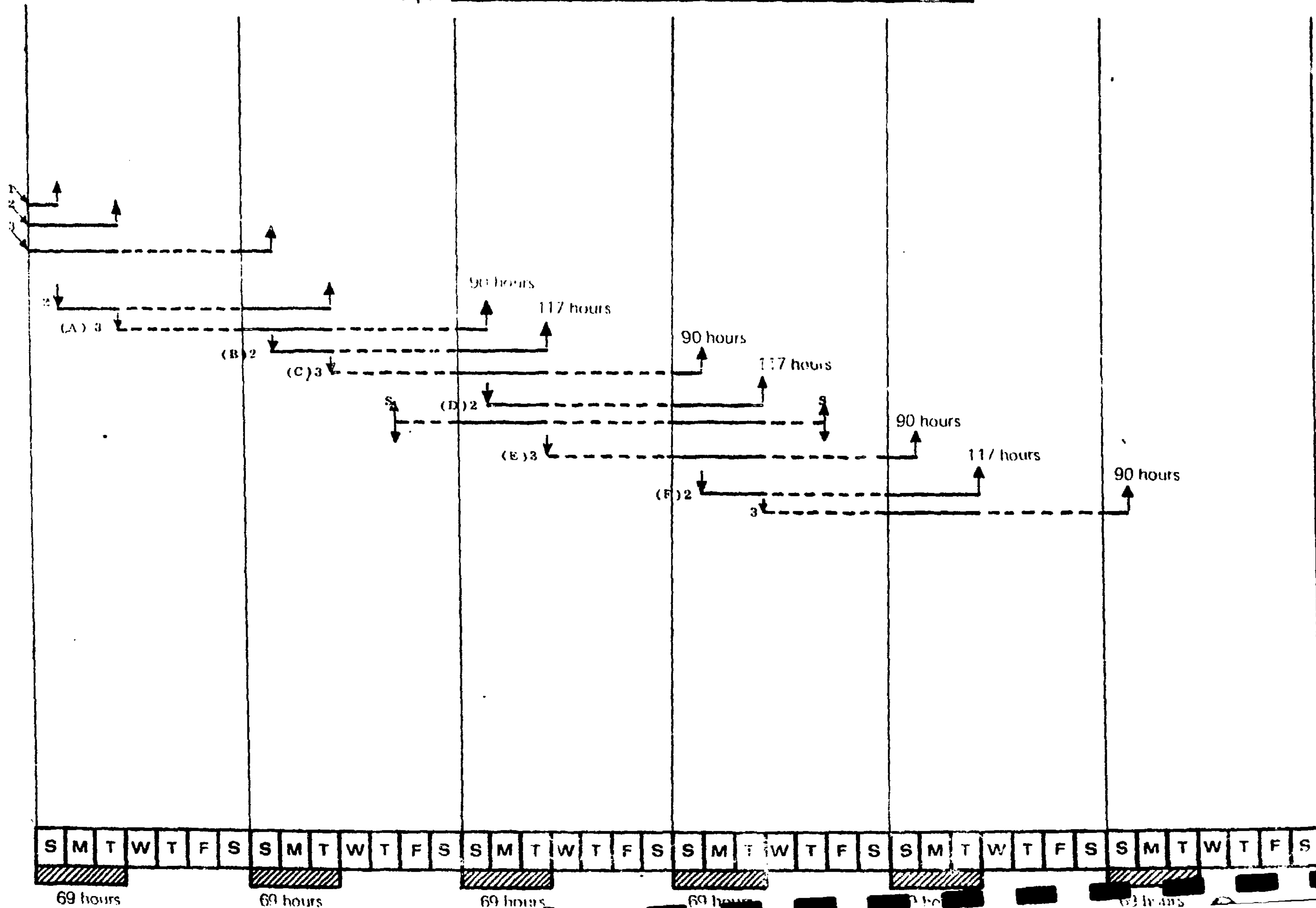


FIGURE 3 : PRODUCTION SEQUENCE OF [illegible]

