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R

REPOSITORY

DOE-OHRE

COLLECTION

PLUTONIUM INJECTION

BOX NO.

1

FOLDER

*Center For Human
Radiobiology (40-015)
(2 of 2)*

8001827

CORRESPONDENCE/PICTURES



8001828

November 27, 1985

TO: E. Huberman
FROM: R. A. Schlenker *RAA*
SUBJECT: Freedom of Information Act Request

We have been unable to locate the memo from Rowland to Schultz dated December 21, 1972 which you requested about 5:15 p.m. yesterday following the receipt of a letter from D. T. Goldman to A. Schriesheim concerning this matter. As today is the last business day before the deadline, December 2, further search is not possible without missing the deadline. Locating this memo is complicated by the fact that Rowland retired about two years ago and Schultz is dead.

Other intra-laboratory memos on the 18 plutonium research subjects referred to in the Goldman letter, mention them by name and give personal information about them. The release of such documents would be a violation of the patients' privacy and the right-to-privacy is protected by law. It would also constitute a violation of normal ethical practice in the handling of patient medical records.

The subjects referred to have been studied by several organizations since the mid 1940s. Non-personal information can be found in the scientific literature. A good review and guide to the literature up to the time of its publication can be found in Patricia W. Durbin, "Plutonium in Man: A New Look at the Old Data," pp.469-530, Radiobiology of Plutonium, Edited by Betsy J. Stover and Webster S.S. Jee, Published by the J. W. Press, Department of Anatomy, University of Utah, Salt Lake City, 1972.

lw

DEC 04 1985

8001829

April 26, 1978

TO: File of (40-015)

FROM: A. F. Stehney

SUBJECT: Inquiry as to the status of reputed relatives from whom we do not have signed permission for exhumation of

While reviewing the case file of , I noted that Dr. Jan Lieben's memo of November 28, 1973, listed an " as one of the second cousins. But no subsequent reference to was found. June Hamilton phoned Dr. Lieben who said that he did not recall why there was no follow-up of and suggested that we phone some of the relatives from Argonne.

April 25, 1978

I phoned (Rochester, New York, area) and asked whether she knew of the whereabouts of who is reported to be a second cousin. was very positive in saying that she had never heard of an .

I phoned . Since he was not in, I told that I was trying to determine who is and where is . said she never heard of him, that must be who is long dead, at least the she knew of is dead. Arranged for AFS to phone after 6:00 p.m.

By phone, confirmed that there was an now dead, who had two sisters in Rochester. He suggested that I call one of the sisters. also informed me that his (father, died in 1974.

April 26, 1978

By phone, confirmed that was her brother and that he died "four years ago."

Summary

1. The " listed in Dr. Lieben's memo of November 28, 1973, is really , who is now dead.

PRIVACY ACT MATERIAL REMOVED

April 27, 1978

TO: M. R. Gaspari LEG
FROM: A. F. Stehney RER
SUBJECT: Request for an opinion on ANL liability relative to
disinterment

As follow-up to our phone conversation, I am sending documentation pertaining to the request from a cemetery for release from liability for exhumation of a man who died in 1947. It happens that this is one of the plutonium injection cases. Our proposal to exhume these cases was approved by the ANL Review Committee (ethics) in June 1974 (R. J. M. Fry to A. F. Stehney, June 28, 1974).

Attached are the following documents:

- (1) Letter of 8/1/73: D. F. Fitzgerald, attorney, to J. Lieben, M.D., a CHR consultant
- (2) Letter of 8/22/77: C. E. Davis to M. M. Shanahan
- (3) Letter of 9/15/77: M. M. Shanahan to C. E. Davis
- (4) Memo of 4/19/78: J. E. Farnham to A. F. Stehney
- (5) Memo of 4/26/78: A. F. Stehney to case file
- (6) Proposed draft of a letter (A. F. Stehney to C. E. Davis)

Please do not hesitate to contact me if you need more information.

AFS:frc
attach.
cc: G. J. Hamilton (wo/attach) ✓

PRIVACY ACT MATERIAL REMOVED

TO: File of
April 26, 1978
Page 2

(40-015)

PRIVACY ACT MATERIAL REMOVED

2. died in 1974.

3. Therefore, the exhumation permissions signed by

and include all of the known surviving next-of-kin
of , who died in 1947.

AFS:frc
cc: G. J. Hamilton
J. Lieben

A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8001832



PRIVACY ACT MATERIAL REMOVED

CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

April 19, 1978

TO: A. F. Stehney
FROM: J. E. Farnham
SUBJECT: Disinterment of

40-015. ✓

At 10:30 am. I received a telephone call from Mary Margaret Shanahan who related the following information:

- 1) She had just received a phone call from _____ of the Funeral Home.
- 2) _____ had said he in turn just received a phone call from the manager of the _____ Cemetery.
- 3) The Cemetery requested a letter from the Center for Human Radiobiology relieving the cemetery of all liability for their involvement in the disinterment.
- 4) The cemetery was ready to perform the disinterment after receipt of the letter.

I told Mary Margaret I would take care of the details. As soon as I receive some feed-back from you on how you wish to word such a letter of having the Center for Human Radiobiology assume all liability, I will call Mr _____ and set up the disinterment.

xc: R. A. Schlenker
M. M. Shanahan
G. J. Hamilton
Record Room

JEF:bjj

PRIVACY ACT MATERIAL REMOVED

8001833

November 4, 1977

TO: A. F. Stehney
FROM: J. L. Lieben
SUBJECT: Plutonium Exhumation Cases

Reference is made to your question, this date, regarding informing relatives of plutonium cases to be exhumed of the actual plutonium injections.

Re: _____ (40-010)

In reviewing my records, I found that, shortly after having received instructions to inform survivors, I told Mr. _____ (May 10, 1975) that his sister had had plutonium injections.

J Re: _____ (40-015)

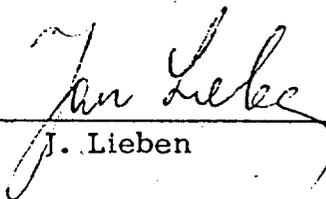
While this does not appear in my records, I do recall that I have informed all relatives, including _____ and _____, of the fact that plutonium injections had been given to _____.

Re: _____ (40-003)

I also informed _____ and, during my last visit, the two brothers, _____ and _____, that _____ had received plutonium injections.

I did not go back to those relatives of cases that had refused exhumation permissions prior to 1975, namely _____ (40-007), _____ (40-008), and _____ (40-011).

In all future contacts with relatives of plutonium cases proposed for exhumation, I will make it a special point to inform them of their deceased relative's exposure and report this disclosure to file.



J. Lieben

JL/llw

xc: G. J. Hamilton
R. E. Rowland
CHR Records Room (7)

PRIVACY ACT MATERIAL REMOVED

8001834

Received: April 13, 1977

TO: CHR Records Room

FROM: Jan Lieben, M.D.

SUBJECT: Exhumation of _____

April 5, 1977

1. After several unsuccessful phone calls to the _____ funeral home to obtain the name of the Monsignor in charge of the _____ Cemetery, who allegedly was blocking the exhumation of _____ I called the Diocese of Rochester. I learned that the Rev. Monsignor _____ was in charge of the cemetery, phone _____ and that the lay person was Mr. _____.
2. I called Monsignor _____ for an appointment and visited him on April 5, 1977 at St. Mary's Church, 15 South Street, Rochester, New York. I explained the program to him—he appeared interested and cooperative. He wishes to discuss matters with his (the cemetery's) lawyer and the board and will let us know.

Apparently this seemed to have been more a problem of communications than anything else. At least, let us hope so.

JL:ddh

cc: A. M. Brues
J. E. Farnham
R. A. Schlenker
M. M. Shanahan
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8001835



PRIVACY ACT MATERIAL REMOVED

AFS
RAS
JEF

CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

December 20, 1976

MEMO TO: Jan Lieben, M.D.

F R O M: M. M. Shanahan

SUBJECT: Exhumation of 40-015

Attached is the correspondence relating to the exhumation of about which we talked on the phone recently:

Ltr 9/9/76 Schlenker to Shanahan
Memo 9/14/76 Schlenker to Stehney
Note 9/21/76 Shanahan to Schlenker
Ltr 9/21/76 Shanahan to Funeral Home
Memo 11/8/76 Mehta to file

I hope you will be successful when you discuss the matter with the Monsignor.

S

xc: M.H.Chalfen
A.F.Stehney ✓

PRIVACY ACT MATERIAL REMOVED

RECEIVED CHR
JAN 04 1977
RECORDS ROOM

8001836



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PRIVACY ACT MATERIAL REMOVED

AFS
RAS
JEF

CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station
November 8, 1976

MEMO TO: File
FROM: Janet Mehta
SUBJECT: Deceased 40-015

I phoned Mr. [redacted] at the [redacted] Funeral Home ([redacted]) in Rochester, NY. Mr. [redacted] informed me that he could not give me an estimate of Mr. [redacted] exhumation. The Monsignor at the cemetery where Mr. [redacted] is buried, is disputing the legality of the exhumation. The Monsignor was a close friend of both Mr. and Mrs. [redacted]. He feels that the [redacted] would have been against the exhumation.

JM
xc: M. H. Chalfen
A. F. Stehney
J. Lieben

PRIVACY ACT MATERIAL REMOVED

RECEIVED CHR
JAN 04 1977
RECORDS ROOM

8001837

September 14, 1976

TO: A. F. Stehney
FROM: R. A. Schlenker
SUBJECT: Exhumation of , 40-015

I spoke with two undertakers on my visit home: Mr. at the Funeral Home, Road, Rochester, New York 14626, and Mr. at the Funeral Home Inc., South, Rochester, New York 14617. In contrast to Mr. of the Memorial Chapel, who finally refused to cooperate with the Center, neither expressed any hesitation to carry out the work. Both gave rough estimates of cost which differed principally in the fee for professional services. Mr. fee is \$275, which I judge to be rather high. Mr. estimates a total of \$350 to cover professional services, transportation to the airport on disinterment, transportation from the airport on reinterment and the reinterment vault. When this total is adjusted for the transportation charges of \$50 each way and the vault cost of \$150, \$100 is left for professional services. While Mr. was less firm about the professional service charge than was Mr. he considers the undertaker's duties to minimal for a disinterment. I have the impression that a firm estimate from him would include professional charges which were much less than Mr. charge. At the end of my conversation with Mr. I told him that a letter formally requesting a cost estimate would be sent to him by Mary Margaret. I also left with him an edited copy of the letter sent by Mary Margaret to Hedges requesting a quotation.

The other charges mentioned in my discussion with Mr. and Mr. were:

Cemetery charge for disinterment	\$300
Cemetery charge for reinterment	150
Transportation to airport	50
Transportation from airport	50
CMAS pouch	35
Reinterment vault	150
Ziegler case or pine box	75
Airline transportation cost	no estimate

Both undertakers would agree to our supplying the case as a cost saving measure.

8001838

Page 2.
R. A. Schlenker
September 14, 1976

PRIVACY ACT MATERIAL REMOVED

I called Mrs. Mary Sypian of the Monroe County Department of Health and learned that an undertaker from a county bordering Monroe County could operate in the county without special permission. Thus should Mr. ' fees be too high, or should he ultimately refuse the work, we could utilize the undertakers from in Livingston County who exhumed (40-010) for us.

The two undertakers and all spontaneously offered the opinion that the major obstacle to this exhumation would be Miss who is in charge of the Cemetery. I learned that she runs the cemetery "with an iron hand", and her decisions are final; she can't be over-ruled, even by the bishop; she is blunt and cold; she doesn't like men. I learned also that the cemetery permits disinterments only at certain times of the year, apparently when there is little grounds maintenance work. They will permit no exhumation right now. Also they probably will want copies of the permission forms signed by the relatives.

The cemetery lies on both sides of Avenue just north of . The grave is a short way from the cemetery office on the west side of Lake. (It is in section tier and is grave number It is a double grave with an attractive ivy covered polished granite headstone bearing, in addition to the family name the following names and dates: 1885-1914, and , 1881-1947.

According to the north end of is wet and the south end is dry. The plot lies midway between the north and south sections making difficult an educated guess as to the condition of the remains.

RAS:clg

cc: J. E. Farnham
M. M. Shanahan

PRIVACY ACT MATERIAL REMOVED

8001839

Received: March 18, 1976

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Contacts

3/5/76:

1. Re: . After many phone calls to
() at China Lakes,
always without reply, I left for San Diego on 3/5/76 at
3:30 p.m.
2. From San Diego, I drove to East Whittier-Los Angeles to the
residence of on . We
had a long conversation--almost two hours. I learned that
, his daughter, and her husband had left the
Navy at China Lakes and now live at
Santa Barbara, phone . has Hashimoto's
disease and thyroid disease (? radiation effect debates
Mr.). He pulled out signature which he has
had for three years! He finally signed his copy with the
condition that he will receive a report!

This case took almost five years and four visits to his home!
The grave, according to is double deep, 8 feet.
Mailed signatures to M. M. Shanahan.

3/6/76:

1. Re _____ I met at his residence on
having made a previous
appointment. He is 70 years old. Obtained his signature
without any difficulty.

JL:jmt

cc: A. M. Brues
J. E. Farnham
M. M. Shanahan
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED.

8001840

Received: March 3, 1976

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Contacts

1/8/76

1. Re _____ Received signed permission from
for exhumation of above.

2. Forwarded same to M. M. Shanahan.

1/10/76

1. Re _____ Called _____, born _____, and offered him measurements and examination at MIT, having first discussed matters with M. M. Shanahan. He is not interested in travel now - maybe in spring. Also asked him re permission for exhumation of _____ "Have not decided yet". Will call him in March re both above. Gave him M. M. Shanahan phone number.

2. Re _____ Called information for phone number of _____ in San Diego - none listed.

3. Called _____ to check on spelling of above name and learned we got it wrong--it is _____.

4. Obtained from information: _____.

1/26/76

1. Re _____ Called _____ in Daytona Beach re exhumation of his great grandfather. "Yes I talked to my mother. You send her the form and she will sign it for you."

2. Forwarded forms to _____ in Sumner, Missouri.

2/13/76

1. Re _____ Received phone number for daughter, in China Lakes, _____.

2. At M. M. Shanahan request, I called _____ phone _____ re his brother _____ of Pittsburgh. The old man is whole and hearty.

3. Re _____ Called his son in San Antonio, Texas, _____ "No, I am not going to go along just now, maybe the next time I get to Belayr, Md. I'll talk to the attorney.

PRIVACY ACT MATERIAL REMOVED

JL:jmt

cc: A. M. Brues
J. E. Farnham

M. M. Shanahan
A. F. Stehney

8001841

Received: March 3, 1976

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT:

Following receipt of a letter to M. M. Shanahan by I visited Funeral Home in Rochester, New York and met Mr. and discussed his letter with him. He appeared much more cooperative than one would have expected. He wants for his own records:

1. A letter from Argonne stating that there was no danger from radioactivity for those employed in the exhumation.
2. The cemetery needs a statement with the exact relationship to Fred Sours of those who gave permission for the exhumation.
3. In the course of the conversation, he informed me that there had been a recent write-up in the Rochester paper that Strong Memorial Hospital had used patients for guinea pigs in plutonium research!

JL:jmt

cc: A. M. Brues
J. E. Farnham
M. M. Shanahan
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8001842

Received: December 19, 1975

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Contacts

12/4/75:

1. Re Received permission from and for exhumation of above.
2. Forwarded both to M. M. Shanahan. This concludes this case.

12/11/75:

3. Re Called of Drive, Danbury, Connecticut, phone to make an appointment. "No I can't see you." I explained purpose of visit. "I need some proof that you are on the level. A letter from MIT or Argonne." I promised to supply this and would also send her the forms. brother, or , lives on San Diego, Calif.
4. Called M. M. Shanahan to write the letter.

12/14/75:

5. Re Visited at his residence at Ave., Atlantic Heights, N. J., . Explained purpose of my visit re exhumation of his mother. He was worried regarding his own radiation exposure while a fetus - he was 4 years old when she died. I discussed this with him. Obtained no commitment. He will think things over and let me know - left forms with him. The best time to call him is about 9:00 p.m., that is when he gets up to go to work as a truck driver. His uncle, in Houston, Texas, has died and he is the only survivor. (See M. M. Shanahan note of 9/17/74.)

JL:jmt

cc: A. M. Brues
J. E. Farnham
G. J. Hamilton
M. M. Shanahan

PRIVACY ACT MATERIAL REMOVED

8001843

Received: December 4, 1975

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Contacts

11/14/75:

Re . Called
"No I have not talked to yet. Will talk to him
over the weekend."

11/17/75:

Called re at his Danville, Illinois
home, . "Yes I'll go along with the exhumation -
will send you the forms."

Mailed signed permissions re to M. M. Shanahan.

JL:jmt

cc: A. M. Brues
J. E. Farnham
G. J. Hamilton
M. M. Shanahan

PRIVACY ACT MATERIAL REMOVED

8001844

Received: November 19, 1975

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: (Plutonium)

11/15/75

1. Drove to Rochester, N. Y. and visited _____ at _____ chester, N. Y., phone _____. I explained our request and obtained her signature for the exhumation of above. No she does not know where _____ is. "Maybe my sister knows."
2. Visited _____, Circle Fairport, N. Y. Again explained purpose of visit and obtained permission. "No I don't know where _____ is, but _____ phone _____, will know. Give her a call."
3. Called _____ is married and is now _____ and lives in _____ Connecticut. "If you call me tomorrow I'll give you her exact address."

(Both above two visits were made without appointments. Please refer to my previous notes of 11/28/73, 1/74 and 5/74 about this case.)

11/16/75

4. Called _____ again. _____ address is:

Connecticut

JL:jmt

cc: A. M. Brues
J. E. Farnham
G. J. Hamilton
M. M. Shanahan

PRIVACY ACT MATERIAL REMOVED

Received: May 14, 1975

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Rochester Plutonium Cases

MICROFILMED

NOV 5 1975

CHR RECORDS

5/10/75:

- 1) Re Informed Mr. ,
Rochester, N. Y., phone , that his sister had plutonium
injections, has been exhumed, and reinterred.* Thanked him for his help.
Plutonium did not seem to register. He said he was glad to be of help.
- 2) Re Drove to Prestige Acres—now Trailer
Park, Batavia, Route 33 (east of Batavia). Visited niece,
phone . Learned that husband, celebrated
his 90th birthday in better health. He's still in the nursing home so we'll
have to continue to wait. She does not know whether family will go along
with project. Batavia is mid-way between Rochester and Buffalo, N. Y.
- 3) Re Called (),
Fairport, Rochester. "This is a bad time to discuss
this — we have sickness in the family. Call me next time you are here."

JL:jmt

cc: A. M. Brues
J. E. Farnham
M. M. Shanahan
A. F. Stehney

- * On 5/14/75, A. F. Stehney asked Dr. Lieben to inform that there had been a delay in returning his sister's body, but this would be done soon.

New York

<u>Name</u>	<u>Date of Death</u>	<u>Place of Death</u>
()	07/31/46	Champlain Valley Hosp. Plattsburg, Clinton Co.
✓	07/02/47	Strong Memorial Hosp. Rochester, Monroe Co.
	05/17/59	Riverhead, Suffolk Co.
	01/13/55	Jamestown, Chautauqua Co.
	12/17/64	William St., Mt. Vernon, Westchester Co.
	07/07/49	Adams St., Bedford, Westchester Co.
	07/08/67	Warrensburg, Warren Co.
	04/07/68	Walkill, Orange Co.
	03/12/52	St. Peter's Hosp. Albany, Albany Co.
	04/08/69	Long Island Jewish Hosp. New Hyde Park, Long Island
	12/25/70	Scarsdale, Westchester Co.
	02/18/35	Benedictine Hosp. Kingston, Ulster Co.
	08/01/70	So. Nassau Comm. Hosp. Albany, Albany Co.
	12/12/52	Bellerose
	07/01/74	Albany Medical Ctr Albany, Albany Co.
()	12/03/71	Res: Bayshore, Suffolk Co.
	01/04/57	No. Westchester Hosp. Bedford-Mt. Kisco, Westchester Co.
	02/26/48	Long Beach Hosp. Long Beach, Nassau Co.



CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

Bureau of Vital Records
State Dept. of Health
Albany, New York 12237

March 10, 1975

Dear Sir:

The Center for Human Radiobiology, whose research is supported by the U. S. Energy Research and Development Administration, is conducting a long-range study of persons exposed to radioactive materials. This study will provide valuable information which will enable us to evaluate the toxicity of radioactive substances.

It is vital that the Center obtain the best copies possible of the ORIGINAL death certificate of each of those deceased persons whose exposure during life requires their inclusion in the study. (Record handling procedures of the Center assure the continued confidentiality of any such records.)

Therefore, we are writing to request two (2) copies of the ORIGINAL death certificate for those persons named on the attached list. The dates and places of death are included wherever possible. In some instances death certificate copies have been requested before, and a certification of death other than a copy of the original certificate has been obtained. Should this be the case for any of the listed persons, we have attached a copy of the information we do have to assist you in your search.

The fee, per certificate copy, for this service is enclosed. Please send your reply to the attention of:

H. A. Schultz, D-203
Curator of Records
Center for Human Radiobiology
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, Illinois 60439

Thank you.

Very truly yours,

G. June Hamilton
Medical Assistant

GJH:jmt
Enclosures

8001848

Received: February 8, 1974

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Phone Calls and Contacts

1. 1/27/74 - Called Yale Baptist Church and spoke to minister. He does not know Duncard or Dunken Cemetery nor Absolom Pierce. Suggests I call Yale Township office.
2. 1/29/74 - Received death certificate of _____ from nephew of _____ Street, Gary, Indiana.
3. Mailed same to M. M. Shanahan.
4. 1/31/74 Re _____ - Called Town Hall in Yale, Oklahoma, 918/387-2121 and spoke to a Miss Porter, Town Clerk (?). She did not know Dripping Springs, Dunkard or Duncan Cemetery, nor but promised to check with some old timers. I am to call her towards end of week.
5. Re _____ - Called _____, second of three daughters in Mission, Texas re her signature for exhumation of _____. "Yes my letter to you is going out tomorrow. I also have Margarete's address in it and I am sure she'll go along."
6. 2/1/74 - Received exhumation permission from _____ - Carmel, California.
7. Mailed same to M. M. Shanahan.

JL:jt

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
J. E. Farnham
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8001849

Received: January 28, 1974

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Phone Calls

January 23, 1974:

1. Re _____ Since I had not heard from _____, I called him today re his signature. I thought of making another attempt to obtain _____ signature the next time I go to Rochester. He said, "I was out of town - will send it to you."
2. Called re _____, re _____ - nobody home.
3. Re _____ Called information to ask for churches in Yale and Ripley, Oklahoma to find out who may have cemetery records of Duncan Cemetery where _____ is buried. The only church listed in the phone book is the Yale Baptist Church, phone 918/387-2235.
4. Called there - nobody home.

JL:jt

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
J. E. Farnham
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8001850

PRIVACY ACT MATERIAL REMOVED

Jan. 15, 1974



Dr. Lieben:

I received your letter & Form this past week in regard to

I talked it over with my sister & we decided against signing the Form.

He's been dead about 23 yrs. & see no reason to disturb him.

I'm sure you can find other people who received this treatment at that time & might be willing to let you have their remains for scientific study.

RECEIVED

J. Dorney

FEB 08 '74

CHR RECORDS

PRIVACY ACT MATERIAL REMOVED

Received: January 23, 1974

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Home Office Work

January 7, 1974:

1. Received second exhumation permission from _____ for _____
2. Forwarded above to M. M. Shanahan.
3. Wrote letters re exhumation of _____ to _____ in Rochester, New York.
4. Received collect call from _____ re status of report. He had been to the cemetery and had seen grave had been disturbed.
5. Called M. M. Shanahan re above.
6. Called _____ and informed him of our meager bone finding. Promised him report would be forthcoming within two months! (Please note.)

January 15, 1974:

7. Phone calls re _____ - no contact.

January 16, 1974:

8. Re _____ . Spoke to _____ . "Yes I spoke to you should have her signature very shortly, I also have my other sister's address in San Diego."
9. Received letter from _____ re _____ saying "No" - will speak to her about it.

January 21, 1974:

10. Made copy of _____ letter. Sent original to CHR-ANL and copy to M. M. Shanahan.

JL:jt

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
J. E. Farnham
A. F. Stehney

May 10, 1973

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: _____ and _____ and others

Visited _____, obtained permission to exhume his sister _____.
The only other relative is his sister _____ has lost touch, her
last address was _____ Street, Tucson, Arizona. Her
husband's name is _____. They are both teachers. He last heard
from her about 5 years ago. She may be in Mexico. Husband taught in
Junior High School or Junior College. He comes from Detroit, his father
was a physician, the team physician for the Detroit Tigers.

There is another man from Geneseo an _____ who went to Tucson.
He may know where the _____ are - if he can be located!

Re: _____ Lady at Holy Sepulchre Cemetery has no information on
him. Grave is in an abandoned section of the cemetery.

Called four _____ listed in Rochester phone book, nobody knows him.

Re: _____ Nobody home.

Called then visited _____ re _____ on West Lake Rd., Canandaigua.
Yes, I am _____ sister. I would give permission. The only
other surviving relative is my sister _____ who now lives on
_____ Rochester, phone _____, is living with the
_____. Left exhumation forms, will talk to sister.

5-6-73. Re _____ Called Tucson phone information.
is listed in Tucson _____

dk

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8001853

Received: January 11, 1974

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: - Rochester

1/4-5/74:

- (1) Visited _____ (name obtained from attorney Fitzgerald) at _____ Street, _____. "No I can't help you, I am a very distant relative - have lost all contacts with the family. Don't know where _____ or _____ live."
- (2) Called four of the six _____ listed in the phone book. _____ is _____ and lives at _____ Fairport. "No I can't see you tomorrow or tonight - am busy! _____ is my sister, lives at _____ phone _____ is dead. _____ is in New York but I don't know where. Why don't you write to me and send me the forms."
- (3) Called _____ several times - nobody home.

JL:jt

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
J. E. Farnham
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8001854

Received: November 28, 1973

TO: A. F. Stehney
FROM: Jan Lieben, M.D.
SUBJECT: Contacts

11/16/73:

1. Re _____ Flew from Philadelphia to Reno, Nevada. Rented automobile and drove to Nevada City. Upon arrival I called _____ . "No I won't give you permission to review records of my sister. There is nothing wrong with her. I don't want to discuss her or my brother-in-law, she was 96 years old when she died. I will have to talk to my lawyer - no I won't see you."
2. Re _____ Drove towards Santa Rosa. From Sacramento I called _____ "No I can't see you this evening - will see you in the morning tomorrow."

11/18/73:

3. Re _____ Drove to Laguna Road, phone _____ and met _____ - was cooperative. "Will have to discuss matters with my brother, _____ of _____ Drive, _____ Bellville, Michigan." We called him together and obtained his consent. _____ signed permission. It was agreed that we shall try to obtain the ashes on her signature and if necessary brother _____ will also sign the form. Community Hospital in Santa Rosa will also have a copy of his hospital record. He had many operations - died at home.

11/21/73:

4. Re _____ Attempted telephone contact with _____ from San Francisco. Number given, _____ is not _____ .
5. Drove to Hihn Road, Ben Lomond. There is no 484 - numbers have been changed. Spoke to half a dozen residents, nobody knows her.
- 7 6. In view of later appointment with Mr. _____ made the night before, I proceeded to Carmel. Had called _____ and _____ is _____ s daughter and _____ is the son of _____ a cousin of _____ now 86 years old. _____ was cooperative - would sign exhumation form but wants to talk it over with his lawyer. There are five other second cousins like him around:

- (1) _____ Rochester, New York
- (2) _____ address unknown
- (3) _____ ? Rochester ?
- (4) _____ , Mt. Vernon, New York
- (5) _____ New York City, once worked for
American Express

_____ has little contact with them - is unsure of their addresses.
Also met _____, his father. He wants to think things over and
may or may not sign the letter. If we can get _____ signature, that
might be enough for the cemetery since he is the only surviving cousin.
The others above are all second cousins. I am to call in a week or so.

7. Drove to Los Angeles

11/24/73:

8. Visited _____ phone
_____ . He is still uncertain - found all kinds of excuses not
to sign permission - latest was that the form does not contain promises
we will reinter his wife. I wrote that into the form but he was not
satisfied. He kept the form.
9. I had planned to visit his daughter, now _____ but learned
that she was away travelling. She is now married _____
(_____ and is still in China Lakes Navy Base.

