Form AEC-313
8-64
10 CFR 30

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

Form approved.
Budget Bureau No. 38-R027

INSTRUCTIONS. – Complete Items 1 through 16 if this is an initial application or an application for renewal of a license. Information contained in previous applications filed with the Commisson with respect to Items 8 through 15 may be incorporated by reference provided references are clear and specific. Use supplemental sheets where necessary. Item 16 must be completed on all applications. Mail two copies to: U.S. Atomic Energy Commission, Washington, D.C., 20545, Attention: Isotopes Branch, Division of Materials Licensing. Upon approval of this application, the applicant will receive an AEC Byproduct Material License. An AEC Byproduct Material License is issued in accordance with the general requirements contained in Title 10, Code of Federal Regulations, Part 30, and the Licensee is subject to Title 10, Code of Federal Regulations, Part 20.

1. (a) NAME AND STREET ADDRESS OF APPLICANT (Institution, firm, hospital, person, etc. Include ZIP Code.)

Department of the Army
Fitzsimons General Hospital and Medical Research and Nutrition Laboratory, Denver, Colorado 80240

(b) STREET ADDRESS(ES) AT WHICH BYPRODUCT MATERIAL WILL BE USED. (If different from 1 (a). Include ZIP Code.)

Same as 1(a)
Fort Sam Houston, Texas and Summit of Pikes Peak, Colorado

2. DEPARTMENT TO USE BYPRODUCT MATERIAL

Bioenergetics Division
U.S. Army Medical Research and Nutrition Laboraty

3. PREVIOUS LICENSE NUMBER(S). (If this is an application for renewal of a license, please indicate and give number.)

Present application is for amendment to License No. 05-00046-13

4. INDIVIDUAL USER(S). (Name and title of individual(s) who will use or directly supervise use of byproduct material. Give training and experience in Items 8 and 9.)

RAYMOND F. BURK, M.D., CPT, MC

5. RADIATION PROTECTION OFFICER. (Name of person designated as radiation protection officer if other than individual user. Attach resume of his training and experience as in Items 8 and 9.)

As approved by Radioisotope Committee, Fitzsimons General Hospital and U.S. Army Medical Research and Nutrition Laboratory

6. (a) BYPRODUCT MATERIAL. (Elements and mass number of each.)

A. Carbon-14

(b) CHEMICAL AND/OR PHYSICAL FORM AND MAXIMUM NUMBER OF MILLICURIES OF EACH CHEMICAL AND/OR PHYSICAL FORM THAT YOU WILL POSSESS AT ANY ONE TIME. (If sealed source(s), also state name of manufacturer, model number, number of sources and maximum activity per source.)

A. Glucose-U (Liquid-Individual prepared doses) A. 1 Millicurie

7. DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED. (If byproduct material is for "human use," supplement A (Form AEC-313a) must be completed in lieu of this item. If byproduct material is in the form of a sealed source, include the make and model number of the storage container and/or device in which the source will be stored and/or used.)

See supplement 313a for human use

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(Continued on reverse side)

TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 *(Use supplemental sheets if necessary)*

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	Individuals will have appropriate training and experience prior to their approval by the Radioisotope Committee, Fitzsimons General Hospital and U. S. Army Medical Research and Nutrition Laboratory		Yes No	Yes No
b. Radioactivity measurement standardization and monitoring techniques and instruments			Yes No	Yes No
c. Mathematics and calculations basic to the use and measurement of radioactivity			Yes No	Yes No
d. Biological effects of radiation			Yes No	Yes No

9. EXPERIENCE WITH RADIATION *(Actual use of radioisotopes or equivalent experience.)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
		SAME AS 8		

10. RADIATION DETECTION INSTRUMENTS *(Use supplemental sheets if necessary.)*

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mr/hr)	WINDOW THICKNESS (mg/cm²)	USE (Monitoring, surveying, measuring)
See Radiation Detection Instruments USAMRNL APPENDIX III					

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.
As described in application for renewal of byproduct material license No. 05-00046-13 dated 25 June 1968.

12. FILM BADGES, DOSIMETERS, AND BIO ASSAY PROCEDURES USED. *(For film badges, specify method of calibrating and processing, or name of supplier.)*
See application for renewal of byproduct material license No. 05-00046-13 dated 25 June 1968.

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS IN DUPLICATE

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached *(Circle answer)* Yes No Same as 11 & protocol attached APPENDIX I

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source. Same as 11 & MRNL Regulation No. 40-14 Attached APPENDIX -II

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved. Section 20.303 of 10 CRF 20 and MRNL Regulation No. 40-14 attached will be complied with

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Dept. of the Army, Fitzsimons General Hospital & USAMRNL, Denver, CO. 80240
Applicant named in item 1

Date 5 January 1971

By: John B Campbell
JOHN B. CAMPBELL, MD., LTC, MC
Chairman, Radioisotope Committee
Title of certifying official

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WARNING.—18 U. S. C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

* U.S. GOVERNMENT PRINTING OFFICE : 1964 O—745-381

CURRICULUM VITAE

31 December 1970

CANHAM, John E. Colonel, MC

Position: Commanding Officer
U. S. Army Medical Research and Nutrition Laboratory
Fitzsimons General Hospital
Denver, Colorado 80240

Born: [redacted]

Married: [redacted]

Military Service:

May 1943 - Mar 1946 Enlisted Service
Jun 1949 - Jun 1950 Intern, Letterman General Hospital San Francisco, California
Jul 1950 - Aug 1950 Medical Resident, Letterman General Hospital, San Francisco, California
Aug 1950 - Feb 1951 TDY to FECOM assigned to 8th Station Hospital, Kobe, Japan. Duty involved care and treatment of patients with surgical and orthopedic conditions and the running of the X-ray department.
Feb 1951 - Dec 1953 Letterman General Hospital, Resident on the Medical Service
Jan 1954 - Jun 1956 Ward Officer, General Medical Service, USAH, Ft. Belvoir, Va.
Jul 1956 - Dec 1956 Student, AMSS, BAMC, Ft. Sam Houston, Texas (Advanced course)
Jan 1957 - Jul 1960 10th Field Hospital (USAH, Wurzburg, Germany)
Duty: Jan 1957 - May 1957 - Asst. Ch., Medical Service
May 1957 - Jul 1960, Chief of Medical Service
Additional Duties:
May 1957 - Jul 1960, Deputy Hospital Commander
Oct 1957 - Jul 1960, Chief of Outpatient and Health Services, Wurzburg Medical Service Area
Oct 1957 - Jul 1960, Chief of Preventive Medicine, Wurzburg Medical Service Area
Sep 1960 - Jun 1961 Biochemistry Dept., Medical School of Vanderbilt University, Nashville, Tenn. for a course entitled, "Nutrition and Metabolism".

DEPARTMENT OF THE ARMY
FITZSIMONS GENERAL HOSPITAL
Denver, Colorado 80240

SPECIAL ORDERS
NUMBER 218
EXTRACT

29 September 1970

25. TC 453. Following individual APPOINTED/DESIGNATED/CERTIFIED as indicated.

WHITE, CHARLES E [redacted] LTC Hq Comp FGH (WOQ2AA) MS

Authority: NA
Appointed as: Post Radiation Protection Officer
Period: NA Purpose: NA Effective date: 29 Sep'70
Special Instructions: (c) Vice King, Gerald A 077-32-0585 MAJ Hq Comp FGH (WOQ2AA) MC.

26. TC 453. Following individual APPOINTED/DESIGNATED/CERTIFIED as indicated.

KING, GERALD A [redacted] MAJ Hq Comp FGH (WOQ2AA) MC

Authority: NA
Appointed as: Alternate Post Radiation Protection Officer
Period: NA Purpose: NA Effective date: 29 Sep 70
Special Instructions: NA

27. TC 469. Following orders are changed as indicated.

Action: Revocation So much of: Para 35 SO 196 this Hq CS
Pertaining to: Convalescent Leave of FOX, ROBERT G [redacted] SP4 94B20 MHC FGH (WOQ2AA)

Action: Revocation So much of: Para 19 SO 215 this Hq CS
Pertaining to: Convalescent Leave of FOX, ROBERT G [redacted] SP4 94B20 MHC FGH (WOQ2AA)

28. TC 453. Following individuals APPOINTED/DESIGNATED/CERTIFIED as indicated.

STEVENS, CHARLES T	[redacted]	LTC	1542	MHC FGH (WOQ2AA)	IN
ROZANSKI, GORDON P		MAJ	Do	Do	Do
CARR, JAMES L		CPT	Do	Do	Do
POTTS, BRUCE		Do	3448	Do	AN
GRANT, DANIAL A		1LT	1542	Do	IN
JANKLOW, FREDRIC V		Do	1193	Do	FA
NELSON, CARL		Do	1542	Do	IN
PFEIFFER, RICHARD L		Do	1193	Do	FA
JOHNSON, KENT E		Do	0221	Hq Comp FGH (WOQ2AA)	SC

Authority: Chap 15 AR 37-103 and Appendix I FM 14-8
Appointed as: Class "A" Agent Officer to the F&A Officer FGH
Period: Sep 70
Purpose: To perform monthly cash and/or check payments of salaries to individuals assigned to MHC FGH (WOQ2AA)

Over, Para 28, SO 218, 29 Sep 70, FGH, Cont

8/20

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Page 1

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

SUPPLEMENT A—HUMAN USE

Form approved.
Budget Bureau No. 38-R080.1

If byproduct material is for "human use" (internal administration of byproduct material, or the radiation therefrom to human beings), complete this supplement and attach to the application for byproduct material license.

1. (a) USING PHYSICIAN'S NAME
RAYMOND F. BURK, M.D., CPT, MC

(b) NAME AND ADDRESS OF APPLICANT (If different from 1(a))
Same as Item 1(a) of AEC-313

2. THE USING PHYSICIAN INDICATED ABOVE IS LICENSED TO DISPENSE DRUGS IN THE PRACTICE OF MEDICINE BY A STATE OR TERRITORY OF THE UNITED STATES, THE DISTRICT OF COLUMBIA, OR THE COMMONWEALTH OF PUERTO RICO. CIRCLE ANSWER	(YES)	NO
3. A STATEMENT OF USING PHYSICIAN'S CLINICAL RADIOISOTOPE EXPERIENCE (PAGE 3 OF THIS SUPPLEMENT) IS SUBMITTED IN SUPPORT OF THIS APPLICATION. IF ANSWER IS NO, USE PAGE 2 OF THIS SUPPLEMENT TO EXPLAIN OR REFER TO OTHER APPLICATION OR RELATED DOCUMENTS ON WHICH THIS INFORMATION APPEARS. CIRCLE ANSWER	(YES)	NO

PROPOSED DIAGNOSIS OR TREATMENT

4. (a) DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED INCLUDING SPECIFIC CONDITIONS OR DISEASES TO BE DIAGNOSED OR TREATED (Use page 2 if necessary): To study glucose metabolism in health and disease and under a variety of experimental conditions. This study is designed to examine the effects of diet and altitude on carbohydrate metabolism of the metabolic responses to exercise.

(b) CHEMICAL FORM ADMINISTERED:
C^{14} labelled Glucose

(c) DESCRIBE PROCEDURES WHICH WILL BE OBSERVED TO MINIMIZE HAZARD FROM HANDLING, STORAGE, AND DISPOSAL OF THE BYPRODUCT MATERIAL:

See MRNL Regulation No. 40-14 attached

(d) DESCRIPTION AND SKETCHES OF SPECIAL DEVICES TO BE USED FOR ADMINISTERING BYPRODUCT MATERIAL TO HUMAN BEINGS ARE (1) ATTACHED (LITERATURE REFERENCES WILL SUFFICE) CIRCLE ANSWER	YES	(NO)
(2) ON FILE WITH THE ISOTOPES EXTENSION REFER TO APPLICATION NO _____ CIRCLE ANSWER	YES	(NO)

5. PROPOSED DOSAGE SCHEDULE
(a) In millicuries for internally administered byproduct material other than discrete fixed sources; and in roentgens or rads, as appropriate, for internal or external irradiation from discrete fixed sources (gold seeds, cobalt needles, etc.) state separately for each condition or disease (use page 2 if necessary):

Maximum of 30 microcuries per subject.