FIGURE 4. **IRRADIATION SCHEDULING FOR Tc99m PRODUCTION**



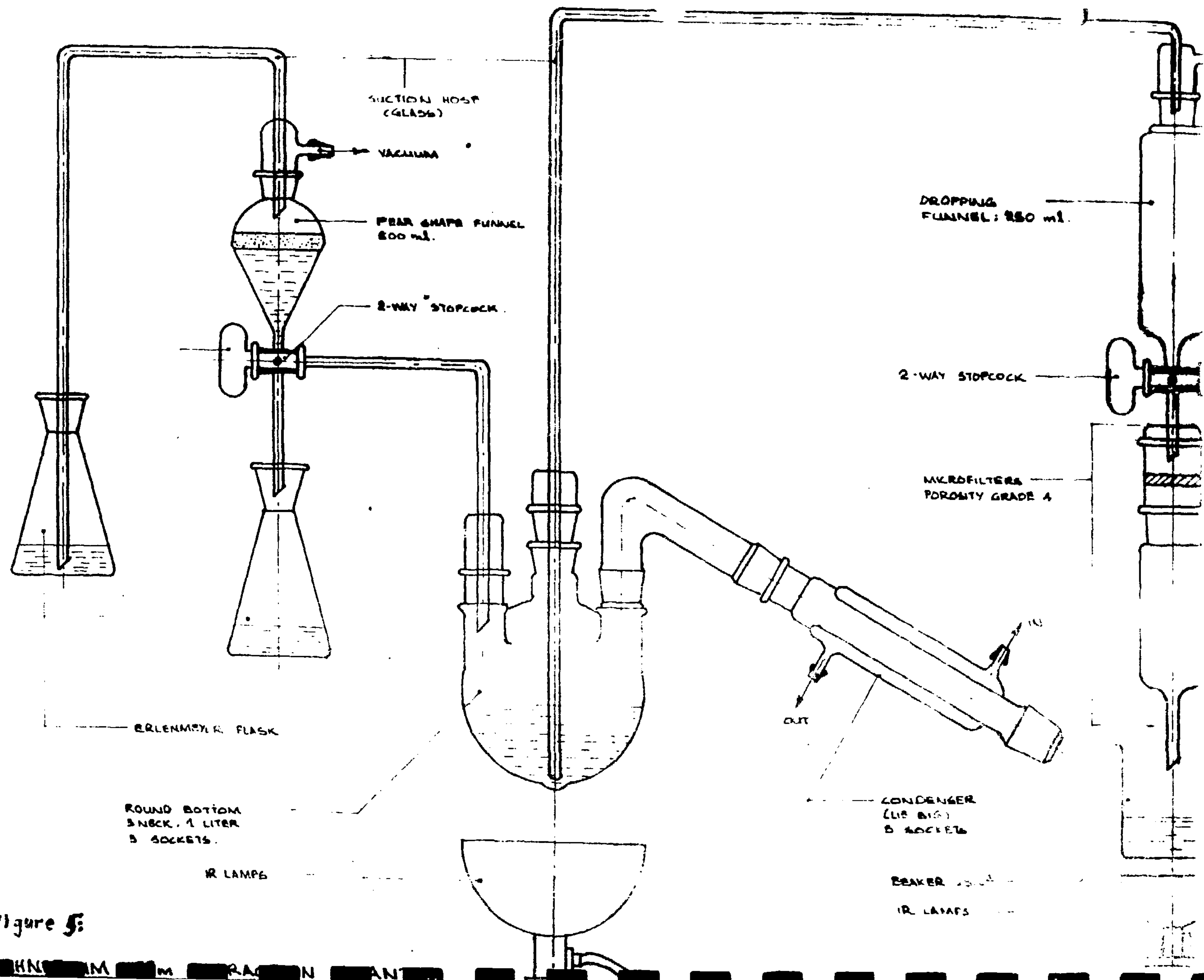
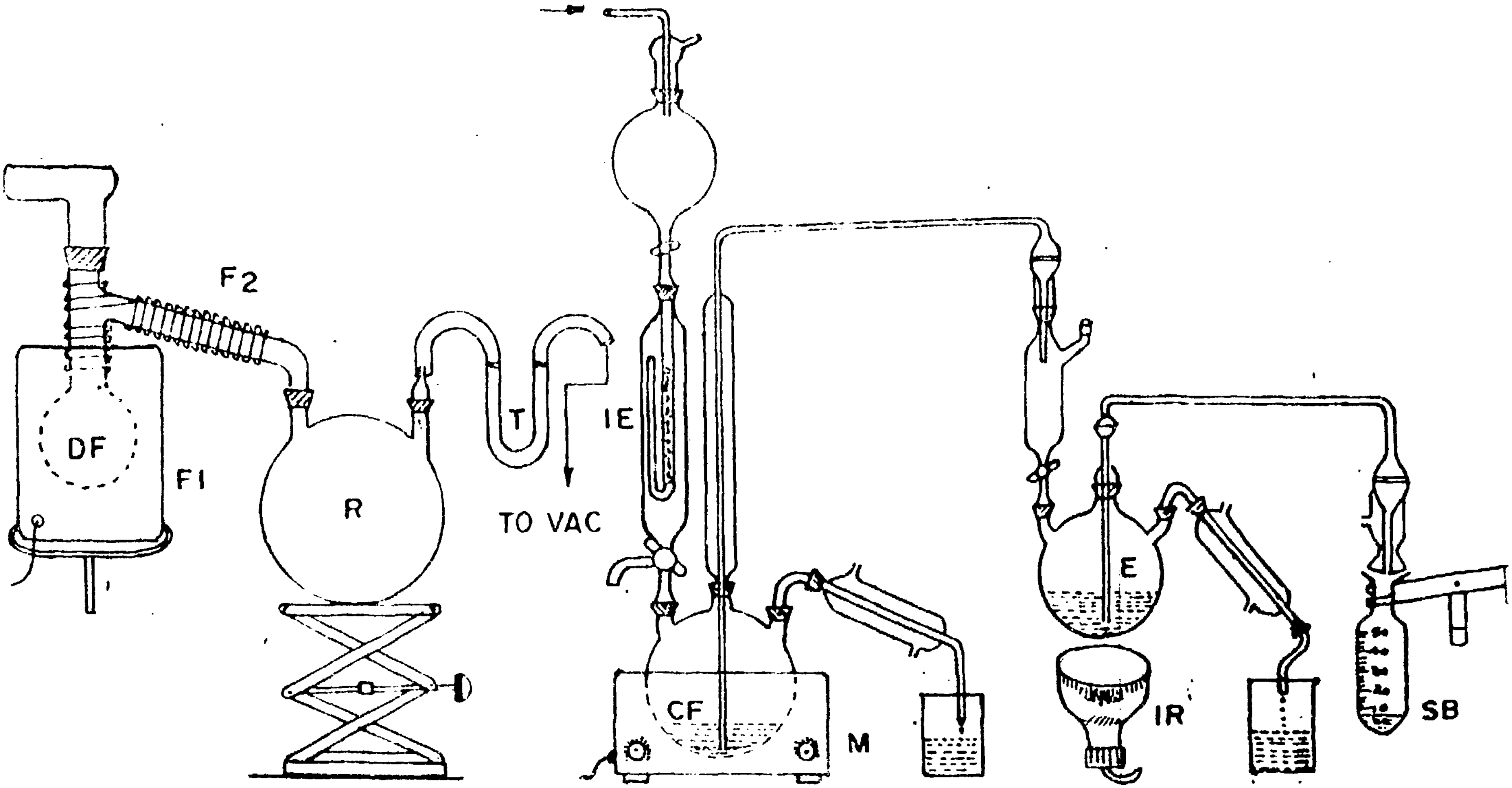