JL:jt

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
A. F. Stehney
J. E. Farnham

Received: December 13, 1973

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Phone calls and contacts

Re :

1. 11/28/73 - Called _____ re address of the _____ . "Mr. _____ is no longer employed here. His forwarding address is _____, Zion, Illinois 60099."
2. Obtained phone number - _____. Talked to _____ . "Yes, I think my mother is _____ granddaughter. She'll be home tomorrow, you better talk to her."
3. 11/29/73 - Called _____ . "Yes my mother is _____ lives in Cleveland, _____ Street, phone _____."

Re :

4. 11/30/73 - Called _____ . "Yes, I remember you. I still don't have any objection. There are still three of my sisters left, and they object to the exhumation, so there is no point in you coming to see me."

Re :

5. 12/4/73 - Called _____ re exhumation signature from his father _____ . "Have not done anything yet, will try to talk to him next week."

Re

6. 12/5/73 - Made appointment to visit _____ in Cleveland, _____ on December 8, 1973, _____ (west side).

JL:jt

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
A. F. Stehney
F. E. Farnham
M. M. Shanahan

PRIVACY ACT MATERIAL REMOVED

Received: January 7, 1974

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Sisters

12/18/73:

1. Called _____ . "No I don't know very much. _____ died May 3, 1945. My mother was buried by the same undertaker _____ on High Street. I'll talk to my brothers and will call you if I find something to help you with."

12/26/73:

2. Called _____ re _____ re lost exhumation form. She will sign new one. Will also look up her mother's death date.
3. Called _____ Grand Rapids, Michigan re _____ . "No you need not come to see me. I feel the same way as my sister _____ We won't permit exhumation."
4. Called _____ . "No I can't get sense into my father, he is too senile. I'll send you my signature and you'll need the other cousins."
5. Wrote letter to _____ in Fredericksburg re lost exhumation form.
6. Made at least 12 calls to _____ within the last two weeks - nobody home.

1/2/74:

7. Received collect call from _____ informing me that his sister-in-law, _____, of _____ West Orange, New Jersey, phone _____ knows where the graves were.
8. Informed M. M. Shanahan of this. She will inform undertaker, _____, of this.

JL:jt

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
A. F. Stehney
J. E. Farnham

PRIVACY ACT MATERIAL REMOVED

PRIVACY ACT MATERIAL REMOVED

Received: July 24, 1973

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Miscellaneous

MICROFILMED

(1) Re: - Rochester - June 28th.

→ Wrote letter to _____ former address at
Rochester, New York, asking him to get in touch with me.

(2) Re: _____, Pittsburgh.

Received letter from _____ informing us in no uncertain
terms that an exhumation is unacceptable to the family.

(3) July 12th, re

Called Rochester post office for forwarding address for
was informed that I have to do this in writing enclosing \$1.00 for
Postmaster.

(4) Wrote letter to postmaster enclosing \$1.00.

(5) Phone call to _____ re: _____, July 14, 1973.

"No I can't see you, I am sick in bed - will see you next time
you come to Pittsburgh".

dk

cc: A. M. Brues, M. D.
M. S. Littman, M.D.
M. M. Shanahan
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

RECEIVED
CHR RECORDS

JUL 25 1973

8001859

Received: August 16, 1973

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Phone calls and contacts

8-6-73 Called _____ re MMS letter - don't think we are interested in exhuming my mother, but I'll talk to my brother - (Am going away, will be back in October). My sister, _____ of Baltimore drank radium water, she is still alive, check her phone _____. She is away 'til middle of August.

Also, _____, mother's sister(?) also drank radium water. Her daughter is _____ in Frederick, phone _____ (her mother is dead now).

40-015 8-7-73 Re: _____ - please refer to letter from _____ & _____ of 8-1-73, called _____ There are some nephews, _____, Carmel, Calif. 93921, home _____ office 408/624-2737. And a _____ Rochester, New York, _____.

8-7-73 Re: _____ - old case - called _____ in Oil City, Pa. The old man is still alive, did not sound very chipper (he is blocking exhumation at age 90).

8-9-73 Re: _____ family. Called for appointment with _____ at Fredericksburg(?) re exhumation of _____ (see above, 1st item).

8-11-73 Visited _____ daughter of _____ at _____ Street, Frederick, Md. (phone _____) to discuss exhumation of her mother, _____, sister of _____. _____ is the only child, there are no brothers or sisters. She remembers that her mother had at least 1 case of radium water which she had been given by _____. She drank it to cure her multiple sclerosis. She died in 1935, the undertaker was _____ no longer in business. _____ is our undertaker who could arrange the exhumation.

Her son, _____ (M.D.) attended the conversation and both mother and son seemed agreeable and will sign but want to discuss matters first with _____. Left the form and my card. _____ would like some literature on the work of M.I.T. to better understand the project. This should be sent to his mother's address above.

PRIVACY ACT MATERIAL REMOVED

dk

cc: A. M. Brues, M.D., M. S. Littman, M.D., M. M. Shanahan, A. F. Stehne

August 1, 1973

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Contacts

7-24-73: Received letter from Postmaster, Rochester.
address is: _____ Carmel, Cal. 93921.

7-25-73: Called Carmel information re: phone listing of _____, not
listed, but there is a _____ there on _____ phone
_____. Will investigate this on trip to California.

Re: _____ - called _____ 7-16 at YWCA where _____ is said to
have been employed. She wants to look through her files re address, etc.,
call me back on Friday.

Received exhumation permits from _____ for _____ sisters. This is
the last signature for these 2 cases. Mailed forms to MMS.

Called _____ re: _____ Don't know whether I'll be home, may
go to our farm on Saturday, call me tomorrow. Called _____ 7-27
5 times until 9 p.m., no answer.

7-27-73: Re: _____ . Called _____ re exhumation permit. Will
see my daughter shortly, you ought to get it soon.

Made appointment with _____ re: _____

7-28-73: Visited _____ at her home at _____
Bath, Ohio, phone _____ explained purpose of visit. She will consult
with "the good Lord" on whether she will give her permission. There is too much
research being done. He - the good Lord - will let me know on what to do.
(Don't know how I (_____ could influence Him). Am to call in a week, left forms.

7-27-73: Called _____ re: _____ Rochester. I have looked
but could not find anything about him. There is one more place, if I find
anything there I'll call you - collect, I said.

dk

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
A. F. Stehney

RECEIVED
CHR RECORDS
AUG 2 1973

PRIVACY ACT MATERIAL REMOVED

Received July 30, 1973

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Contacts

(1) Re: Sisters. 7-15-73.

Called _____ Orange, N.J., phone _____
re exhumation of above. (This was at least the 12th call) found him finally
home - "Send me the forms, I'll sign them".

(2) Wrote letter with exhumation forms to _____

(3) Called _____ in Rochester 3 times - not home.

7-21-73

7 (1) Re: _____ - went to Algonquin Apts. to look for _____ talked to
superintendent, "_____ was funny, walked around naked in the halls so
we had to throw him out, don't know where he is". Sat down in the lobby of
the apt. building and asked residents whether they knew _____ 4 didn't,
the 5th said yes, "he moved to 86 South Union."

(2) Drove to 86 South Union, superintendent is away for the weekend. A
_____ said he moved away about 2 months ago. Superintendent's name
is _____ later looked for him in phone book - is not listed.

(3) Returned to 86 South Union, his number (the superintendent's) is 454-4867
He may be back on Sunday.

(4) Went to Post Office to check re my letter to Postmaster for _____
forwarding address - closed on Saturday.

(5) Re: _____ - Went to _____ where he allegedly had worked. The
only person who may know about him is _____ not here today, call
Monday, _____ ext. 15.

cc: A. M. Brues, M.D.
M. S. Littman, M.D.

M. M. Shanahan
A. F. Stehney

dk

PRIVACY ACT MATERIAL REMOVED

RECEIVED
CHR RECORDS

JUL 31 1973

8001862

Received: June 26, 1973

TO: CHR Records Room
FROM: J. Lieben, M.D.
SUBJECT: Rochester, 6-18-73 (and phone calls).

(1) Called _____ owner of property on _____ where _____ had lived. Yes, I bought property from _____. His wife is also deceased. There is a relative _____, phone _____ in Rochester.

(2) Called _____ Funeral Home, _____ 716/BU 8 - 464 ?
Spoke to _____ re: relatives of _____. Call back in 20 minutes, I'll look it up.

(3) Returned call. He was buried by the other _____ Funeral Chapel, _____ . There are 2 relatives listed, _____ and _____ - address unknown.

(4) Called above, there was a recording has moved new number is _____.

(5) Called above No. Spoke to _____ who has been removed to St. Ann's Home. She was deaf, communication difficult, could not get point across, may be is senile.

(6) Called _____, made appointment for Saturday, 6-23. _____ was his uncle, he married his mother's sister. He lives on _____ Drive, off Winton Rd., phone _____.

(7) Called _____. No she would not give permission for exhumation of her brother. She would not see me - it is too upsetting for me. I don't even want to talk about it. That finishes our hopes for Purcell.

(8) RE: _____ After many phone calls to _____ with no answer from _____, I called information and got a new number, _____. Spoke to her son, mother is in the hospital, I'll talk to her about your request, call me back.

(9) 7-22-73. Called as discussed above. Spoke at length to senior about the Johns. He said after discussion with his son, they had decided not to bring my request to _____ attention since she is very ill, and may not make it. I am to call back in 1 month.

dk

PRIVACY ACT MATERIAL REMOVED

cc: A. M. Brues, M. S. Littman, M. M. Shanahan, A. F. Stehney

8001863

Received: June 26, 1973

TO: CHR Records Room
FROM: J. Lieben, M. D.
SUBJECT: - Rochester (6-23-73)

(1) Visited _____ learned he was no blood relative of _____
his mother had a sister who was _____ wife's mother.

_____, his mother, is the deaf lady mentioned on phone call 4.
"Aged 92 in St. Anne's Home. _____ is dead.

He thinks that _____ one of the 4 _____ I called on 5-4-73, is the one
surviving blood relative. He is listed in the phone book at _____
Rochester. The phone call revealed a recording, number not assigned now.
(_____). _____ does not want to get involved and thinks I ought to
look for _____. Drove to _____ the Algonquin Apt. Tried
to find superintendent, nobody home. Found him on 2nd trip, talked to him
through speaker, _____ does no longer live here, no forwarding address. He
may be at Cadillac Hotel. Drove to Cadillac Hotel, is not known there,
will have to try further.

Re: _____ Drove to _____ met 83 year
old _____, widow wife of _____, explained our purpose, exhumation.
I'll have to discuss with my daughter. I'll call her. She arrived 1/2 hour
later, explained purpose, both ladies signed permissions (1 - _____
2 - _____ daughter) There are no other relatives, an easy one
for a change.

I forgot to ask _____ his daughter, for her address and phone number.
Called information, there is a _____, listed on
phone _____. He is a research chemist at Kodak, Rochester.

Sent permission to M. M. S.

Drove to Buffalo to catch early plane for Philadelphia since I was unable
to make 4:19 p.m. flight out of Rochester.

dk

PRIVACY ACT MATERIAL REMOVED

cc: A. M. Brues, M. S. Littman, M. M. Shanahan, A. F. Stehney

8001864

PRIVACY ACT MATERIAL REMOVED

Received June 20, 1973

TO: CHR Records Room
FROM: J. Lieben, M.D.
SUBJECT: Contacts

Office Work

- (1) Received permission to exhume _____ from her husband _____
- (2) Mailed both his and son's permission to MMS. Still needed is sister's -
- she is in Florida.
- (3) Called _____ in East Whittier, Calif. re exhumation of his wife _____
"We are sick - am still awaiting some news - you'll have to wait!"
- (4) Having called _____ re _____ about 8 times re appointment
and not receiving any reply - I called her sister, _____ in
Canandaigua, "They are out of town will probably be back over weekend".
- (5) Called _____ re his father _____ re appointment.
"Will see you at home at 7:30 p.m. 6-16-73.

Rochester Cases 6-16 and 6-17.

- (1) Re: _____ Drove to _____ - Gates - just West of Rochester
There is a funeral home at that address and the lady who answered the door
did not know any _____. May be they were the people from whom the
Funeral Director, _____, bought the property. Call _____ on
Monday, he is not available.
- (2) Several calls to _____ no answer - about 4 p.m. somebody answered
the phone and said she was away and will be back next week.
- (3) Visited _____ at _____ off Clifford, phone _____.
His brother _____, has died and so did his mother, he is the only survivor.
At first I received a flat "NO" to my request for permission to exhume
_____ his father, but then his son-in-law got into the act and said,
"If it helps other people you ought to at least consider it". I am to call
in 2 weeks or so. Some hope.

dk

cc: A. M. Brues, M.D.
M. M. Shanahan

M. S. Littman, M.D.
A. F. Stehney

8001865

PRIVACY ACT MATERIAL REMOVED

May 10, 1973

TO: CHR Records Room
FROM: Jan Lieben, M.D.
SUBJECT: Rochester 5/4 and 5/5

Re: _____ Went to _____ Cemetery to try to find relatives. Their records start at 1948, records prior to 48 are kept at town clerk's office. Phone Monday 717/HO 7-8840.

Went to _____ Cemetery re _____ and _____. Lady very uncooperative but finally learned that there are six _____ in the grave. The last one, _____, was buried in 1959. May be by Mattle Funeral director. Called Mattle funeral home, no records. But they think _____ may have buried him.

Called _____ no answer. Called all 8 _____ listed in the phone book. Spoke to 4 of them, none is related to _____ or _____.

Called _____ funeral home again. Man there remembers that _____ was a _____. She is a vice president of _____ Company - 328-0880. No residence listed. Owner of _____ Restaurant. No _____ listed in Rochester phone book.

Drove to _____ Restaurant, yes, _____ sold the restaurant. Now lives in Canandaigua. Called information at Canandaigua, his phone number is _____ on West Lake Road.

Called above number, nobody home. Drove to Carl Street, where informant _____ had lived. There is no such number, street is deteriorated. Policeman stated it could be _____ Street. Drove to _____. Present owner did not know _____ but had bought home from _____ owner of _____.

Called Canandaigua again, spoke to _____, my wife is out, she will be back tomorrow. Called about 10 a.m., does not know _____.

dk

cc: A. M. Brues, M.D.
M. S. Littman, M.D.
M. M. Shanahan
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8001866



PRIVACY ACT MATERIAL REMOVED

CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

TO: M. M. Shanahan MIT Radioactivity Center
FROM: A. F. Stehney RER Division
SUBJECT: Exhumation of CHR cases with prefix number 40.

Enclosed are folders containing copies of all CHR information on ten radioactivity patients in the "40" series. These are all the cases in this series for which we now have death certificates.

Please take the necessary steps to locate relatives and obtain permissions to exhume any or all of these ten persons. It should be noted that we want to examine the remains in order to determine the microscopic distribution of residual radioactivity from past medical treatment.

Date

A. F. Stehney, Deputy Director
Center for Human Radiobiology

Today, I received from A. F. Stehney copies of folders for the following ten CHR cases:

40-001	40-005	40-008	40-011	40-015
40-004	40-007	40-010	40-013	40-017

Date

M. M. Shanahan, Deputy Director
MIT Radioactivity Center

dk

cc: R. D. Evans
R. E. Rowland
CHR Records Room

PRIVACY ACT MATERIAL REMOVED

8001867

PRIVACY ACT MATERIAL REMOVED

CENTER FOR HUMAN RADIOBIOLOGY

January 2, 1973

Bureau of Vital Records
State Department of Health
Albany, New York 12200

Gentlemen:

The Center for Human Radiobiology was established by the United States Atomic Energy Commission and given the responsibility of making a long-range study of persons who have been exposed to radioactive materials. We would like very much to have you search the official death records of New York for five names of persons who may have been exposed to such materials at sometime.

I have asked that a check be issued for advance payment of the search fee. Would you please send the results of your search to my personal attention at the address at the bottom of the page.

Many thanks for your cooperation with our long-range investigations.

Very truly yours,

Harvey A. Schultz
Curator of Records
Center for Human Radiobiology

dk

encl: List

Orig.: Purch. Dept.
cc: R. E. Rowland
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

8981008

CENTER FOR HUMAN RADIOBIOLOGY

January 2, 1973

New York (Death Record Search)

()
Date of Birth: about _____
Date of Death: 27 October 1946
Last known address: Stafford, New York

(Female)
Date of Birth: about _____
Date of Death: April 1967
Last known address: _____ Genesee, N.Y.

Date of Birth: about _____
Date of Death: April 1946
(Autopsy at Strong Memorial Hospital of
the University of Rochester)

Date of Birth: about _____
Date of Death: 2 July 1947
Last known address: _____ Gates, N.Y.

Date of Birth: about _____
Date of Death: 26 February 1946
(Autopsy at Strong Memorial Hospital of
the University of Rochester)

Requested by:
Harvey A. Schultz
Curator of Records
Center for Human Radiobiology

dk

PRIVACY ACT MATERIAL REMOVED

6981008

ARGONNE NATIONAL LABORATORY

9700 SOUTH CASS AVENUE, ARGONNE, ILLINOIS 60439

file
40-015

Telephone: 312-972-7678

February 27, 1986

Dr. Robert G. Thomas
ER-72
GTN
Mail Stop G236
U.S. Department of Energy
Washington, D. C. 20545

Bob
Dear Dr. Thomas:

With respect to your telephone inquiry relating to plutonium studies in the Environmental Health Section (previously Center for Human Radiobiology), I refer you back to the factsheet furnished Dr. Thiessen in 1984 (copy enclosed).

I had follow-up completed on cases Cal-III and HP-6. Case Cal-III died in 1984 of causes not reasonably relatable to plutonium. Case HP-6 is living as of several days ago. Both the interviewer who contacted the household, and a review of the case file, suggest that the functioning of this subject is such that direct contact is contraindicated. I hope this is of some assistance to you.

Best personal wishes.

Sincerely yours,

Jim Stebbings

James H. Stebbings, Sc. D.
Epidemiology Group Leader

JHS:llf

Enclosures

cc w/enc.: H. Drucker, BIM
E. Huberman, BIM
D. T. Goldman, DOE-CH

MICROFILMED

FEB 24 1987

CONFIDENTIAL

8001871

ARGONNE NATIONAL LABORATORY

9700 SOUTH CASS AVENUE, ARGONNE, ILLINOIS 60439

40-015

TELEPHONE 312/972-4146

July 23, 1984

RECEIVED

JUL 25 1984

J. R.

Dr. Jacob Thiessen
Mailstop E-201, Human Health Studies
Office of Health and Environmental Research
Office of the Environment
U.S. Department of Energy
Washington, D. C. 20545

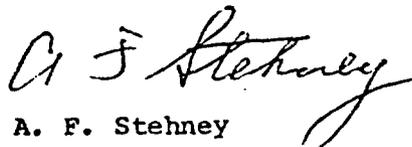
SUBJECT: Congressional Investigation into Health and Safety Policies of the
Department of Energy (DOE)

Dear Dr. Thiessen:

In response to Dr. C. W. Edington's memorandum of June 27, 1984, on the above subject, I have enclosed a factsheet on "Plutonium Studies at the Center for Human Radiobiology (CHR)." The factsheet is in the format requested by Dr. Edington.

Please let me know if you need more information or documentation.

Sincerely yours,



A. F. Stehney
Environmental Research Division

AFS:pat
Enclosures

cc: H. Drucker
H. J. Rauch
P. Failla
P. F. Gustafson
E. Huberman
J. Rundo

MAR 05 1986

8001872

Project Name:

Plutonium Studies at the Center for
Human Radiobiology (CHR)

Date Started: 2 January 1973

Date Terminated: Ongoing

Principal Investigators: R. E. Rowland, A. F. Stehney

Objectives of Test:

1. To determine the excretion rate of plutonium 27 years after injection.
2. To determine the retention and body distribution of plutonium.

Short Description:

In 1945-1947, 18 hospital patients of limited life expectancy were injected with plutonium in order to obtain information about the retention and organ distribution of plutonium. An important objective was to determine the relationship between the body content and the rate of excretion in order to provide data for estimating the body content of plutonium from measurements of plutonium in excreta (bioassay). The results of this study were described in Report LA-1151 (1950).⁽¹⁾

The data in LA-1151 were reviewed in a manuscript prepared by P. W. Durbin for publication in the 1972 volume, Radiobiology of Plutonium.⁽²⁾ Tissue and bone samples had been obtained at autopsy from six of the cases at times ranging from 5 days to 456 days after injection, and the longest collection time for excreta was about 5 years. In addition to preparing the manuscript, Durbin traced the later history of the cases and discovered that four were still living in 1972.

The Center's direct knowledge of the plutonium injection cases dates from December 13, 1972, when Dr. Durbin brought her records to CHR for possible further follow-up. The Center then undertook to determine excretion rates in study subjects who were still alive and to exhume deceased subjects in order to determine the amounts and body distribution of plutonium. During 1973, CHR obtained metabolism samples from three living patients, obtained permission to exhume from next of kin of three deceased patients, and disinterred and transferred to CHR the remains of one of these deceased. The metabolism samples (blood and excreta) were taken at Strong Memorial Hospital (SMH), Rochester, New York.

In 1974, the U.S. Atomic Energy Commission (AEC) reviewed the origins and subsequent follow-up of the plutonium studies. On December 31, 1974, the AEC authorized CHR to proceed with the program of study of the living patients who were injected with plutonium during 1945-1947 and of the bodies of deceased individuals from that group for whom legal consent for examination is obtained.

Follow-up Data:

Table 1 summarizes CHR follow-up activities and last known status (July 5, 1984) for each of the plutonium injection cases.

CHR personnel have published 10 reports on results obtained by study of these cases.⁽³⁻¹²⁾ Copies of these reports are attached.

8001873

Table 1. Plutonium injection cases: Summary of CHR activities and last known status (July 5, 1984).

Old Case Number	CHR Case Number	CHR Activities	Status
Cal-I	40-001	10/16/75: Exhumed cremains Aug 78: Returned	Died 1/9/66
Cal-II	40-002	No contacts; said to have died in Australia	Died 1/6/47
Cal-III	40-003	6/11/73: Examined at CHR 6/23-26/77: Metabolism study at SMH	Living 10/19/83
Chi-1	40-004	6/10/75: Exhumed Apr 78: Returned	Died 10/3/45
Chi-2	40-005	No contacts; cremation ashes scattered	Died 1/13/46
Chi-3	40-006	No contacts; case unidentified	Lost to study, 1946
HP-1	40-007	1973: Next of kin refused permission to exhume	Died 1/12/60
HP-2	40-008	1973: Next of kin refused permission to exhume	Died 4/4/48
HP-3	40-009	1/28-2/18/73: Metabolism study and radioactivity measurement at SMH 1/23-24/79: Metabolism study at SMH	Died after 6/5/81
HP-4	40-010	9/24/73: Exhumed Jul 75: Returned	Died 4/29/47
HP-5	40-011	1973: Next of kin refused permission to exhume	Died 4/29/46
HP-6	40-012	2/14/73: Metabolism study at SMH 6/21-7/1/73: Metabolism study at SMH	Living 12/30/74
HP-7	40-013	1973 and 1977: Next of kin refused permission to exhume	Died 10/27/46
HP-8	40-014	No contacts	Died 11/22/75
HP-9	40-015	5/18/78: Exhumed Jul 81: Returned	Died 7/2/47
HP-10	40-016	No contacts	Died 6/2/57
HP-11	40-017	No contacts	Died 2/26/46
HP-12	40-018	No contacts	Died 4/13/53

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References:

1. W.H. Langham, S.H. Bassett, P.S. Harris and R.E. Carter. Distribution and excretion of plutonium administered to man. Los Alamos Scientific Laboratory, LA-1151 (September 1950).
2. P.W. Durbin. Plutonium in man: a new look at the old data. In The Radiobiology of Plutonium, B.J. Stover and W.S.S. Jee (eds.), The J.W. Press, Salt Lake city, UT, pp. 469-537 (1972).
3. J. Rundo, P.M. Starzyk, J. Sedlet, R.P. Larsen, R.D. Oldham and J.J. Robinson. The excretion rate and retention of plutonium 10,000 days after acquisition. In Diagnosis and Treatment of Incorporated Radionuclides, Proc. Seminar, Vienna, 8-12 December 1975, IAEA, Vienna, pp. 15-22 (1976).
4. R.E. Rowland and P.W. Durbin. Survival, causes of death, and estimated tissue doses in a group of human beings injected with plutonium. In The Health Effects of Plutonium and Radium, Proc. Symp. Sun Valley, Idaho, 6-9 October 1975, W.S.S. Jee (Ed.), The J.W. Press, Salt Lake City, UT, pp. 329-342 (1976).
5. R.A. Schlenker, B.G. Oltman, and H.T. Cummins. Microscopic distribution of ^{239}Pu deposited in bone from a human injection case. In The Health Effects of Plutonium and Radium, Proc. Symp. Sun Valley, Idaho, 6-9 October 1975, W.S.S. Jee (Ed.), The J.W. Press, Salt Lake City, UT, pp. 437-450 (1976).
6. J. Rundo and F.H. Ilcewicz. Blood content and excretory plasma clearance of plutonium 10^4 days after injection. Abstracts of Papers-22nd Ann. Mtg. Health Phys. Soc., Atlanta, 3-8 July 1977, Pergamon Press, NY, p.26 (1977); Health Phys. 33, 668 (1977).
7. R.E. Rowland. The risk of bone sarcoma from plutonium-239. In Biological Implications of Radionuclides Released from Nuclear Industries, Proc. Symp., Vienna, 26-30 March 1979, Vol. II, IAEA, Vienna, pp. 211-224 (1979).
8. R.P. Larsen, R.D. Oldham, and R.E. Toohey. Macrodistribution of plutonium in the human skeleton. In Actinides in Man and Animals, Proc. Snowbird Actinide Workshop, 15-17 October 1979, M.E. Wrenn (Ed.), RD Press, Salt Lake City, UT, pp. 191-197 (1981).
9. J. Rundo. The late excretion of plutonium following acquisition of known amounts. In Actinides in Man and Animals, Proc. Snowbird Actinide Workshop, 15-17 October 1979, M.E. Wrenn (Ed.), RD Press, Salt Lake City, UT, pp. 253-260 (1981).
10. R.A. Schlenker and B.G. Oltman. Plutonium microdistribution in human bone. In Actinides in Man and Animals, Proc. Snowbird Actinide Workshop, 15-17 October 1979, M.E. Wrenn (Ed.), RD Press, Salt Lake City, UT, pp. 199-206 (1981).

11. R.A. Schlenker and B.G. Oltman. Uranium concentrations in human bone. In Actinides in Man and Animals, Proc. Snowbird Actinide Workshop, 15-17 October 1979, M.E. Wrenn (Ed.), RD Press, Salt Lake City, UT, pp. 473-476 (1981).
12. R.E. Toohy, C.G. Cacic, R.P. Larsen, and R.D. Oldham. The concentration of plutonium in hair following intravenous injection. Health Phys. 40, 881-886 (1981).

Attachments:

Reprints of references 3-12 are attached.

MAR 05 1986

8001876

40-015



Department of Energy

Argonne Area Office
9800 South Cass Avenue
Argonne, Illinois 60439

RECEIVED

1985 NOV 23 PM 12:51

BIO-MED RESEARCH

NOV 21 1985

Dr. Alan Schriesheim, Director
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, Illinois 60439

Dear Dr. Schriesheim:

SUBJECT: FREEDOM OF INFORMATION ACT (FOIA) REQUEST DATED OCTOBER 30, 1985,
DOCKET NO. 11048504D

The enclosed FOIA request is for a copy of a memo from R. E. Rowland to H. A. Schultz dated December 21, 1972, which discusses records of 18 plutonium research subjects. The requestor is also asking for any supporting documentation and any subsequent memos regarding the subject.

Due to statutory time limitations for responding to FOIA requests, we must have your response no later than December 2, 1985.

Sincerely,

for David T. Goldman
Area Manager

Enclosure:
As Stated

cc: A. Zilberstein, ANL, w/enclosure
R. E. Rowland, Princeton, KY, w/enclosure

502-365-2979

~~ENCLOSURE~~

DEC 04 1985

8001877

40-015

THE KNOXVILLE JOURNAL

A GANNETT NEWSPAPER
P.O. BOX 911
KNOXVILLE, TENNESSEE 37901

1985 NOV -4 PM 3:39

Oct. 30, 1985

Mr. Ronald Turner
MA-232.1
U.S. Department of Energy
Freedom of Information and Privacy Act Branch
1000 Independence Ave. S.W.
Washington, D.C. 20585

To the FOI Officer:
This request is made under the federal Freedom of Information Act, 5 U.S.C. '552.