(b) INVESTIGATIVE PROPOSAL FOR EXPERIMENTAL, NEW OR UNUSUAL HUMAN USES IS ATTACHED. (Attachment should include outline of conditions to be evaluated, including data from animal studies and/or abstract of literature reference if any, number and type of patients (i. e. age group, moribund, etc.)) CIRCLE ANSWER	(YES)	NO

SEE PROTOCOL ATTACHED

6. IF BYPRODUCT MATERIAL WILL NOT BE OBTAINED IN PRECALIBRATED FORM FOR ORAL ADMINISTRATION OR IN PRECALIBRATED AND STERILIZED FORM FOR PARENTERAL ADMINISTRATION, DESCRIBE IDENTIFICATION, PROCESSING, AND STANDARDIZATION PROCEDURES:

Obtained in precalibrated form, (sterile and pyrogen-free). Will be administered to subjects by the above stated medical officer

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7. THE PROPOSED USE OF BYPRODUCT MATERIAL HAS BEEN, OR WILL BE, APPROVED BY THE MEDICAL ISOTOPE COMMITTEE. CIRCLE ANSWER	(YES)	NO

HOSPITAL FACILITIES FOR INDIVIDUAL PRACTICE USE ONLY

8. (a) THE APPLICANT HAS COMPLETED ARRANGEMENTS FOR A HOSPITAL TO ADMIT RADIOACTIVE PATIENTS WHENEVER ADVISABLE. CIRCLE ANSWER	YES	NO
(b) A COPY OF INSTRUCTIONS TO BE FURNISHED TO THE HOSPITAL AS TO RADIOLOGICAL SAFETY PRECAUTIONS TO BE TAKEN AND AVAILABLE RADIATION INSTRUMENTATION IS ATTACHED. CIRCLE ANSWER	YES	NO

TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 (Use supplemental sheets if necessary)

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	Vanderbilt Univ. Med. School	1 yr	(Yes) No	(Yes) No 1 Semester
b. Radioactivity measurement standardization and monitoring techniques and instruments	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 1 Semester
c. Mathematics and calculations basic to use and measurement of radioactivity	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 1 Semester
d. Biological effects of radiation	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 2 Semesters

9. EXPERIENCE WITH RADIATION. (Actual use of radioisotopes or equivalent experience.)

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
^{75}Se	10 mc	Vanderbilt Univ.	5 yrs.	Human scans and metabolic studies, animal studies
^{35}S	5 mc	Vanderbilt Univ.	3 mos.	Human plasma protein turnover studies

10. RADIATION DETECTION INSTRUMENTS. (Use supplemental sheets if necessary)

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mr/hr)	WINDOW THICKNESS (mg/cm^2)	USE (Monitoring, surveying, measuring)

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.

12. FILM BADGES, DOSIMETERS, AND BIO ASSAY PROCEDURES USED. (For film badges, specify method of calibrating and processing, or name of supplier.)

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS IN DUPLICATE

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached. (Circle answer) Yes No

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source.

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved.

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Raymond F. Burk, Jr.
Applicant named in item 1 RAYMOND F. BURK, JR.

Date 6 Sept 1970

By: John E. Canham
Title of certifying official
JOHN E. CANHAM, COL., MC, Commanding

WARNING.—18 U. S. C., Section 1001, Act of June 25, 1948; 62 Stat. 749, makes it a criminal offense to make a willf. USAMIML representation to any department or agency of the United States as to any matter within its jurisdiction.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—316-321

DEPARTMENT OF THE ARMY

For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office.

REFERENCE OR OFFICE SYMBOL	SUBJECT
MEDEN-AR	Radioisotope User Certification

TO: Recorder, Radioisotope Committee of FGH and USAMRNL

FROM: Radioisotope Branch, USAMRNL

DATE: 29 Sep 70

CMT 1

SFC Abernathy/dml/26111

1. Request that Raymond F. Burk, Jr., CPT., MC, be certified as a user of radioisotopes in human subjects under the conditions outlined in "Request for Approval for Human Use of Radioisotopes in Tracer Amounts in Volunteer Subjects", also for non-human use.

2. The maximum amount of radioisotopes that the individual may possess is in parenthesis following the name of isotope.

"A"	"B"
^{42}Potassium	(2 mc)
^{14}Carbon	(1 mc)
^{3}Tritium	(1 mc)
^{75}Selenium	(2 mc)
^{35}Sulfur	(1 mc)
^{131}Iodine	(1 mc)
^{51}Chromium	(1 mc)

3. A summary of the training and experience of this individual is attached. It is requested that this approval be made a permanent part of individual's 201 file.

Robert L. Morrissey

Incl
as

ROBERT L. MORRISSEY
CPT, V.C.
Chief, Radioisotope Branch

MEDEO-X (29 Sep 70)

TO: Ch, Military Personnel Br, Officer Records Section

FROM: Chairman, Radioisotope Committee

DATE: 10 Nov 70

CMT 2

rek/26218

1. The above-requested certification in the case of Cpt Raymond F. Burk, MC, is granted by the Radioisotope Committee, as noted in the minutes of their meeting held 13 October 1970.

2. It is requested that this DF, together with the attached documentation of training and experience, be made a permanent part of Cpt Burk's 201 file.

1 Incl
nc

JOHN B. CAMPBELL, M.D.
LTC, MC
Chairman, Radioisotope Committee

Form AEC-313 e (10-61) Page 3

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

SUPPLEMENT A—HUMAN USE

Form approved Budget Bureau No. 38-R0761

This page may be completed by the physician's preceptor (if any) in the medical use of radioisotopes. When the information is not furnished by the preceptor, the name and present address of the preceptor (if any) should be shown in item 12 below.

9. (a) USING PHYSICIAN'S NAME	(b) NAME AND ADDRESS OF APPLICANT (if different from 9(a))
Raymond F. Burk, Jr.	

10. CLINICAL TRAINING AND EXPERIENCE OF PHYSICIAN WHO WILL USE BYPRODUCT MATERIAL

(A) ISOTOPE	(B) CONDITION(S) DIAGNOSED OR TREATED	(C) NUMBER OF CASES	(D) TYPE OF PARTICIPATION FOR ALL CASES IN COLUMN B (circle applicable numbers of items in accordance with key set forth below)
I-131	Diagnosis of thyroid function	30	(1) (2) (3) 4
	Treatment of hyperthyroidism	2	(1) (2) 3 4
	Treatment of thyroid cancer		1 2 3 4
	Treatment of cardiac conditions		1 2 3 4
	Brain tumor localization	25	(1) 2 3 4
	Blood determinations	5	(1) 2 3 4
	Kidney function	5	(1) 2 3 4
	Others: Lung scans	25	(1) 2 3 (4)
P-32 Soluble	Treatment of polycythemia and leukemia	1	(1) 2 3 4
	Brain tumor localization		1 2 3 4
	Treatment of bone metastases		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
P-32 $CrPO_4$	Treatment of prostatic cancer		1 2 3 4
	Treatment of cervical cancer		1 2 3 4
	Treatment of pleural effusions and/or ascites		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Au-198 Colloid	Treatment of prostatic cancer		1 2 3 4
	Treatment of cervical cancer		1 2 3 4
	Treatment of pleural effusions and/or ascites		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Cr-51	Blood determinations	5	(1) 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Other Isotopes	Liver scans with gold & ^{131}I	40	(1) 2 3 4
	Parathyroid scan ^{75}Se-selenomethionine	1	(1) (2) 3 4
	Pancreas scan ^{75}Se-selenomethionine	5	(1) (2) (3) (4)
	Lymphoma scan $^{75}SeO_3$	1	(1) (2) 3 (4)

Key to above numbers (column D)

Active Participation and Discussion in the:

1. Examination of patients to determine suitability for radioisotope diagnosis and/or treatment and recommendations on dosage to be prescribed.
2. Collaboration in calibration and administration of dosages including related measurements and plotting of data.
3. Active period of training and experience of sufficient duration to permit followup of patients through treatment and posttreatment period including reevaluation as to effectiveness and complications.
4. Study and discussion of case histories to establish most efficacious diagnostic and/or therapeutic techniques for this radioisotope use.

11. TOTAL NUMBER OF HOURS OF PARTICIPATION IN CLINICAL TRAINING 200 hours

12. THE TRAINING AND EXPERIENCE INDICATED ABOVE WAS OBTAINED UNDER THE SUPERVISION OR GUIDANCE OF

A. B. Brill, M.D., Ph.D. (Name of physician (preceptor)) AT Vanderbilt Univ. (Institution)

Raymond F. Burk, Jr. (Signature)

CURRICULUM VITAE

Full Name: Raymond Franklin Burk, Jr.

Date of Birth: [redacted]
Height: [redacted]
Marital Status: [redacted]

Place of Birth: [redacted]
Weight: [redacted]
Children: [redacted]

Educational Record:

1963 B.A. University of Mississippi
1964 Johannes Gutenberg University in Mainz, Germany - 1 year (residenc
1968 M.D. Vanderbilt University

Research and Professional Experience:

1964-68 Summer and part-time research experience with Dr. W. N. Pearson in Nashville and Guatemala City

1968-69 Straight medical internship, Vanderbilt University

1969-70 1st year medical residency, Vanderbilt University

Administrative Background: None.

References: Dr. W. J. Darby, Nashville, Tennessee
Dr. Grant W. Liddle, Nashville, Tennessee

Publications:

R. F. Burk, W. N. Pearson and F. Viteri. Discussion of Selenium in Human Nutrition. Symposium: Selenium in Biomedicine, Avi Publ. Co., 1967.

R. F. Burk, W. N. Pearson, R. P. Wood II, and F. Viteri. Blood Selenium Levels and in vitro Red Blood Cell Uptake of ^{75}Se in Kwashiorkor. Am. J. Clin. Nutr., 20: 723-733, 1967.

R. F. Burk, R. Whitney, H. Frank, and W. N. Pearson. Tissue Selenium Levels during the Development of Dietary Liver Necrosis in Rats fed Torula Yeast Diets. J. Nutr., 95: 420-428, 1968.

Public Relations Experience: None.

Honors: Vanderbilt Borden Award in Nutrition, 1967.
Dean's Award for Student Research Presentation, 1968.

APPENDIX I

USAMRNL - Bioenergetics Division 14 January 1971

FINAL PROTOCOL

Project No.: 3A061102B71R Research in Biomedical Science

Task No: 05 Environmental

Work Unit No.: 080 High Altitude Bioenergetics

ST-13: Effects of Diet and Altitude on Carbohydrate Metabolism and the Metabolic Responses to Exercise (with Labelled Glucose)

INTRODUCTION

Recent studies in this laboratory (1,2,3,4) have dealt with metabolic derangements which develop in human subjects who are abruptly exposed to altitude. Attempts have also been made to evaluate the beneficial effects of a high carbohydrate intake and with heavy physical exercise on performance and severity of acute mountain sickness symptoms (AMS). Of particular importance is the demonstration that a high carbohydrate diet and heavy physical activity prior to rapid exposure of men to high altitude appear to diminish the AMS symptoms, and improve maximum physical performance. The mechanism by which high-carbohydrate-low-fat intakes and exercise influence the response of human subjects to high altitude remain to be elucidated. The following is a summary dealing with carbohydrate metabolism at altitude and the metabolic changes.

At altitude, the fasting blood sugar may or may not be altered, depending on whether animals or human subjects are used, the altitude level and acclimatization In cats, anoxemia increases the fasting blood sugar in the absence of excitement (5). In guinea pigs, reduction of barometric pressure to 340 millimeters of mercury does not alter the fasting blood sugar (6). In dogs, abrupt

exposure to high altitude does not appreciably alter the blood sugar (7,8). On the other hand, in man variable results have been reported by various investigators. At altitudes in the neighborhood of 15,000 feet, and ... somewhat acclimatized human subjects, the fasting blood sugar is not altered significantly (9,10,11,12). However, Picon-Reategui (13) showed in native residents of Morococha, at an altitude of 4540 m (14,900 feet), the fasting blood sugar was lower than at sea level. Similar findings were reported by San Martin (14) and Monge (15). Finally, several investigators (16,17,18,19) reported increments in fasting blood sugar at high altitude. The latter subjects were apparently poorly acclimatized to the altitude which was in excess of 15,00 feet.

As with fasting blood sugars, variable changes have been reported in glucose tolerance tests at high altitude. Forbes (19) performed oral glucose tolerance tests in three human subjects at an altitude of 5300 m. In two of the men who had been at this altitude for 17 days, glucose tolerance was increased. In the third man who had been at this altitude for only 6 days, glucose tolerance was lowered. Subsequent studies by Picon-Reategui (11), utilizing both oral and intravenous glucose tolerance, revealed a faster rate of glucose utilization in high altitude residents as compared with those at sea level. More recently, Janoski and Anderson (20) performed both oral and intravenous glucose tolerance tests on 10 normal human subjects at sea level and during residence at 14,100 feet. Results showed that at altitude the glucose disappearance was lower than the respective values at sea level. They also showed that insulin secretion was delayed at high altitude. It should be noted, however, that their subjects were semi-starved by choice while at altitude, and the decreased glucose tolerance may be a reflection of

semi-starvation rather than altitude. Most recent studies in the Bioenergetics Division of USAMRNL (21) reveal normal glucose tolerance in normal human subjects both at sea level and altitude when the intake of food remained high (in excess of 3100 Cal/day).

Turnover studies of glucose at high altitude have not been reported in the literature to date.

Picon-Reategui (11) performed insulin tolerance tests on human subjects who resided at an altitude of 4540 m. Results showed no changes in blood glucose, pyruvate and lactate during the tests. However, during insulin tolerance tests at altitude, plasma inorganic phosphate decreased more rapidly and plasma potassium less rapidly than at sea level. Interestingly enough, insulin reactions were reported less frequently in high altitude residents than in human subjects at sea level. Picon-Reategui (22) also showed a normal hyper-glycemic response to epinephrine but a subnormal response to glucagon in altitude residents.