Figure 5:

[redacted]

FIG 61: APPARATUS FOR THE PRODUCTION OF PHOSPHORUS – 32



F1, F2 – FURNACES   DF – DISTILLATION FLASK.   CF – CONCENTRATION FLASK.
E – EVAPORATION VESSEL.   R – RECEIVER.   T – TRAP.   IE – ION-EXCHANGE COLUMN.
M – HEATING MANTLE.   IR – INFRA RED LAMP.   SB – STORAGE BOTTLE.

TABLE I: INDUSTRIES (TOTAL OF 42)

	Radioisotope	Half-life	Form	No. of **industries** using	**Total** activity used/required per year.
1.	Am[illegible]	432 yrs.	solid	5	17 Ci
2.	[illegible]^{109}	453 days	solid	1	500 uCi
3.	[illegible]	271 days	solid	1	6 uCi
4.	[illegible]	5.27 yrs.	solid	7	535,200 Ci
5.	[illegible]^{137}	30.17 yrs.	solid	7	17.5 Ci
6.	[illegible]	2.[illegible]7 yrs.	solid	1(ceased using)	20 mCi
7.	[illegible]	12.33 yrs.	solid	2	10 Ci
8.	[illegible]	74.2 days	solid	11	1,200 Ci
9.	[illegible]^{85}	10.72 yrs.	gas	11	880 Ci
10.	[illegible]	2.62 yrs.	solid	10	5.5 mCi
11.	[illegible]	138.38 days	solid	1	8 Ci
12.	[illegible]	1600 yrs.	solid	1	100 uCi
13.	[illegible]	3.824 days	gas	1	2 Ci
14.	[illegible]	29 yrs.	solid	4	800 mCi
15.	[illegible]	3.77 yrs.	solid	9	1 mCi