Please send me copies of Memorandum, dated 12-21-72, from Dr. R.E. Rowland to H.A. Schultz, senior staff assistant, Records and Data Processing, Center for Human Radiobiology, Argonne National Lab. Memo discusses instructions from Rowland to Schultz on records of 18 plutonium research subjects. Records were transferred to Schultz for his disposition. Please include any supporting documentation and any subsequent memos regarding this subject.

As you know, the FOI Act provides that if portions of a document are exempt from release, the remainder must be segregated and disclosed. Therefore, I will expect you to send me all nonexempt portions of the records which I have requested, and ask that you justify any deletions by reference to specific exemptions of the FOI Act. I reserve the right to appeal your decision to withhold any materials.

I promise to pay reasonable search and duplication fees in connection with this request. However, if you estimate that the total fees will exceed \$50, please notify me so that I may authorize expenditure of a greater amount.

I am prepared to pay reasonable search and duplication fees in connection with this request. However, the FOI Act provides for waiver or reduction of fees if disclosure could be considered as "primarily benefiting the general public." I am a journalist employed by The Knoxville Journal and intend to use the information I am requesting as the basis for a planned article. Therefore, I ask that you waive all search and duplication fees. If you deny this request, however, and the fees will exceed \$50, please notify me of the charges before you fill my request so that I may decide whether to pay the fees or appeal your denial of my request for a waiver.

As I am making this request as a journalist and this information is of timely value, I will appreciate your calling me by telephone, rather than by mail, if you have any questions. Thanks and I will look forward to your reply within 10 business days, as required by law.

Sincerely,
Randall Beck
Randall Beck, reporter
(615) 522-4141 Ext. 422

MICROFILMED

DEC 04 1985

8001878

U.S. DEPARTMENT OF ENERGY

memorandum

DATE November 12, 1985

REPLY TO
ATTN OF MA-232.1 - Joan Ogbazghi

SUBJECT Freedom of Information Request #110485050

TO Jane Monhart, CH Operations Office
ATTN Bernie Russ

The attached Freedom of Information (FOI) request is being sent to you for action as the records requested appear to be principally within the purview of your organization. If our determination is incorrect, please inform me immediately to whom you are forwarding this request.

If other divisions, offices or field organizations also have records relevant to this request, you as the appropriate FOI Office are responsible for requesting their participation and for coordinating the response. It is important that an appropriate response be forwarded to the requester within 10 working days as failure to act can be deemed a denial.

On the reverse side of this memorandum, a "Reminder of Procedures for Handling FOI Requests" should assist your staff. If you have any questions, I can be reached on FTS 252-5955.

John H. Carter
John H. Carter
Chief of FOI and Privacy Acts
Activities Branch
Division of Reference and
Information Management

Attachment

MINOR

DEC 01 1985

November 14, 1985

Mr. Randall Seck
The Knoxville Journal
P.O. Box 911
Knoxville, TN 37901

Re: 110485009
110485079
110485080
110485220

Dear Mr. Seck:

Your October 30, 1985, Freedom of Information requests (copies enclosed) addressed to the U.S. Department of Energy were received on November 8, 1985, and have been sent to our Freedom of Information Officers at our Chicago, Oak Ridge, Richland and San Francisco Operations Offices. They will correspond directly with you about your requests.

In compliance with the Freedom of Information Act, the 10 day response period will begin when the offices designated above have received your requests. If you need further assistance, please contact Jane Mohart, Chicago Operations Office, 9800 South Cass Avenue, Argonne, IL 60439, (312) 972-2376; Wayne Range, Oak Ridge Operations Office, P.O. Box E, Room 1012, Oak Ridge, TN 37831, (615) 576-0685; Gail H. Bokkan, Richland Operations Office, 825 Jaden Avenue, P.O. Box 550, Richland, WA 99352, (509) 378-8274; Elsie Motoko, San Francisco Operations Office, 1333 Broadway, Wells Fargo Building, Oakland, CA 94612, (415) 273-4352.

We have assigned the above referenced numbers to your requests and ask that you refer to these in any future correspondence.

Sincerely,

Original signed by John H. Carter

John H. Carter
Chief of FOI and Privacy Acts
Office of Administrative Services

Official File Copy
Action Officer 4
Official File (RF)

40110485232

MA-232.1:J80:sjb:26025:11/13/85

ARGONNE NATIONAL LABORATORY

9700 SOUTH CASS AVENUE, ARGONNE, ILLINOIS 60439

TELEPHONE 312/972-3050

PRIVACY ACT MATERIAL REMOVED

May 2, 1978

AES
MAY 3 1978

Mr. _____
Funeral Home, Inc.

Rochester, New York 14617

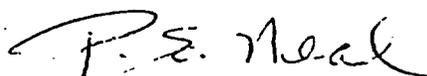
Dear Mr. Davis:

I am writing about the proposed disinterment of _____, who died in 1947 and whose remains are in the _____ Cemetery. The Center for Human Radiobiology, Argonne National Laboratory, accepts full liability for any claims of the next-of-kin of _____ that his remains were exhumed and transported to Argonne without their permission.

You will recall that exhumation permissions signed by _____, and _____ were sent to you on September 15, 1977, by M. M. Shanahan on our behalf. These persons are all the known surviving next-of-kin of _____.

I trust that this satisfies your request for a statement and that we may now proceed with the disinterment of _____.

Very truly yours,



P. E. Neal
Associate Director

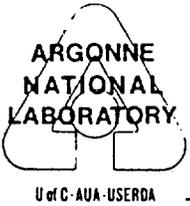
PEN:MRG:kw

cc: M. M. Shanahan
J. E. Farnham

bc: M. R. Gaspari
R. E. Rowland
A. F. Stehney ✓

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AFS
JEF
RAS

CENTER FOR HUMAN RADIOBIOLOGY 40-015

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

September 15, 1977

Mr. _____
Funeral Home, Inc.
Rochester, New York 14617

Dear Mr. _____:

Many thanks for your recent letter regarding
Mr. _____ (40-015).

As requested we are enclosing the exhumation permissions
signed by _____, and _____.

The estimate of \$825.00, as itemized in your letter,
is acceptable to us and we would appreciate your starting
the necessary paper work with the local health department.

Mr. Joseph E. Farnham of the Argonne National Laboratory
will be in touch with you soon to arrange a mutually con-
venient date for the exhumation of _____.

Sincerely yours,

Mary Margaret Shanahan
Deputy Director
Radioactivity Center

MMS:pag
enclosures:

xc: M. H. Chalfen
A. F. Stehney
J. E. Farnham

PRIVACY ACT MATERIAL REMOVED

8001882

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
RADIOACTIVITY CENTER Room 4-063
Cambridge, Massachusetts 02139 Tel. 617-253-4831

RECEIVED
SEP 20 '77
CHR RECORDS

AFS

AFS
JEF
RAS

FUNERAL HOME INC.

Rochester, N. Y. 14617

Phone 544-2041

PRIVACY ACT MATERIAL REMOVED

Ms. Mary Margaret Shanahan;
5619 East Monterosia
Phoenix; Arizona 85018
August 10, 1977

Re:

Dear Ms. Shanahan;

I am writing you in regards to disinterring the remains of

First of all, we have been in contact with Msgr. _____ who is the religious head of _____ Cemetery. He is willing for us to go ahead with the disinterment, after he has;

1. A copy of the authorization from all people involved with this disinterment.
2. A statement from you stating that the cemetery is absolutely free from all responsabilty in regards to possible Law Suits etc. which could arise now or at any date in the future.

We have misplaced the original information which was sent to us in regards to this matter, so if you could furnish us with this again, we would appreciate it.

Also, when could we expect payment in regards to this? Do we have to wait until burial is made at a later date? If so we would not be able to take care of this matter for you. We Have cash expenditures and can not keep this amount due on our books for a period of over 2 Weeks.

We will be waiting to hear from you.

Very Truly yours,

Charles E. Davis
Charles E. Davis
Associate

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PRIVACY ACT MATERIAL REMOVED

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RAS

FUNERAL HOME INC.

Rochester, N. Y. 14617

Phone 544-2041

Ms. Mary Margaret Shanahan
5619 East Monterosa Street
Phoenix, Arizona 85018
August 30, 1977

SEP 3 1977

Re: (40-015)

Dear Ms. Shanahan:

In answer to your letter of August 20, 1977, we have again listed the costs as you have requested. The only change is the cemetery cost for reinterment, which was increased the first of this year. Our charge for reinterment vault has also increased, but we are not going to change our original charge.

The costs are as follows:

Cemetery Charge (Disinterment)	\$ 300.00
Cemetery Charge (Reinterment)	175.00
Transportation to Airport	50.00
Transportation from Airport	50.00
Professional services	100.00
Concrete Reinterment Vault	<u>150.00</u>
	\$ 825.00 Total

If everything is in agreement with you, please forward the authorizations from the next of kin and also a statement from you requesting the disinterment, so that we may start the paper work with the local health department, in order to obtain the proper papers.

Sincerely yours.

, Associate

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SEP 09 1977
RECORDS ROOM

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CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

August 22, 1977

The Right Reverend Msgr. _____
Church

Rochester, New York, 14607

RECEIVED CHR
SEP 09 1977
RECORDS ROOM

Dear Monsignor _____ :

Enclosed is a copy of a letter which was recently received from Mr. _____ of the _____ ; Funeral Home, Inc. relating to the disinterment of the late Mr. _____ . I believe that you and Dr. Jan Lieben of our staff discussed this matter on April 5, 1977. I 40-01

As requested by you we are enclosing xerox copies of the signed permission forms from all known living next-of-kin of _____ , namely _____ (niece), _____ (niece), _____ (second cousin), _____ (2nd cousin), and _____ (second cousin).

In regard to your second request that we provide a statement "that the cemetery is absolutely free from all responsibility in regards to possible law suits, etc. which could arise now or at any date in the future", we hope that the following will be satisfactory.

First of all, all known living next-of-kin have given their permission for the disinterment. As you will see in the disinterment form we instruct the cemetery that the grave site must be restored to its original condition both after disinterment and also after reinterment. We believe that there should be no problems which might be initiated by any of the next-of-kin, and in fact we have never had any problems with next-of-kin during the many years we have been carrying out this most important research work.

Secondly, in the past some cemetery superintendents have inquired about quantitative information concerning the handling of bodies of persons who have been exposed to radioactive materials. We can assure you, and the cemetery personnel, that there is no medically significant radiation from such bodies, and no possibility of transfer of radioactivity to persons handling them. They

SOUTHWEST FIELD STATION

5619 East Monterosa St., Phoenix, Arizona 85018 Tel. 602-949-5600

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August 22, 1977

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PRIVACY ACT MATERIAL REMOVED

can be regarded exactly like any other body.

This follows from the fact that the amount of radioactivity retained by these persons is extremely small. The biological effects on the person ingesting the material arise because the material becomes fixed in their skeletal tissues, where the alpha radiations can irradiate the bone cells continuously for a period of many years or several decades. These alpha radiations have a range of only two-thousandths (2/1000's) of an inch. The alpha rays which may have produced biological effects in the deceased have such a short range that none of them can emerge. They cannot be detected outside the body.

The total amount of radioactive material contained in the body of Mr. _____ is less than 0.4 microcuries, or 0.0004 millicuries. This is an even smaller amount of radioactivity than the radium that is contained on the face of a typical luminous dial of a watch or clock.

It is now customary in medical practice to administer radioactive isotopes for the treatment of various kinds of illnesses. Occasionally persons die in the hospital while they still contain large amounts of radioactive isotopes, such as radioactive iodine, radioactive gold, or radioactive phosphorus. The National Committee on Radiation Protection studied this situation carefully and in 1958 issued its conclusions in the U. S. National Bureau of Standards Handbook 65 titled "Safe Handling of Bodies Containing Radioactive Isotopes". On page 3 of this handbook, in discussing the possible radiation exposure to a surgeon, pathologist, or embalmer, the Committee remarked, "It is important for members of these groups to realize the existence and the magnitude of this problem and to know how to meet it. It is equally important not to exaggerate the danger and not to be unreasonably fearful when the hazard is minimal or nonexistent.". And on page 4, as a guide line for bodies which could be considered as essentially nonradioactive, "A body containing less than 30 millicuries may be released directly to the funeral director for embalming without the advice of a safety officer.". You will note that this cut-off at 30 millicuries is 75,000 times greater than the radioactive content of Mr. _____. Thus, there is no question that this minute amount of radioactivity is completely negligible from the standpoint of persons dealing with the deceased.

We will be glad to supply any other information you may wish.

Sincerely yours,

s
xc: M.H.Chalfen, A.F.Stehney, ✓
J.E.Farnham, J.Lieben
R.A.Schlenker

Mary Margaret Shanahan
Deputy Director
M.I.T. Radioactivity Center

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AFS
JEF
RAS

CENTER FOR HUMAN RADIOBIOLOGY

U of C-AUA-USERDA

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

August 20, 1977

Mr. _____
Funeral Home, Inc.

Rochester, N. Y. 14617

Dear Mr. _____ :

RECEIVED CHR
AUG 24 1977
RECORDS ROOM

This will acknowledge receipt of your recent letter regarding the disinterment of Mr. _____ (40-015). We are very pleased to learn that Msgr. _____ is willing to have the disinterment proceed after he has received a copy of the authorization from all next-of-kin (which will be sent directly to him with a separate letter) and a statement regarding responsibility from law suits which might arise.

Meanwhile we are enclosing xerox copies of the following material previously sent to you. In addition to the material listed below, we understand that there was a conversation between you and Dr. Robert A. Schlenker of Argonne National Laboratory last September in which the following charges for the _____ disinterment were quoted to Dr. Schlenker:

Cemetery charge (disinter)	\$300	CMAS pouch	\$ 35
Cemetery charge (reinter)	150	Reinterment vault	150
Transport. to airport	50	Ziegler case	75
Transport. from airport	50	Airline transp.	not stated
Professional services, about	100	TOTAL . . .	\$910 (approx.)

We will provide the Ziegler and the CMAS pouch and will take care of the airline transportation costs separately, so if the above figures are still firm, the total would come to about \$800. We appreciate receiving a letter from you notifying us that the above figure is your present estimate, or if it is not then please let us know where it differs and by how much.

The material mentioned above (previously sent) is as follows:

- Ltr June 17, 1977 M.M. Shanahan to Mr. Davis
- Ltr September 21, 1976 M.M. Shanahan to Mr. Davis

8001887

SOUTHWEST FIELD STATION

PRIVACY ACT MATERIAL REMOVED

5619 East Monterosa St., Phoenix, Arizona 85018 Tel. 602-949-5600

Mr. _____

-2-

August 20, 1977

PRIVACY ACT MATERIAL REMOVED

In answer to your question about payment, Mr. Farnham of the Argonne National Laboratory will have with him when he comes to Rochester for the disinterment a check which will cover the expenses as listed on page 1 of this letter, or as amended by you if an amendment becomes necessary and is mutually agreed upon.

If you have any other questions or need any additional information regarding this disinterment please do not hesitate to write or phone me collect. You will find my address and phone number at the bottom of page 1 of this letter.

I will look forward to receiving from you a letter confirming the exhumation costs either as listed on page 1 or as amended if necessary.

Sincerely yours,

s

encs.

xc: M.H.Chalfen

A.F.Stehney ✓

J.E.Farnham

R.A.Schlenker

J.Lieben

Mary Margaret Shanahan
Deputy Director
M.I.T. Radioactivity Center

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CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

June 17, 1977

Mr. _____

Funeral Home, Inc.

Rochester, New York 14617

Dear Mr. _____:

This letter is being sent to inquire about the present status of the exhumation of Mr. _____ (40-015).

In April 1977 one of our staff physicians, Dr. Jan Lieben, discussed our research program with Monsignor _____. It was Dr. Lieben's impression that Monsignor _____ appeared interested and cooperative, and it was left that the Monsignor would discuss the matter with the lawyer for the _____ Cemetery.

We would like to know whether you have received word from either Monsignor _____ or the _____ Cemetery lawyer about the exhumation of Mr. _____. If you have not heard anything from them, we would appreciate it very much if you would look into this matter and let me know where it stands at present.

Please feel free, if you wish, to call me collect. You will find my phone number at the bottom of this letter.

Sincerely yours,

s
cc: M.H.Chalfen
A.F.Stehney
J.E.Farnham
J.Lieben

Mary Margaret Shanahan
Deputy Director
M.I.T. Radioactivity Center

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RECEIVED CHR
JUL 06 1977
RECORDS ROOM

8001889

SOUTHWEST FIELD STATION

5619 East Monterosa St., Phoenix, Arizona 85018 Tel. 602-949-5600



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AFS
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CENTER FOR HUMAN RADIOBIOLOGY 40-015

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

September 21, 1976

Funeral Home, Inc.

Rochester, New York 14617

Attn: Mr. _____

Dear Mr. _____ :

MICROFILMED

OCT 28 1976

CHR RECORDS

This letter will confirm the discussion which you and Dr. Robert A. Schlenker of the Argonne National Laboratory had recently relative to the exhumation of the remains of Mr. _____.

I would appreciate receiving from you at your earliest convenience an estimate of the cost of exhuming Mr. _____ remains and shipping them by air to Argonne National Laboratory. According to Cook County, Illinois, regulations the ziegler case containing Mr. _____ remains must be sealed prior to shipment to O'Hare Airport, Chicago. The ziegler case will be supplied by Argonne National Laboratory.

We have on hand permission forms for this exhumation from the following relatives of Mr. _____ : _____ of Carmel, California (2nd cousin); _____ and _____, both of Rochester, N. Y. (both are nieces); _____ of San Diego, Calif. (2nd cousin); and _____ of Danbury, Conn. (niece). _____ is deceased and we know of no living children. We believe the above to be the closest relatives of the late Mr. _____.

The undertaker who will handle the arrangements on the Illinois end is

Mr. _____
_____ Funeral Home
_____ Lemont, Illinois 60439

RECEIVED CHR
SEP 27 1976

PRIVACY ACT MATERIAL REMOVED

Our studies, which are sponsored by the Environmental and Research Development Administration of the U. S. government take

RECORDS ROOM

8001890

SOUTHWEST FIELD STATION

5619 East Monterosa St., Phoenix, Arizona 85018 Tel. 602-949-5600

September 21, 1976

PRIVACY ACT MATERIAL REMOVED

about a year, so it will be necessary to close the grave once the remains have been removed, and to reopen the grave when the remains are returned for reburial.

We hope that your charges and those of the cemetery can be kept to a minimum since, as you probably know, government research funds are rather limited these days.

Upon receipt of your estimate of the cost of this exhumation we will notify you of its acceptance. A member of our staff, Mr. Joseph E. Farnham, will be present at the time of the exhumation so we will want to arrange in advance a date which is convenient for you, for the cemetery, and for Mr. Farnham to carry out this work.

If either you or the cemetery needs further information, please call me collect at 602-949-5600 or write to me at the address below.

I would appreciate having your cost estimate sent to me at the following address: 5619 East Monterosa Street, Phoenix, Arizona 85018.

Sincerely yours,

(Miss) Mary Margaret Shanahan

s
xc: R.A.Schlenker
M.H.Chalfen
A.F.Stehney ✓
J.E.Farnham

PRIVACY ACT MATERIAL REMOVED

8001891

September 21, 1976

AFS
JEF

Dear Bob:

It was good to talk with you the other day. Enclosed is a xerox copy of my letter to Mr. _____ about _____ exhumation.

The prior undertaker (_____) had inquired about possible radioactivity and in their letter of 1/23/76 said that neither they nor the cemetery would exhume and ship radioactive remains. The cemetery, according to _____, wanted to know the relationships to Mr. _____ of those giving permission for the exhumation. The Board of Health (1/22/76) wanted assurance that there was no possible radiation hazard, and from their examination of the death certificate could not see anything which suggested such a hazard.

Since you have visited and talked with both the new undertaker (Mr. _____) and someone at the Board of Health in Rochester, it seemed best to me to write as little as possible about radioactivity at this particular moment. If Mr. _____ or the cemetery inquires about radioactivity later on we can then send the letter which we have used in the past with complete success about the non-hazards of exhuming dial painters, suitably reworded. Your memo of 9/14/76 indicated that the cemetery would not permit any exhumation right now. It is just possible that as a result of your visits in Rochester, the exhumation arrangements can go through smoothly, assuming the lady at the cemetery cooperates.

s

Mary Margaret

xc: M.H.Chalfen
A.F.Stehney

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SEP 27 1976

RECORDS ROOM

8001892



PRIVACY ACT MATERIAL REMOVED

ARGONNE NATIONAL LABORATORY

September 9, 1976

Miss Mary Margaret Shanahan
5619 East Monterosa Street
Phoenix, AZ 85018

Dear Mary Margaret,

While on a vacation trip September 8, I spoke with Mr. _____ a Rochester, New York undertaker, about the exhumation of _____ (40-015). His rough cost estimate was reasonable, he raised no objection about the exhumation, and he seems quite interested in and sympathetic to our work. For his information I left with him an edited copy of the letter requesting a cost estimation which you sent to _____ Memorial Chapel, dated January 13, 1976. (The date, funeral home address, the phrase "by your organization" in the first sentence, your name, and the distribution list were deleted.) On parting I told him you would be sending him a letter formally requesting a cost estimation, in the near future. Please send the letter to the attention of Mr. _____ at the _____, Funeral Home, Inc., _____ Rochester, NY 14617.

You will be receiving a copy of a memo covering my inquiry to Mr. _____ and another Rochester area undertaker.

Sincerely yours,

Robert A. Schlenker, Ph.D.

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clg

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MMS
JEF
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AMB



MEMORIAL CHAPEL, Inc.

• ROCHESTER, NEW YORK 14605 • TEL: 454-7070
Area Code 716

At Alexander

March 1, 1976

Dr. Jan Lieben
Argonne National Laboratory
Argonne, Illinois 60439

Dear Dr. Lieben:

Thank you for stopping in the other day and explaining the situation regarding Mr. _____.

Enclosed is the newspaper article I mentioned regarding plutonium.

After much discussion, we have decided that we do not want to be involved in this exhumation and prefer that you contact another funeral director to do the work.

Sincerely yours,

Herbert W. Rech
Vice President

HWR/c

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MAR 05 '76

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MONROE COUNTY



DEPARTMENT OF HEALTH

111 WESTFALL ROAD, ROCHESTER, NEW YORK 14602

TELEPHONE 442-4000
AREA CODE 716

January 22, 1976

JAN 26 1976

Miss Mary Margaret Shanahan
Center for Human Radiobiology
Southwest Field Station
5619 East Monterosa Street
Phoenix, Arizona 85018

Dear Miss Shanahan:

I am writing concerning your request for exhumation of _____

The _____ Memorial Chapel and the _____ Cemetery
have both consulted us to inquire as to whether there would
be any radiation hazard involved in exhuming the remains,
and in handling them, shipping them, etc.

We have consulted the copy of the Death Certificate and see
no information there that would suggest a possible radiation
hazard. However, we would like to have your assurances in
this regard.

Very sincerely yours,

Richard Nauen
Richard Nauen, M.D.
Deputy Health Director

RN/jd

CC: Mr. Joseph E. Farnham
Memorial Chapel
Mrs. Mary Sypian
Dr. Glenn Haughie

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CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

January 13, 1976

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JAN 21 '76
CHR RECORDS

Memorial Chapel, Inc.
Street
Rochester, New York 14605

Gentlemen:

We are writing to you concerning the exhumation of Mr. _____ who died in Rochester, N. Y., on July 2, 1947 and who was buried by your organization in the _____ Cemetery in Rochester.

We have on hand signed permission forms for this exhumation from the following relatives of _____ : _____, _____, and _____.

I would appreciate receiving from you at your earliest convenience an estimate of the cost of exhuming _____ remains and shipping them by air to:

Mr. Joseph E. Farnham
Center for Human Radiobiology
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

According to Cook County, Illinois, regulations the ziegler case containing the remains of _____ must be sealed prior to shipment to O'Hare Airport, Chicago.

The undertaker who will handle the arrangements on the Illinois end is _____

Funeral Home

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Lemont, Illinois

Our studies, which are sponsored by the Environmental and Research Development Administration (formerly the Atomic Energy Commission) take about a year, so it will be necessary to close the grave once the remains have been removed, and to reopen the grave when the remains are returned for reburial.

SOUTHWEST FIELD STATION

8001897

5619 East Monterosa St., Phoenix, Arizona 85018 Tel. 602-949-5600

Memorial Chapel, Inc. -2-

January 13, 1976

We hope that your charges and those of the cemetery can be kept to a minimum since, as you probably know, government research funds are rather limited these days.

Upon receipt of your estimate of the cost of this exhumation we will notify you of its acceptance. A member of our staff will be present at the time of the exhumation so we will want to arrange in advance a mutually convenient date for this work to be carried out.

Please send your reply to me at the address given on the bottom of the first page of this letter.

Sincerely yours,

s

(Miss) Mary Margaret Shanahan

xc: M.H.Chalfen
A.F.Stehney
J.E.Farnham
V.Markiewicz

8001898



Re: (relation)

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JEF
✓ CHRR

CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

December 22, 1975

Mrs. C. W. Martin
22 Terryville Lake Road
Danbury, Connecticut 06810

Dear Mrs. Martin:

Dr. Jan Lieben, who is a member of the staff of the Center for Human Radiobiology (Argonne National Laboratory headquarters, Mass. Institute of Technology satellite laboratory), has asked me to write to you identifying him as being associated with the Center.

He has been a consultant for the Center since it was set up in 1970, and prior to that time Dr. Lieben was a consultant to the Radioactivity Center of the Massachusetts Institute of Technology for a number of years.

We trust that the above will be sufficient information for you and that should Dr. Lieben wish to discuss our studies with you personally a mutually convenient time can be arranged. If there are any other details you would like to have, please feel free to write me at the address given below.

Sincerely yours

Mary Margaret Shanahan
Deputy Director
M.I.T. Radioactivity Center

s
xc: M.H.Chalfen
A.F.Stehney ✓
J.Lieben

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JAN 05 '76

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40-015

PRIVACY ACT MATERIAL REMOVED

FITZGERALD AND FITZGERALD
ATTORNEYS AND COUNSELORS AT LAW
1033 TIMES SQUARE BLDG.
ROCHESTER, NEW YORK 14614

DANIEL F. FITZGERALD
DANIEL F. FITZGERALD, JR.

TELEPHONE
454-2585
AREA 716

August 1, 1973

Jan Lieben, M.D.
515 West Chelton Avenue
Philadelphia, PA 19144

Dear Dr. Lieben:

I am answering your letter to _____.
I am his attorney. At present _____ is about 85
years of age and senile to the extent that he could
not comprehend any questions you may have.

I was also the attorney for the estate of Lulu
Sours, the widow of _____ and in her will she be-
queathed the sum of \$1,000.00 to St. Mary's Hospital,
Rochester, New York, for research in the matter of
dermatomyositis. Apparently he died of that disease.

If you will let me know just what information
you wish and if I am able to provide the same I shall be
glad to do so.

Very truly yours,



Daniel F. Fitzgerald

DFF:GEN

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HISTORICAL

8001901

PLUTONIUM

From Page 1A

the gastro-intestinal system. The primary aim was to protect workers working with plutonium. It was essentially a manufacturing hygiene experiment, connected with atomic bomb production, Bale said.

What we found out is that the plutonium is not excreted rapidly and at some doses it becomes carcinogenic (cancerous)."

His finding, he said, had already been confirmed in experiments on animals.

At the doses given the patients from about two to more than ten times the present permissible dose, none of these doses was fatal, Bale said.

"I have mixed feelings about the experiment and I know it would be considered as an unethical experiment," Bale said. "But it seemed to have a useful purpose at the time and was conducted in the middle of a war."

Dr. Lederman, a University of Rochester Medical Center spokesman,

said, in a statement that 11 patients were given "trace amounts of radioactive plutonium" at Strong during wartime project.

He said the university believed the patients knew they were part of a scientific investigation and "we also believe the patients voluntarily consented."

"As far as we can determine, there was no adverse effect on the patients' health as a result of the studies."