Davidson (23) has summarized the effect of chronic exposure to actual or simulated high altitude on carbohydrate metabolism in both animals and human subjects. At altitude, compared to sea level controls, there is a smaller rise after glucagon and a greater fall after tolbutamide in plasma glucose concentrations, decreased liver glycogen after administration of cortisone, pyruvate and glutamate, and decreased venous (but similar arterial concentrations) during all glucose uptake or carbon dioxide production by rat diaphragms, using glucose alone or with insulin in the incubation medium. Furthermore, there was no significant difference in the insulin-glucose ratios between hypoxic and control rats. However, hypoxic animals had a fasting plasma glucose of 17 mg percent less than sea level controls.

These conflicting data about carbohydrate metabolism at altitude reflect incomplete knowledge of this area. In order to determine the metabolic effects of a high carbohydrate diet, it is necessary to elucidate the derangements in carbohydrate metabolism which result from abrupt exposure of human subjects to high altitude. One aim of this study is to delve into the problem at greater depth than has hitherto been reported.

OBJECTIVE

The first labelled glucose C^{14} study was approved and conducted in June 1970. This is a continuation of an approved study.

The immediate aims of the proposed study are to evaluate whether glucose metabolism is impaired during abrupt exposure of human subjects at high altitude (4300 m). The following parameters will be compared to sea level control data:

a. Intermixing glucose mass, apparent distribution space of glucose, and rates of appearance (hepatic output) and disappearance (tissue uptake) of glucose measured by the techniques of measured tracer injection of glucose-U-C^{14}.

b. Influence of physiologic dose of glucagon (1 microgram/kg body weight) on concentrations of plasma glucose and insulin.

c. The changes in acid-base blood parameters (pH, pCO_2 bicarbonate, etc., will be evaluated at various times of altitude exposure.

d. The evaluation of respiratory function parameters (especially FRC) during altitude exposure.

JUSTIFICATION

Two of the major problems encountered at high terrestial environments are the "mountain sickness" syndrome after abrupt altitude exposure, and the decreased ability to perform maximal physical work at altitude. These effects of altitude would seriously handicap our military personnel if they were engaged in any

conflict under these conditions. This study deals specifically with this problem, in attempting to determine why a high carbohydrate diet and heavy physical exercise will decrease the clinical symptoms of acute mountain sickness, and to investigate the derangements in carbohydrate and lipid metabolism at altitude.

EXPERIMENTAL DESIGN

Twenty-four normal male Army volunteers from Ft. Sam Houston, Texas will be studied. The criteria for acceptance of the subjects into the study included a normal, complete physical examination, including EKG's, the absence of prior exposure to high altitude, and a history of normal or average American food intake for at least two weeks prior to the beginning of the study.

The 12 subjects for the altitude phase will be housed in an air conditioned building at Ft. Sam Houston during the control phase. Six men will be transported to Denver and Pike's Peak at a time. Glucose turnover will be measured on 2 men after 2-3 hours of altitude exposure, the second 2 men after 20 hours of exposure, and the last 2 men after 42 hours of exposure. The major emphasis in the 1970 study was to measure the glucose activity after a glucose-C^{14} infusion. As a result, the 6 men were monitored for only a short period of time (20-30 min.) for the expired CO_2 production continuously will be extended. Two men will be infused at 180 min. intervals so that oxygen uptakes, CO_2 production and C^{14} respiratory excretion can be monitored for 140 min. after C^{14} glucose infusion, and for 30 min. after the glucagon infusion (Schedule 1). Three of the 6 men will be delayed at the Denver area for 3 hours so that the exposure and measuring time at altitude will be the same for each group of men. Bloods will be taken at various intervals for glucose, insulin and glucose activity (Schedule 1). The second group of men will be taken to altitude on day 4, and the same schedule will be followed.

Abnormal changes in arterial acid-base blood parameters have been observed during acute high altitude exposure, and are due to the respiratory alkalosis that occurs. Since high carbohydrate diets have been known to greatly reduce AMS, it is anticipated that these acid-base blood parameters may be normal under these conditions. Measurements will be taken at frequent intervals during acute altitude exposure. Arterialized finger blood samples will be drawn on each man during the control period, and twice daily during high altitude exposure. The hand will be warmed at 45°C for 5 min. prior to sampling of blood. These bloods will be analyzed for hemoglobin, pH, pCO_2, pO_2 and bicarbonate using the radiometer.

Functional residual capacities (FRC) and other measurements of respiratory function will also be done on each man during sea level control, and twice daily during high altitude exposure. The same measurements will be performed on the sea level control group during the same time intervals.

The first 2 men to be measured at altitude will breakfast at Ft. Sam Houston. They will then fast until the daily measurements are completed. All men measured at 20 and 42 hours of altitude exposure will be in a fasting state. All subjects will receive meals in the nearest military mess at FSH prior to the study beginning. The liquid ration containing 3000 Cal/day will be fed for 3 days prior to altitude exposure (control), and for a 3-day period at high altitude (TABLE I). The men will be encouraged to consume as much of the ration as possible. The daily intake of the sea level control group will be controlled by the exact consumption of his partner at high altitude. It will be a pair feeding study. The liquid diets will be offered in 4 equal meals to the altitude subjects: at 0730,

1100, 1600 and 2100 hours, except for the days that C^{14} glucose is administered. On these days, 3 equal meals will be offered at 1145, 1630 and 2100 hours. The 12 sea level subjects will be studied at corresponding times 2 weeks later at FSH.

This study will be conducted during the period of 7 May to 17 June 1971. The sea level control phase will be between 7 and 12 May; the altitude phase at Pike's Peak from 12 to 29 May, and the final phase on the control group at Ft. Sam Houston between 4 and 18 June 1971.

Glucose Turnover: The technique of measured tracer injection of glucose-U-C^{14} will be utilized to determine the intermixing glucose mass, apparent distribution space of glucose, and rate of glucose appearance into the disappearance from circulation. A single dose of 30 microcuries of high specific activity glucose-U-C^{14} will be injected intravenously after obtaining a blood sample in the fasting state. This dose is approximately 1/7 of the maximal recommended dose of C^{14} labelled glucose. Following injection of labelled glucose, blood samples will be obtained at 15, 25, 40, 55 and 65 minutes for determination of specific activity of plasma glucose as described by Sanbar (24). Curve fittings of the results of specific activity will be performed by an IBM Computer, and calculations will be carried out as described by Wrenshal and Hetenyi (25), and Forbath and Hetenyi (26). No other radioisotope will be administered to the subjects. Since the dose of radioisotope is relatively small, no special precautions will be utilized such as isolation of the subjects. However, the blood samples obtained from the subjects will be placed in non-breakable vials, and all contaminated solutions will be sent to the Radioisotope Branch for disposal. Urine and

fecal disposal will be done according to AEC regulations, although it is known that most of the labelled glucose (75%+) will be disposed of as $C^{14}O_2$ in the expired air (see inclosed request for an amendment permitting the use of C^{14} labelled glucose in human volunteers).

Glucagon Tests: This will be performed on the same day that glucose turnover is done. Exactly 140 minutes following administration of glucose-U-C^{14}, a single injection of glucagon (1 microgram/kilogram body weight) will be injected intravenously, and blood samples will be obtained at 1, 5, 10, 15, 20 and 30 minutes following the injection. The plasma will be analyzed for glucose specific activity, which will provide information regarding release of glucose by the liver, and measurements will also be made of plasma insulin.

Mental Attitude and Ability: (a) General High Altitude Mood Questionnaire - a check list that reflects attitude changes and symptoms of mountain sickness will be administered twice daily (at 0800 and 1700 hours) on each subject throughout the study. This questionnaire has proven to be valid in recent studies (27, 28), and will provide a final numerical value which may describe the degree of severity of the clinical symptoms. (b) Digit Symbol Substitution Test (Convergent Production): this test may be adversely affected by hypoxia (28, 29). It is intended to measure information processing ability when minimal pressure of constant attention is required.

Body Weight: Body weight will be taken on each man twice daily, immediately upon arising and after voiding, and at 1800 hours.

Preliminary Measurements for Standardization of Procedures: Prior to the beginning of this study, volunteers from Bioenergetics Division will receive an IV test dose of 30 uci of ^{14}-C-glucose to ascertain the maximal time requirement for obtaining the necessary data. A maximum of 6 men will be required for establishing the necessary information (monitoring of $^{14}C\ CO_2$, etc.) It is requested that permission be granted to infuse ^{14}C glucose into a maximum of 30 men (24 from Ft. Sam Houston and 6 from USAMRNL).

ADMINISTRATIVE

1. Division Responsibility: This will be a Bioenergetics Division study, with the collaboration of the Metabolic Division for the purchasing and preparation of the liquid diets.

2. Project Leaders: The project leaders will be C. Frank Consolazio, Chief, Bioenergetics Division; Herman L. Johnson, Ph.D., and Captain Raymond F. Burk, Jr., M.D., M.C.

3. Responsibility of the Welfare of the Human Subjects: The Medical Officer, CPT Raymond F. Burk, Jr., M.C., will be medically responsible for the health of the human subjects. The medical officer will be present during all phases of the study, and will have the authority to terminate all phases of the study if he has suspicions that continuation will result in injury, disability, or death to the volunteer subjects. CPT Burk's vita, experience and qualification for handling and infusing isotopes are included in APPENDIX III, and APPENDIX IV, respectively.

4. The Use of Radioisotopes at Ft. Sam Houston and Pike's Peak: Liaison will be established with the Radioisotope Branch, Brooks Army Hospital, San Antonio, Texas, regarding use of isotopes at Ft. Sam Houston,

and a request for monitoring for contamination of areas will be made. In the event that they do not monitor, equipment will be present (on loan from the USAMRNL Radioisotope Branch. Captain Burk and Dr. Johnson will monitor for contamination and decontaminate any required area. Assistance from the USAMRNL Radioisotope Branch will be requested for monitoring of the Pike's Peak Laboratory Facility to insure that no contamination has occurred after the study.

5. Costs:

a. Personnel salaries

CPT Burk, 100% for 4 weeks	$ 800.00
Dr. Johnson, 100% for 4 weeks	$1400.00
Mr. Consolazio, 25% for 4 weeks	$ 500.00
4 EM, 100 for 5 weeks	$2200.00
1 Civilian, 100% for 4 weeks	$ 650.00
1 Combined Maintenance	$ 224.00
	$5774.00

b. Travel

2 Investigators (site visit)	$ 220.00
8 Team Members	$ 880.00
6 Team Members	$ 660.00
12 Subjects	$1320.00
	$3080.00

c. Per Diem

1 Officer and 2 Civilians @ $25/day	$1050.00
2 EM to drive truck @ $25/day	$ 200.00
8 Team Members (Pike's Peak) @ $12/day	$ 384.00
12 EM @ $2/day	$ 312.00
	$2046.00

d. Class A Funds

Blood drawing, $25/subject	$ 600.00
Dry Ice for air shipment of samples, etc.	$ 400.00
	$1000.00

e.. Contract Funds

Truck Rental	$ 100.00
Car Rental	$ 800.00
Air shipment of equipment	$ 100.00
	$1000.00

f. Supplies

C^{14} Glucose	$ 800.00
Miscellaneous	$1000.00
	$1800.00

Grand Total $14,800.00

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7 Incls
1. Schedule 1
2. Schedule 2
3. TABLE I
4. APP I - Req for Approval
5. APP II - Vol Consent State
6. APP III - Curriculum Vitae
7. APP IV - Invest Experience

C. Frank Consolazio
C. FRANK CONSOLAZIO, Ch, Bioenergetics

Herman L. Johnson
HERMAN L. JOHNSON, Ph.D.

Raymond F. Burk, Jr.
RAYMOND F. BURK, JR., CPT, M.D., M.C.

Work Unit 080; ST 13

SCHEDULE 1

Expired CO_2 Production

Subject I	Subject II
Measure control for 15 min.	Keep 3 men at Denver altitude for 3 hrs.
Infuse C^{14} glucose	
Collect expired air for 140 min.	These have same schedule as Subject I.
Infuse glucagon	
Collect expired air for 30 min.	

Incl 1

Work Unit 0[illegible]0; ST 13

SCHEDULE 2

Blood Samples

Ø1	Control sample	→ glucose, insulin and growth hormone
	Glucose C^{14} infusion	
	15 min. after	→ glucose
	25	glucose activity
	40	insulin
	55	growth hormone
	70	
	105	
	135	
Infuse Glucagon		
	1 min. after	
	5	
	10	
	15	
	20	
	30	

Incl 2

TABLE I

Liquid Diets

Ingredients	grams/man/day
Sucrose	100
Meritene	200
Casec	45
Dextri Maltose	140
Corn Oil	135
NaCl	8
KCl	5
$MgSO_4$	2
Tween	3 drops
Distilled Water	1365 or 1765
Total	2000 or 2400

	per man/day	% of calories
Calories	3000	
Protein, g	105	13.7
Fat, g	136	40.0
Carbohydrate, g	354	46.3
Calcium	2.734	
Phosphorus	2.002	
Iron	0.032	

Work Unit 080; ST 13

APPENDIX I

A Request for an Amendment is Submitted Pertaining to the Use of C^{14} Labelled Glucose in Tracer Amounts in Volunteer Human Experimental Research Subjects

I. INTRODUCTION

In the "Request for Approval for Human Use of Radioisotopes in Tracer Amounts in Volunteer Experimental Research Subjects", submitted in 1968 by the U.S. Army Medical Research and Nutrition Laboratory, Denver, Colorado, for reconsideration and renewal of radioisotope license by the Atomic Energy Commission and the Office of the Surgeon General, detailed reference is made for use of C^{14} labelled carbohydrates.