TABLE II: HOSPITALS (TOTAL OF 3)

	Radioisotope	Half-life	Form	No. of hospitals using	Total activity used/required per year
1.	Co^{57}	271 days	solid	1	uCi range
2.	Co^{58}	70.8 days	solid	1	uCi range
3.	Co^{60}	5.27	solid	1	5,600 Ci
4.	Cr^{51}	27.71 days	soln.	2	mCi range
5.	Cs^{137}	30.17	solid	3	1,700 Ci
6.	Fe^{59}	44.6 days	soln.	1	uCi range
7.	H^{3}	12.33 yrs.	soln.	1	mCi range
8.	I^{125}	59.7 days	soln.	2	mCi range
9.	I^{131}	8.041 days	soln.	2	Ci range
10.	P^{32}	14.28 days	soln.	1	mCi range
11.	Ra^{226}	1600 yrs	solid	1	uCi range
12.	Sr [illegible]	29 yrs.	solid	1	10 mCi
13.	Tc^{99m}	6.02 hrs.	solid	2	900 mCi/per forni
14.	Xe^{133}	5.25 days	gas	1	mCi range

TABLE III: RESEARCH INSTITUTIONS (TOTAL OF 13)

Radioisotope	Half-life	Form	No. of research institutions using	Total activity used/ required per year
1. Ac [illegible]	525 days	soln.	1	50 uCi
2. Ar [illegible]	432 yrs.	solid	4	40 mCi
3. As [illegible]	17.8 days	soln.	1	uCi range
4. Ba [illegible]	10.7 yrs.	soln.	2	100 uCi
5. [illegible]	53.28 days	soln.	1	uCi range
[illegible]	5730 yrs.	soln.	10	1.2 Ci
[illegible]	32.5 days	soln.	1	uCi range
[illegible]	$3x10^5$ yrs.	soln.	1	uCi range
[illegible]	271 days	solid	3	mCi range
[illegible]	5.27 yrs	solid	6	Ci range
[illegible] Cr [illegible]	27.71 days	soln.	2	500 uCi
[illegible]	30.17 yrs.	soln.	6	mCi range
[illegible]	2.7 yrs.	soln/solid	2	uCi range
[illegible]	44.6 days	soln.	3	uCi range
15. [illegible]	12.33 yrs.	soln.	8	1.2 Ci
[illegible]	46.6 days	soln	3	uCi range
[illegible]	59.7 days	soln.	4	mCi range
[illegible] I^{131}	8.041 days	soln.	6	mCi range
[illegible] In [illegible]	1.658 hrs.	soln.	1	mCi range
[illegible]	74.2 days	solid	1	100 Ci
[illegible]	10.72 days	gas	1	mCi range
[illegible]	[illegible].5 days	soln.	2	mCi range
[illegible] Na [illegible]	2.601 yrs.	soln	4	mCi range
[illegible] ^{63}	100 yrs	soln.	1	uCi range
[illegible]	14.28 days	soln.	7	mCi range

26.	Pm^{147}	2.62 yrs.	solid	3	mCi range
27.	Po^{210}	138.38 days	soln.	2	mCi range
28.	Pu^{239}	$2.4x10^{4}$ yrs.	solid	1	uCi range
29.	Ra^{226}	1600 yrs.	solid	3	uCi range
30.	Rb^{86}	18.65 days	soln.	1	uCi range
31.	Ru^{103}	39.4 days	soln.	1	uCi range
32.	S^{35}	87.2 days	soln.	2	5 mCi
33.	Sn^{113}	115 days	soln.	2	mCi range
34.	Sr^{90}	29 yrs.	solid	3	mCi range
35.	Tc^{99m}	6.02 hrs.	soln.	1	mCi range
36.	Th^{232}	$1.4x10^{10}$ yrs.	solid	1	uCi range
37.	Tl^{204}	3.77 yrs.	solid	1	mCi range
38.	Y^{90}	64 hrs.	solid	1	mCi range
39.	Zn^{65}	243.8 days	soln.	1	1 mCi
40.	Labelled tracers/RIA	-	soln.	1	mCi range
41.	Neutron sources(Pu:Be Am: Be)		solid	2	mCi range
42.	Reference source (α, β, γ)		solid	2	uCi range