All of the 18 subjects in the experiment nationwide were considered terminally ill at the time.

Three of the subjects tested nationwide are alive today, Dr. James Liverman of the energy Research and Development Administration said yesterday.

One of the subjects, a black man, now living in Texas, was the only one to get the maximum dose, Liverman said. He said the man was injected in the leg, below the knee, about 48 hours before the leg was amputated at the knee because of existing cancer.

The agency's fact sheet on the experimental injections said that seven people who received them lived less than one year afterwards; three lived between one and three years; two between 14 and 29 years; one 28 years, and the fate of two is unknown.

Thirteen of the human guinea pigs were men and five were women; 15 were whites and three were blacks; and most were middle-aged adults, although the age span ranged from 4 to 65, the fact sheet said.

Leemans and Thompson

Men

50 CENTS
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Published by Gannett Co., Inc., in Rochester, N.Y., Sunday Morning, February 22, 1976

1 YEAR

Leemans injected with plutonium at Strong

VANCE H. THOMPSON
D&C Staff Writer

Memorial Hospital was one of the hospitals that took part in a government project toward the end of World War II, in which about 18 people were injected with plutonium. The subjects weren't told they were being given a plutonium injection, a University of Rochester professor said yesterday.

Dr. William F. Bale, a professor of radiation biology and biophysics at the University, said the experiment was to determine how much of the poisonous radioactive substance workers in a power plant could withstand.

The Manhattan District Corps of Engineers Project — code name for the government's secret and successful effort to develop the world's first atomic bomb — sponsored the tests at Strong and at the Billings Hospitals at

Part of WW II
atomic bomb project

the University of Chicago, the University Hospital at the University of California in San Francisco and at a government hospital in Oak Ridge, Tenn.

Dr. Bale, who was at the time commissioned as a researcher for the related Atomic Energy Project at the university, said a team of three physicians and nurses at Strong administered the plutonium tests on "about a dozen people who were supposed to have a short life expectancy."

The test subjects, he said, "did not come voluntarily to the project and it is my impression they did not know they were being treated with

plutonium." The justification for the project said, was that Americans feared Germans would "develop and use an atomic bomb before we did." The U.S. needed to know, he said, what effects plutonium would have when absorbed by the body. "We had to determine, by whether or not and how fast plutonium would be absorbed, or ex-

Turn to Page 5A

8001902

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MAR 05 '76

CHR RECORDS

LOS ALAMOS SCIENTIFIC LABORATORY

P. O. Box 1663

LOS ALAMOS, NEW MEXICO

~~SECRET~~

PRIVACY ACT MATERIAL REMOVED

IN REPLY
REFER TO:

July 15th, 1947

Dr. Samuel H. Bassett
The University of Rochester
School of Medicine and Dentistry
P. O. Box 207, Crittenden Station
Rochester 7, New York

Dear Dr. Bassett:

I received your letter regarding Hp-9. I think the weights you sent will be satisfactory for the analysis. I will get someone started on them right away.

I am enclosing the analyses of the urine specimens collected from Hp-9 before and after treatment with citrate solutions. I think you will agree with me that it amounts to a nice set of negative results. Citrate seemed to make no difference whatsoever.

I am also sending you a few analyses on Hp-4. I am a bit concerned about the fact that these excretion rates are a factor of two to three above the theoretical excretion values according to the formulas developed for us by Helen Baldwin and Leonard Kogan of your statistics department.

Dr. Beller has written you regarding the things we would like to have on a physical examination of your subjects. Use your own discretion in regard to getting these examinations.

I was wrong about the date of the meeting at Oak Ridge. It is not in August, but in October.

You may be interested in reporting the effect of citrate on the excretion of plutonium and the deposition of plutonium in the body, as indicated by the data obtained on Hp-11, Hp-9 and Hp-5.

I have a complete record of the method of assay of the Hp solutions. I will write up this phase of the report.

Sincerely yours,

Wright E. Langanham
Wright E. Langanham

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Classification Cancelled

WLL/ars

Or Changed To

By Authority Of *Dir. of Classification*
By *JH Hartsoc/cb* Date *5/11/74*

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8001903

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW	DETERMINATION (CIRCLE NUMBER(S))
	1. CLASSIFICATION RETAINED
SINGLE REVIEW AUTHORIZED BY:	2. CLASSIFICATION CHANGED TO:
	3. CONTAINS "NO" DON CLASSIFIED INFO
DATE: <i>Dec 14/68</i>	4. COORDINATE WITH:
REVIEWER (ADD): <i>[Signature]</i>	5. CLASSIFICATION CANCELLED
NAME: <i>[Signature]</i>	6. CLASSIFIED INFO BRACKETED
DATE: <i>8/14/68</i>	7. OTHER (SPECIFY):

Table 1. (Part 1)
 Material balances of soft tissues and excreta. Six persons injected i.v. with Pu(IV) citrate, Pu(VI) nitrate, or Pu(VI) citrate

	HP-5, 151 days p. i. Male, 56 yr. 70.8 kg ^a			Pu(IV) Citrate HP-9; 456 days p. i. Male, 66 yr. 63 kg			HP-11; 5 days p. i. Male, 68 yr. 70.8 kg ^a		
	% Pu/g	wt (g)	Calc. (% dose)	% Pu/g	wt (g)	Calc. (% dose)	% Pu/g	wt (g)	Calc. (% dose)
Liver	0.032	1,340 ^b	42.8	0.0144	1,600 ^b	23.0	0.0053	2325	12.3
Spleen	0.0007	184	0.13	0.0015	162	0.24	0.0048	184	0.89
Kidney	0.0002	312	0.062	0.0002	277	0.055	0.0015	312	0.47
Lung	0.0005	1,000	0.50				0.0016	1,000	1.60
Pancreas	0.0002	100	0.02	0.0002	90	0.018			
Intestines	0.00015	1,070	0.15				0.00045	1,020	0.46
Testes	0.0003	64	0.018				0.0012	64	0.077
Thyroid	0.0001	16	0.0016				0.0009	16	0.014
Adrenals	0.0004	14	0.0056				0.0022	14	0.031
Muscle	0.0002 ^c	28,400	6.67	0.0002 ^c	25,200	5.92	0.0002	28,400	5.68
Residual soft tissue	0.0001 ^d	4,950		0.0001 ^d	4,410		0.0002	4,950	0.99
Excreted ^e		23,080	2.31		22,280	2.23		22,200	2.22
Total (accounted for)			5.20			16.5			2.00
			57.9			48.0			34.7
Skeleton (calc.)		10,300	42.1		9,166	52.0		10,300	65.3

WR 2-20850 8001904

Footnotes to Table I

- ^a Body weight estimated to be the mean weight of six male cases whose body weights were recorded.
- ^b Measured tissue weight.
- ^c Pu concentrations in muscle and skin (when not measured) were estimated to be the average of other measured soft tissues such as heart, pancreas, etc.
- ^d Pu concentration of residual soft tissue was estimated to be one-half the concentration in skin and muscle.
- ^e Measured totals are used when available. Excretion between the cessation of collections and deaths of HP-5 and HP-9 was estimated from extrapolation of the last available measurements and the slopes of the U and F curves of persons followed for longer times. Excreta from HP-11 were estimated to be the mean for all the other Pu(IV) citrate-injected cases.
- ^f Includes 7.95%, the average Pu content of blood of the two sickest persons (HP-4 and HP-10), from whom blood samples were obtained at this time.
- ^g $\mu\text{Ci/g}$ of Pu recalculated from original data.
- ^h Includes 3.25% estimated from the tissues of Chi-2, and HP-11.
- ⁱ Chi-2 was emaciated; her skeleton was assumed to be the average reported by Mechanik ⁶⁶ for slightly built females. Cal-1 had lost 15 lb during his illness; his skeletal weight was calculated from his body weight in good health, 64.8 kg.

8001905

TABLE 2

**CLINICAL DATA ON SUBJECTS RECEIVING INTRAVENOUS INJECTION OF
APPROXIMATELY 5 µg OF PLUTONIUM AS Pu⁺⁴ CITRATE**

PATIENT CODE	SEX	AGE	WT. Kg.	Pu ADMIN		LABORATORY STUDIES*											
				AMT. µg	DATE	DATE	HGB g %	RBC x 10 ⁻⁶	WBC x 10 ⁻³	PMN %	LYMPHS %	EOS. %	BASO. %	MONO. %	UREA Cl. %	BUN	NPN
Hp- 1	M	67	70.3	4.6 2.82	10/16	10/4 10/19	13.9 13.7	4.47 4.55	7.1 7.0	71 54	19 34	1 4	0 1	9 7	96 90	21 23	- -
Hp- 2	M	49	69.0	5.1 3.13	10/23	10/6 11/7	15.0 14.5	4.7 4.1	9.05 7.85	57 68	28 22	8 8	0 0	2 2	58 48	25 23	- -
Hp-3	F	49	69.9	4.9 2.21	11/27	11/2 12/16	14.5 -	4.3 5.6	5.7 6.8	59 69	39 25	2 0	0 1	0 5	70 -	- -	34 31
Hp- 4	F	18	55.5	4.9 3.01	11/27	10/30 3/21	15.0 16.0	5.3 -	10.0 6.9	77 74	20 22	0 0	1 0	2 4	- -	- -	- -
Hp- 7	F	59	68.0	6.3 2.27	2/8	1/23 2/20	12.6 -	3.26 -	4.75 5.25	64 64	24 25	3 0	0 0	6 9	94 -	- -	26 -
Hp- 8	F	41	54.4	6.5 3.17	3/8	2/22 8/21	13.9 14.5	4.7 4.05	9.5 11.9	71 88	22 12	0 0	0 0	13 0	85 -	10 -	30 -
Hp- 9	M	66	63.0	6.3 2.82	4/3	3/13 1/25	12.3 12.3	3.9 4.1	6.25 7.3	70 61	17 9	0 12	0 1	13 17	72 -	- -	- -
Hp-10	M	52	71.0	6.1 2.82	7/16	7/9 8/13	13.3 -	5.5 -	5.65 -	31 42	52 45	5 3	2 2	7 8	87 82	11 -	22 -
Hp-12	M	53	-	4.7 2.82	4/9	4/4 7/3	8.9 13.5	2.85 4.51	5.6 4.3	74 32	18 64	- -	- -	6 4	- -	30 12	44 37

Explanation of Symbols: HGB = Hemoglobin; RBC = Red Blood Cell Count; WBC = White Blood Cell Count; PMN = Polymorphonuclear Cells; LYMPHS = Lymphocytes; EOS. = Eosinophiles; BASO. = Basophiles; MONO. = Monocytes; BUN = Blood Urea Nitrogen; NPN = Non-Protein Nitrogen; UREA Cl. = Urea Excretion in Per Cent of Normal at One Hour.

subjects before plutonium injection and at frequent intervals thereafter. All tissue samples were analyzed for plutonium by the cupferron extraction procedure subsequent to ashing.

The data in Table 3 show the results of analyses of the various samples for plutonium. The results obtained by Russell and Nickson (13) (referred to as Chi. I, II, III) and Hamilton et al (14) (referred to as Cal. I) are presented also. Two important points must be kept in mind when considering these data: (1) The samples of human tissues were, for obvious reasons, rather unsatisfactory. In most cases they were too small, poorly representative and were usually what could be obtained under the circumstances rather than what were desired; (2) The subjects were chronically ill and/or elderly and the results may not represent exactly the distribution of plutonium in tissues of healthy persons of average working age. These data, however, are all that are available and, therefore, must provide the basis for our present concept of the distribution of plutonium in the organs and tissues of man. They must also provide a basis for comparison with the results obtained from the numerous studies of plutonium deposition in experimental animals.

1. Deposition in the Skeleton

Animal experiments (1), (2) reveal that approximately 60 per cent of plutonium injected as PuO₂++ and Pu⁺⁴ - citrate is localized in bone. If the vertebra, sternum and whole rib are taken as representative bones of the skeleton, and the average plutonium content (.00657%/g),

LA-1151
8001906

STATUS VERIFIED UNCLASSIFIED

Dennis W. Murphy 6/13/96
Dennis W. Murphy, ARS-8 DATE

14 bone specimens
 Radius head
 patella
 rib with
 rib cortex
 vertebrae
 sternum

Av_g = .00906 X 7000 = 63.4

~~CONFIDENTIAL~~

TABLE 3

DISTRIBUTION OF PLUTONIUM IN HUMAN TISSUES FOLLOWING
 INTRAVENOUS INJECTION OF PLUTONIUM SALTS

Tissue ⁽²⁾	Subjects ⁽¹⁾ and % of Injected Dose/g of Tissue								Rel. Pu Affinity ⁽³⁾	Org. Wt./g ⁽⁴⁾	Calc. %/Organ
	51	56	111	Chi. I	Chi. II	12	58	48			
Bone Marrow	--	.0096	.0153	.0210	--	.0290	.0187	13.3	3,000	(56.1) ⁽⁶⁾	
Radius (Frag. head)	--	--	--	--	--	.0187	--	--	--	--	
Liver	.0320	.0144	.0053	.0139	.0024	--	--	.0136	1,700	23.1	
Rib (Cortex)	--	--	--	.0015	.0196	--	.0170	.0127	--	--	
Patella	--	--	--	--	--	.0109	--	--	--	--	
Vertebra	.0071	.0080	.0070	--	--	--	--	.0073	--	--	
Sternum	.0070	--	.0100	.0044	--	--	--	.0071	10,000	65.7 ⁽⁵⁾	
Rib (Whole)	.0050	.0038	.0068	--	--	--	--	.0052	--	--	
Periosteum (Rib)	--	--	--	.0043	.0019	--	.0048	.0037	--	--	
Spleen	.0007	.0015	.0048	.0024	.0014	--	.0019	.0021	200	0.4	
Kidney	.0002	.0002	.0015	.0004	.0054	--	--	.0015	300	0.4	
Thyroid	.0001	--	.0009	--	.0034	--	--	.0014	30	--	
Adrenal	.0004	--	.0022	--	--	--	--	.0013	14	--	
Lung	.0005	--	.0016	.0006	.0016	--	--	.0011	950	1.0	
Pancreas	.0002	.0002	--	--	.0022	--	--	.0009	65	--	
Gonads	.0003	--	.0012	.0005	.0009	--	--	.0007	--	--	
Lymph Node	--	--	--	.0014	.0001	--	--	.0007	700	0.5	
Teeth (Av. of 7)	--	--	--	--	--	.0003	--	--	--	--	
Heart	.0000	.0000	--	.0003	.0011	--	--	.0003	350	0.1	
Large Intestine	.0002	--	.0004	--	.0001	--	--	.0002	2,300	0.5	
Small Intestine	.0001	--	.0005	--	.0001	--	--	.0002	--	--	
Muscle and Skin	.0000	--	.0002	.0002	.0001	--	--	.0001	38,500	3.9	
Blood	--	--	--	--	--	--	--	--	5,400	0.2 ⁽⁸⁾	
Balance	--	--	--	--	--	--	--	.0001 ⁽⁷⁾	9,600	0.9	
Total	--	--	--	--	--	--	--	--	70,000	96.7	

- The various subjects received the following doses of plutonium: Hp-5 = 5 µg; Hp-9 = 6.3 µg; Hp-11 = 6.5 µg; Chi. I = 6.5 µg; Chi. II = 94.9 µg; Hp-12 = 4.7 µg; Cal. I = 103 µg.
- Tissues were obtained at the following times after injection: Hp-5 151 days; Hp-9 456 days; Hp-11 5 days; Chi. I 155 days; Chi. II 16 days; Hp-12 5 days; Cal. I 4 days.
- Calculated by dividing %/g of tissue by %/g of body weight if a unit dose of Pu was equally distr. in a 70 Kg. man.
- Hermann Lisco, Memorandum to AEC, July 21, 1947, Project Standard Man.
- Assumption made that vertebra, sternum and whole rib represent average bone of skeletal system.
- Bone marrow not included in total recovery because bone samples were not freed of marrow before analysis.
- Balance assumed to have same Pu content as muscle.
- Value for blood taken at 30 day point, Fig. 3.

STATUS VERIFIED UNCLASSIFIED

Dennis W. Murphy 6/13/96
 DATE

LA-1151
 8001907

TABLE 5

PLUTONIUM CONTENT OF BLOOD SAMPLES* FOLLOWING INTRAVENOUS INJECTION OF APPROXIMATELY 5 µg OF PLUTONIUM AS Pu⁺⁴ - CITRATE

DAYS AFTER INJECTION	PATIENT CODE AND PERCENT OF INJECTED DOSE IN TOTAL BLOOD VOLUME*											AVERAGE
	Hp-1	Hp-2	Hp-3	Hp-4	Hp-5	Hp-6	Hp-7	Hp-8	Hp-9	Hp-10	Hp-12	
1/6	46.02	-	28.32	83.31	31.51	36.70	32.57	37.64	40.83	51.57	5.34	35.7
1	21.83	19.35	-	-	6.23	10.97	16.40	14.51	12.39	24.66	5.34	15.7
2	-	8.38	11.56	-	-	-	-	-	-	-	-	9.97
3	-	10.03	-	16.64	1.16	2.94	6.97	4.94	6.22	20.06	-	8.62
4	-	-	4.22	-	-	-	-	-	-	-	-	4.9
5	-	-	-	-	0.66	-	-	-	-	-	-	-
6	3.30	4.25	2.17	6.14	-	1.00	2.96	2.07	3.91	4.91	-	3.4
8	-	2.32	1.42	-	-	-	-	-	-	-	-	1.9
9	-	-	-	4.60	-	-	-	-	-	-	-	-
10	1.42	-	-	-	0.39	0.38	1.13	1.37	2.21	1.72	-	1.2
13	-	-	0.61	2.34	-	-	-	-	-	-	-	1.5
15	-	-	-	-	0.11	0.26	0.66	0.71	1.42	1.02	-	.70
17	-	-	0.51	1.45	-	-	-	-	-	-	-	1.0
22	-	0.70	-	-	0.18	0.25	-	-	-	-	-	.38
23	-	-	0.25	0.72	-	-	-	-	-	-	-	.48
29	-	-	-	-	-	-	0.37	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	0.36	-	-
31	-	-	-	-	-	-	-	-	-	-	0.51	-
36	-	-	-	-	-	-	-	-	0.42	-	-	-
42	-	-	-	-	-	-	-	0.17	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	0.45	-

* Total Weight of Blood Taken as 7.71% of Total Body Weight.

C. Excretion of Plutonium

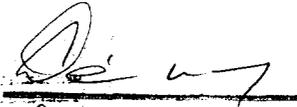
1. Urinary Excretion

The urinary excretion of plutonium was studied in eleven of the subjects following the intravenous injection of approximately 5 µg of plutonium as Pu⁺⁴ in 0.4 per cent solution of sodium citrate · 2H₂O. With the exception of the first day, urine from all subjects was collected in 24 hour samples through 22 days post injection. After 22 days the collection of 24 hour urine samples was continued as long as the patients were available for study. It was not possible to retain the subjects as long as was desired and the major weakness in these results is the short time interval over which the studies were continued. Two subjects were followed 22 days, one for 23 days, one for 27, and the remainder for 30 days or longer after injection. The Chicago cases (13) were followed for 16, 140, and 186 days and the California case (14) was followed for a period of 341 days. Because of the great importance of measurements at longer time intervals, the Chicago and California data have been incorporated with

LA-1151

8001908

STATUS VERIFIED UNCLASSIFIED


6/13/96

Deans W. Murphy AOC-BW DATE

STATUS VERIFIED UNCLASSIFIED

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Dennis W Murphy

6/13/96

Dennis W Murphy AOC-^{AD} DATE

TABLE 6

INDIVIDUAL URINARY EXCRETION VALUES OF PLUTONIUM FOLLOWING INTRAVENOUS ADMINISTRATION TO HUMAN SUBJECTS (EXPRESSED AS PER CENT OF DOSE EXCRETED PER DAY)

DAYS POST INJECTION	PER CENT OF INJECTED DOSE EXCRETED PER DAY													Chl-1(1)	Chl-2(2)	Chl-3(2)	Cal-1(3)
	Hp-1	Hp-2	Hp-3	Hp-4	Hp-5	Hp-6	Hp-7	Hp-8	Hp-9	Hp-10	Hp-11	Hp-12					
1	.181	.472	.569	.440	.296	-	.217	.377	.160	.414	.101	.857	2.531*	.152	.480		
2	.146	.294	.289	.236	.166	.216	.212	.232	.085	.330	.103	.182	.153	.167	.150		
3	.114	.174	.112	.221	.077	.127	.137	.123	.069	.218	.088	.063	.184	.067	.120		
4	.094	.123	.107	.132	.052	.111	.098	.140	.068	.170	.078	.077	.133	.033	.031		
5	.069	.116	.078	.116	.030	.076	.069	.083	.047	.089	.068	.026	.032	.042	.037		
6	.066	.061	.043	.119*	.020	.057	.059	.078	.052	.060	.044	.0256	.029	.042	-		
7	.082	.062	.043	.077	.033	.044	.045	.066	.050	.079	.069	.0234	.024	.024	-		
8	.055	.048	.049	.001	.026	.043	.037	.057	.032	.065	.080	.0227	.023	.025	.016		
9	.051	.046	.022	.095*	.027	.032	.033	.047	.032	.051	.043	-	.027	.019	.069		
10	.045	.038	.027	.081*	.022	.031	.023	.050	.035	.044	.058	.0082*	.034	.030	.026		
11	.040	.048	.027	.075*	.021	-	.018	.044	.026	.041	.038	.0097	.047	.019	.036		
12	.038	.039	.015	.072*	.028	.024	.019	.023	.030	.038	.027	.0095	.047	.014	.029		
13	.034	.045	.020	.067*	.023	.023	.019	.037	.027	.029	.030	.0236	.018	.034	-		
14	.035	.036	.020	.058*	.018	.020	.013	.035	.030	.029	.039	.007	.034	.009	-		
15	.034	.039	.028	.050	.015	.022	.012	.035	.030	.025	.029	.0059	.026	.016	.013		
16	.026	.024	.024	.033	.020	.017	.012	.036	.049*	.021	.023	.0109	.012	.004	.016		
17	.027	.027	.021	.032	.020	.013	.011	.032	.038	.023	.029	-	.028	-	.0056		
18	.026	.020	.017	.037	.020	.015	.011	.029	.027	.021	.026	-	.026	-	.010		
19	.025	.019	.018	.032	.018	.015	.010	.031	.029	.017	.029	.0022	.015	-	.006		
20	.017	.021	.012	.025	.021	.013	.008	.032	.029	.018	.032	.0093	.033	-	.0048		
21	.017	.017	.019	.029	.020	.012	.010	.029	.032	.022	.025	.0676	.032	-	.0017		
22	.016	.015	.014	.035	.018	.012	.013	.021	.032	.016	.025	.0145	.027	-	.0050		
23	.025	.018	.014	.014	-	-	.008	.021	.032	.019	.039	.0151	.029	-	.0091		
24	.021	.014	-	-	-	-	.008	.025	.032	.016	.023	.0128	.020	-	.0076		
25	.013	.014	-	.011	-	-	.008	.023	.029	.016	.021	.0128	.143*	-	.011		
26	-	.017	-	.011	-	-	.007	.022	.032	.016	.023	.0175	.024	-	.0022		
27	-	.008	-	.008	-	-	.008	.028	.032	.014	.017	.0151	.043*	-	.0044		
28	-	.009	-	-	-	-	.008	.023	.024	.013	.024	.0197	.034	-	.0074		
29	-	.009	-	-	-	-	.008	.019	.025	.014	.023	.0139	.022	-	.0043		
30	-	.008	-	-	-	-	.006	.021	.023	.014	.021	.0151	.024	-	.0069		
31	-	.007	-	-	-	-	.005	.017	.025	-	.021	.010	.027	-	.0077		
32	-	.007	-	-	-	-	.007	.016	.024	-	.012	.010	.020	-	.0063		
33	-	.009	-	-	-	-	.006	.015	.022	-	.037*	.017	.011	-	.0073		
34	-	.009	-	-	-	-	.006	.015	.020	-	.020	.0139	.008	-	.0084		
35	-	-	-	-	-	-	.006	-	.022	-	.026	.0127	.009	-	.0069		
36	-	-	-	-	-	-	.006	.015	.022	-	.018	.0165	.015	-	.0079		
37	-	-	-	-	-	-	.006	.011	-	-	.023*	.0111	.011	-	.0063		
38	-	-	-	-	-	-	-	.016	-	-	.018	.0174	.009	-	.0085		
39	-	-	-	-	-	-	-	.012	-	-	.021	.0112	.009	-	.0064		
40	-	-	-	-	-	-	-	.017	-	-	.019	.0072	.009	-	.0072		
41	-	-	-	-	-	-	-	.019	-	-	.013	.0092	.011	-	.0080		
42	-	-	-	-	-	-	-	.014	-	-	.013	.0127	-	-	.0081		
43	-	-	-	-	-	-	-	.016	-	-	.015	.0095	.017	-	.0076		
44	-	-	-	-	-	-	-	.014	-	-	.015	.0031	-	-	.0055		
45	-	-	-	-	-	-	-	.013	-	-	.017	.013	.018	-	.0063		
46	-	-	-	-	-	-	-	.015	-	-	-	.012	-	-	.0073		
47	-	-	-	-	-	-	-	.014	-	-	.015	-	.020	-	.0059		
48	-	-	-	-	-	-	-	.014	-	-	.017	.0064	-	-	.0059		
49	-	-	-	-	-	-	-	.018	-	-	.015	.0063	-	-	.0063		
50	-	-	-	-	-	-	-	.014	-	-	-	.0054	.018	-	.0078		
51	-	-	-	-	-	-	-	.013	-	-	-	.007	-	-	.0082		
52	-	-	-	-	-	-	-	-	-	-	.035	.0073	-	-	.0093		
53	-	-	-	-	-	-	-	.013	-	-	.019	.0623	-	-	.0074		
54	-	-	-	-	-	-	-	.015	-	-	.043*	-	-	-	.0077		
55	-	-	-	-	-	-	-	.015	-	-	.043*	.0073	.014	-	.0096		
56	-	-	-	-	-	-	-	.013	-	-	.036	.003	-	-	.0084		
57	-	-	-	-	-	-	-	.012	-	-	.018	.0075	-	-	.0050		
58	-	-	-	-	-	-	-	.013	-	-	.036	.0094	-	-	.0058		
59	-	-	-	-	-	-	-	.012	-	-	-	.011	-	-	.0058		
60	-	-	-	-	-	-	-	.011	-	-	-	.0063	.022	-	.0067		
61	-	-	-	-	-	-	-	.012	-	-	-	.0038	-	-	.0066		
62	-	-	-	-	-	-	-	.010	-	-	-	.0392	-	-	.0056		
63	-	-	-	-	-	-	-	.009	-	-	-	.0034	-	-	.0077		
64	-	-	-	-	-	-	-	.012	-	-	-	.0071	-	-	.0042		
65	-	-	-	-	-	-	-	.011	-	-	-	.0059	.024	-	.0042		
66	-	-	-	-	-	-	-	-	-	-	-	.014	-	-	.0047		
67	-	-	-	-	-	-	-	-	-	-	-	.014	-	-	.0044		
68	-	-	-	-	-	-	-	-	-	-	-	.011	-	-	.0043		
69	-	-	-	-	-	-	-	-	-	-	-	.011	-	-	.0040		
70	-	-	-	-	-	-	-	-	-	-	-	.014	-	-	.0100		
71	-	-	-	-	-	-	-	-	-	-	-	.0058	-	-	.0072		
72	-	-	-	-	-	-	-	-	-	-	-	.0089	.014	-	.0032		
73	-	-	-	-	-	-	-	-	-	-	-	.0033	-	-	.0039		