The general health physics for Carbon-14 was described on page 6 of the request:

With regard to the proposed usage of labelled carbohydrates, the following statement was made on page 19, paragraph 3, of the request:

> "Studies on the interrelationship of various types of carbohydrates and other dietary components on serum triglyceride and cholesterol in the human have advanced to the state where tracer levels of common sugars are necessary to provide the desired information. Details as to procedures employed in the use of C^{14} labelled carbohydrates were included in the previous license".

The "previous license" included the following statement (page 14 of formerly approved request).

> "b. Request for Use of Carbon-14 to label Vitamin C and Related Compounds.
>
> Therefore, because of demonstrated usefulness and necessity of using tracer techniques to study metabolic pathways, the proposal is being made that tracer amounts of Carbon-14, as glucose-6-C^{14},

glucuronolactone-6-C^{14}, glucuronic-6-C^{14} acid and ascorbic-1-C^{14} acid be administered by mouth to humans in further studies for the purpose of measuring the pool size and the rate of utilization of body ascorbic acid under varying conditions. The subjects to be used will be military personnel (volunteering for the specific study) or laboratory personnel, both male and female, or Fitzsimons General Hospital personnel (as well as Fitzsimons General Hospital patients who volunteer). The possible hazards of the experiments will be explained in advance to all subjects. Although multiple experiments may be performed on individuals, in no case will the total body radiation dose from this experiment, other experiments, or from xrays, exceed the maximum permissible limits for normals of 5 rem per year (lower below age 25)."

II. SPECIFIC AMENDMENT REQUEST

The following amendment of the inclosed request is being sought:

That, in addition to what has been stated in the "Request for Approval for Human Use of Radioisotopes in Tracer Amounts in Volunteer Experimental Research Subjects", pertaining to C^{14} labelled carbohydrates, approval be granted for intravenous administration of a maximum of 50 microcuries of C^{14} labelled glucose per adult for purpose of studying glucose metabolism in health and disease and under a variety of experimental conditions.

A sterile and pyrogen-free solution of C^{14} labelled glucose will be injected intravenously in its pure form. All other safety standards will be followed as detailed in the inclosed 1968 request.

III. DOSAGE CONSIDERATIONS AND CALCULATIONS:

a. The maximum dose of 50 micro les of C^{14} labelled glucose to be administered per adult is well within officially approved dosage (maximum permitted is 300 microcuries) for study of metabolic processes in man as noted in reference 30, 31.

b. Since 1954, C^{14} labelled glucose has been used in human subjects to study glucose metabolism, and the following references are only 3 of a voluminous and well-known litereature on this subject (32, 33, 34).

c. According to Baker, et al. (32) and Bolinger, et al. (33), about 60% of C^{14} labelled glucose, injected intravenously, was expired in the first 4 hours as $C^{14}O_2$. About 90% of the label will appear in $C^{14}O_2$ in expired air within 72 hours after injection. Thus, the majority of injected glucose is oxidized to CO_2 and H_2O, mostly via breakdown to active acetate and entry into the Krebs cycle. In that regard, following the intravenous administration in man of 100 μc of acetate-1-C^{14}, Gould, et al. (35) reported that approximately 56% of radiocarbon was eliminated during the first 4 hours. On this basis, they assumed that less than 25 μc of C^{14} is "retained" in the "fat compartments" of the body following a single 100 μc dose. Inasmuch as the maximum permissible dose of C^{14} compounds retained in the body is estimated to be 450 μc (Handbook 52 of the National Bureau of Standards [36]), Gould and his co-workers felt justified in administering, over a period of several months, a maximum of five 100 μc doses of C^{14} acetate to human subjects without regard to their life expectancy. Radioautograph studies by Hellman and co-workers (37) of tissues obtained at postmortem examination from patients who had received 200 μc of C^{14} acetate also failed to disclose areas of concentration of the isotope.

d. The dose of radiation from 50 microcuries of C^{14} glucose is calculated, based on above information in the literature and using the formulae described elsewhere (38). If one assumes that all 50 microcuries of C^{14} glucose are retained in the body indefinitely (which of course is not the case), then -

$$d\beta = 51.2 \times C \times \bar{E}\beta \text{ rads (per day)}$$

where,

C = microcuries per gram body weight

= 50 μc/70,000 g for an average-size adult

E_β = average beta ray energy per disintegration in Mev

= 0.050 Mev for C^{14}

thus,

$$d_\beta = 51.2 \times \frac{50 \times 0.05}{70,000} = 1.83 \times 10^{-3} \text{ r/day}$$

(or 0.013 r/week)

Therefore, even if one assumes all 50 μc of C^{14} glucose are retained in the body, the radiation received from them will be within the permissible dose of 0.1 rem per week (39).

It must be emphasized; however, that the majority of the injected dose is excreted as $C^{14}O_2$ in expired air, as referenced earlier. Thus, each subject will receive a considerably less radiation dose from the 50 μc of C^{14} glucose than 1.83×10^{-3} r/day.

Assuming that 90% (45 μc) of C^{14} is excreted from the body and 10% (5 μc) retained indefinitely, each subject will receive a total life time dose of $.35 \times 10^{-3}$ rad from the 45 μc, and 1.83×10^{-4} r/day from the 5 μc retained in the body.

IV. USE OF GLUCOSE C^{14}:

Intravenous administration of C^{14} labelled glucose will be used to study:

a. Intermixing glucose mass.

b. Apparent distribution space of glucose, and

c. Rates of appearance (mostly hepatic output) and disappearance (tissue uptake) of glucose in human subjects exposed to altitude and various dietary and drug regimens, and in patients with metabolic disorders.

Each volunteer will sign a Voluntary Consent Statement. (Appendix II)

APPENDIX II

VOLUNTARY CONSENT STATEMENT

I, _____, having the legal capacity to consent, do hereby voluntarily consent to participate as a test subject in the experiment described in the protocol entitled "Effect of Altitude on Carbohydrate Metabolism and Metabolic Responses", a copy of which has been furnished to me and which I have read, studied, and fully understand after it was completely explained and discussed with me by _____.

I have been informed of the nature, duration, and purpose of the experiment and I fully understand the inconveniences and hazards to be expected from this experiment and the possible effects the experiment may have upon my health. Also, the medications, procedures, and devices including the infusion of glucose-U-^{14}C to be used in this experiment have been explained to me and I understand them in their entirety.

I understand that as a result of exposure to high altitude and the procedures employed in this study, I may experience any or all of the following symptoms: dryness of the mouth and nose, dizziness, tiredness, lack of appetite, thirst, a sense of well-being, sleepiness, nausea, runny nose, headache, hunger, sleeplessness, coughing, rapid heart beat, fatigue and st mach ache.

Knowing and understanding the above, I agree without reservation, to assume the risks and consequences involved by my participating in this research as an experimental subject.

I hereby agree to relinquish any and all claims of whatever kind and nature that I may hereafter have against the person or property of any personnel of the United States Government while they are acting in the scope of their employment in the conduct of this experiment.

Work Unit 080; ST 13

I hereby expressly reserve my rights to present any claims against the United States which may hereafter arise as a result of my participation as an experimental subject under the above described protocol.

I understand that at least one attending physician will be present during all tests or experiments in which I will participate and that he may terminate my participation as an experimental subject at any time and for any reason.

I also understand that I am free to revoke my consent and withdraw from the experiment at any time, for my own reasons and without prejudice.

To the best of my knowledge, I do not at this time have any mental or physical diseases or allergies, except for _____

_____.

_____ (Date)

_____ (Signature)

_____ (Witness)

_____ (Witness)

CURRICULUM VITAE

RAYMOND FRANKLIN BURK, JR. 12 August 1970

Personal

Born: [redacted]
Height and Weight:
Marital Status:

Educational Institutions Attended

1963 - B.A. - University of Mississippi
1964 Johannes Gutenberg University, Mainz, Germany
(1 year residence)
1968 - M.D. - Vanderbilt University, Nashville, Tennessee

Educational Background

1968-69 - Straight medical internship, Vanderbilt University.
1969-70 - 1st year medical residency, Vanderbilt University.

Research Background

1964-68 - Summer and part-time research experience with Dr. W.N. Pearson in Nashville, Tennessee and Guatemala City.

Administrative Background

None

Professional and Scientific Societies

Associate member of Society of the Sigma XI

References

Dr. W. J. Darby, Vanderbilt University, Nashville, Tennessee
Dr. Grant W. Liddle, Vanderbilt University, Nashville, Tennessee

Public Relations Experience

None

APPENDIX III

Incl 6

Curriculum Vitae - Raymond Franklin Burk, Jr., M. D.

Honors and Fellowships Received

1967 - Vanderbilt Borden Award in Nutrition
1968 - Dean's Award for Student Research Presentation

Publications

Burk, R. F., Jr., W. N. Pearson, and F. Viteri. Discussion of Selenium in Human Nutrition. Symposium: Selenium in Biomedicine, Avi Publishing Company, 1967.

Burk, R. F., Jr., W. N. Pearson, R. P. Wood II, and F. Viteri. Blood Selenium Levels and in vitro Red Blood Cell Uptake of ^{75}Se in Kwashiorkor. Am. J. Clin. Nutr. 20:723-733, 1967.

Burk, R. F., Jr., R. Whitney, H. Frank, and W. N. Pearson. Tissue Selenium Levels During the Development of Dietary Liver Necrosis in Rats Fed Torula Yeast Diets. J. Nutr. 95:420-428, 1968.

Sandstead, H.H., R.F. Burk, Jr., G.H. Booth, Jr. and W.J. Darby. Current Concepts of Trace Minerals: Clinical Considerations. Med. Clin. N. Am. 54:1509-1531, 1970.

INVESTIGATOR'S ISOTOPE EXPERIENCE

The investigator had a formal one-semester course on the use of radioisotopes in medicine and biology in 1965 at Vanderbilt University. The course was a graduate course, oriented toward research and was conducted by the biochemistry department.

Since 1965, the investigator has used ^{75}Se continuously in research activity and has administered it to human beings as indicated in APPENDIX I. Also, he has used ^{35}S similarly.

He holds the M.D. degree, and has practical experience with the clinical use of ^{131}I and ^{51}Cr, as well as Schilling tests and various scanning procedures.

While at his present duty station, he has administered ^{42}K to human beings to calibrate the whole-body counter in this division.

APPENDIX-11

U. S. ARMY MEDICAL RESEARCH AND NUTRITION LABORATORY
FITZSIMONS GENERAL HOSPITAL
DENVER, COLORADO 80240

MRNL REGULATION
NUMBER 40-14

15 July 1970

CONTROL AND HANDLING OF RADIOACTIVE MATERIAL

This regulation supersedes USAMRNL Standing Operating Procedure entitled "Procedures for Use of Radioactive Material" dtd. 1 March 1969.

MRNL REGULATION
NUMBER 40-14

15 July 1970

1. Purpose. The purpose of this regulation is to provide direction and guidance to all persons and activities producing, procuring, receiving, storing, using, disposing or transferring material that produces ionizing radiation, to insure the safe handling of radioactive materials within the USAMRNL.

2. Applicability.

a. This regulation is applicable to all persons assigned to the USAMRNL who utilize isotopes and the facilities of the Radioisotope Branch in the conduct of research projects.

b. The procedures outlined in this regulation are published for local use and must not be construed to be án amendment or change to any existing federal regulation, Army regulation, or hospital regulation governing the use of radioactive material.

3. Definitions.

a. Post Radiological Protection Officer.

An individual designated by the Commanding General, Fitzsimons General Hospital to provide consultation and advice on the degree of hazards associated with ionizing radiation and the effectiveness of measures to control these hazards throughout the entire post.

b. Radiological Protection Officer - USAMRNL.

An individual appointed by the Commanding Officer, USAMRNL and having the same functions as the Post RPO as affects the USAMRNL.

c. Principal User.

Those responsible investigators whose qualifications have been certified by the joint (FGH - USAMRNL) Radioisotope Committee as being technically qualified by virtue of education, training and/or rofessional experience to conduct research studies using radioactive isotopes.