TABLE IV: RADIOISOTOPES THAT ARE USED FREQUENTLY/ROUTINELY

Radioisotopes with recurring orders (more that twice a year .	Category	No. of companies/ institution with recurring orders
[illegible]	Industrial	[illegible]
[illegible]	Industrial	4
Tc^{99m}	Medical	2
[illegible]	Medical	2
[illegible]	Medical	2
[illegible]	Medical	[illegible]
[illegible] labelled compounds	Research	[illegible]

TABLE V : RADIOISOTOPE REQUIREMENTS WITHIN PUSPATI

	Radioisotopes	Half-life	Form	No. of units intending to use	Activity/ quantity required.
1.	Ag^{110m}	525 days	Soln.	1	10 mCi
2.	Am^{241}	432 yrs.	Soln.	2	20 mCi
3.	Am^{243}	7280 yrs.	soln.	1	5 mCi
4.	Au^{198}	2.3 days	solid(powder)	2	500 mCi
5.	Ba^{133}	10.7 yrs.	soln.	1	10 mCi
6.	Br^{82}	35.3 hrs.	soln.	2	10 mCi
7.	C^{14}	5720 yrs	soln.	2	10 mCi
8.	Ca^{45}	163 days	soln.	2	20 mCi
9.	Co^{57}	271 days	soln.	1	10 mCi
10.	Co^{60}	5.27 yrs	sealed source /soln.	2	20 mCi
11.	Cs^{134}	2.06 yrs.	soln.	1	mCi range
12.	Cs^{137}	30.17 yrs.	sealed source /soln.	4	20 mCi
13.	Cr^{51}	27.71 days	soln.	1	mCi range
14.	Eu^{152}	13.4 yrs.	sealed source	1	uCi range
15.	Fe^{55}/Fe^{59}	2.7 yrs/44.6 days	soln.	1	10 mCi
16.	H^{3}	12.33 yrs.	soln.	4	5 mCi
17.	I^{131}	8.04 days	soln.	1	mCi range
18.	Ir^{192}	74.2 days	solid	1	-
19.	K^{40}	1.28×10^{9} yrs.	soln.	1	10 mCi
20.	K^{42}	12.36 hrs.	soln.	1	10 mCi
21.	Kr^{85}	10.72 yrs.	gas	1	1 Ci
22.	Mg^{28}	21 hrs.	soln	1	10 mCi
23.	Mixed radio-nuclides	-	soln.	1	5 mCi
24.	Na^{22}	2.6 yrs.	sealed source	2	10 mCi

25.	Na^{24}	15.0 hrs	sealed source /soln.	3	500 mCi
26.	P^{32}	14.28 days	soln.	2	20 mCi
27.	Pu^{236}	2.85 yrs.	soln.	1	5 mCi
28.	Pu^{239}	2.4×10^{4} yrs.	soln	1	5 mCi
29.	[illegible]^{242}	3.76×10^{5} yrs.	soln.	1	5 mCi
30.	[illegible]^{36}	18.65 days	soln.	1	10 mCi
31.	[illegible]^{35}	87.2 days	soln.	1	10 mCi
32.	[illegible]^{119}	293 days	soln.	1	10 mCi
[illegible]	[illegible]^{90}	29 yrs.	soln.	3	15 mCi
[illegible]	[illegible]^{91m}	[illegible].02 hrs.	soln.	3	1 Ci
35.	[illegible]	7.7×10^{4} yrs.	soln.	1	5 mCi
36.	[illegible]^{204}	3.77 yrs.	soln.	2	15 mCi
37.	[illegible]^{232}	72 yrs.	soln.	1	5 mCi
38.	[illegible]^{233}	1.59×10^{5} yrs.	soln.	1	5 mCi
39.	[illegible]	243.8 days	soln.	1	10 mCi
40.	[illegible] and β contamination sources	–	sealed sources	1	uCi range

TABLE VI: The radioisotopes to be produced by PUSPATI.