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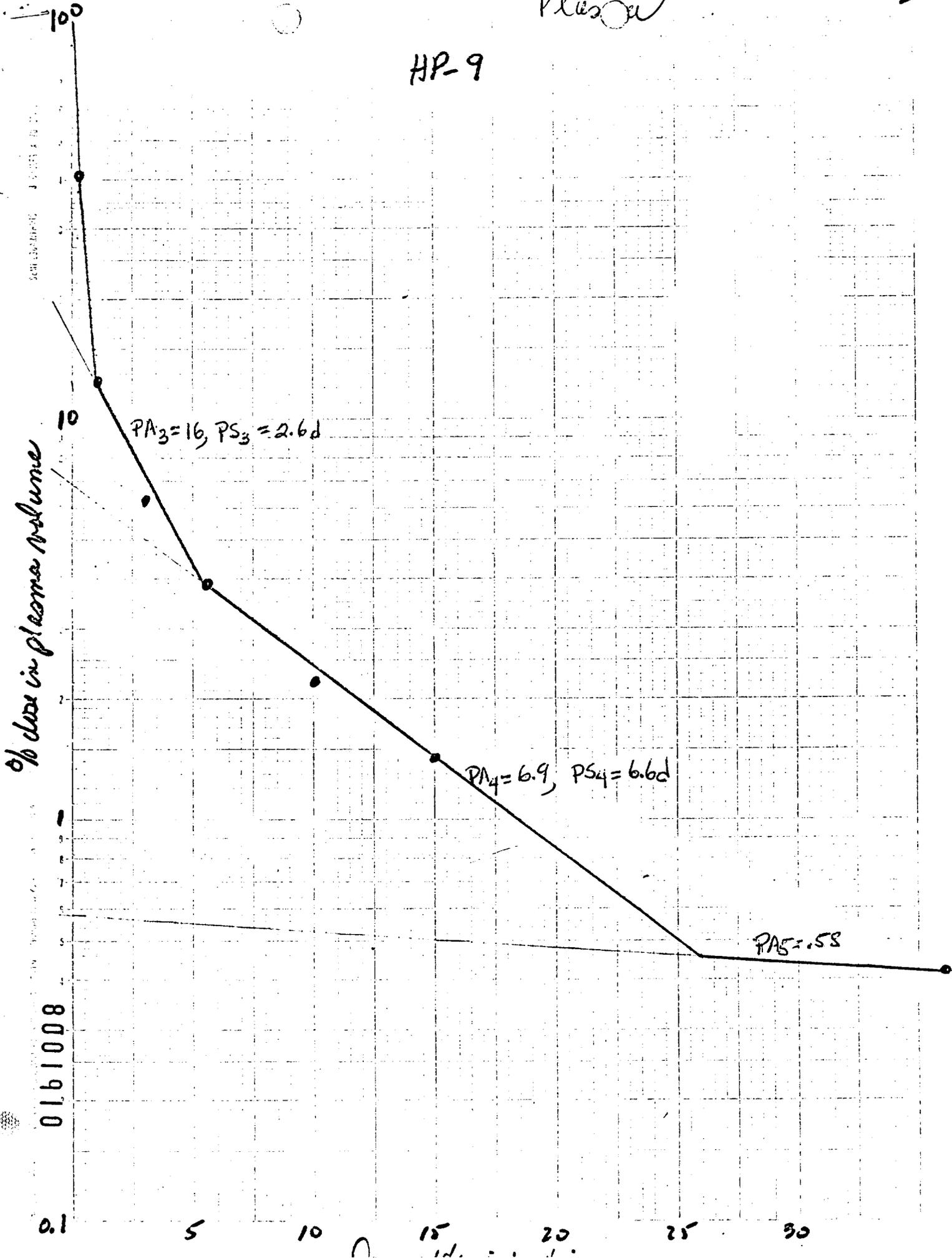
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CH-3007
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HP-9



STATUS VERIFIED UNCLASSIFIED

~~CONFIDENTIAL~~

De W

6/13/96

Dennis W Murphy, ADC-BW

DATE

TABLE 9

INDIVIDUAL FECAL EXCRETION VALUES OF PLUTONIUM FOLLOWING
INTRAVENOUS ADMINISTRATION⁽¹⁾ TO HUMAN SUBJECTS
(EXPRESSED AS PER CENT OF DOSE EXCRETED PER DAY)

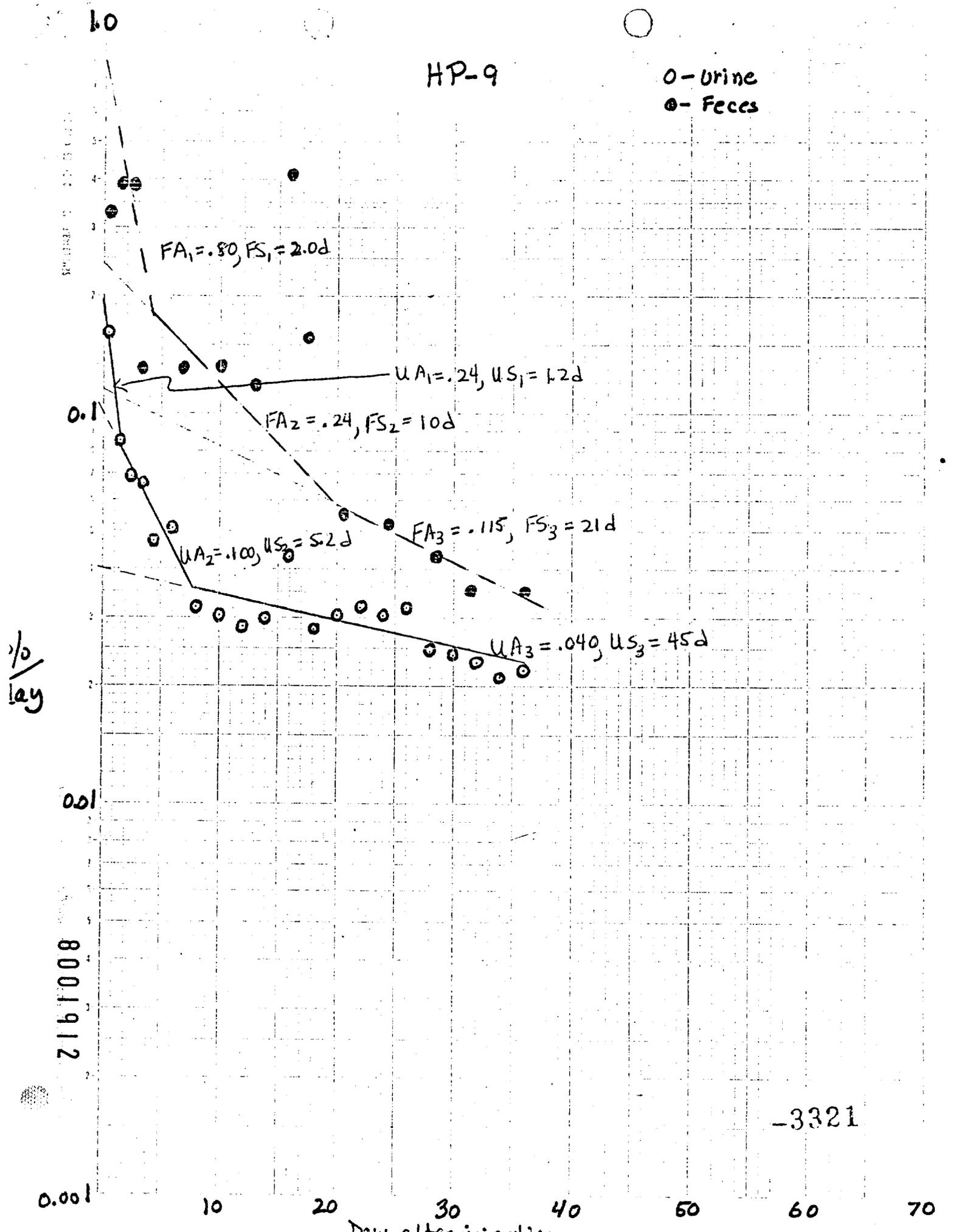
DAYS POST INJECTION	PER CENT OF INJECTED DOSE EXCRETED PER DAY											
	Hp-1	Hp-2	Hp-3	Hp-4	Hp-5	Hp-6	Hp-7	Hp-8	Hp-9	Hp-10	Hp-12	Chl-7 ⁽²⁾
1	.052*	.204	.018*	.134	.004*	.085	.147	.178	.333	.087	.370	.250
2	.221	.204	.157	.274	.311	.085	.120	.266	.589	.037	.370	.465
3	.241	.204	.157	.274	.311	.179	.087	.210	.389	.087	.297	.294
4	.050	.317	.095	.306	.185	.179	.080	.080	.131	.110	.297	.330
5	.105	.317	.099	.306	.110	.179	.055	.080	.131	.110	.183	.223
6	.046	-	.070	.126	.110	.179	.055	.080	.131	.110	.183	.116
7	.021	-	.070	.126	.110	.037	.055	.080	.131	.110	.020	.033
8	.021	.120	.070	.126	.064	.037	.055	.070	.131	.034	.020	.112
9	.021	.120	.070	.126	.051	.037	.032	.070	.131	.034	.020	-
10	.021	.084	.027	.117	.051	.037	.032	.070	.131	.034	.020	.021
11	.046	.084	.027	.117	.052	.023	.032	.070	.118	.034	.020	-
12	.046	.084	.027	.117	.052	.023	.032	.045	.118	.034	.020	.033
13	.046	.084	.027	.117	.032	.023	.023	.045	.118	.034	.020	.045
14	.046	.062	.023	.085	.032	.023	.023	.045	.118*	.022	.020	.044
15	.035	.062	.023	.085	.032	.015	.023	.045	.110*	.022	.023	.042
16	.035	.062	.023	.040	.017	.015	.023	.032	.414*	.022	.023	.034
17	.035	.062	.023	.040	.017	.015	.016	.032	.157*	.022	.023	-
18	.035	.055	.016	.040	.017	.015	.016	.025	.157*	.022	.023	.031
19	.015	.055	.016	.028	.017	.015	.016	.025	.055	.012	.053	.027
20	.015	.055	.016	.028	.020	.015	.016	.025	.055	.012	.053	.019
21	.015	.055	.016	.028	.020	.010	.008	.025	.055	.012	.053	.019
22	.015	.022	.006	.028	.020	.010	.008	.045	.055	.012	.053	.018
23	.017	.022	.006	.026	-	-	.008	.045	.052	.012	.026	.010
24	.017	.022	-	-	-	-	.008	.009	.052*	.012	.026	.023
25	-	.022	-	-	-	-	.011	.009	.052*	.006	.026	.013
26	-	.021	-	-	-	-	.011	.009	.052*	.006	.026	.023
27	-	.021	-	-	-	-	.011	.009	.043*	.006	.016	.0083
28	-	-	-	-	-	-	.011	.009	.043*	.006	.016	.0069
29	-	-	-	-	-	-	-	.009	.043	.006	.016	.0158
30	-	-	-	-	-	-	-	.018	.043	.006	.016	.0033
31	-	-	-	-	-	-	-	.018	.035	-	.016	.0074
32	-	-	-	-	-	-	-	.018	.035	-	.016	.0062
33	-	-	-	-	-	-	-	.018	.035	-	.016	.0079
34	-	-	-	-	-	-	-	.018	.035	-	.016	.0079
35	-	-	-	-	-	-	-	.018	.035	-	.022	.0054
36	-	-	-	-	-	-	-	.018	.035	-	.022	.0054
37	-	-	-	-	-	-	-	.028	-	-	.022	.0050
38	-	-	-	-	-	-	-	.028	-	-	.022	.0042
39	-	-	-	-	-	-	-	.011	-	-	-	.0047
40	-	-	-	-	-	-	-	.011	-	-	-	.0066
41	-	-	-	-	-	-	-	.011	-	-	-	.0064
42	-	-	-	-	-	-	-	.011	-	-	-	.0053
43	-	-	-	-	-	-	-	.011	-	-	.008	.0047
44	-	-	-	-	-	-	-	.011	-	-	.008	.0032
45	-	-	-	-	-	-	-	.014	-	-	.008	.0042
46	-	-	-	-	-	-	-	.014	-	-	.008	.0033
47	-	-	-	-	-	-	-	.014	-	-	-	.0023

LA-1151 8001911

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HP-9

○ - Urine
● - Feces



Urinary Excretion of Plutonium by Hp-9

Injected with 6.38 (432,000 c/m) 7

~~SECRET~~

Date and Period	Hours per Period	c/m per Period	c/m per 24 hours	% Injection Dose Per 24 hrs.
5-2-47 8 A.M. to 5-3-47 8 A.M.	24	12.6	12.6	0.003
5-3-47 8 A.M. to 5-4-47 8 A.M.	24	8.6	8.6	0.002
5-4-47 8 A.M. to 5-5-47 8 A.M.	24	14.4	14.4	0.003
5-5-47 8 A.M. to 5-6-47 8 A.M.	24	13.1	13.1	0.003
5-6-47 8 A.M. to 5-7-47 8 A.M.	24	12.3	12.3	0.003
5-7-47 8 A.M. to 5-8-47 8 A.M.	24	12.4	12.4	0.003
5-8-47 8 A.M. to 5-9-47 8 A.M.	24	26.2	26.2	0.006
5-9-47 8 A.M. to 5-10-47 8 A.M.	24	16.2	16.2	0.004
rate-- 5-16-47 8 A.M. to 5-17-47 8 A.M.	24	7.6	7.6	0.002
" 5-17-47 8 A.M. to 5-18-47 8 A.M.	24	11.0	11.0	0.003
" 5-18-47 8 A.M. to 5-19-47 8 A.M.	24	16.9	16.9	0.004
" 5-19-47 8 A.M. to 5-20-47 8 A.M.	24	7.2	7.2	0.002
" 5-20-47 8 A.M. to 5-21-47 8 A.M.	24	10.8	10.8	0.003

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW	
SINGLE REVIEW AUTHORIZED BY: <u>Doc/HB/10d/1/1/96</u>	
VIEWER (ADD):	<u>[Signature]</u>
NAME:	<u>[Signature]</u>
DATE:	<u>8/16/96</u>
1. CLASSIFICATION (CIRCLE NUMBER(S))	
2. CLASSIFICATION CHANGED TO:	
3. CONTAINS NO DATA CLASSIFIED INFO	
4. COORDINATE WITH:	
5. CLASSIFICATION CANCELLED	
6. CLASSIFIED INFO BRACKETED	
7. OTHER (SPECIFY):	

~~SECRET~~

~~SECRET~~

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Number 5 of 5 copies, Series A

PRIVACY ACT MATERIAL REMOVED

40-015

July 9, 1947

Dr. Wright Langham
P. O. Box 1663
Santa Fe, New Mexico

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW	
SINGLE REVIEW AUTHORIZED BY: <i>DoE/HQ/60/1007/1/14</i>	DETERMINATION (CIRCLE NUMBER(S))
REVIEWER (ADD):	1. CLASSIFICATION RETAINED
NAME: <i>DoE</i>	2. CLASSIFICATION CHANGED TO:
DATE: <i>8/16/96</i>	3. CONTAINS NO DOE CLASSIFIED INFO
	4. COORDINATE WITH:
	5. CLASSIFICATION CANCELLED
	6. UNCLASSIFIED - INEL. BRACKETED
	7. OTHER (SPECIFY):

Dear Wright:

I am sending you a box containing tissues obtained from HP-9 on July 2, 1947. This was a difficult post mortem to obtain and we were unable to take very large specimens.

Organ Weights

Heart	420 gm	
Liver	1600 gm	
Spleen	100 gm	
Pancreas	110 gm	
Left Lung	500 gm) Pneumonic consolidation in each
Right Lung	950 gm	
Right Kidney	150 gm	
Left Kidney	159 gm	

Sample Weights

1. Heart - Left Ventricle	23.1 gm
2. Liver - Right Lobe	60.7 gm
3. Spleen	57.7 gm
4. Pancreas	25.1 gm
5. Lung - Right	44.2 gm
6. Kidney (which unknown)	60.4 gm
7. Blood (from heart)	90.0 gm
8. Pectoral Muscles	21.8 gm
9. Vertebral Body (Lumbar)	21.8 gm
10. Rib - (Right 4th Anterior)	9.3 gm

RECEIVED CHR
JUN 27 1977
RECORDS ROOM

The subject died as a result of dematomyositis. Most of the organs appeared to be in good condition except lungs where there was a terminal pneumonia probably due to aspiration.

All of the skeletal muscles were very pale and flabby in appearance and evidently lacked myoglobin. The anatomical diagnosis will, I believe, confirm the clinical impression.

This is probably our most interesting case from the standpoint of elapsed time and I sincerely hope you will have enough material to work with.

8001914

PRIVACY ACT MATERIAL REMOVED

Classification Cancelled

Or Changed To

~~SECRET~~

By Authority Of *Dir. of Classification*

~~SECRET~~

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Number 5 of 5 copies. Serial A

PRIVACY ACT MATERIAL REMOVED

May 27, 1947

Dr. Wright Langham
P. O. Box 1663
Santa Fe, New Mexico

Dear Wright:

You will receive another shipment of specimens from Hp9 within a few days. These include five (5) 24 hour urine specimens and two bottles containing the feces collected between carcinoma markers given at 8:00 A.M., 5/16/47 and 8:00 A.M., 5/21/47. These specimens have been collected during the intravenous administration of sodium citrate solution. The citrate was given intravenously in a concentration of 1.5% dissolved in physiological saline. The dates of injection, interval over which injected and total amount are given in the following tabulation:

<u>Date</u>	<u>Time taken for injection</u>	<u>Amount gms.</u>
5/16/47	120 min.	10.0
5/17/47	145	15.0
5/18/47	160	15.0
5/19/47	180	15.0
5/20/47	160	15.0

We were rather cautious about the amount given since some data in the medical literature suggested that large amounts of sodium citrate are toxic. In paper by Bruneau and Graham, Arch. Surg., 1945, 47, 319, it is stated that 15 gm. of sodium citrate may be toxic if given rapidly. We did not notice any adverse effect giving it slowly as indicated. I presume considerably larger amounts would be tolerated but perhaps not by Hp9 who is a difficult subject in many respects.

Sincerely yours,

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW	
SINGLE REVIEW AUTHORIZED BY: DOE/MR/OD Aget 1/1/96	DETERMINATION (CIRCLE NUMBER(S)) 1. CLASSIFICATION RETAINED 2. CLASSIFICATION CHANGED TO: 3. CONTAINS NO DOE CLASSIFIED INFO 4. COORDINATE WITH: 5. CLASSIFICATION CANCELLED 6. CLASSIFIED INFO BRACKETED 7. OTHER (SPECIFY):
REVIEWER (ADD): NAME: <i>AK</i>	
DATE: 8/16/96	

Samuel H. Bassett

SMB:phb

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Classification Cancelled

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By Authority Of *Dir of Classification*

By *U. H. ...* Date *5/16/96*

STATUS VERIFIED UNCLASSIFIED
 6/13/96
 DATE
 Dennis W. Murray
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This is a Joint Report from the Los Alamos Scientific Laboratory of the University of California and the Atomic Energy Project of the University of Rochester School of Medicine and Dentistry.

The Report covers a Cooperative Research Project initiated under the supervision of the Manhattan Engineer District and completed under Contract No. W-7401-Eng-49 and Contract No. 7405-Eng-36 for the Atomic Energy Commission.

September 20, 1950

LA - 1151

ACKNOWLEDGEMENT

The authors wish to acknowledge the invaluable aid and interest of a number of persons who directly or indirectly contributed to the execution of these studies and the completion of this report.

Dr. Stafford L. Warren was primarily responsible for the initiation of the program under the Manhattan Engineer District.

Drs. W. S. McCann, A. H. Dowdy, W. F. Dale, Harold Hodge and L. H. Hempelmann participated in the early planning of the work and frequently made general and specific decisions which contributed much to the success of the program.

Dr. Hymer Friedell and Dr. Fred Bryan were of great assistance as representatives of the office of the Medical Director of the Manhattan District.

Drs. J. G. Hamilton, Jack Schubert, E. H. Russell, Austin Brues and H. M. Parker contributed some of the information used in this report and in some cases reviewed parts or all of the manuscript.

Drs. L. H. Hempelmann, T. N. White, Frederick Reines, E. C. Anderson, J. T. Brennan and G. W. Taylor reviewed the report and contributed many constructive criticisms.

DISTRIBUTION AND EXCRETION OF PLUTONIUM ADMINISTERED INTRAVENOUSLY TO MAN

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by authority of *R.C.L.*

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HEALTH AND BIOLOGY

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Fig. 1 Nuclear Track Autoradiograph Showing Localization of Polonium in the Bone of the Rat. (A. Williams, J. Wellnitz; Photomicrography by Lee Alston Photographic Laboratory).



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DISTRIBUTION AND EXCRETION OF PLUTONIUM
ADMINISTERED INTRAVENOUSLY TO MAN

1. INTRODUCTION

It is now a well established fact that the deposition of radioactive material (Ra, its isotopes and daughter products) in the skeletal system of radium dial painters was responsible for the bone necrosis, radiation osteitis, osteogenic sarcoma and other pathological changes in bone which characterize the condition commonly known as chronic radium poisoning.

Harrison and co-workers (1) were the first to demonstrate that plutonium, like radium, concentrates in the skeletal system of the rat. Numerous reports have emphasized that bone is a major site of plutonium deposition regardless of the animal species, the valence state of the material or the route of administration (2), (3), (4), (5), (6), (7). Autoradiographic studies of the mode of deposition of plutonium in bone (4), (5), (6), (7) showed that it was deposited in a pattern quite different from that of radium. The latter element tends to be incorporated into the bone salts exclusively and becomes buried in the crystalline structure in the manner to be expected from a member of the calcium family in the periodic table. Plutonium, however, shows some deposition in soft tissues (especially in the liver) and a remarkable affinity for the non-calcified, non-cartilaginous areas of bone. The material is highly localized in the epiphyseal line, the periosteum and the endosteum so that localization is predominantly in the regions of trabecular bone (See Fig. 1, frontpiece). The general conclusion was that the mode of deposition of plutonium made it potentially more hazardous than radium. Although there is only limited proof that the above conclusion is justified, it must be considered when evaluating the potential chronic toxicity of the material.

Subsequent experiments with rodents by Brues, Lisero and Finkel (8) and others (9) have demonstrated that plutonium is quite effective in producing pathological changes in bone including osteogenic sarcoma (See Fig. 2).

Brues (10) compared the relative chronic toxicity of equivalent microcurie amounts of plutonium and radium by following 1000 rats, 600 mice throughout life and 37 rabbits for over 400 days. A comparison of survival time, radiographically determined bone damage, pathological fractures and bone tumors in these animals appeared to bear out a plutonium-radium chronic toxicity ratio of 12-15/1 on the basis of injected dose or about 4.5/1 on the basis of retained material.

The above observations and the experiences of the radium dial industry have emphasized the necessity of employing extremely rigid control over all plutonium operations. The major health problem associated with plutonium poisoning is, of course, the possibility that small amounts of plutonium accumulated in the skeletal systems of workers may, over a period of from ten to thirty years, cause bone changes similar to those observed in chronic radium poisoning. The possibility is serious enough to justify the adoption of a rigid maximum permissible body burden as is currently done with radium.

Only recently the subcommittee on internal radiation standards of the National Bureau of Standards established a tentative maximum permissible body content of 2.5 μ c (0.092 μ c) for plutonium. This value was adopted immediately by the Division of Biology and Medicine of the Atomic Energy Commission as the official maximum permissible tolerance for plant personnel (11).

Adequate information as to the fixation and excretion of plutonium by man is essential to the evaluation and interpretation of the maximum permissible body tolerance. More specifically such studies seem highly important for the following purposes:

1. To minimize the degree of uncertainty inherent in extrapolating the total amount of annual experimental data to man.

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2. To provide the best possible quantitative basis for the diagnosis of degree of exposure of personnel to plutonium.
3. To determine the degree of fixation of plutonium by man and establish criteria for the period of retirement from further exposure of workers having received a maximum permissible dose.
4. To provide more extensive and quantitative data on the deposition and excretion of plutonium by man as a basis for future consideration of maximum permissible body tolerance.

Need for the above information was recognized several years ago. It was also recognized that such information could be obtained only by administering small tracer amounts of plutonium to persons with a relatively short life expectancy. The first tracer study was initiated April 10, 1945 (12). Shortly thereafter, both the Chicago and Berkeley Groups initiated similar studies (13), (14).

This report is the final presentation of the results of twelve plutonium tracer cases studied as a joint project of the Los Alamos Scientific Laboratory of the University of California and the Atomic Energy Project of the University of Rochester School of Medicine and Dentistry.

The results of the studies conducted by the Berkeley and Chicago groups are correlated with the present ones providing a collection of data from sixteen cases.

In addition to the twelve tracer cases mentioned above, the Los Alamos Scientific Laboratory has had approximately six years' experience with exposure problems associated with the processing of large amounts of plutonium.

Wherever applicable, the Laboratory's experiences with the exposure of personnel are used to enlarge and supplement the data collected from the plutonium tracer studies presented in this report.

II. METHODS

A. Selection and Description of Subjects

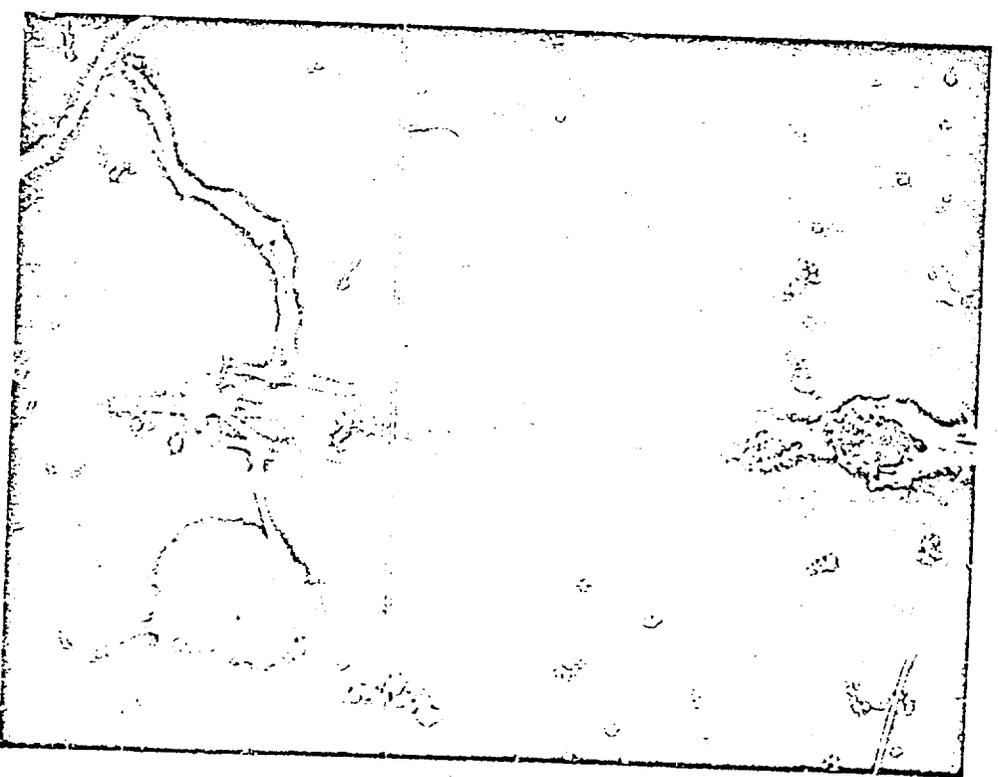
The life expectancy of the individual was carefully considered as a basis of selection of subjects for study. As a rule, the subjects chosen were past forty-five years of age and suffering from chronic disorders such that survival for ten years was highly improbable. By adhering to these criteria, the possibility of late radiation effects developing would be avoided. Furthermore, an opportunity to obtain post-mortem material within a few months, or at most a few years, would be much greater.

Of twelve patients chosen, ten were past the age of forty-five. One was only eighteen years old, and has since died of Cushing's Syndrome. Up to the time of this report, and approximately five years since the initiation of the first study, five subjects are known to have died of their diagnosed illness. Autopsies and tissue samples were obtained from only three of the five terminated cases.

Brief summaries of the medical histories of the subjects of these studies are as follows:

Hp-1

This patient, a sixty-seven year old white male with a nine year history of peptic ulcer, was admitted to the hospital following a severe gastrointestinal hemorrhage. The presence of a duodenal ulcer was confirmed by x-ray examination and a trace of diverticulum of the esophagus was noted. Clinical diagnoses included duodenal ulcer, gastrointestinal hemorrhage with secondary anemia, and esophageal diverticulum.



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Hp-2

This patient, a forty-nine year old white male, was a known hemophiliac and entered the hospital on this occasion for the thirty-eighth time. Symptoms referable to hypofibrinogenemia had been present for three years. Clinical diagnoses on this admission included hemophilia, chronic hypertension with hypertensive cardiovascular disease and coronary insufficiency, and phlebitis of pigmentation of the skin, purpura dermatitis and dependent edema. Final clinical diagnosis of unknown etiology and hypofibrinogenemia were made. She was admitted for follow-up examination in October 1948, when she appeared in good health.