4. Responsibilities.

a. The Commanding Officer of the USAMRNL is responsible for ensuring that measures are established to control ionizing radiation from any source so that the radiation dose to those individuals under his command will be no greater than the amount prescribed in AR 40-14.

b. The joint (FGH - USAMRNL) Radioisotope Committee has the responsibility of technical supervision over the handling and use of radioactive isotopes.

c. The Chief, Supply and Services Branch, USAMRNL is responsible for the procurement and receipt of radioactive material through Fitzsimons General Hospital in accordance with HR 40-602. Upon notification of arrival on post, the material will be picked up and delivered to the Radioisotope Branch, USAMRNL.

d. The Chief, Radioisotope Branch will direct the storage and handling of the contents of each shipment of radioactive material after it has been delivered to him or his designated representative in the Radioisotope Branch and is responsible for the maintenance of the records pertaining thereto. He is responsible for the handling and disposition of radioisotope contaminated liquid and solid wastes; area monitoring and supervision of the decontamination procedures in all areas under USAMRNL jurisdiction where radioactive isotopes are used, in accordance with the recommended procedures specified in Part 20, Title 10, C.F.R. and applicable Army regulations.

e. Principal users (responsible investigators) of radiation sources have the following responsibilities:

(1) Become thoroughly familiar with the contents of applicable regulations prior to the use of radiation sources.

(2) Research projects utilizing radioisotopes will be covered by protocols approved under existing USAMRNL regulations. The type, quantity, and method in which they will be used will be described. A copy of the approved protocol will be provided the Radioisotope Branch.

(3) Obtain and use radiation sources only as authorized by these regulations.

(4) Take precautionary measures to protect himself and others from unwarranted exposure to radiation.

(5) Seek advice and assistance from the Radiological Protection Officer when in doubt concerning the safety of an operation.

(6) Report to the Radiological Protection Officer of known or suspected overexposures. The overexposed individual shall cooperate in any and all attempts to evaluate his radiation exposure.

(7) Supervise and instruct all co-workers in the proper uses of radiation sources to insure safe working procedures.

(8) Maintain a current inventory within his Division of the quantity of radioactive material on hand in fractions of curies, to be readily available to the Radiological Protection Officer conducting the quarterly physical inventory of radioactive material.

5. Procedures.

a. Radioisotope Committee.

(1) The U. S. Army Medical Research and Nutrition Laboratory operates jointly with Fitzsimons General Hospital under the same General Atomic Energy Commission License. Use of radioisotopes, within the limitations of the AEC License, is controlled by a joint installation Radioisotope Committee. The persons making up the Radioisotope Committee and the functions of the committee are outlined in AR 40-37 and HR 15-1. The functions of the Committee are:

(a) Review protocols and grant permission for, or disapproval of, the use of radioactive material.

(b) Certify individual users for each type of procedure with each individual radioisotope and insure that a copy of such certification is placed in the appropriate user's 201 file. Maintain current records of the approved users, documenting the qualifications and limitations of each.

(c) Prescribe special conditions which may be necessary to include and give advice concerning proposed studies where it is needed.

(d) Review records and receive reports from the Radiological Protection Officer and recommend corrective action when indicated.

(e) Make recommendations for improvement of present laboratory facilities and for expansion of the laboratories in accordance with needs.

(f) Hold meetings at the call of the Chairman and report in writing to the Commanding General, FGH, the results of its deliberation.

b. Hazard Control.

(1) Permission for the use of radioactive materials under AEC General License in USAMRNL is granted only by the Radioisotope Committee. This permission may be denied or withdrawn from any investigator who, in the opinion of the Radioisotope Committee or on the advice of the Radiological Protection Officer, is inadequately trained in the handling and use of radioactive materials, or is guilty of any breach of discipline in the handling and use of radioactive materials so as to incur real or possible hazard to himself or others.

(2) The Chief of the Radioisotope Branch, USAMRNL, will instruct, direct, and supervise all individuals at USAMRNL working with or near radioactive materials in the observance of radiological safety. Safety of routine operations is the responsibility of principal investigators.

(3) Each individual working with radioactive material will be issued a film badge. Before a film badge is issued, each individual must read both CFR, Title 10, Part 20, and USAMRNL Regulation 40-14, and certify in writing that he had read and understands both.

(4) The safety rules listed hereinafter are to be observed, but it is emphasized that mere following of the rules will not eliminate all possible hazards associated with the handling of radioactive materials.

(5) The protection rules are based upon assumed long-term whole-body exposure to ionizing radiation by personnel whose duties involve regular handling of radioactive materials or regular use of x-ray equipment. These rules apply to all persons occupationally employed using any source of ionizing radiation in a controlled area or those incidentally exposed as a result of such use. A controlled area is one in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of a Radiological Protection Officer. (This implies that a controlled area is one that requires control of access, occupancy and working condition for radiation protection purposes.)

c. Safety Rules.

(1) In order to avoid undue exposure to ionizing radiation, unauthorized personnel will not enter the Laboratory of the Radioisotope Branch except when accompanied by an authorized person.

(2) Only persons specifically authorized to do so by the Radioisotope Committee will handle any shipment of radioactive material or any part thereof after it has been delivered to the Radioisotope Branch.

(3) Only persons specifically authorized to do so by the Radioisotope Committee will dispense or use a dose of any radioactive material.

(4) In all rooms where radioactive materials are being used, the following additional regulations are in effect:

(a) No eating or drinking, and no application of cosmetics.

(b) Smoking is not permitted while active material is being handled.

(c) Absolutely no mouth pipetting of radioactive material under any circumstances.

(d) Under no circumstances will radioactive waste be handled or disposed of by the janitorial staff.

(e) Rubber or protective gloves will be worn at all times when radioactive material is being handled, except sealed, or capped containers of radioactive materials.

(f) All gloves, protective clothing, instruments, and glassware will be placed in the appropriate receptacle to await decontamination.

(g) All contaminated glassware, instruments, pipettes, and waste incurred in any radioisotope experiment or study will be policed and placed in an appropriate receptable by the persons performing the experiment or study.

(h) At the end of each work period the hands will be carefully washed.

(i) Before placing radioactive material in any container, the container will be clearly labeled with radioactive caution tape of yellow and magenta to show the particular radioactive material, the concentration in microcuries or millicuries per unit volume or weight as of some particular date, and the identifying initials of the person preparing the material.

(j) Work surfaces will be covered with absorbent paper. The work in hoods will be similarly performed on absorbent paper. The work bench will be equipped with wiping papers for the prompt removal of spills.

(k) When using radioactive material, special equipment suitable for the type and level of activity being used will be used for each type of operation. This will include handling tools such as tongs, forceps, trays, and mechanical holders. When the isotopes concerned are beta emitters, efficient use can be made of transparent plastic shields.

(l) No individual will knowingly expose himself, or cause others to be unnecessarily exposed.

(m) All laboratory operations involving isotopes in Group III (below) will be conducted in hoods.

(5) Safe Handling Level For Some Representative Radioisotopes Authorized For Use in USAMRNL

GROUP I **No special handling required in normal laboratory procedures		GROUP II **Not dangerous, but unnecessary exposure is to be avoided		GROUP III **Dangerous, should be handled with utmost caution	
Isotope	Maximum Amount	Isotope	Maximum Amount	Isotope	Amount
Au^{198}	0.025 mc	Au^{198}	1.000 mc	Au^{198}	over 1.000 mc
Br^{82}	0.300 mc	Br^{82}	5.000 mc	Br^{82}	" 5.000 mc
Be^{7}	0.005 mc	Be^{7}	0.100 mc	Be^{7}	" 0.100 mc
* C^{14}Urea	0.050 mc	C^{14}Urea	1.000 mc	C^{14}Urea	" 1.000 mc
* C^{14} All Other	0.025 mc	C^{14} All other	1.000 mc	C^{14} All other	1.000 mc
Ca^{45}	0.005 mc	Ca^{45}	0.100 mc	Ca^{45}	" 0.100 mc
Co^{60}	0.025 mc	Co^{60}	1.000 mc	Co^{60}	" 1.000 mc
Cr^{51}	0.025 mc	Cr^{51}	1.000 mc	Cr^{51}	" 1.000 mc
Fe^{55}	0.005 mc	Fe^{55}	0.100 mc	Fe^{55}	" 0.100 mc
Fe^{59}	0.025 mc	Fe^{59}	1.000 mc	Fe^{59}	" 1.000 mc
* H^{3}Water	0.025 mc	H^{3}Water	10.000 mc	H^{3}Water	" 10.000 mc
* H^{3}Thymidine	0.001 mc	H^{3}Thymidine	0.050 mc	H^{3}Thymidine	" 0.050 mc
* H^{3}all other	0.005 mc	H^{3}all other	0.100 mc	H^{3}all other	" 0.100 mc
I^{131}	0.025 mc	I^{131}	1.000 mc	I^{131}	" 1.000 mc
Na^{22}	0.025 mc	Na^{22}	1.000 mc	Na^{22}	" 1.000 mc
P^{32}	0.025 mc	P^{32}	1.000 mc	P^{32}	" 1.000 mc

(Continued)

GROUP I **No special handling required in normal laboratory procedures		GROUP II **Not dangerous, but unnecessary exposure is to be avoided		GROUP III **Dangerous, should be handled with utmost caution		
Isotope	Maximum Amount	Isotope	Maximum Amount	Isotope		Maximum Amount
S^{35}	0.025 mc	S^{35}	1.000 mc	S^{35}	over	1.000 mc
Se^{75}	0.025 mc	Se^{75}	1.000 mc	Se^{75}	"	1.000 mc
Sr^{85}	0.025 mc	Sr^{85}	1.000 mc	Sr^{85}	"	1.000 mc
Sr^{89}	0.025 mc	Sr^{89}	1.000 mc	Sr^{89}	"	1.000 mc
Sr^{90}	0.005 mc	Sr^{90}	0.100 mc	Sr^{90}	"	0.100 mc
Zn^{65}	0.005 mc	Zn^{65}	0.100 mc	Zn^{65}	"	0.100 mc

* Group classification dependent upon chemical form.

** It must be remembered that these limits are by no means fixed and that any undue exposure is undesirable. Therefore, when working with the above radioisotopes, the physical characteristics, half-life, the internal and external hazard, and the radiative properties of the radioactive material must be considered. If in doubt, always consult the Chief, Radioisotope Branch.

d. Human Studies.

In the conduct of research studies involving the use of radioactive isotopes in humans, the principal investigator is guided by applicable government and military regulations, the current AEC license, U. S. Army Authorization and advice and counsel of the joint Radioisotope Committee.

e. Animal Studies.

Investigators conducting in vitro and/or animal studies involving the use of radioactive isotopes will be guided by applicable documents as above and in addition will provide, in their protocols, the specific areas in their divisions where isotopes are planned for use or storage, the housing area of animals, and waste disposition procedures.

f. Radioactive Waste.

(1) The Radiological Protection Officer is responsible for the disposal of all radioactive waste within USAMRNL. Such disposal

will be accomplished under all existing regulations listed in Part 20, Title 10, CFR, NBS Handbooks, and Army Regulations.

(2) Solid radioactive waste will be segregated into combustible and non-combustible. This waste includes such items as carcasses, fecal material, litter, scintillation counting vials, etc. It will be placed in a plastic waterproof disposable container then deposited in a second container marked with a radiation caution symbol with the wording, "Danger, Radioactive Material". When full, the outer container will be labelled as to content, isotope present, approximate amount of microcuries (millicuries), the date and investigators name. (The radiation level outside the container should not exceed 1.0 milliroentgens per hour). These waste containers will then be delivered to the Radioisotope Branch for disposition.

(3) Liquid waste including the pooled contents of the liquid scintillation counting vials will be placed in a plastic bottle and marked with radiation caution tape, isotope content, approximate amount of microcuries (millicuries) date of collection and investigators name. Pooling of vials maybe done in the individual sections; except, in those cases where the vapors from solutions may contain radioactivity, the pooling may be performed in the hood in the "high level" room in the Radioisotope Branch. These contaminated liquid waste bottles will then be delivered to the Radioisotope Branch for disposition.

(4) All clothing that is known or suspected of being contaminated with isotopes will be placed in a separate plastic container, appropriately labelled, and delivered to the Radioisotope Branch for proper disposition.

g. Decontamination of Glassware.

(1) All glassware which is utilized directly with radioactive material will be deemed "contaminated". The decontamination of such glassware is important not only in the interests of radiation safety but also to prevent the unintentional invalidation of subsequent experiments.

(2) Contaminated glassware will be delivered to the Radioisotope Branch for removal of the radioactive contaminant by ultrasonic means.

h. Radioactive Spill.

(1) All radioactive material, when spilled, constitutes a hazard, either to personnel or to equipment. If a spill of radioactive material occurs with Group I [5c(5)] isotopes, turn off all fans in the immediate area and notify all other personnel in the controlled

area. If the spill is liquid, drop absorbent paper on the spill and mark off the area with chalk or cord. If the spill is dry, proceed in the same manner, but convert the dry spill to liquid by applying wet absorbent paper over the area.

(2) If a spill of radioactive material occurs with Group II isotopes [5c (5)], hazard control is of first importance. In order to accomplish this, the person responsible for the spill will:

(a) Notify the Radiological Protection Officer or his designated representative.

(b) Be prepared to evaluate the hazard by knowing at all times which radioisotope is being handled, its chemical form, and the approximate amount being used (in millicuries or microcuries).

(c) See that all personnel in the area are notified and that they leave the immediate area of the spill without delay.