No.	Radioisotopes/ Radiopharmaceuticals	* Half life	Expected year of production	Expected quantity produced/year (early production)
1.	Technetium-99m and radiopharmaceutical kits (For brain, bone, lung & liver scans).	6.02 h	1983/1984	100 Ci
2.	Iodine-131 (Dispensing)	8.041 d	1984	10 Ci
3.	Phosphorus - 32	14.28 d	1984	1200 mCi
4.	Chromium - 51	27.71 d	1984	1250 mCi
5.	[illegible]m - 24	15.02 h	1984	100 mCi
6.	[illegible]m - 42	12.36 h	1984	100 mCi
7.	Co[illegible] - 64	12.71 h	1985	100 mCi
8.	[illegible] - 65	243.8 d	1985	100 mCi
9.	Iron - 59 (Fe-59)	44.6 d	1985	100 mCi
10.	Rubidium - 86	18.65 d	1986	100 mCi
11.	[illegible]-198	2.696 d	1986	100 mCi
12.	Bromine - 82	35.30 h	1986	100 mCi
13.	Radioimmunoassay kits [illegible], T3, T4, TSH.	-	1986-1987	Not available.

* h - Hours

d - Day(s)

TABLE: VII Radioisotopes for which production by PUSPATI is at present not possible or desirable and which will normally be imported.

No.	Radioisotope Preparation	Reason not produced by PUSPATI.
1.	Accelerator - produced neutron-deficient isotopes.	An accelerator not yet available in PUSPATI.
2.	Fission products	Expensive and complex plant required.
3.	Tritium and other radioactive gases (Kr-85, Xe-133); tritiated water.	Easily available from overseas - no transport problems.
[illegible]	[illegible]led compounds of C-14, [illegible], [illegible]-75, Cl-36,	Extensive resources and hichly trained staff required and not normally economic.
5.	Sealed sources (Ir-192, Co-60, Cs-137).	Flux density of the reactor not high enough.
6.	Experimental & Demonstration sources (Cs-137, Am-241, Ra-226, [illegible], Po-210 etc.).	Very small demand.

TABLE VIII — List of production facilities that will be made available before the end of 1984.

No.	Equipment	Quantity
[illegible]	Autoclave •	3
[illegible]	Balances •	4
[illegible]	Rotary evaporator •	1
[illegible]	Furnace •	1
[illegible]	Oven •	2
[illegible]	Incubator •	1
[illegible]	Refractometer •	1
[illegible]	Refrigerator •	2
[illegible]	Freezer •	1
[illegible]	Compound microscope	1
[illegible]	Ultracentrifuge	1
[illegible]	Fraction collector •	1
[illegible]	Gamma ionisation chamber system •	3
[illegible]	Thin layer scanner •	1
[illegible]	Electrophoresin equipments.	1
[illegible]	UV-vis spectrophotometer •	[illegible]
[illegible]	Isotop/dose calibrator	2
[illegible]	Atomic absorption spectrophotometer •	1
[illegible]	Freeze drier •	1
[illegible]	Single analyser with NaI detection system •	1
[illegible]	MCA with Ge(Li) detection system •	1
[illegible]	Laminar flow cabinet •	4
[illegible]	Fume hood •	[illegible]
2[illegible].	Production cells for Tc-99m and miscellaneous products.	4 - cells in series
2[illegible].	Production cell for I-131	1
2[illegible].	Automatic gamma counter	1
[illegible]	Glove boxes •	4
[illegible]	Beta-gamma boxes •	3

• already available (October 1983)

TABLE IX

Standard Radiopharmaceutical Products to be produced in [illegible].

	Radioisotope	Activity concentration	Total activity to be produced per week	Packing	Intended Usage
1.	Tc99m - pertechnetate.	235.2mCi/10ml	236mCi/week	"generator packing" 30 - 50mCi/ml (instant Tc-99m)	1) For brain scan. 2) For labelling to cold kits (as out line below).
2.	I-131 Sod. Iodide ([illegible]spensing)	10.73mCi/week	10.73mCi/week	10ml vial	1) Radiotherapy. 2) Thyroid studies.
[illegible]	[illegible] Phosphate.	1-2mCi/ml	Depend on the demand Production average 50mCi/week of irradiation.	5ml vial	1) Radiotherapy

	Kits	Activity concentration	Total No. of vial/ year	Packing	Intended usage
1.	[illegible] fur [illegible]	5mCi/ml	600 vials per/ year	1) 30ml vial 2) 2 x 10ml vials.	Liver scan.
2.	[illegible]	15mCi/ml	600 vials per/ year	10 vial	Bone scans.
3.	[illegible]	15mCi/ml	600 vials per/ year	5 ml vial	Brain/kidney scans.
4.	[illegible]	5mCi	as required	5 ml vial	Lungs scan.