Hp-3

This patient, a forty-nine year old white female, was admitted to the hospital with complaints of pigmentation of the skin, purpura dermatitis and dependent edema. Final clinical diagnosis of unknown etiology and hypofibrinogenemia were made. She was admitted for follow-up examination in October 1948, when she appeared in good health.

Hp-4

This patient, an eighteen year old white female, had a history of Cushing's syndrome since 1941. Her admission in October 1943 was the fifth period of hospitalization. Diagnoses on this occasion were referable to hypertension and osteoporosis. Chief complaints were basophilic adenoma of the pituitary gland with hypernatremia, hypotension, and a slow hill course with death in uremia occurred in April 1947. Diagnoses at autopsy included basophilic adenoma of the pituitary gland, atrophy of the urinary bladder, hypertrophy of the adrenal, hypertrophy of the left ventricle, hypoplasia of the uterus and ovaries, osteoporosis of the spine and pelvis, and chronic nephritis.

Hp-5

This patient, a fifty-six year old white male, was admitted to the hospital in November 1945 with complaints of generalized weakness and difficulty in walking and swallowing of three years duration. The clinical diagnosis was amyotrophic lateral sclerosis. Death occurred in April 1946. The diagnoses at autopsy included amyotrophic lateral sclerosis, bronchopneumonia, generalized arteriosclerosis, renal cysts and adenoma of the right kidney.

Hp-6

This patient, a forty-five year old white male with a history of Addison's disease since January 1945, was admitted to the hospital on December 14, 1945, for treatment of numerous infected lesions of the eyelids and nose. He responded to conservative treatment and studies began during convalescence. On readmission in June 1947, his condition was essentially unchanged.

Hp-7

This patient, a fifty-nine year old white female who had been previously treated for heart disease and hyperthyroidism, was hospitalized on January 21, 1946, for cardiac decompensation. The clinical diagnoses were rheumatic heart disease with mitral insufficiency and auricular fibrillation, and toxic nodular goiter. She expired in October 1946. Permission for autopsy was withheld, but the probable cause of death was lobar pneumonia.

Hp-8

This patient, a forty-one year old white female, had a history of scleroderma since January 1945, and a duodenal ulcer first diagnosed in 1944. The clinical diagnoses on this admission were scleroderma and duodenal ulcer.

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Hp-9
This patient, a sixty-six year old white male, was admitted to the hospital in March 1946 with a history of generalized dermatitis and weakness of eighteen months duration. A diagnosis of dermatomyositis was made. The patient expired in July 1947. Diagnoses at autopsy included generalized muscular atrophy, dermatitis, purulent bronchitis and broncho-pneumonia, hypertrophy and dilatation of the heart, and chronic passive congestion of the liver and spleen.

Hp-10
This patient, a fifty-two year old negro male, was admitted to the hospital on March 24, 1946, in acute congestive heart failure. A history of heart disease since 1920 was obtained, and his history included both rheumatic fever and lentic infection. The clinical diagnoses on admission included rheumatic heart disease, latent treated syphilis and ethmoidal and frontal sinusitis.

Hp-11
This patient, a sixty-eight year old white male with history of alcoholism and dietary inadequacies for many years, was admitted to the hospital on December 12, 1945, with complaints of dyspnea and abdominal swelling. He expired on February 26, 1946, and diagnoses at autopsy were cirrhosis of the liver, ascites, and thrombosis of the portal vein.

Hp-12
This patient, a fifty-three year old colored male, was hospitalized on March 25, 1945, and right patella and a transverse fracture of the right radius and ulna. Physical findings of note included a left lenticular cataract and marked hypertrophic and atrophic arthritic changes in both knees, together with osteochondromatosis of the left knee.

B. Management of Subjects and Collection of Sample

Ten of the twelve patients were cared for in the special metabolic ward of Strong Memorial Hospital. The general management of the ward patients was as follows:
A control period of about ten days was utilized to instruct the patient in the quantitative collection of urine and fecal specimens. During this period all necessary adjustments to ward routine and all necessary modifications in diet were completed. After the patient had proven himself capable of cooperation, a series of control urine and fecal samples were collected for the purpose of "blank" determinations by the method of plutonium analysis. Preliminary samples were drawn into dry sodium citrate as an anticoagulant. Samples of 10 ml were taken before administration of plutonium and at four hours, one day, three days, 10 days, ten days, fifteen days, etc. post injection.
When sample were collected directly into half-gallon fruit jars and preserved with formaldehyde. The urine was usually collected in 24 hour periods except on the day the plutonium was given. During the first day it was collected in three-1/2 liter beakers. Fecal samples were collected in three-1/2 liter beakers. The patient was instructed to empty the bladder before defecation to avoid admixture of urine and feces. As a rule feces were pooled during intervals of four days, except immediately after the plutonium was given when the first two stools were collected separately. All samples were preserved by boiling for ten minutes with 8 N HCl.
These samples of from 25 to 150 g were obtained at autopsy and preserved in 40 per cent alcohol.

C. Administration of Plutonium

The plutonium solution used in these studies was prepared by dissolving 5.0 mg of spectrographically pure plutonium metal in 1.0 ml of 2 N HNO₃. The solution was assayed for plutonium by alpha counting. An appropriate aliquot of the plutonium solution was placed in a 10 ml volumetric flask and diluted to volume with sterile 0.41 per cent sodium citrate-2H₂O. The solution prepared in the above manner had a pH of approximately 5.5 and the plutonium was in the form of Pu⁴⁺-citrate complex.
The technique of injection and the method of assay of the injected dose were as follows: One syringe was filled with sterile saline and a 22-gauge needle attached. The other syringe was filled with 0.5 ml of the plutonium solution and the needle used for filling the into a cubital vein and the saline slowly injected to insure unrestricted entry into the vein. The syringe was then carefully detached from the needle, which was still in the vein, and the syringe containing the plutonium injection solution was substituted. The plutonium solution was injected rapidly after which the syringe was rinsed once by drawing it full of the patient's blood and discharging the blood back into the vein.
The same syringe and needle used to inject the patient was used to measure 0.5 ml aliquots of the plutonium solution into each of four volumetric flasks. The washing of the syringe and the other essential steps of the injection technique were duplicated. The contents of each flask was diluted to volume with 2 N HCl and a suitable aliquot of each evaporated directly on platinum discs and assayed for alpha activity. The average of the four assays was taken as the amount of plutonium administered to the patient. The average standard deviation for each set of four results was 3.0 per cent. The amount of material received by each subject and the date of injection are presented in Table I.

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TABLE I
AMOUNT OF PLUTONIUM ADMINISTERED TO SUBJECT VIA INTRAVENOUS INJECTION* AND THE DATE OF ADMINISTRATION

Designation of Subject	Date of Injection	µg Pu Injected**
Hp-1	October 16, 1945	4.0
Hp-2	October 23, 1945	5.1
Hp-3	November 27, 1945	4.9
Hp-4	November 27, 1945	4.9
Hp-5	November 30, 1945	5.1
Hp-6	February 1, 1946	5.3
Hp-7	February 8, 1946	6.3
Hp-8	March 9, 1946	6.5
Hp-9	April 3, 1946	6.3
Hp-10	July 16, 1946	6.1
Hp-11	February 20, 1946	6.5
Hp-12	April 10, 1945	4.7

* Pu was administered as Pu⁴⁺-citrate in 0.5 ml of 0.41% solution sodium citrate-2H₂O.
** Average standard deviation of determination of dose was 3.0 per cent.

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D. Analytical Procedures

All urine samples were analyzed for plutonium using the cupferron extraction procedure developed at the Los Alamos Scientific Laboratory for the determination of exposure of laboratory personnel (15).
Fecal samples were analyzed by a modification of the cupferron procedure published earlier (16).

Blood and other tissue samples were "ashed" either in a muffle furnace or with conc. HNO₃ and H₂O₂. The ash solution was analyzed for plutonium by the cupferrous extraction procedure in exactly the same manner employed for the analysis of urine ash solutions.

III. RESULTS

A. Clinical Observations

Acute toxic effects from the small doses of plutonium administered in these studies were neither expected nor observed.

As seen from the summaries of case histories (Paps. 10-14), the subjects used in this study were suffering from a variety of conditions. In most cases, however, kidney and liver function appeared to be essentially normal. There were two notable exceptions.

Hp-4 was suffering from Cushing's Syndrome and chronic nephritis. The highly abnormal condition of this subject was accompanied by higher plutonium content in blood and urine and apparently a slower rate of plutonium fixation in bone. In fact, several of the urine analyses were ruled non-representative on the basis of the Chauvret criterion.

Hp-11 was hospitalized at the time plutonium was administered. Therefore, no plutonium excretion values were obtained. A final diagnosis revealed cirrhosis of the liver with associated ascites, which indicated marked impairment of liver function.

The data in Table 2 summarize some of the clinical laboratory observations. These data show no consistent trends in hemoglobin, red blood cell count, white blood cell count and differential count as a result of the injection of approximately 5 µg of plutonium. The rise in the other readings in Table 2 were quite in accord with those made by Russell and Nickson (13) who collected excellent clinical laboratory data from two cases following administration of plutonium. One individual received 6.5 µg of plutonium and was followed for 155 days. Another subject received 1.9 µg of plutonium and was followed for six months. No alterations attributable to plutonium were found in the constituents of the peripheral blood of either patient.

In the present series clinical evidence suggestive of liver damage did not appear. Specific tests of liver function were not as a rule included in the protocols, the possibility that injury to this organ might appear was considered.

Admittedly, the observations made during this study provide no evidence of what may happen in the 30 years. It may be said, however, that these studies and those of other investigators indicate that the intravenous injection of a single dose of 5 to 100 µg of plutonium was without acute subjective or objective clinical effects.

B. Deposition of Plutonium in the Body

Since the beginning of this study, four of the subjects (Hp-4, 5, 7 and 9) have died as a result of their diagnosed illness. Another subject, Hp-11, was in the terminal phase at the time of injection. Autopsy and tissue samples were obtained in only three of the five cases. Two bone specimens were obtained from Hp-12 during open reduction of fractures and a number of his teeth were obtained at a later date. Blood samples were obtained from all

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TABLE 2
CLINICAL DATA ON SUBJECTS RECEIVING INTRAVENOUS INJECTION OF
APPROXIMATELY 5 µg OF PLUTONIUM AS Pu-239 CITRATE

PATIENT CODE	SEX	AGE, YR	HT, CM	WT, KG	DATE ADMIT	DATE INJ	DATE DISCH	HIGH CONC		WBC CONC		LABORATORY STUDIES		URINARY		BONE		
								µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	
Hp-1	M	45	170.3	4.6	10-19-47	10-4-47	10-4-47	10.4	12.8	4.47	1.1	31	1	1	0	0	96	21
Hp-2	M	49	168.0	5.1	10-23-47	11-2-47	11-2-47	11.2	14.5	4.3	1.2	29	2	2	0	0	98	23
Hp-3	F	49	65.8	4.9	11-27-47	12-16-47	12-16-47	12.16	15.0	5.0	1.2	29	2	2	0	0	98	23
Hp-4	F	48	55.5	4.8	11-27-47	12-16-47	12-16-47	12.16	15.0	5.0	1.2	29	2	2	0	0	98	23
Hp-5	F	49	64.0	6.3	2-8-48	2-22-48	2-22-48	2.22	2.76	4.7	1.1	24	2	2	0	0	104	28
Hp-6	F	41	54.4	6.3	2-8-48	2-22-48	2-22-48	2.22	2.76	4.7	1.1	24	2	2	0	0	104	28
Hp-7	M	46	74.0	6.3	2-8-48	2-22-48	2-22-48	2.22	2.76	4.7	1.1	24	2	2	0	0	104	28
Hp-8	M	46	74.0	6.3	2-8-48	2-22-48	2-22-48	2.22	2.76	4.7	1.1	24	2	2	0	0	104	28
Hp-9	M	46	74.0	6.3	2-8-48	2-22-48	2-22-48	2.22	2.76	4.7	1.1	24	2	2	0	0	104	28
Hp-10	M	41	61	3.16	7-9-48	10-5-48	10-5-48	10.5	12.1	4.1	1.1	17	1	1	0	0	45	11
Hp-11	M	41	61	3.16	7-9-48	10-5-48	10-5-48	10.5	12.1	4.1	1.1	17	1	1	0	0	45	11
Hp-12	M	41	61	3.16	7-9-48	10-5-48	10-5-48	10.5	12.1	4.1	1.1	17	1	1	0	0	45	11

* Explanatory: 4 Symbols: HT, Height; WT, Weight; DATE, Date; CONC, Concentration; URINARY, Urinary; BONE, Bone; DISCH, Discharge; INJ, Injection; ADMIT, Admitted; HT, Height; WT, Weight; DATE, Date; CONC, Concentration; URINARY, Urinary; BONE, Bone; DISCH, Discharge; INJ, Injection; ADMIT, Admitted.

subjects before plutonium injection and at frequent intervals thereafter. All tissue samples were analyzed for plutonium by the cupferron extraction procedure subsequent to ashing.

The data in Table 3 show the results of analyses of the various samples for plutonium. The results obtained by Russell and Nickson (13) (referred to as Ch. I, II, III) and Hamilton et al (14) (referred to as Ch. I, II, III) are presented also. Two important points must be kept in mind when considering these data: (1) The samples of human tissues were for obvious reasons, rather unsatisfactory. In most cases they were too small, poorly representative and were usually what could be obtained under the circumstances rather than what were desired. (2) The subjects were chronically ill and/or elderly and the results may not represent exactly the distribution of plutonium in tissues of healthy persons of average working age. These data, however, are all that are available and, therefore, must provide the basis for our present concept of the distribution of plutonium in the organs and tissues of man. They must also provide a basis for comparison with the results obtained from the numerous studies of plutonium deposition in experimental animals.

1. Deposition in the Skeleton

Animal experiments (1) (2) reveal that approximately 66 per cent of plutonium injected as PuO₂ and Pu-4 citrate is localized in bone. If the vertebral, sternum and whole ribs are taken as representative bones of the skeleton, and the average plutonium content is 6.67 x 10⁻⁶ g.

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TABLE 3
DISTRIBUTION OF PLUTONIUM IN HUMAN TISSUES FOLLOWING
INTRAVENOUS INJECTION OF PLUTONIUM SALTS

Tissue (2)	Subject (1)										Org. Wt. (4)	Calc. (5)
	Hp-5	Hp-9	Hp-11	Chi-1	Chi-2	Chi-3	Chi-4	Chi-5	Chi-6	Chi-7		
bone marrow	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3,000	1.8 (10)
liver	0.030	0.018	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	1,700	31.1
rib (costal)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
vertebra	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
sternum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
rib (white)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
pericardium (hr)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
spleen	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
kidney	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
thyroid	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
adrenal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
lung	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
pancreas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
glands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
lymph node	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
testis (av. of 7)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
heart	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
large intestine	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
small intestine	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
muscle and skin	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
blood	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
salivary	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10,000	85.3 (5)
total	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	70,000	94.7

(1) The various subjects received the following doses of plutonium: Hp-5, 5.0 μc; Hp-9, 6.3 μc; Hp-11, 6.3 μc; Chi-1, 6.3 μc; Chi-2, 6.3 μc; Chi-3, 6.3 μc; Chi-4, 6.3 μc; Chi-5, 6.3 μc; Chi-6, 6.3 μc; Chi-7, 6.3 μc.

(2) Tissues were assayed at the following times after injection: Hp-5, 121 days; Hp-9, 456 days; Hp-11, 5 days; Chi-1, 155 days; Chi-2, 18 days; Chi-3, 5 days; Chi-4, 5 days.

(3) Calculated by dividing the amount of tissue in % of body weight by the amount of Pu in equally diet, in a 70 kg. man.

(4) Interim Report, Memorandum to AEC, July 21, 1951, Project Standard Man.

(5) Assumption made that vertebra, sternum and whole rib represent average bone of skeletal system.

(6) Bone marrow not included in total recovery because bone samples were not found of marrow in four analyses.

(7) Balance assumed to have same Pu content as muscle.

(8) Value for blood taken at 30 day point, Fig. 3.

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multiplied by the skeletal weight of the "Standard Man" (17), then 65.7 per cent of the injected dose is the estimated amount of plutonium in the skeleton of a 70 kg man. Although the latter value was established rather arbitrarily, it is in good agreement with the value expected from animal experiments.

The data in Table 3 indicate a rather high plutonium content in bone marrow. The average of four determinations from three different laboratories was 0.0187 per cent of the injected dose per gram of marrow. On the basis of 3000 g of bone marrow, there would be 56 per cent of the injected dose concentrated in the marrow of a 70 kg man. Animal studies do not show appreciable concentrations of plutonium in the marrow. The major areas of plutonium concentration in rats and mice are the endosteum, periosteum and the epiphyseal line. It is quite possible that the samples of human marrow were too small to be representative, contained endosteum or epiphyseal, or that the high deposition was an indication of an age factor related to the fact that the epiphyses of man unlike those of the rat unite at maturity.

2. Deposition in the Liver

The average plutonium deposition in the liver for the five cases was 3.6136 per cent of the injected dose per gram, which corresponds to 23.1 per cent of the dose in a 700 gram liver (Standard Man). Table 4 presents the liver data in more detail, including the two cases reported by the Chicago investigators (13).

TABLE 4

LIVER DEPOSITION OF PLUTONIUM ADMINISTERED INTRAVENOUSLY TO MAN

Subject	Days After Injection	Liver Wt. in Grams	% of Dose per Gram	% of Dose per Organ
Hp-5	151	1340	.0320	42.8
Hp-9	456	1600	.0144	23.0
Hp-11 (1)	5	2325	.0053	12.3
Chi-1 (3)	155	2050	.0139	26.5
Chi-2 (2,3)	16	1110	.0024	2.7
AVERAGE	156	1641	.0136	21.9

(1) Hp-11 was in terminal phase of illness; plutonium deposition probably low because of severe cirrhosis of the liver.

(2) Chi-11 was in terminal phase of adenocarcinoma; plutonium deposition probably low because of metastases to the liver.

(3) Russell, E. R. and Nickerson, J. J. (13)

Two cases (Hp-11 and Chi-11) were in the terminal phase of cancer of the liver; plutonium was administered. Both showed advanced liver disease. The values for plutonium deposition in the liver of these cases is highly questionable. The results in the other three cases, however, were rather striking. As pointed out by Russell and Nickerson (13), the content of

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plutonium in the liver was much higher than was to be expected from results in experimental animals. Even though one of their cases survived 155 days after receiving plutonium in the 6 valence state (a form known to give low liver deposition in rats (1) (2)), 28.5 per cent of the injected dose was found in the liver. Subject Hp-5 had 42.8 per cent of the plutonium injected as Pu⁴⁺-citrate deposited in the liver after 151 days. The third case (Hp-9) survived 136 days and had 23.0 per cent of the injected material deposited in the liver. Considering the elapsed time after injection, the plutonium content of the liver in the two latter cases was even higher than that observed by Russell and Nickson (13). The apparent higher deposition in the latter cases might indicate the destruction of the Pu⁴⁺-citrate complex by the human liver. The results compare favorably with those obtained when rats were injected with uncomplexed quadrivalent plutonium ion (1), (2), (3). The limited data presented in Table 4 indicated rather strongly that the retention of plutonium by the liver may be much greater for man than for rats and mice, and may be of the order of 20-40 per cent of the injected dose during the first year. A comparison of the survival times and the amounts of plutonium deposited in the livers of Hp-5 and Hp-9 seems to indicate a "plutonium retention half-time" in the liver of one year or greater for man as compared to 40-60 days for rats.

3. Concentration in Blood

The data in Table 5 show the concentration of plutonium in blood at various times after the intravenous injection of approximately 5 μ g of plutonium as Pu⁴⁺-citrate. The results are expressed in per cent of the injected dose in the total blood volume. The retention was assumed to be 7.7 per cent of the total body weight (17).

The individual observations varied widely, especially during the first four days. The mean values, however, fall on a smooth curve (shown in Fig. 3).

The drop in blood plutonium content was very rapid at first, and reflected the very rapid rate of fixation of the material in the body. The mean blood concentration 4 hours after injection was 35.7 per cent, at one day 15.7 per cent, at 10 days 1.2 per cent. Thirty days after injection the blood concentration of plutonium read from the curve in Fig. 3 was only 0.3 per cent of the injected dose in the total blood volume. The extreme small amount of plutonium in the circulating blood eliminates blood analysis by the usual counting procedures as a means of measuring the degree of exposure of personnel. The application of techniques employing the counting of alpha tracks registered by alpha sensitive nuclear track photographic emulsions may prove possible.

4. Deposition in Other Organs

The amounts of plutonium deposited in organs and tissues other than skeleton, liver and blood were rather small. When the per cent per organ was calculated, based on the organ weight of the "Standard Man", the results were in reasonable agreement with what was anticipated from animal experiments. The data showing the per cent of dose per gram of organ and per cent per organ are given in Table 3 (Page 18). The kidney and spleen each had an estimated average plutonium content of 0.4 per cent of the injected dose per organ.

The relative affinity of the various tissues for plutonium was calculated by dividing the per cent of the dose per gram of organ by the per cent of the dose per gram of body weight when the material was assumed to be equally distributed in a 70 kg man.

The bone, liver, marrow and liver were the only tissues that showed a relative plutonium affinity appreciably greater than unity. The spleen was 1.5, all other tissues and samples were 1.0 or less. Obviously the skeletal system and liver are the tissues of major interest when one considers the plutonium tolerants, as these two organs alone account for 90 per cent or more of the total plutonium in the entire body.

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TABLE 5
PLUTONIUM CONTENT OF BLOOD SAMPLES* FOLLOWING INTRAVENOUS INJECTION OF APPROXIMATELY 5 μ g OF PLUTONIUM AS Pu⁴⁺-CITRATE

DAYS AFTER INJECTION	PATIENT CODE AND PER CENT OF INJECTED DOSE IN TOTAL BLOOD VOLUME*												AVERAGE	
	Hp-1	Hp-2	Hp-3	Hp-4	Hp-5	Hp-6	Hp-7	Hp-8	Hp-9	Hp-10	Hp-11	Hp-12		
1/0	46.02	-	26.32	60.31	31.37	36.70	22.57	37.64	40.83	31.57	5.31	-	-	35.7
1	21.80	19.35	-	-	6.23	16.97	16.40	14.51	12.38	24.96	-	-	-	15.7
2	-	8.38	11.58	-	-	-	-	-	-	-	-	-	-	8.92
3	-	0.03	-	16.84	1.16	2.94	6.97	4.84	6.22	20.06	-	-	-	8.62
4	-	-	4.22	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	0.66	-	-	-	-	-	-	-	-	-
6	3.30	4.25	2.17	6.14	-	1.00	2.56	2.07	2.81	4.91	-	-	-	3.4
8	-	4.32	1.42	-	-	-	-	-	-	-	-	-	-	1.9
9	-	-	-	4.60	-	-	-	-	-	-	-	-	-	-
10	1.42	-	-	-	0.39	0.38	1.13	1.37	2.21	1.72	-	-	-	1.2
13	-	-	0.61	2.34	-	-	-	-	-	-	-	-	-	1.5
15	-	-	0.51	1.45	0.11	1.26	0.66	0.71	1.42	1.02	-	-	-	1.1
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	-	0.79	-	0.72	0.16	0.25	-	-	-	-	-	-	-	1.0
23	-	-	0.25	-	-	-	-	-	-	-	-	-	-	0.54
29	-	-	-	-	-	-	0.37	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	0.36	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	0.42	-	-	-	-	-
32	-	-	-	-	-	-	-	0.17	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	0.45	-	-	-

* Total Weight of Blood Taken = 7.70 of Total Body Weight.

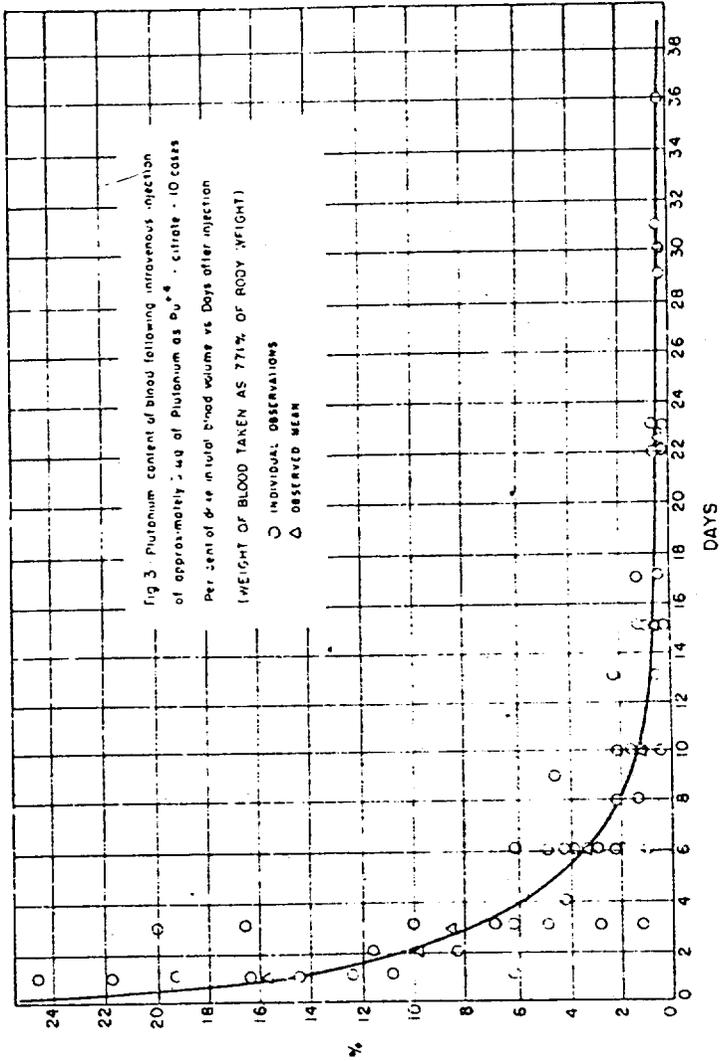
C. Excretion of Plutonium

1. Urinary Excretion

The urinary excretion of plutonium was studied in eleven of the subjects following the intravenous injection of approximately 5 μ g of plutonium as Pu⁴⁺ in 0.4 per cent solution of sodium citrate 2H₂O. With the exception of the first day, urine from all subjects was collected in 24 hour samples through 22 days post injection. After 22 days the collection of 24 hour urine samples was continued as long as the patients were available for study. It was not possible to retain the subjects as long as was desired and the major weakness in these results is the short time interval over which the studies were continued. Two subjects were followed 22 days, one for 23 days, one for 27, and the remainder for 30 days or longer after injection. The Chicago cases (13) were followed for 16, 140, and 185 days and the California case (14) was followed for a period of 341 days. Because of the great importance of measurements at longer time intervals, the Chicago and California data have been incorporated with

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the data from these studies. The results of all urine analyses through 138 days post-injection are given in Table 6. Results are expressed as per cent of injected dose excreted per day. The means, revised t , $s.e.$, and standard deviations for the daily urinary excretion of plutonium from 0 to 138 days post-injection are given in Table 7. The equation of best fit for the observed means is a logarithmic function:

$$Y = aX^b \quad [1]$$

where Y is the amount of plutonium (expressed as per cent of injected dose) excreted in a single day, X is the time of observation in days post-injection, and a and b are constants derived from the observed data by the method of least squares. Solution gives the following expression for the best curve of fit for the urinary excretion of plutonium utilizing all available data from 0 to 138 days post-injection:

$$Y = 0.23 X^{-0.77} \quad [2]$$

The agreement between observed mean values and the derived expression for the urinary excretion of plutonium through 138 days post-injection is illustrated graphically in Fig. 4. In this graph the circles represent the observed means and the solid line represents the derived expression. The agreement is fairly good. The overall standard error of estimate, S_{YX} , (determined by the usual methods of correlation analysis) was ± 32 per cent. The largest contributions to the standard error of estimate come from the 0 to 10 day portion of the curve and from the latter portion where there is an increased scatter of points because of the decrease in number of observations. Actually, attempts at curvilinear regression line fitting indicate that the function $Y = aX^{-1}$ is the best curve for the 0 to 10 day period rather than the logarithmic curve presented. We believe this difference in functional relationship may be due to the clearance of the injected plutonium from the blood during this early period after injection.