(3) In the event of a spill of radioactive material in Group III [5c (5)], the procedure listed for Group II above, will be carried out, plus the following:

(a) Determine the extent of personal contamination by inspection and monitoring of the involved personnel.

(b) Remove contaminated clothing.

(c) Rinse the contaminated body parts with water or the emergency shower if the spill took place in the high level room of the Radioisotope Branch, and then wash with soap and water, collecting the water for proper disposition. Monitoring the contaminated body part after each washing will be performed by personnel of Radioisotope Branch.

(4) Decontamination of the area of the spill will be carried out under the supervision of the Radiological Protection Officer, but only after the personnel contamination problem has been resolved. As a general rule, the work associated with the decontamination is performed by the person responsible for the spill.

(5) If ingestion or inhalation is suspected from a spill of radioactive material, TB MED 232 will be complied with, and report to the Chief, Radioisotope Branch for further processing and reporting of the incident.

i. Personnel Monitoring:

(1) Film badges are provided for persons working with radioactive material in USAMRNL. These film badges will be worn during normal working hours and are not to be removed from USAMRNL. Care of the film badge will be the responsibility of the individual user.

(2) Badges will be delivered to Radioisotope Branch monthly for shipment to the Lexington Signal Depot, Lexington, Kentucky for processing and reading. The returned values will be permanently recorded in Radioisotope Branch files on DD Form 1141 as a duplicate of the original recording which is maintained by custodian of medical records.

(3) A thorough medical examination will be made of each individual potentially exposed to significant amounts of radiation before employment and annually thereafter.

(4) Those persons working with millicurie amounts of Tritium will have urine checks for radioactivity within 15 days of termination of each experiment.

6. Functions of Radioisotope Branch

a. Procurement, storage and administration.

(1) All radioactive materials for use in USAMRNL will be processed by personnel of the Radioisotope Branch through official supply channels.

(2) The Radiological Protection Officer will direct the storage and handling of the contents of each shipment of radioactive material after it has been delivered to him or his designated representative in the Radioisotope Branch, and is responsible for the records pertaining thereto.

(3) The storage area will be neat and segregated by type emission. Gamma emitting isotopes will be stored so that the radiation level at the edge of the storage area does not exceed one milliroentgen per hour.

(4) The Radiological Protection Officer is responsible for the handling and disposal of all radioisotope contaminated liquid and solid wastes in or delivered to the Radioisotope Branch in accordance with the recommended procedures found in Part 20, Title 10, CFR, and pertinent Army regulations.

b. Radiation Safety Monitoring.

(1) Area Monitoring:

(a) Routine monitoring will be accomplished according to the following time schedule:

Weekly

(1) Radioisotope Branch (according to diagram in Appendix 1).

Monthly

(1) Research Divisions within US Army Medical Research and Nutrition Laboratory (According to diagrams in Appendix 1).

(b) Other areas will be monitored when deemed necessary by the Radiological Protection Officer, i.e. - Pikes Peak Laboratory Facility.

(c) Readings obtained during the surveys will be recorded and retained as a permanent record.

(d) Routine monitoring in USAMRNL (including blowers on roof above Radioisotope Branch) will be done, using a portable PAC3G gas proportional counter with a beta detection probe and a GM counter. If contamination is detected, the area will be immediately decontaminated. If the activity with the GM counter, exceeds a value of 2.0 milliroentgens per hour, the Radiological Protection Officer will be notified. The area will be marked as to reading in milliroentgens/hour and the working time limit.

(e) Swipe tests will be conducted during area monitoring and when contamination is suspected. The swipes will be counted in the liquid scintillation counters for quantitative determinations. Any activity above background will be considered a contamina ed area. Readings obtained will be recorded as a permanent record and responsible investigator notified.

(f) Any areas of previously undetected contamination will be promptly cleaned by those persons responsible for the contamination, under the supervision of the Radiological Protection Officer or his designated representative.

(2) Personnel Monitoring.

(a) In the event of a spill of radioactive material in Group III, the procedures outlined in par 5h(3) will be carried out and in addition, personnel of the Radioisotope Branch will perform the following procedures.

(1) Decontaminate the film badge (when necessary) and forward it by Air Mail Special Delivery to the Lexington Signal Depot; Lexington, Kentucky, with all data concerning the incident (i.e., isotope and its chemical form, amount involved, date, names, etc.).

(2) Carry out routine decontamination of clothing, work spaces, etc., which were involved.

(3) Notify the Surgeon General, Department of the Army, Washington, D. C., ATTN: MEDPS-PO, by telegram, of possible internal exposure. Complete DA Form 285 (Accident Report).

(4) In the event a potentially dangerous radioisotope is involved such as H^3, Ca^{45}, Fe^{55}, Sr^{90}, Y^{91}, Zr^{95}, Ce^{144}, Pm^{147}, or Bi^{210}, immediately notify The Surgeon General, Department of the Army, Preventive Medicine Division by telephone of:

(a) Time and date of incident.

(b) Millicurie strength of isotope and its chemical form.

(c) Name of individual and treatment already undertaken. Include a statement indicating the treatment rendered (or that no treatment has been rendered).

(d) Extent of individual contamination as determined by immediate monitoring.

(Telephone notifications will be confirmed by telegraphic notifications)

(5) A 24 hour urine sample will be collected under the direction of the Radiological Protection Officer from the person concerned. The collection shall be in a polyethylene liter bottle which will have a card attached containing the following data:

(a) Name, grade and SSAN

(b) Date of incident

(c) Inclusive dates of collection

(d) Isotope and chemical form

(6) The 24 hour urine sample will be collected as follows:

(a) Wash hands before collecting a portion of sample.

(b) Void urine at 0800 hrs (or any other convenient time) and discard it. Do not collect it in the bottle.

(c) Collect all urine from that time up to and including the corresponding hour the following day. ALL URINE MUST BE COLLECTED. LOSS OF A SIGNIFICANT AMOUNT WILL RENDER THE SAMPLE USELESS.

(7) Samples will be held until further instructions are received from the Surgeon General.

(8) If an overexposure to ionizing radiation occurs, DD Form 1141 (Report of Exposure to Ionizing Radiation) must be completed. A brief description of the condition of act which resulted in the overexposure will be attached to the DD Form 1141.

c. Decontamination of Glassware.

(a) Upon receipt of contaminated glassware in the Radioisotope Branch, it will be placed in the "hot" sink where it will be rinsed or washed with detergent if necessary then rinsed and placed in the ultrasonic bath. This includes pipettes and disassembled syringes although maximum use of disposable syringes and needles is suggested. Upon completion of the ultrasonic cleaning, the glassware may be oven or air dried.

(b) All glassware which has been decontaminated will be monitored by an appropriate detector. Always monitor after drying, never wet.

(c) All glassware which, upon monitoring, is still contaminated, will be recycled and will be properly discarded if decontamination is not complete after the second cleaning cycle.

d. Waste Disposal.

(1) Liquid waste disposition

(a) Contaminated liquid waste may be disposed of in the "hot" sink provided the quantity which, if diluted by the average daily quantity of sewage (sanitary sewage flow per 24 hours is 525,000 gallons) released into the sewer by the licensee, will not result in an average concentration in excess of values specified in Appendix B, Table I, Column 2 of CFR, Title 10, Part 20; (extracted applicale portion listed below); or

(b) Ten times the quantity of such material specified in Appendix C of same; and

(c) The gross quantity of licensed and other radioactive material released into the sewage system by the licensee does not exceed one curie per year.

Listed below is the quantity of any single radioactive isotope that may be released into the sewer in any one day. Daily maximums are listed for each isotope. In accordance with the Code of Federal Regulations, title 10, part 20.

Radioactive Material	Microcuries
Bromine-82	100
Calcium-45	100
Carbon-14	500
Chromium-51	500
Cobalt-60	10
Gold-198	100
Hydrogen-3	2500
Iodine-131	100
Iron-55	500
Iron-59	10
Phosphorus-32	100
Selenium-75	100
Strontium-85	10
Strontium-89	10
Strontium-90	1
Sulfur-35	500
Zinc-65	100

(d) Sewage disposal of liquid radioactive isotopes will be disposed of from the Radioisotope Section, Radiology Service, Fitzsimons General Hospital on Tuesdays and Fridays only, with all other days reserved for Radioisotope Branch, USAMRNL. Any deviation from this policy by either section will be cleared with the other Radioisotope Section before hand.

(e) All liquid radioactive waste disposal through the sanitary sewer at USAMRNL will be logged in Liquid Waste Disposal Log Book and activity listed in microcuries.

(2) Solid waste disposition

(a) Under no circumstances will waste be incinerated.

(b) Solid waste will be segregated into combustible and non-combustible waste and placed in properly labelled and lined fifty-five gallon sealable drums. These drums will comply with the requirements of the specific isotopes contained therein. See Code of Fed. Reg., Title 49, Jan 1969.

(c) Drums containing solid perishable waste, i.e. carcasses, tissues, etc., will be stored in a freezer prior to shipment.

(d) Instructions for shipping radioactive waste for proper disposition will be requested from:

Commanding Officer
U. S. Army Edgewood Arsenal
ATTN: SMUEA-ISDO
Edgewood, Maryland 21010

e. Logs and Records

(1) AEC Form 3 (Notice to Employees - Standards for Protection Against Radiation) will be posted in a conspicuous location.

(2) DD Form 1141 in accordance with AR 40-14 are prepared and maintained by the custodian of medical records, Fitzsimons General Hospital, duplicate copies for personnel in USAMRNL are retained in Radioisotope Branch.

(3) USAMRNL Regulation 40-14, the joint AEC license and U. S. Army authorization will be posted and readily available.

(4) Radioisotope inventory balance will be audited monthly. (Radioisotope inventory records are kept on Forms DA 8-235 and DA 8-212).

(5) Instrument logs will be maintained indicating calibration and maintenance of the portable survey instruments.

(6) Records of surveys (including swipe tests) will be kept.

(7) Caution signs, labels, and signals will be utilized according to CFR, Title 10, Part 20, para. 20.203.

(8) A report covering the period of each calendar quarter is prepared by the Commander of Fitzsimons General Hospital in accordance with AR 40-37. This report is dispatched to The Surgeon General, ATTN: MEDPS-PO, by the fifteenth working day following the close of the report period and contains the following information as a minimum:

(a) Copy of minutes of each Radioisotope Committee meeting, including a record of all actions taken by the Committee.

(b) Copy of the training and experience of each newly approved user of radioisotopes or any change in qualifications or certifications of previously approved users (for human use, AEC Form 313a, page 3).

(c) Radioisotope inventory, including data on quantities of radioisotopes procured, used, or disposed of, or currently in storage.

(d) Information on unsolved problems, new or improved developments, or other comments of interest to, or having a bearing on, support rendered by The Surgeon General.

(e) Notification of all changes in membership of Radioisotope Committee.

f. Other Routine Radioisotope Branch Procedures.

(1) Neatness in the laboratory is a prime requisite for elimination of the spread of contamination. The work area should be free of equipment and materials not required for the experiment at hand, and equipment used will be decontaminated and stored in a controlled location after use.

(2) At the end of each work period the hands will be washed and tested for contamination with an instrument of suitable sensitivity.

(3) The sinks in the laboratory portion of the Radioisotope Branch will not be used for purposes of performing personal toilet, except that the non-contaminated sinks may be used for the purpose of hand washing after the removal of protective gloves.

(4) No water for drinking purposes will be obtained from the laboratory portion of the Radioisotope Branch.

(5) Floors in the Radioisotope Branch will be cleaned frequently by wet mopping. Brooms and mops will not be transferred to other areas.

(6) Table tops, equipment, or any surface within the Radioisotope Branch will be kept clean. Under no circumstances will there be an accumulation of dust and/or possible contamination.

(7) Floors will be waxed and buffed on a monthly basis.

(8) Air conditioner filters, glove box filters, and hood filters will be checked quarterly and properly cleaned or replaced when necessary.

(9) Desiccant in the liquid scintillation counter will be checked weekly and changed when necessary.

(10) The emergency shower will be checked weekly.

(11) The portable survey meters will be calibrated at least every six months and after every maintenance procedure or battery change.

(12) Batteries in the portable survey meters will be checked monthly, and changed when necessary.