Extrapolation of the derived expression beyond 138 days introduces increasing uncertainty with increasing values of X . In order to interpret the excretion results in standard terms, i.e., "biological half-life", despite the fact that the data are not fitted by a single exponential curve, we have chosen to determine $T_{1/2}$ by assuming exponential excretion beyond the limits of observation and estimating $T_{1/2}$ from the last point on the excretion curve of single value of the ordinate. One may then assume the slope of the excretion curve to be zero at this point and calculate an absolute minimum value for the "biological half-life". For the above reasons it is important to supplement the urinary excretion data beyond 138 days to the greatest possible extent. Three additional groups of samples were obtained from two of the cases after the close of the experiment. One group of four consecutive daily urine samples was obtained from Hipp-6 beginning on the 523rd day and another group beginning on the 1610th day after injection. The average daily urinary excretion of plutonium at 523 days was 0.002 per cent, and at 1610 days 0.0011 per cent of the injected dose. Four daily samples collected from Hipp-3 beginning at 1243 days after injection showed an average daily urinary excretion of 0.0008 per cent of the injected dose.

In addition to the three groups of samples mentioned above a number of urine plutonium assays were made on workers at the Los Alamos Laboratory. A few of these individuals accumulated measurable amounts of plutonium during wartime operations. They were removed from further exposure to plutonium and occasional urine assays were made over a period of about several months. The urine assays on three members of this group are given in Table 8. One of these individuals received unknown exposure doses via the usual routes of entry over an indefinite time; the results are not tabulated in the usual manner of a known amount of plutonium. However, the inclusion of these individuals has been attempted in order to extend the excretion curve. An attempt has been made to interpret their

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TABLE 6 (Contd)

INDIVIDUAL URINARY EXCRETION VALUES OF PLUTONIUM FOLLOWING INTRAVENOUS ADMINISTRATION⁽¹⁾ TO HUMAN SUBJECTS (EXPRESSED AS PER CENT OF DOSE EXCRETED PER DAY)

DATE POST INJECTION	PER CENT OF INJECTED DOSE EXCRETED PER DAY										Cal. (2)	
	Sp-1	Sp-2	Sp-3	Sp-4	Sp-5	Sp-6	Sp-7	Sp-8	Sp-9	Sp-10		
11												
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71												
72												
73												

(1) Values tabulated from original reports on basis of the "Cumulative Criterion."
 (2) Values are Cal. 1, 2, 3 and Cal. 4 received ^{239}Pu in 3 per cent Na_2CO_3 solution. The latter value received ^{239}Pu .
 (3) Samuel, E. R., Rickham, J. J., Argonne National Laboratory Report CN-3627 and unpublished data.
 (4) Hamilton, J. G., et al., Report No. CN-3248.

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TABLE 6

INDIVIDUAL URINARY EXCRETION VALUES OF PLUTONIUM FOLLOWING INTRAVENOUS ADMINISTRATION⁽¹⁾ TO HUMAN SUBJECTS (EXPRESSED AS PER CENT OF DOSE EXCRETED PER DAY)

DATE POST INJECTION	PER CENT OF INJECTED DOSE EXCRETED PER DAY										Cal. (2)	
	Sp-1	Sp-2	Sp-3	Sp-4	Sp-5	Sp-6	Sp-7	Sp-8	Sp-9	Sp-10		
1												
2												
3												
4												
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(1) Values tabulated from original reports on basis of the "Cumulative Criterion."
 (2) Values are Cal. 1, 2, 3 and Cal. 4 received ^{239}Pu in 3 per cent Na_2CO_3 solution. The latter value received ^{239}Pu .
 (3) Samuel, E. R., Rickham, J. J., Argonne National Laboratory Report CN-3627 and unpublished data.
 (4) Hamilton, J. G., et al., Report No. CN-3248.

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TABLE 7

MEANS*, REVISED MEANS, AND STANDARD DEVIATIONS OF URINARY, FECAL,
AND URINARY PLUS FECAL EXCRETION OF PLUTONIUM FOLLOWING INTRAVENOUS
ADMINISTRATION TO HUMAN SUBJECTS (EXPRESSED AS PER CENT OF INJECTED DOSE)

DAYS POST INJECTION	URINARY EXCRETION			FECAL EXCRETION			URINARY & FECAL EXC.	
	Mean %/Day	Revised Mean %/Day	Standard Deviation	Mean %/Day	Revised Mean %/Day	Standard Deviation	Mean %/Day	Standard Deviation
1	.3176	.3628	.614	.1553	.1988	.1168	.5816	.1175
2	.1974	-	.070	.2458	.4232	.1230	.4232	.1778
3	.1286	-	.032	.2275	.3541	.0805	.3541	.1778
4	.0962	-	.041	.1842	.2804	.1125	.2804	.1778
5	.0652	-	.030	.1582	.2234	.0857	.2234	.1778
6	.0540	.0490	.028	.1096	.1588	.0440	.1588	.1778
7	.0501	-	.026	.0796	.1287	.0401	.1287	.1778
8	.0440	-	.022	.0717	.1157	.0412	.1157	.1778
9	.0424	.0384	.023	.0647	.1031	.0415	.1031	.1778
10	.0355	.0341	.018	.0538	.0856	.0285	.0856	.1778
11	.0350	.0319	.018	.0566	.0865	.0380	.0865	.1778
12	.0300	.0270	.018	.0566	.0865	.0380	.0865	.1778
13	.0307	.0279	.013	.0588	.0791	.0351	.0791	.1778
14	.0274	.0250	.014	.0512	.0711	.0351	.0711	.1778
15	.0253	-	.012	.0453	.0636	.0286	.0636	.1778
16	.0219	.0199	.011	.0617	.0296	.0286	.0296	.1778
17	.0236	-	.0092	.0172	.3285	.0411	.3285	.1778
18	.0219	-	.0074	.0377	.0288	.0394	.0288	.1778
19	.0190	-	.0081	.0278	.0466	.0168	.0466	.1778
20	.0200	-	.0101	.0274	.0474	.0169	.0474	.1778
21	.0195	-	.0093	.0283	.0458	.0183	.0458	.1778
22	.0186	-	.0083	.0243	.0431	.0182	.0431	.1778
23	.0203	-	.0105	.0224	.0427	.0156	.0427	.1778
24	.0176	-	.0077	.0211	.0417	.0141	.0417	.1778
25	.0279	.0159	.0082	.0199	.0145	.0160	.0145	.1778
26	.0172	-	.0074	.0211	.0160	.0156	.0160	.1778
27	.0178	.0149	.0082	.0211	.0119	.0122	.0119	.1778
28	.0180	-	.0092	.0163	.0265	.0140	.0265	.1778
29	.0153	-	.0074	.0180	.0332	.0146	.0332	.1778
30	.0154	-	.0072	.0170	.0333	.0069	.0333	.1778
31	.0150	-	.0067	.0191	.0333	.0119	.0333	.1778
32	.0128	-	.0067	.0188	.0318	.021	.0318	.1778
33	.0155	-	.0102	.0192	.0317	.0317	.0317	.1778
34	.0125	.0125	.0058	.0192	.0317	.0111	.0317	.1778
35	.0138	-	.0083	.0201	.0339	.012	.0339	.1778
36	.0143	-	.0058	.0151	.0294	.0091	.0294	.1778
37	.0114	.0091	.0062	.0183	.0274	.0119	.0274	.1778
38	.0138	-	.0043	.0181	.0318	.0121	.0318	.1778
39	.0119	-	.0055	.0079	.0188	.0044	.0188	.1778
40	.0119	-	.0058	.0088	.0207	.0031	.0207	.1778
41	.0120	-	.0044	.002*	.0202	.0040	.0202	.1778
42	.0120	-	.0027	.0082	.0031	.0031	.0031	.1778
43	.0130	-	.0040	.0079	.0015	.0015	.0015	.1778
44	.0094	-	.0050	.0094	.0087	.0049	.0087	.1778
45	.0135	-	.0041	.0064	.0222	.0053	.0222	.1778
46	.0114	-	.0041	.0064	.0202	.0072	.0202	.1778
47	.0137	-	.0058	.0064	.0072	.0072	.0072	.1778

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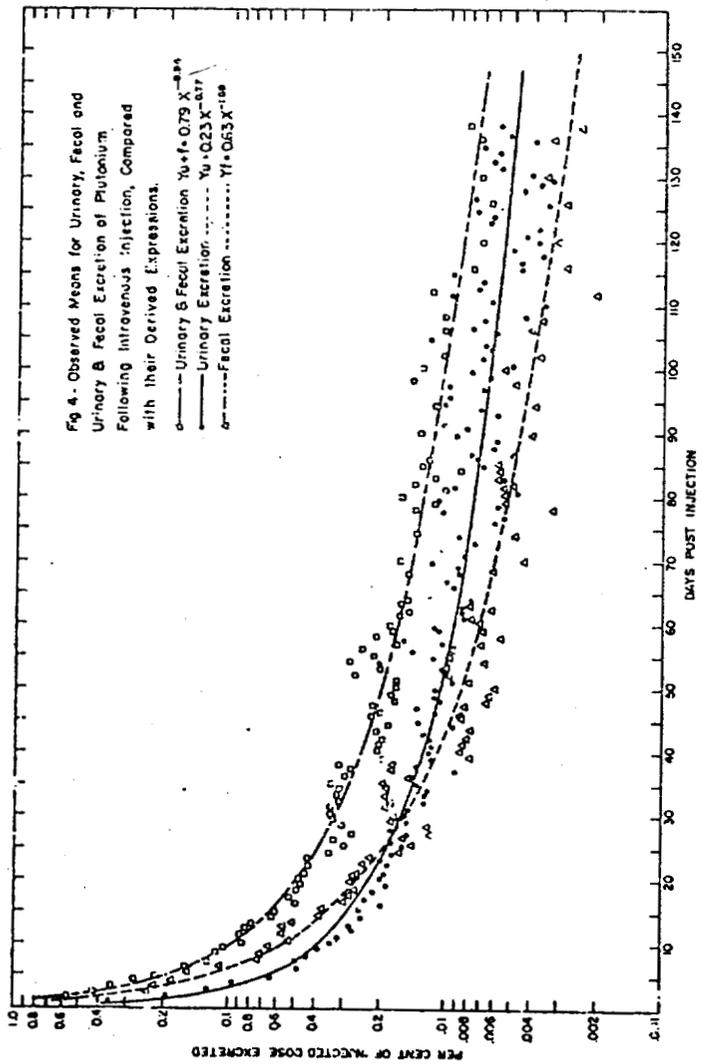
TABLE 7 (Contd)

MEANS*, REVISED MEANS, AND STANDARD DEVIATIONS OF URINARY, FECAL,
AND URINARY PLUS FECAL EXCRETION OF PLUTONIUM FOLLOWING INTRAVENOUS
ADMINISTRATION TO HUMAN SUBJECTS (EXPRESSED AS PER CENT OF INJECTED DOSE)

DAYS POST INJECTION	URINARY EXCRETION			FECAL EXCRETION			URINARY & FECAL EXC.	
	Mean %/Day	Revised Mean %/Day	Standard Deviation	Mean %/Day	Revised Mean %/Day	Standard Deviation	Mean %/Day	Standard Deviation
49	.0108	-	.0036	.0087	-	.0018	.0087	.0018
50	.0114	-	.0042	.0094	-	.0026	.0094	.0026
51	.0113	-	.0059	.0080	-	.0038	.0080	.0038
52	.0094	-	.0032	.008	-	-	.008	-
53	.0173	-	.0154	.010	-	-	.010	-
54	.0104	-	.0074	.010	-	-	.010	-
55	.0212	.0115	.0189	.0089	-	.0047	.0089	.0047
56	.0146	-	.0144	.010	-	-	.010	-
57	.0106	-	.0056	.0070	-	-	.0070	-
58	.0109	-	.0138	.0057	-	.0019	.0057	.0019
59	.0115	-	.010	.0070	-	-	.0070	-
60	.0115	-	.0074	.0070	-	-	.0070	-
61	.0085	-	.0028	.0080	-	-	.0080	-
62	.0083	-	.0021	.0084	-	.0023	.0084	.0023
63	.0087	-	.0007	.008	-	-	.008	-
64	.0076	-	.0041	.008	-	-	.008	-
65	.0089	-	.0028	.0063	-	-	.0063	-
66	.0120	-	.0028	.0045	-	-	.0045	-
67	.0090	-	.0022	.0050	-	-	.0050	-
68	.0107	-	.0050	.0033	-	-	.0033	-
69	.0059	-	.0022	.0055	-	.0007	.0055	.0007
70	.0111	-	.0110	.0055	-	.0007	.0055	.0007
71	.0048	-	.0010	.0055	-	.0007	.0055	.0007
72	.0093	-	.0061	.0051	-	.0009	.0051	.0009
73	.0026	-	.0022	.0060	-	-	.0060	-
74	.0026	-	.0010	.0060	-	-	.0060	-
75	.0073	-	.0036	.0060	-	-	.0060	-
76	.0093	-	.0071	.0042	-	-	.0042	-
77	.0101	-	.0044	.0040	-	-	.0040	-
78	.0079	-	.0044	.0050	-	-	.0050	-
79	.0073	-	.0036	.0060	-	-	.0060	-
80	.0093	-	.0071	.0042	-	-	.0042	-
81	.0101	-	.0044	.0040	-	-	.0040	-
82	.0073	-	.0036	.0060	-	-	.0060	-
83	.0093	-	.0071	.0042	-	-	.0042	-
84	.0026	-	.0010	.0060	-	-	.0060	-
85	.0073	-	.0036	.0060	-	-	.0060	-
86	.0073	-	.0036	.0060	-	-	.0060	-
87	.0093	-	.0071	.0042	-	-	.0042	-
88	.0101	-	.0044	.0040	-	-	.0040	-
89	.0079	-	.0044	.0050	-	-	.0050	-
90	.0073	-	.0036	.0060	-	-	.0060	-
91	.0093	-	.0071	.0042	-	-	.0042	-
92	.0101	-	.0044	.0040	-	-	.0040	-
93	.0079	-	.0044	.0050	-	-	.0050	-
94	.0073	-	.0036	.0060	-	-	.0060	-
95	.0093	-	.0071	.0042	-	-	.0042	-
96	.0101	-	.0044	.0040	-	-	.0040	-
97	.0079	-	.0044	.0050	-	-	.0050	-
98	.0073	-	.0036	.0060	-	-	.0060	-
99	.0093	-	.0071	.0042	-	-	.0042	-
100	.0101	-	.0044	.0040	-	-	.0040	-
101	.0079	-	.0044	.0050	-	-	.0050	-
102	.0073	-	.0036	.0060	-	-	.0060	-
103	.0093	-	.0071	.0042	-	-	.0042	-
104	.0101	-	.0044	.0040	-	-	.0040	-
105	.0079	-	.0044	.0050	-	-	.0050	-
106	.0073	-	.0036	.0060	-	-	.0060	-
107	.0093	-	.0071	.0042	-	-	.0042	-
108	.0101	-	.0044	.0040	-	-	.0040	-
109	.0079	-	.0044	.0050	-	-	.0050	-
110	.0073	-	.0036	.0060	-	-	.0060	-
111	.0093	-	.0071	.0042	-	-	.0042	-
112	.0101	-	.0044	.0040	-	-	.0040	-
113	.0079	-	.0044	.0050	-	-	.0050	-
114	.0073	-	.0036	.0060	-	-	.0060	-
115	.0093	-	.0071	.0042	-	-	.0042	-
116	.0101	-	.0044	.0040	-	-	.0040	-
117	.0079	-	.0044	.0050	-	-	.0050	-
118	.0073	-	.0036	.0060	-	-	.0060	-
119	.0093	-	.0071	.0042	-	-	.0042	-
120	.0101	-	.0044	.0040	-	-	.0040	-
121	.0079	-	.0044	.0050	-	-	.0050	-
122	.0073	-	.0036	.0060	-	-	.0060	-
123	.0093	-	.0071	.0042	-	-	.0042	-
124	.0101	-	.0044	.0040	-	-	.0040	-
125	.0079	-	.0044	.0050	-	-	.0050	-
126	.0073	-	.0036	.0060	-	-	.0060	-
127	.0093	-	.0071	.0042	-	-	.0042	-
128	.0101	-	.0044	.0040	-	-	.0040	-
129	.0079	-	.0044	.0050	-	-	.0050	-
130	.0073	-	.0036	.0060	-	-	.0060	-
131	.0093	-	.0071	.0042	-	-	.0042	-
132	.0101	-	.0044	.0040	-	-	.0040	-
133	.0079	-	.0044	.0050	-	-	.0050	-
134	.0073	-	.0036	.0060	-	-	.0060	-
135	.0093	-	.0071	.0042	-	-	.0042	-
136	.0101	-	.0044	.0040	-	-	.0040	-
137	.0079	-	.0044	.0050	-	-	.0050	-
138	.0073	-	.0036	.0060	-	-	.0060	-

* Cases of Russell and Nickson and Hamilton, et al used in computing means where applicable.

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chronic variable exposure dose in terms of an effective single dose given at some effective time between the limits of exposure. This interpretation was accomplished by fitting the slopes of the urinary excretion curves of these individuals to the slope of the 138 day curve in the following manner: If $Y_q = 0.23 X^{-0.77}$ gives the percent (Y_q) of a single dose excreted on day X, then $0.0023 DX^{-0.77}$ is the expression for the percent (Y_q) of a single dose excreted minute, excreted on day X when the single dose (D) is expressed in the same units. If the assumption is made that a chronic variable exposure dose may be represented by a single effective dose (D_E) then the activity (Y_q) in the sample excreted q effective days after this single dose is given by the expression

$$Y_q = 0.0023 D_E q^{-0.77} \quad (3)$$

The activity (Y_{q+a}) of the sample excreted on $q+a$ days after the single dose (there being no exposure between q and $q+a$) is given by the expression

$$Y_{q+a} = 0.0023 D_E (q+a)^{-0.77} \quad (4)$$

Dividing 3 by 4 and solving for q gives

$$q = \frac{a}{\left(\frac{Y_q}{Y_{q+a}}\right)^{1.30} - 1} \quad (5)$$

q then is the effective time of exposure and its substitution in (3) gives the effective dose D_E , as follows:

$$Y_q = 0.0023 D_E \left[\frac{a}{\left(\frac{Y_q}{Y_{q+a}}\right)^{1.30} - 1} \right]^{-0.77}$$

$$D_E = 434.8 Y_q \left[\frac{a}{\left(\frac{Y_q}{Y_{q+a}}\right)^{1.30} - 1} \right]^{0.77} \quad (6)$$

This expression gives an approximation of the total body burden of a person chronically exposed to plutonium. The body burden is expressed in terms of a single effective dose as determined from two urinary excretion measurements (Y_q and Y_{q+a}) taken sufficiently far apart (with no exposure between) so that the two measurements are significantly different. The method of interpretation given above was applied to the urinary plutonium excretion data from three Los Alamos personnel and their average total plutonium body content approximated in terms of an effective dose at some effective time (q). The effective doses for W. B. G., W. A. B. and D. L. W. were estimated at 1.3 μ Ci, 1.2 μ Ci, and 1.0 μ Ci respectively for respective effective times of 37, 53, and 42 days before the first urine assay used in the calculation. Assuming the above doses, all urinary excretion data (Table B) collected from these persons were used to adjust the experimental urinary excretion curve (2) extending it to 1750 days again using least squares analysis. The adjusted expression is

$$Y_{ua} = 0.20 X^{-0.74} \quad (7)$$

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$$A_{ua} = 0.20 \int_0^{n+1/2} x^{-0.74} dx = \frac{0.20}{0.26} \left[(n+1/2)^{0.26} - (1/2)^{0.26} \right]$$

$$= 0.77 (n+1/2)^{0.26} - 0.61$$

When $n = 1750$ days, A_{ua} (the total amount of plutonium excreted in the urine through 1750 days) is only 6.3 per cent of the total injected dose.

2. Fecal Excretion

The same cases used for urinary excretion studies were used for the study of fecal elimination of plutonium following intravenous administration of Pu-239-citrate. Fecal samples were collected daily for the first few days. Later stools were pooled at four day intervals because of the uncertainty of obtaining representative 24-hour samples. Plutonium analyses were made on aliquots of each specimen using methods described earlier. The results of analysis of individual fecal specimens are given in Table 9. Results are expressed as per cent of the administered dose excreted per day. Fecal excretion data could be obtained for only one of the cases (Chi.-1) reported by Russell and Nickson (13). The original data were no longer available and it was necessary to read individual values from the graph given in their report. The original fecal excretion data were not available for the one case studied

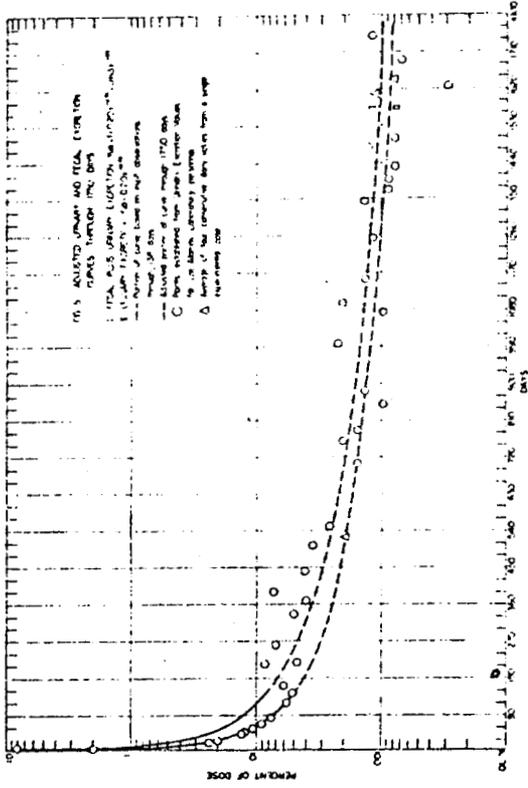
TABLE 8
PLUTONIUM URINE ASSAYS ON LOS ALAMOS PERSONNEL AFTER REMOVAL FROM FURTHER PLUTONIUM EXPOSURE

W. B. G.			W. A. B.			D. L. W.		
Days	(1) c/m/24-hr.	(2) p. Error	Days	(1) c/m/24-hr.	(3) p. Error	Days	(1) c/m/24-hr.	(3) p. Error
1	8.4	0.33	1	11.3	0.60	1	13.1	0.33
27	6.8	0.51	20	11.8	0.54	31	8.4	0.33
104	5.3	0.50	45	8.2	0.52	84	3.9	0.48
225	6.4	0.51	193	7.7	0.51	118	3.5	0.48
315	4.6	0.49	370	6.7	0.50	185	3.2	0.48
450	3.7	0.48	1480(4)	1.3	0.17			
587	3.8	0.48						
450	2.4	0.47						
652	1.4	0.46						
707	1.9	0.47						
784	1.4	0.45						
786	0.9	0.46						
831	1.3	0.46						
847	2.1	0.47						
1022	0.9	0.46						
1044	1.9	0.47						
1162	1.3	0.46						
1203	1.1	0.46						
1294	1.3	0.47						
1322	0.8	0.46						
1346	0.7	0.46						
1418	0.7	0.46						
1521	0.3	0.45						
1638	0.6	0.46						
1698	1.1	0.48						
W. A. B.			D. L. W.			D. L. W.		
W. B. G.			W. A. B.			D. L. W.		
D. L. W.			D. L. W.			D. L. W.		

(1) Days after removal from further plutonium exposure.
 (2) Alpha counts per minute per 24-hour urine sample at 80 per cent counting geometry.
 (3) Probable error calculated from empirical formula derived specifically for the effluor extraction procedure for determining plutonium in urine (13).
 (4) Result due in H. M. Parker in private communication to N. E. Bradbury, July 7, 1949.
 (5) Estimated by equation (6) Page 18.

Figure 5 shows the adjusted curve through 1750 days represented as a heavy broken line. The points representing the three sets of data collected from Hp-3 and Hp-8 beyond 138 days after injection are shown on the graph as triangles. Points originating from the urine assays of the three Los Alamos workers are shown as circles and the theoretical curve [2] through 138 days is given as a heavy solid line for comparison. The standard error of estimate for the adjusted expression is 42 per cent due largely to the poorer fit during the first few days and to the small number of observations during the later time period.

Integration of the expression $Y_{ua} = 0.20 X^{-0.74}$ between the limits of $X = 1/2$ and $X = (n+1/2)$ gives the area (A_{ua}) under the urinary excretion curve which represents the total per cent of the injected dose of plutonium excreted in the urine up to and including the nth day after injection.



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TABLE B (Cont'd)
INDIVIDUAL FECAL EXCRETION VALUES OF PLUTONIUM FOLLOWING
INTRAVENOUS ADMINISTRATION TO HUMAN SUBJECTS
(EXPRESSED AS PER CENT OF DOSE EXCRETED PER DAY)

DAYS POST INJECTION	PER CENT OF INJECTED DOSE EXCRETED PER DAY											
	Hp-1	Hp-2	Hp-3	Hp-4	Hp-5	Hp-6	Hp-7	Hp-8	Hp-9	Hp-10	Hp-11	Chl-12
48												.0054
49												.0047
50												.0040
81												
82												
83												
84												
85												
86												
87												
88												
89												
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134												
135												
136												
137												
138												

* Values eliminated from revised mean on basis of the Chauvenet Criterion.
(1) All cases except Chl-1 received Pu-239 in 0.4 per cent Na₂C₂O₄ · 2d₂O Solution.
(2) Russacu, E. R., Nickson, J. J., Argonne National Laboratory, Report CH-3807.

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TABLE B
INDIVIDUAL FECAL EXCRETION VALUES OF PLUTONIUM FOLLOWING
INTRAVENOUS ADMINISTRATION TO HUMAN SUBJECTS
(EXPRESSED AS PER CENT OF DOSE EXCRETED PER DAY)

DAYS POST INJECTION	PER CENT OF INJECTED DOSE EXCRETED PER DAY											
	Hp-1	Hp-2	Hp-3	Hp-4	Hp-5	Hp-6	Hp-7	Hp-8	Hp-9	Hp-10	Hp-11	Chl-12
1	.052*	.204	.018*	.134	.004*	.085	.147	.178	.333	.087	.370	.350
2	.221	.204	.157	.274	.311	.085	.120	.206	.369	.087	.370	.488
3	.241	.204	.157	.274	.311	.176	.087	.210	.329	.087	.297	.294
4	.050	.317	.099	.306	.185	.179	.080	.080	.131	.110	.163	.380
5	.105	.046	-	.070	.126	.110	.055	.080	.131	.110	.163	.116
6	.021	.120	.070	.126	.064	.037	.055	.080	.131	.110	.020	.083
7	.021	.120	.070	.126	.064	.037	.055	.070	.131	.034	.020	.112
8	.021	.120	.070	.126	.064	.037	.055	.070	.131	.034	.020	.112
9	.021	.120	.070	.126	.064	.037	.055	.070	.131	.034	.020	.112
10	.021	.120	.070	.126	.064	.037	.055	.070	.131	.034	.020	.112
11	.016	.084	.027	.117	.052	.023	.032	.070	.116	.034	.020	.021
12	.016	.084	.027	.117	.052	.023	.032	.070	.116	.034	.020	.083
13	.046	.084	.027	.117	.052	.023	.032	.045	.116	.034	.020	.045
14	.046	.084	.027	.117	.052	.023	.032	.045	.116	.034	.020	.045
15	.035	.062	.023	.085	.032	.023	.032	.045	.116	.034	.020	.044
16	.035	.062	.023	.085	.032	.023	.032	.045	.116	.034	.020	.044
17	.035	.062	.023	.085	.032	.023	.032	.045	.116	.034	.020	.044
18	.035	.062	.023	.085	.032	.023	.032	.045	.116	.034	.020	.044
19	.015	.055	.016	.028	.017	.015	.016	.025	.055	.012	.053	.037
20	.015	.055	.016	.028	.017	.015	.016	.025	.055	.012	.053	.037
21	.015	.055	.016	.028	.017	.015	.016	.025	.055	.012	.053	.037
22	.015	.055	.016	.028	.017	.015	.016	.025	.055	.012	.053	.037
23	.017	.022	.006	.026	.010	.008	.045	.045	.043	.006	.016	.018
24	.017	.022	.006	.026	.010	.008	.045	.045	.043	.006	.016	.018
25	.023	-	-	.008	.009	.052*	.066	.028	.028	.028	.028	.028
26	.021	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
27	.021	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
28	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
29	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
30	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
31	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
32	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
33	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
34	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
35	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
36	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
37	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
38	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
39	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
40	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
41	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
42	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
43	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
44	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
45	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
46	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028
47	-	-	-	.011	.009	.052*	.066	.028	.028	.028	.028	.028

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by Hamilton and co-workers (14) and it was not feasible to include their results. The present report of the fecal elimination of plutonium is, therefore, confined to twelve cases.

The means, revised means, and standard deviations for the daily fecal excretion of plutonium from 0 to 138 days post injection are given in Table 7 (Page 26). The best curve of fit for the observed means was established by the method of least squares and was found to be:

$$Y_f = 0.63 X^{-1.09} \quad [9]$$

with a standard error of estimate of 28 per cent. In the above expression Y_f is the amount of plutonium excreted in the feces on a specific day (expressed as per cent of the injected dose) and X is the day of measurement in days after injection. The agreement between the observed values and the derived expression is shown graphically in Fig. 4 (Page 28). In this figure the derived expression is represented by a heavy broken line and the observed points are represented as open triangles. The fecal excretion of plutonium in per cent of the injected dose excreted per day is plotted against time in days.

No representative fecal excretion data beyond 138 days were available from Los Alamos personnel because of small but significant contamination of feces from swallowed material removed from the lungs of the workers by ciliary action. One may ask why the small amount of lung contamination does not prevent the use of the urinary excretion results from these workers to adjust the 138 day urinary excretion curve to 1750 days. This material does not reach the absorbing area of the lung and is not absorbed, appreciably from the gastrointestinal tract (probably less than 0.01 per cent). The small amount of material which has reached the alveoli is being absorbed into the blood at an indigestible rate. Of the amount absorbed only a fraction of a per cent contributes to the daily urinary excretion.

Studies of the excretion of plutonium by mice, rats, rabbits and dogs (1), (2), (18), (19) showed the urinary excretion of all species was quite uniform. The plutonium excretion in the urine thirty to fifty days after injection was 0.01 - 0.02 per cent of the administered dose per day. The urinary/fecal excretion ratio varied widely, however, for the various species. The ratio was 1/10 - 15 for the rat and only 1/2 - 3 for the dog.

Russell and Nickson (13) reported a plutonium urinary/fecal excretion ratio of 3/1 in man based on the observation of one case through 140 days. The California group (14) reported an excretion ratio of 3-4/1 by one subject followed for 341 days.

The adjusted urinary excretion curve for 0 to 1750 days and the fecal excretion curve for 0 to 138 days may be solved for the urinary to fecal excretion ratio:

$$\frac{Y_{ua}}{Y_f} = \frac{0.20 X^{-0.74}}{0.63 X^{-1.09}} = 0.32 X^{0.35} \quad [10]$$

The urinary/fecal ratio is 1.8/1 at 138 days post injection and 4.4/1 at 1750 days when calculated from the above expression. Unfortunately no applicable fecal excretion data are available from the Los Alamos personnel to permit adjustment of the expression for fecal excretion beyond 138 days. If the urinary/fecal ratios at 138 and 1750 days are calculated from the unadjusted expressions (Y_u and Y_f) for both urinary and fecal excretion, the values are 1.7/1 and 3.9/1, respectively. Although extrapolation beyond 138 days is subject to increasing uncertainty with increasing values of X , the above values lead to the conclusion that the urinary/fecal plutonium excretion ratio is not constant, over the range (0-138 days) measured, but approaches 4/1 as a limit at some later time. The results obtained by Hamilton (14) on the case followed for 341 days seem to support the above conclusion.

The expression $Y_f = 0.63 X^{-1.09}$ gives the amount of plutonium (expressed as per cent of injected dose) excreted in the feces on a particular day (X) after injection. Integration of the expression between the limits of $X = 1/2$ and $X = n+1/2$ gives the total per cent (A_f)

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of the injected dose excreted through day n :

$$A_f = \int_{1/2}^{n+1/2} X^{-1.09} dx = -7.00 \left[(n+1/2)^{-0.09} - (1/2)^{-0.09} \right] \\ = -7.00 (n+1/2)^{-0.09} + 7.45 \quad [11]$$

From the above expression $A_f = 2.80$ per cent through the first 138 days.

3. Total Excretion (Urine plus Feces)

From the practical point of view, the total urinary plus fecal excretion rate of plutonium is extremely important. The summed elimination rate determines how long a worker should avoid further exposure to plutonium after having reached an accepted maximum permissible body level.

The observed mean urinary plus fecal plutonium excretion values are given in Table 7 (Page 26). Results are expressed as per cent of injected dose excreted per day. The means were obtained from the individual urinary excretion data from fifteen cases and the individual fecal excretion data from eleven. The results reported by the Chicago and California groups were used when available and applicable.

Application of the method of least squares gives the expression

$$Y_{u+f} = 0.79 X^{-0.84} \quad [12]$$

as the best curve of fit for the urinary plus fecal excretion data for 0 to 138 days. The standard error of estimate of the compilation is 17 per cent. Y_{u+f} is the total plutonium excreted in feces plus urine on a particular day (expressed as per cent of injected dose) and X is the time after injection in days.

The observed means and derived expressions are compared graphically in Fig. 4 (Page 28). Observed values are represented by squares and the derived expression by the heavy broken line designated Y_{u+f} .

The expression $Y_{u+f} = 0.79 X^{-0.84}$ represents the total excretion of plutonium only through the 138th day. Adjustment can be made, however, for urinary excretion measurements through 1750 days by summing the expression for fecal elimination [9] and the adjusted expression for urinary excretion [7].

$$Y_{ua+f} = Y_{ua} + Y_f = 0.20 X^{-0.74} + 0.63 X^{-1.09} \quad [13]$$

This equation is adjusted to include all urinary excretion results from Los Alamos Laboratory personnel through 1750 days, and gives the total per cent of an injected dose of plutonium which may be excreted on a given day (X) after the time of injection.

The adjusted expression for total elimination rate (Y_{ua+f}) through approximately five years and the observed means are presented graphically in Fig. 5 (Page 31) for comparison with the adjusted urinary excretion rate (Y_u) for the same time interval.

Integration of the adjusted expression for total elimination rate between $X = 1/2$ and $X = n+1/2$ days, gives the total amount of plutonium expected to be excreted up to and including day n

$$A_{ua+f} = \int_{1/2}^{n+1/2} X^{-0.74} dx + 0.63 \int_{1/2}^{n+1/2} X^{-1.09} dx \\ = 0.77 (n+1/2)^{-0.26} - 7.00 (n+1/2)^{-0.09} + 6.81 \quad [14]$$

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Table 10 compares the observed and calculated values of total plutonium excretion for various time intervals using the integrated expression [14]. These results emphasize the relatively slow rate of elimination of systemically deposited plutonium by man. According to these data only 8.7 per cent of a single injected dose is excreted in 1750 days (approximately 5 years).

TABLE 10
OBSERVED AND DERIVED TOTAL URINARY PLUS FECAL PLUTONIUM EXCRETION VALUES FOR VARIOUS TIMES AFTER ADMINISTRATION OF A SINGLE DOSE OF PLUTONIUM TO MAN

TIME AFTER INJECTION	PER CENT OF INJECTED DOSE	
	Observed	Calculated*
10 days	2.43	2.56
20 days	3.06	3.17
30 days	3.41	3.58
40 days	3.70	3.81
50 days	3.90	4.03
60 days	4.11	4.21
70 days	4.27	4.36
80 days	4.42	4.50
90 days	4.54	4.62
100 days	4.67	4.74
120 days	4.87	4.93
140 days	5.01	5.10
1 year		6.26
2 years		7.22
3 years		7.83
4 years		8.30
5 years		8.68
10 years		9.66
20 years		12.17

* Calculated from the integrated expression for adjusted urinary plus fecal excretion [14]. The calculated values appear higher than the observed values by a constant amount because of the decision to accept a poor curve fit during the first ten days (See Page 23).

IV. DISCUSSION

A. Distribution of Plutonium in Tissues and Organs of Man

Table 3 (Page 18) contains all available data (up to the time of this report) on the distribution of plutonium in the tissues and organs of man. These data were the results of analysis of a miscellaneous group of samples collected from seven human subjects. The subjects were elderly persons or persons suffering from an incurable chronic disease. The samples were often small and poorly representative and not obtained from the seven cases at comparable times after injection of the plutonium. These unavoidable difficulties must be recognized and accepted when considering the results. Despite the above difficulties, the data are extremely valuable as a supplement to a much greater and more reliable mass of data

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concerning the distribution of plutonium in the tissues and organs of laboratory animals. The data on man are in good agreement with results of similar studies in rats, mice, rabbits, and dogs. The good agreement permits the conclusion that there are no major differences in the quantitative distribution of plutonium in the tissues and organs of man and those of common laboratory animals with perhaps one exception - the liver. The results indicate that the retention of plutonium in the liver following its intravenous injection as Pu²³⁹-citrate complex and as plutonyl ion may be 20 - 40 per cent for man as compared to 10 per cent or less for rats. The "biological half-time" of plutonium in the liver of man is probably much greater than that for rats.

The average amount of plutonium found in vertebra, sternum and rib was 0.0063 per cent of the injected dose per gram of whole bone. Assuming vertebra, sternum and rib as representative of the entire skeleton, 66 per cent of the injected dose would be deposited in a 10 kg skeletal system (7 kg of bone, 3 kg of marrow) of a 70 kg man.

The observed concentration of plutonium in bone may be used to estimate the radiation dose received per gram of skeletal system when a "standard man" has accumulated the official maximum permissible plutonium body content of 0.5 μg (0.032 μc). Using the dosage rate formula: $\text{rep/day} = 54 \text{ CE}$ (where C = concentration of radioisotope in $\mu\text{c/g}$, E = energy of the radiation in Mev, and the rep = 93 crs/E), the radiation dosage received per gram of skeleton from 0.032 μc of plutonium is as follows:

$$\text{rep/day} = 54 \times 6.6 \times 10^{-5} \times 0.032 \mu\text{c} \times 5.15 \text{ Mev} = .00057$$

A similar calculation for the official maximum permissible radium content of 0.1 μc may be made for comparison. If 50 per cent of the radon from radium decay is retained in the body, then approximately 15 Mev of energy will be re-radiated in the body by the alpha particles per decay. If 100 per cent of the radium is deposited in a 10 kg skeletal system, then the radon dosage in rep per day is given as follows:

$$\text{rep/day} = 54 \times 1 \times 10^{-5} \times 15 = 0.0081$$

According to the above calculation, the radiation dosage per gram of skeleton delivered by 0.1 μg of radium would be 14 times that delivered by the maximum permissible dose of plutonium if the two materials were distributed in a comparable manner in the skeleton. Autoradiographic studies show conclusively, however, that radium and plutonium do not distribute in a comparable manner. Plutonium is more localized and concentrates in the endosteal and periosteal surfaces. The choice of a more conservative body tolerance dose for plutonium was made to allow for its more specific localization in the skeletal system. It should be noted, however, that radium does not distribute uniformly throughout bone and Evans (20) has reported that analyses of bone samples from radium cases showed the radium to be unevenly distributed by as much as a factor of 10. It may be necessary, therefore, for plutonium to be concentrated by a factor of 140 over radium in order that 0.5 μg will give radiation intensities comparable to that which may occur with 0.1 μg of radium. Evans (21) has also pointed out that the presence of mesothorium in the radium responsible for the early radium poisoning cases may account for an additional safety factor of 5 in the 0.1 μg radium tolerance.

The above discussion supports the possibility that the 0.5 μg maximum permissible tolerance dose for plutonium is extremely conservative.

B. "Biological Half-Time" of Plutonium in Man

The "biological half-time" of plutonium in man can be estimated from the excretion data presented in this report. Although the adjusted urinary plus fecal excretion curve is (empirically at least) logarithmic in nature, it appears that the curve approaches an exponential for longer times. Such an exponential curve would be in keeping with the assumption that

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metabolic processes are primarily first order reactions. Whatever the true process is, from the data and curves given in this report, it is possible to calculate the absolute minimum half-time of plutonium in the body. It is assumed (not unreasonably) that the excretion of the plutonium measured in terms of the amount in the body at a given time does not increase at some time. If one takes the last point on the combined urinary plus fecal excretion curve (a single value of the ordinate in Fig. 5) and assumes exponential excretion thereafter, an absolute minimum value is obtained for the biological half-time. On this figure, which is a plot of AC/Co versus adjusted curve shows that $0.001 \pm .00035$ per cent per day is zero slope. Examination of the adjusted curve shows that $0.001 \pm .00035$ per cent per day is excreted at 1750 days (approximately 5 years) after exposure. Up to five years 8.7 per cent of the total has been excreted. The time required to excrete an additional 41.3 per cent (assuming exponential excretion beyond 1750 days) is

$$41.3 \cdot 0.001 \pm 0.00035 = 41,300 \text{ days} = 113 \text{ years with limits of 84 and 175 years.}$$

Thus, the mean minimal biological half-time estimate is 118 years. From the above, one may conclude that the excretion coefficient is too small to be of any practical significance in determining the maximum permissible dose of plutonium or in permitting the return to work of an individual who has reached the maximum permissible body burden. Once a worker is retired from work with plutonium because of a maximum tolerance exposure, it must be assumed that he is retired from such work for the balance of his lifetime.

C. Determination of Plutonium Body Burden from Urinary Excretion

In the determination of exposure doses by the use of excretion data, one is primarily concerned with three different situations. First is the case of a single acute exposure dose occurring at a known time. Second is the case of a variable chronic or subacute dose with only the total exposure time being known. Third is the case of a chronic invariant (usually low level) exposure dose with the time limits known.

The evaluation of the single acute exposure dose occurring at a known time is the basis of this paper. A urinary excretion curve through 138 days after a single acute exposure is given in Fig. 4 (Page 28). This curve has been extended beyond the observation limit to 1750 days (Fig. 5) by applying data collected on exposed personnel from the Los Alamos Laboratory. The method used to apply these data was explained earlier (Pages 23 and 29). It is worth noting that the difference between the adjusted curve and the extrapolated 138-day curve at 1750 days is less than the standard error of estimate of the former. This finding allows more confidence in further extrapolation beyond 1750 days post exposure. The calculation of the body burden from a single acute exposure is simple.

Since

$$Y_{na} (B) = 0.20 X^{-0.74}$$

$$Y (c/m) = 0.0020 D_E X^{-0.74}$$

Then

$$D_E = .00Y (c/m) X^{0.74} \quad [15]$$

Thus, a single urine count, Y, made X days after an unknown, single acute exposure, D_E , determines D_E in counts per minute. The exposure dose in μC or μR is easily determined if the counting geometry, etc., is known.

In the Los Alamos exposures, we have an illustration of the variable chronic exposure case with known time of exposure. Only under conditions of stress when safety factors of design may be exceeded will this type of exposure be seen. There are three methods of

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estimating the total exposure 'see under such conditions. Past practice at the Los Alamos Laboratory was to assume that an individual contracted his total exposure dose on the last day of the exposure period. His total body burden was then determined by substitution in the urinary excretion formula as shown above. In this case, zero time is the last day of exposure. Obviously this method gives too low a value for the exposure dose as the estimated dose is directly proportional to time. A second method which has been used is exactly the same as the previous one except that zero time is taken as the first day of exposure which assumes that all of the dose was accumulated on exposure day one. It is evident that this estimate of total exposure is too high. The third method, which was used in this paper to determine the adjusted urinary excretion curve, is believed to more closely approximate the true situation. In this method it has been assumed that the total exposure dose may be represented by a single effective dose occurring at some effective time intermediate to the limits of exposure. The equations and steps to be followed with this method are shown on Pages 23 and 29. Ordinarily the first urine count is used to determine whether an individual should or should not be withdrawn from exposure. It is not used as one of the two significantly different dose determining counts. This is due to the fact that the initial withdrawal count may reflect the high urinary excretion resulting from the previous ten days exposure, and to the relatively high per cent excretion during the first 10 days post-exposure period. The high rate of elimination resulting therefrom may relatively obscure any exposure doses accumulated previous to that time.

The case of chronic invariant exposure is probably of primary interest. This is the type of exposure (within limits) that occurs in processing procedures in the plutonium industry in which air concentrations, etc., are rigidly controlled and the work is routine. An analysis of the general case is presented as follows:

If m = time of exposure in days, and
 n = days from the beginning of an exposure to the time a urine analysis is made
 then the counts per minute in the urine excreted on day n is:

$$Y_n = 0.0020 [D_1 n^{-0.74} + D_2 (n-1)^{-0.74} + D_3 (n-2)^{-0.74} + \dots + D_m [n-(m-1)]^{-0.74}]$$

where D_1 is the exposure dose in counts per minute on exposure day 1,
 D_2 is the exposure dose in counts per minute on exposure day 2,
 \dots
 D_m is the exposure dose in counts per minute on exposure day m .

Considering the case in which we are interested, namely, $D_1 + D_2 + \dots + D_m = D_j$ (the constant daily exposure dose), then

$$Y_n = 0.0020 D_j [n^{-0.74} + (n-1)^{-0.74} + \dots + [n-(m-2)]^{-0.74} + [n-(m-1)]^{-0.74}]$$

$$D_j = \frac{Y_n}{0.0020 [n^{-0.74} + (n-1)^{-0.74} + \dots + [n-(m-2)]^{-0.74} + [n-(m-1)]^{-0.74}]}$$

Thus

Considering the bracketed term in the denominator:

$$n^{-0.74} + (n-1)^{-0.74} + \dots + [n-(m-1)]^{-0.74} = (n-m+1)^{-0.74} + (n-m+2)^{-0.74} + \dots + n^{-0.74}$$

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r^n term is similar to the infinite series r^n where r has the limiting values $(n-m+1)$ and (n) and $r = 0.74$. The sum of the series r^n may be written:

$$\sum_{r=1}^n R = \frac{1}{r^{0.74}} + \frac{1}{2^{0.74}} + \frac{1}{3^{0.74}} + \dots + \frac{1}{R^{0.74}}$$

Thus we may write:

$$(n-m+1)^{-0.74} + (n-m+2)^{-0.74} + \dots + n^{-0.74} = \sum_{r=n}^{r=n-m+1} \frac{1}{r^{0.74}}$$

$$= \sum_{r=1}^{r=n} \frac{1}{r^{0.74}} - \sum_{r=1}^{r=n-m} \frac{1}{r^{0.74}} = \sigma(n) - \sigma(n-m)$$

and on substitution

$$D_j = \frac{130 Y_n}{0.002 [\sigma(n) - \sigma(n-m)]}$$

The following empirical formula is good to 2 parts in 50 for $r = 1$ and to better than 1 part in 1000 for $r = 5$:

$$\sigma(r) = 3.8462 (r+1/2)^{0.26} - 3.2880$$

Thus, on substitution we have:

$$D_j = \frac{130 Y_n}{0.002 [3.8462(n+1/2)^{0.26} - 3.8462(n-m+1/2)^{0.26}]}$$

or

$$D_j = \frac{130 Y_n}{[(n+1/2)^{0.26} - (n-m+1/2)^{0.26}]}$$

Since the total exposure dose = $mD_j = T_{D_m}$

$$T_{D_m} = \frac{130 m Y_n}{[(n+1/2)^{0.26} - (n-m+1/2)^{0.26}]} \quad [17]$$

In addition to the empirical formula for $\sigma(r)$ a plot of the real values of $\sigma(r)$ versus (r) for values of r up to 50 days has been included (Fig. 6) from which the values of the sums may be read directly.

In the equation for T_{D_m} seven exposure days per week are assumed. The formula for T_{D_m} may be adjusted for six exposure days per week as follows:

Obviously the only days not contributing to exposure are those on which $D_j = 0$. In the six day week, therefore, $D_7 = D_{14} = D_{21} = \dots = D_{7a} = 0$ where $a =$ number of weeks worked by the subject. Thus, the terms corresponding to $D_7, D_{14}, D_{21}, \dots$ etc., must be subtracted from the dose equation.

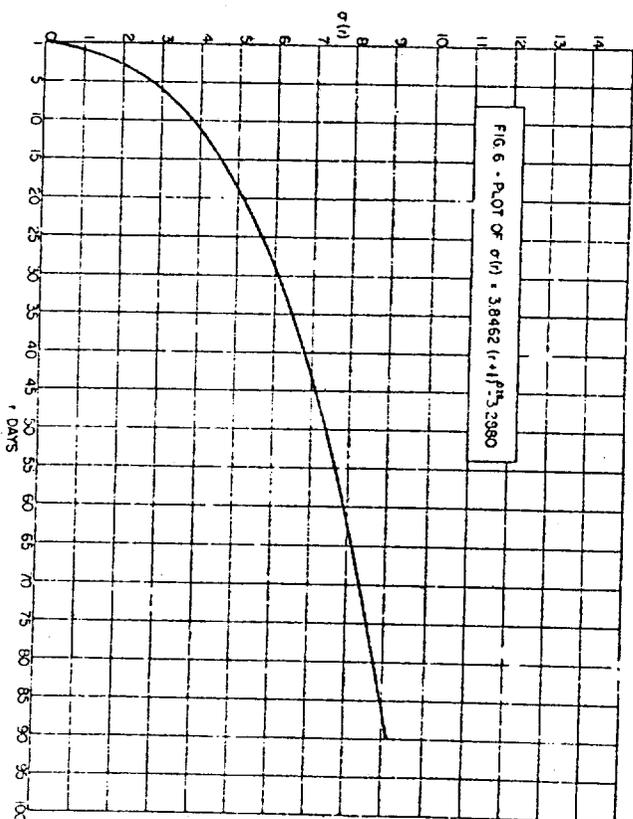
Determined by Bengt Carlsson of the Los Alamos Theoretical Division.

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Hence:

$$D_j = \frac{130 Y_n}{0.002 \left\{ \left[\sigma(n) - \sigma(n-m) \right] - \left[(n-6)^{-0.74} + (n-13)^{-0.74} + (n-20)^{-0.74} + \dots + (n-7a+1)^{-0.74} \right] \right\}}$$

And designating the total exposure dose for the six day week as T_{D_m6} then

$$T_{D_m6} = \frac{130 m Y_n}{500 m Y_n \left\{ \left[\sigma(n) - \sigma(n-m) \right] - \left[(n-6)^{-0.74} + (n-13)^{-0.74} + (n-20)^{-0.74} + \dots + (n-7a+1)^{-0.74} \right] \right\}} \quad [18]$$

Similarly for 5 exposure days per week

$$D_6 = D_7 = D_{13} = D_{14} = D_{20} = D_{21} = \dots = D_{7a-1} = D_{7a} = 0$$

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the total exposure dose $T_{Dm} = 500 m^2 n$

$$3.8402 \left[\frac{(n+1/2)^{-0.28} - (n-m+1/2)^{-0.28}}{(n-5)^{-0.74} + (n-6)^{-0.74} + (n-12)^{-0.74} + (n-13)^{-0.74}} + \dots + (n-7a+2)^{-0.74} + (n-7a+1)^{-0.74} \right]$$

In the preceding formulae exposure conditions were assumed to consist of an equal and constant daily exposure dose D_1 equivalent to a single injected dose. Also, the constants 0.0020 and -0.74 were empirically established on the basis of data available at the time of this report. These values may change as more data become available. In fact, the seven day exposure formula is a specific example of the application of the above dosage calculation is given below, using the expression for seven exposure days per week. Such would be the case if one considers that absorption from the lung is the primary source of contamination and that the equilibrium between the alveolar and blood plutonium concentration is not radically altered by one or two day period of no exposure each week.

For purposes of presenting a specific example we may assume the following conditions:
Duration of exposure (m) = 330 days
Duration of time from beginning of exposure until urine sample taken (n) = 380 days
Counts per minute of urine sample (Y_n) = 2 c/m
The total body dose T_{Dm} may be calculated from the formula:
 $T_{Dm} = 130 \times m \times Y_n$

On substitution:
 $T_{Dm} = \frac{130 \times 330 \times 2}{(380.5)^{-0.28} - (30.5)^{-0.28}} = \frac{8.58 \times 10^4}{2.19} = 3.9 \times 10^4 \text{ c/m}$

Assuming a 50 per cent counting geometry was used (1 $\mu\text{g} = 7 \times 10^4 \text{ c/m}$)
 $T_{Dm} = 0.56 \mu\text{g}$

V. SUMMARY

The distribution and excretion of plutonium administered intravenously to man has been studied. The data from twelve subjects have been correlated with similar data collected by other investigators, making a total of sixteen cases considered. The data have been supplied for use with observations made on three Los Alamos Laboratory personnel who administered measurable amounts of plutonium in the course of their work. The results of these studies may be summarized as follows:

1. Clinical observations and clinical data collected on the various subjects indicate that the intravenous injection of a single dose of 5 to 100 μg of plutonium is without acute subjective or objective clinical effects.
2. The analysis of tissues following the intravenous injection of plutonium in man that there was little difference in the mode of deposition of plutonium in man

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3. Concentration of plutonium in the blood following intravenous injection drops very rapidly; only 0.3 per cent of the total injected dose was fixed in the total blood volume thirty days after injection.
4. The urinary excretion of intravenously administered plutonium was not exponential. Curvilinear regression line fitting showed that the urinary excretion through 138 days was best expressed by the fractional logarithmic function
 $Y_u = 0.23 X^{-0.77}$

In this expression Y_u is the per cent of the injected dose excreted in a single day and X is the time of observation in days post-injection. The standard error of estimate is 32%.

5. The above expression for the urinary excretion through 138 days was adjusted by including data collected on Los Alamos Laboratory personnel. This adjustment permitted the development of an expression for the urinary excretion of plutonium through 1750 days. The adjusted expression is:
 $Y_{ua} = 0.20 X^{-0.74}$

The standard error of estimate of the adjusted expression is 42 per cent.

6. The excretion of plutonium in the feces likewise was not exponential. Application of the method of least squares showed the best curve of fit for the fecal excretion of plutonium through 138 days was:
 $Y_f = 0.63 X^{-1.08}$

In this expression Y_f is the per cent of the injected dose excreted on a specific day and X is the time of measurement in days post-injection. The standard error of estimate of the above expression is 28 per cent.

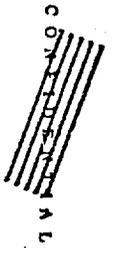
7. The urinary to fecal plutonium excretion ratio obtained by solution of the above expressions for urinary and fecal excretion showed the urinary to fecal ratio was not constant. It was essentially 1:1 at 30 days and approached 4:1 at approximately five years.
8. The total (urine and fecal excretion) through 138 days was best expressed by the equation:
 $Y_{u+f} = 0.79 X^{-0.94}$

9. The total urine plus fecal excretion through 1750 days could be approximated by adding the expression for the urinary excretion through 1750 days and the adjusted expression for the combined excretion is:
The expression for the combined excretion is:

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$$Y_{na,t} = 0.20 X^{-0.74} + 0.63 X^{-1.09}$$

In which $Y_{na,t}$ represents the per cent of the injected dose excreted in the urine plus feces on a specific day, and X designates the time of observation in days post-injection.

10. Integration of the above expression gives the following expression:
days post-injection gives the following expression:

$$A_{na,t} = 0.77 (n+1/2)^{-0.26} - 7.00 (n+1/2)^{-0.09} + 0.61$$

which represents the integrated amount of plutonium in per cent of the injected dose ($A_{na,t}$) excreted up to and including the nth day after injection. Substitution in this expression showed that only 8.7 per cent of a single injected dose was excreted in approximately five years.

11. Application of the data of this report to the calculation of the "biological half-time" of plutonium in man gives a mean minimal "biological half-time" estimate of 118 years, with a variation of from 84 to 175 years.

12. The urinary excretion data of this report were applied to the diagnosis of exposure of personnel to plutonium. Three sets of exposure conditions were considered:

- (a) The application of plutonium urine analysis to estimate the total body dose following a single acute exposure occurring at a known time,
 - (b) The application of plutonium urine analysis to estimate the total body burden of plutonium following variable chronic or sub-acute exposure with only the total exposure time being known and,
 - (c) The application of urine analysis to estimate the total body burden following chronic invariant exposure (such as may occur in a carefully controlled routine plant process) with time of exposure known.
- Expressions for the calculation of body dose under the conditions set forth in (a), (b) and (c) are included in this report.

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