7. References:

Title 10 Code of Federal Regulations, Part 20

Title 49 Code of Federal Regulations

AR 40-14, 40-37, 70-25, 385-30, 700-15, 700-52, 711-16, 755-15

TB MED 232

FGH Reg. 15-1, 40-602, 40-604

USAMRNL Reg. 40-3

National Bureau of Standards Handbooks

No. 42 Safe Handling of Radioactive Isotopes

No. 47 Recommendations of the International Commission on Radiological Protection

No. 48 Control and Removal of Radioactive Contamination in Laboratories

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No. 49 Recommendations for Waste Disposal of Phosphorus-32 and Iodine-131 for Medical Users

No. 51 Radiological Monitoring Methods and Instruments

No. 52 Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water

No. 53 Recommendations for the Disposal of Carbon-14 wastes

No. 56 Safe Handling of Cadavers Containing Radioactive Isotopes

No. 59 Permissible Dose From External Sources of Radiation

FOR THE COMMANDER:

MARVIN G. KIECA
CPT, MSC
Adjutant

1 Incl
as

DISTRIBUTION
C
C, Radioisotope Br.
C, Sup & Svc Br.
Each Investigator

MRNL REGULATION
NUMBER 40-14

15 July 1970

APPENDIX I

Attached are the floor plans which are within jurisdiction of USAMRNL where Radioisotopes are planned to be used. The below listed areas and Divisional responsibilities follow:

Building 600

1st floor east - Chemistry Division
2nd floor east - Chemistry Division
2nd floor west - Physiology Division

Building 601

1st floor east - Surgery (Pathology)
1st floor west - Physiology Division
2nd floor east - Pathology Division
2nd floor west - Microbiology Division

Building 602

1st floor east - Bioenergetics Division
1st floor west - Animal Facility (Pathology)
2nd floor east - Chemistry Division
2nd floor west - Chemistry Division

Building 603

1st floor east - Radioisotope Branch

Building 619

1st floor west - Metabolic Division

Pikes Peak Lab Facility

Entire Laboratory - Division conducting experiment

Incl 1

RADIATION DETECTION INSTRUMENTS - USAMRIL

[redacted] 114

TYPE OF INSTRUMENTS	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE(mr/hr)	WINDOW THICKNESS (mg/cm^2)	USE
1. Packard Mod. 314EX Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
2. Packard Mod. 3375 Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
3. Packard Mod. 314E Auto-Gamma Scintillation Counting System	1	Gamma	N/A	N/A	measuring
4. Nuclear-Chicago Mod. 6801 Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
5. Nuclear-Chicago Mod. Mark I Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
6. Tracerlab Versa matic V Scaler with GM tube or Sodium Iodide Crystal	1	Beta, Gamma	N/A	150mg/cm^2	measuring
7. Atomic Ass. Chromatograph Plate Scaner	1	Beta	N/A	N/A	measuring
8. Nuclear-Chicago Survey Meter Mod. 2612	1	Beta, Gamma	0-200mr/hr	1.4mg/cm^2	surveying
9. IM-154/PDR-54 with Beta Probe Mod. AC-21B	1	Beta	N/A	0.85mg/cm^2	surveying
10. Nuclear-Chicago Labitron Mod. 1619A	2	Beta, Gamma	N/A	100mg/cm^2	surveying
11. Nuclear-Chicago Mod. 4351 Tobar Gamma Counting System	1	Gamma	N/A	N/A	measuring

TYPE OF INSTRUMENTS	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE(mr/hr)	WINDOW THICKNESS (mg/cm^2)	USE
12. Beckman Low Beta II	1	Alpha, Beta	N/A	80 ug/cm^2	measuring
13. Eberline Mod. PAC Mod. AC-2B	1	Beta	N/A	0.85mg/cm^2	surveying
14. Thyac III Victoreen GM-Scintillation Survey Meter Model 490 with GM Probe Model 489-4	1	Beta, Gamma	0-800.000cpm & 0-200mr/hr	30mg/cm^2	surveying
15. Packard Mod. 331A Tri-Carb Liquid Scintillation Spectrometer System	1	Alpha, Beta	N/A	N/A	measuring
16. Packard, Liquid Scintillation, Spectrometer, Mod. 3380	2	Alpha, Beta	N/A	N/A	measuring
17. Dosimeter, Tracer-lab, Pocket Chamber Mod. K-112	2	X-ray, Gamma	1-200mr/hr	N/A	measuring
18. Nuclear-Chicago Mod. 722. Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
19. Radiation Monitor Model RM-14 Eberline with Hand Probe Model HP-190	2	Alpha, Beta & Gamma	0-50,000cpm	1.4 to 2mg/cm^2	monitoring & surveying
20. Nuclear-Chicago Scintillation System, Model 4420	1	Gamma	N/A	N/A	measuring
21. Whole Body Shadow Shield Counter, W/sodium-iodide crystal and multi channel analyzer	1	Gamma	N/A	N/A	measuring

Form AEC-313
8-64
10 CFR 30

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

Form approved.
Budget Bureau No. 38-R027

INSTRUCTIONS. – Complete Items 1 through 16 if this is an initial application or an application for renewal of a license. Information contained in previous applications filed with the Commisson with respect to Items 8 through 15 may be incorporated by reference provided references are clear and specific. Use supplemental sheets where necessary. Item 16 must be completed on all applications. Mail two copies to: U.S. Atomic Energy Commission, Washington, D.C., 20545, Attention: Isotopes Branch, Division of Materials Licensing. Upon approval of this application, the applicant will receive an AEC Byproduct Material License. An AEC Byproduct Material License is issued in accordance with the general requirements contained in Title 10, Code of Federal Regulations, Part 30, and the Licensee is subject to Title 10, Code of Federal Regulations, Part 20.

1 (a) NAME AND STREET ADDRESS OF APPLICANT (Institution, firm, hospital, person, etc. Include ZIP Code.)

Department of the Army, Fitzsimons General Hospital
U. S. Army Medical Research and Nutrition Laboratory, Denver, Colorado 80240

(b) STREET ADDRESS(ES) AT WHICH BYPRODUCT MATERIAL WILL BE USED (If different from 1 (a). Include ZIP Code.)

Same as 1(a)

2 DEPARTMENT TO USE BYPRODUCT MATERIAL

Bioenergetics Division
U.S. Army Medical Research and Nutrition Laboratory

3 PREVIOUS LICENSE NUMBER(S). (If this is an application for renewal of a license, please indicate and give number.)

Present application is for amendment to AEC License No. 05-00046-13

4 INDIVIDUAL USER(S). (Name and title of individual(s) who will use or directly supervise use of byproduct material. Give training and experience in Items 8 and 9.)

RAYMOND F. BURK, MD., CPT, MC

5 RADIATION PROTECTION OFFICER (Name of person designated as radiation protection officer if other than individual user. Attach resume of his training and experience as in Items 8 and 9.)

As approved by the Radioisotope Committee, Fitzsimons General Hospital and U. S. Army Medical Research and Nutrition Laboratory

6 (a) BYPRODUCT MATERIAL (Elements and mass number of each.)	(b) CHEMICAL AND/OR PHYSICAL FORM AND MAXIMUM NUMBER OF MILLICURIES OF EACH CHEMICAL AND/OR PHYSICAL FORM THAT YOU WILL POSSESS AT ANY ONE TIME. (If sealed source(s), also state name of manufacturer, model number, number of sources and maximum activity per source.)
A. Selenium-75	A. Selenite (liquid-individual prepared doses) A. 2 millicuries

7 DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED. (If byproduct material is for "human use," supplement A (Form AEC-313a) must be completed in lieu of this item. If byproduct material is in the form of a sealed source, include the make and model number of the storage container and/or device in which the source will be stored and/or used.)

See supplement AEC Form 313a attached

(Continued on reverse side)

Form AEC-313 a (10-61) PAGE 1	UNITED STATES ATOMIC ENERGY COMMISSION **APPLICATION FOR BYPRODUCT MATERIAL LICENSE** SUPPLEMENT A—HUMAN USE	Form approved. Budget Bureau No. 38-R060.1

If byproduct material is for "human use" (internal administration of byproduct material, or the radiation therefrom to human beings), complete this supplement and attach to the application for byproduct material license.

1. (a) USING PHYSICIAN'S NAME	(b) NAME AND ADDRESS OF APPLICANT (If different from 1(a))
RAYMOND F. BURK, M.D. CPT, MC	Same as Item 1(a) of Form AEC-313

2. THE USING PHYSICIAN INDICATED ABOVE IS LICENSED TO DISPENSE DRUGS IN THE PRACTICE OF MEDICINE BY A STATE OR TERRITORY OF THE UNITED STATES, THE DISTRICT OF COLUMBIA, OR THE COMMONWEALTH OF PUERTO RICO. CIRCLE ANSWER	(YES)	NO
3. A STATEMENT OF USING PHYSICIAN'S CLINICAL RADIOISOTOPE EXPERIENCE (PAGE 3 OF THIS SUPPLEMENT) IS SUBMITTED IN SUPPORT OF THIS APPLICATION. IF ANSWER IS NO, USE PAGE 2 OF THIS SUPPLEMENT TO EXPLAIN OR REFER TO OTHER APPLICATION OR RELATED DOCUMENTS ON WHICH THIS INFORMATION APPEARS. CIRCLE ANSWER	(YES)	NO

PROPOSED DIAGNOSIS OR TREATMENT

4. (a) DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED INCLUDING SPECIFIC CONDITIONS OR DISEASES TO BE DIAGNOSED OR TREATED (Use page 2 if necessary):

SEE PAGE 2

(b) CHEMICAL FORM ADMINISTERED:

SEE PAGE 2

(c) DESCRIBE PROCEDURES WHICH WILL BE OBSERVED TO MINIMIZE HAZARD FROM HANDLING, STORAGE, AND DISPOSAL OF THE BYPRODUCT MATERIAL:

See MRNL Regulation No. 40-14 Attached

(d) DESCRIPTION AND SKETCHES OF SPECIAL DEVICES TO BE USED FOR ADMINISTERING BYPRODUCT MATERIAL TO HUMAN BEINGS ARE (1) ATTACHED (LITERATURE REFERENCES WILL SUFFICE) CIRCLE ANSWER	YES	(NO)
(2) ON FILE WITH THE ISOTOPES EXTENSION REFER TO APPLICATION NO _____ CIRCLE ANSWER	YES	(NO)

5. (a) PROPOSED DOSAGE SCHEDULE.—In millicuries for internally administered byproduct material other than discrete fixed sources; and in roentgens or rads, as appropriate, for internal or external irradiation from discrete fixed sources (gold seeds, cobalt needles, etc.) state separately for each condition or disease (use page 2 if necessary):

SEE PAGE 2

(b) INVESTIGATIVE PROPOSAL FOR EXPERIMENTAL, NEW OR UNUSUAL HUMAN USES IS ATTACHED. (Attachment should include outline of conditions to be evaluated, including data from animal studies and/or abstract of literature reference if any, number and type of patients (i. e. age group, moribund, etc.)) CIRCLE ANSWER	(YES)	NO

SEE PROTOCOL ATTACHED

6. IF BYPRODUCT MATERIAL WILL NOT BE OBTAINED IN PRECALIBRATED FORM FOR ORAL ADMINISTRATION OR IN PRECALIBRATED AND STERILIZED FORM FOR PARENTERAL ADMINISTRATION, DESCRIBE IDENTIFICATION, PROCESSING, AND STANDARDIZATION PROCEDURES:

Obtained in precalibrated form, (sterile & pyrogen-free)

21431

7. THE PROPOSED USE OF BYPRODUCT MATERIAL HAS BEEN, OR WILL BE, APPROVED BY THE MEDICAL ISOTOPE COMMITTEE. CIRCLE ANSWER	(YES)	NO

HOSPITAL FACILITIES FOR INDIVIDUAL PRACTICE USE ONLY

8. (a) THE APPLICANT HAS COMPLETED ARRANGEMENTS FOR A HOSPITAL TO ADMIT RADIOACTIVE PATIENTS WHENEVER ADVISABLE. CIRCLE ANSWER	YES	NO
(b) A COPY OF INSTRUCTIONS TO BE FURNISHED TO THE HOSPITAL AS TO RADIOLOGICAL SAFETY PRECAUTIONS TO BE TAKEN AND AVAILABLE RADIATION INSTRUMENTATION IS ATTACHED. CIRCLE ANSWER	YES	NO

TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 *(Use supplemental sheets if necessary)*

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	Individuals will have appropriate training and experience prior to their approval by the Radioisotope Committee, Fitzsimons General Hospital and U. S. Army Medical Research and Nutrition Laboratory		Yes No	Yes No
b. Radioactivity measurement standardization and monitoring techniques and instruments			Yes No	Yes No
c. Mathematics and calculations basic to the use and measurement of radioactivity			Yes No	Yes No
d. Biological effects of radiation			Yes No	Yes No

9. EXPERIENCE WITH RADIATION *(Actual use of radioisotopes or equivalent experience.)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
		SAME AS 8		

10. RADIATION DETECTION INSTRUMENTS *(Use supplemental sheets if necessary.)*

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mr/hr)	WINDOW THICKNESS (mg/cm²)	USE (Monitoring, surveying, measuring)
See radiation detection instruments attached. APPENDIX - 3					

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.
See application for renewal of byproduct material license No. 05-00046-13 dated 25 June 1968

12. FILM BADGES, DOSIMETERS, AND BIO-ASSAY PROCEDURES USED. *(For film badges, specify method of calibrating and processing, or name of supplier.)*
SAME as 11

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS IN DUPLICATE

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached. (Circle answer) Yes (No) SAME as 11 and attached protocol. APPENDIX - 1

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source. SAME as 11 and MRNL Regulation No. 40-14 attached. APPENDIX - 2

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved. Section 20.303 of 10 CRF 20. and MRNL Regulation No. 40-14 Attached will complied with

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Dept. of the Army, Fitzsimons Gen. Hosp. and USAMRNL, Denver, Colorado 80240
Applicant named in item 1

Date 5 Jan 1971

By: John B. Campbell
JOHN B. CAMPBELL, MD., LTC, MC
Chairman, Radioisotope Committee
Title of certifying official

WARNING.—18 U. S. C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

* U.S. GOVERNMENT PRINTING OFFICE : 1964 O—745-381

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

SUPPLEMENT A—HUMAN USE

Form approved.
Budget Bureau No. 38-R080.1

This page may be used for providing additional information. Please cross reference to specific items.

Items 4a, 4b, and 5a

ISOTOPE	FORM	PURPOSE	DOSAGE RATES
Selenium-75	Selenite	Determine site and nature of selenium-protein bond in human plasma to evaluate nutritional liver disease	up to 200 microcuries

U.S. GOVERNMENT PRINTING OFFICE : 1961 O-615865

DEPARTMENT OF THE ARMY

For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office.

SYMBOL	SUBJECT
MEDEN-AR	Radioisotope User Certification

TO	FROM	DATE	CMT 1
Recorder Radioisotope Committee of FGH and USAMRNL	Radioisotope Branch USAMRNL	29 Sep 70 SFC Abernathy/dml/26111	

1. Request that Raymond F. Burk, Jr., CPT., MC, be certified as a user of radioisotopes in human subjects under the conditions outlined in "Request for Approval for Human Use of Radioisotopes in Tracer Amounts in Volunteer Subjects", also for non-human use.

2. The maximum amount of radioisotopes that the individual may possess is in parenthesis following the name of isotope.

"A"	"B"
^{42}Potassium	(2 mc)
^{14}Carbon	(1 mc)
^{3}Tritium	(1 mc)
^{75}Selenium	(2 mc)
^{35}Sulfur	(1 mc)
^{131}Iodine	(1 mc)
^{51}Chromium	(1 mc)

3. A summary of the training and experience of this individual is attached. It is requested that this approval be made a permanent part of individual's 201 file.

Robert L. Morrissey

Incl
as

ROBERT L. MORRISSEY
CPT, V.C.
Chief, Radioisotope Branch

MEDEO-X (29 Sep 70)

TO Ch, Military Personnel Br, Officer Records Section | FROM Chairman, Radioisotope Committee | DATE 10 Nov 70 | CMT 2 rek/26218

1. The above-requested certification in the case of Cpt Raymond F. Burk, MC, is granted by the Radioisotope Committee, as noted in the minutes of their meeting held 13 October 1970.

2. It is requested that this DF, together with the attached documentation of training and experience, be made a permanent part of Cpt Burk's 201 file.

21431

1 Incl
nc

JOHN B. CAMPBELL, M.D.
LTC, MC
Chairman, Radioisotope Committee

TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 (Use supplemental sheets if necessary)

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	Vanderbilt Univ. Med. School	1 yr	(Yes) No	(Yes) No 1 Semester
b. Radioactivity measurement standardization and monitoring techniques and instruments	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 1 Semester
c. Mathematics and calculations basic to the use and measurement of radioactivity	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 1 Semester
d. Biological effects of radiation	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 2 Semesters

9. EXPERIENCE WITH RADIATION. (Actual use of radioisotopes or equivalent experience)

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
^{75}Se	10 mc	Vanderbilt Univ.	5 yrs.	Human scans and metabolic studies, animal studies
^{35}S	5 mc	Vanderbilt Univ.	3 mos.	Human plasma protein turnover studies

10. RADIATION DETECTION INSTRUMENTS. (Use supplemental sheets if necessary)

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mr/hr)	WINDOW THICKNESS (mg/cm²)	USE (Monitoring, surveying, measuring)

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.

12. FILM BADGES, DOSIMETERS, AND BIO-ASSAY PROCEDURES USED. (For film badges, specify method of calibrating and processing, or name of supplier.)

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS IN DUPLICATE

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached. (Circle answer) Yes No

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source.

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved.

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Raymond F. Burk, Jr.
Applicant named in item 1 RAYMOND F. BURK, JR.

Date 6 Sept 1970

By: John E. Cantrell
Title of certifying official JOHN E. CANHAM, COL, MC, Commanding, USAMRNL

WARNING.—18 U. S. C., Section 1001, Act of June 25, 1948, 62 Stat. 749, makes it a criminal offense to make a willful representation to any department or agency of the United States as to any matter within its jurisdiction.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1968 O—315-327

Form AEC-313 a (10-61) PAGE 3

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

SUPPLEMENT A—HUMAN USE

Form approved. Budget Bureau No. 38-R030.1

This page may be completed by the physician's preceptor (if any) in the medical use of radioisotopes. When the information is not furnished by the preceptor, the name and present address of the preceptor (if any) should be shown in item 12 below.

9. (a) USING PHYSICIAN'S NAME	(b) NAME AND ADDRESS OF APPLICANT (If different from 9(a))
Raymond F. Burk, Jr.	

10. CLINICAL TRAINING AND EXPERIENCE OF PHYSICIAN WHO WILL USE BYPRODUCT MATERIAL

(A) ISOTOPE	(B) CONDITION(S) DIAGNOSED OR TREATED	(C) NUMBER OF CASES	(D) TYPE OF PARTICIPATION FOR ALL CASES IN COLUMN B (circle applicable numbers of items in accordance with key set forth below)
I-131	Diagnosis of thyroid function	30	(1) (2) (3) 4
	Treatment of hyperthyroidism	2	(1) (2) 3 4
	Treatment of thyroid cancer		1 2 3 4
	Treatment of cardiac conditions		1 2 3 4
	Brain tumor localization	25	(1) 2 3 4
	Blood determinations	5	(1) 2 3 4
	Kidney function	5	(1) 2 3 4
	Others: Lung scans	25	(1) 2 3 (4)
P-32 Soluble	Treatment of polycythemia and leukemia	1	(1) 2 3 4
	Brain tumor localization		1 2 3 4
	Treatment of bone metastases		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
P-32 $CrPO_4$	Treatment of prostatic cancer		1 2 3 4
	Treatment of cervical cancer		1 2 3 4
	Treatment of pleural effusions and/or ascites		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Au-198 Colloid	Treatment of prostatic cancer		1 2 3 4
	Treatment of cervical cancer		1 2 3 4
	Treatment of pleural effusions and/or ascites		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Cr-51	Blood determinations	5	(1) 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Other Isotopes	Liver scans with gold & I^{131}	40	(1) 2 3 4
	Parathyroid scan ^{75}Se-selenomethionine	1	(1) (2) 3 4
	Pancreas scan ^{75}Se-selenomethionine	5	(1) (2) (3) (4)
	Lymphoma scan $^{75}SeO_3$	1	(1) (2) 3 (4)

Key to above numbers (column D)

Active Participation and Discussion in the:

1. Examination of patients to determine suitability for radioisotope diagnosis and/or treatment and recommendations on dosage to be prescribed.
2. Calibration and administration of dosages including related measurements and plotting of data.
3. Active period of training and experience of sufficient duration to permit followup of patients through treatment and posttreatment period including reevaluation as to effectiveness and complications.
4. Study and discussion of case histories to establish most efficacious diagnostic and/or therapeutic techniques for this radioisotope use.

11. TOTAL NUMBER OF HOURS OF PARTICIPATION IN CLINICAL TRAINING 200 hours

12. THE TRAINING AND EXPERIENCE INDICATED ABOVE WAS OBTAINED UNDER THE SUPERVISION OR GUIDANCE OF

A. B. Brill, M.D., Ph.D. (Name of physician (preceptor)) AT Vanderbilt Univ. (Institution)

Raymond F. Burk, Jr. (Signature)

CURRICULUM VITAE

Full Name: Raymond Franklin Burk, Jr.

Date of Birth: [redacted] Place of Birth: [redacted]
Height: [redacted] Weight: [redacted]
Marital Status: [redacted] Children: [redacted]

Educational Record:

1963 B.A. University of Mississippi
1964 Johannes Gutenberg University in Mainz, Germany - 1 year (residenc
1968 MoD. Vanderbilt University

Research and Professional Experience:

1964-68 Summer and part-time research experience with Dr. W. N. Pearson in Nashville and Guatemala City

1968-69 Staight medical internship, Vanderbilt University

1969-70 1st year medical residency, Vanderbilt University

Administrative Background: None.

References: Dr. W. J. Darby, Nashville, Tennessee
Dr. Grant W. Liddle, Nashville, Tennessee

Publications:

R. F. Burk, W. N. Pearson and F. Viteri. Discussion of Selenium in Human Nutrition. Symposium: Selenium in Biomedicine, Avi Publ. Co., 1967.

R. F. Burk, W. N. Pearson, R. P. Wood II, and F. Viteri. Blood Selenium Levels and in vitro Red Blood Cell Uptake of ^{75}Se in Kwashiorkor. Am. J. Clin. Nutr., 20: 723-733, 1967.

R. F. Burk, R. Whitney, H. Frank, and W. N. Pearson. Tissue Selenium Levels during the Development of Dietary Liver Necrosis in Rats fed Torula Yeast Diets. J. Nutr., 95: 420-428, 1968.

Public Relations Experience: None.

Honors: Vanderbilt Borden Award in Nutrition, 1967.
Dean's Award for Student Research Presentation, 1968.

APPENDIX-I

USAMRNL - Bioenergetics 11 January 1971

FINAL PROTOCOL

Project: 3A0[illegible]02B71P Basic Research in Support of Military Medicine

Task: 01 Biochemistry

Work Unit: 061 Mineral Metabolism

ST-6: Selenium Metabolism

EX-3: Selenium in Human Plasma Proteins

INTRODUCTION

The preceding protocol outlined a study to determine the site and nature of the selenium-protein bond in rabbit plasma. This protocol outlines a similar study on human plasma. It is hoped that a specific protein can be isolated and that the protein-selenium bond can be studied.

Unpublished data (Appendix I) indicate that after an intravenous injection of $Na_2{}^{75}SeO_3$ into a human being, the ^{75}Se concentrates in the beta-lipoprotein fraction reaching a specific activity eight times that of the alpha-lipoprotein fraction at 48 hours. Furthermore, when the beta-lipoprotein fraction is dialyzed against an alkaline bath, which is known to release selenium (1), it retains 68% of its activity whereas the alpha-lipoprotein fraction and the total plasma protein fraction retain only 32-34% of their activities. The activity is in the protein portion of each fraction. These observations indicate that there is a protein in the beta-lipoprotein fraction of human plasma which binds selenium to a greater extent than other proteins do, and that the type of bond in this protein is not the same as those in the others. The aim of this study is to isolate and study that protein.

Form AEC-313
8-64
10 CFR 30

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

Form approved.
Budget Bureau No. 38-R027

INSTRUCTIONS. – Complete Items 1 through 16 if this is an initial application or an application for renewal of a license. Information contained in previous applications filed with the Commisson with respect to Items 8 through 15 may be incorporated by reference provided references are clear and specific. Use supplemental sheets where necessary. Item 16 must be completed on all applications. Mail two copies to: U.S. Atomic Energy Commission, Washington, D.C., 20545, Attention: Isotopes Branch, Division of Materials Licensing. Upon approval of this application, the applicant will receive an AEC Byproduct Material License. An AEC Byproduct Material License is issued in accordance with the general requirements contained in Title 10, Code of Federal Regulations, Part 30, and the Licensee is subject to Title 10, Code of Federal Regulations, Part 20.

1. (a) NAME AND STREET ADDRESS OF APPLICANT. (Institution, firm, hospital, person, etc. Include ZIP Code.)

Department of the Army, Fitzsimons General Hospital
U. S. Army Medical Research and Nutrition Laboratory, Denver, Colorado 80240

(b) STREET ADDRESS(ES) AT WHICH BYPRODUCT MATERIAL WILL BE USED. (If different from 1 (a). Include ZIP Code.)

Same as 1(a)

2. DEPARTMENT TO USE BYPRODUCT MATERIAL

Bioenergetics Division
U.S. Army Medical Research and Nutrition Laboratory

3. PREVIOUS LICENSE NUMBER(S). (If this is an application for renewal of a license, please indicate and give number.)

Present application is for amendment to AEC License No. 05-00046-13

4. INDIVIDUAL USER(S). (Name and title of individual(s) who will use or directly supervise use of byproduct material. Give training and experience in Items 8 and 9.)

RAYMOND F. BURK, MD., CPT, MC

5. RADIATION PROTECTION OFFICER. (Name of person designated as radiation protection officer if other than individual user. Attach resume of his training and experience as in Items 8 and 9.)

As approved by the Radioisotope Committee, Fitzsimons General Hospital and U. S. Army Medical Research and Nutrition Laboratory

6. (a) BYPRODUCT MATERIAL. (Elements and mass number of each.)

A. Selenium-75

(b) CHEMICAL AND/OR PHYSICAL FORM AND MAXIMUM NUMBER OF MILLICURIES OF EACH CHEMICAL AND/OR PHYSICAL FORM THAT YOU WILL POSSESS AT ANY ONE TIME. (If sealed source(s), also state name of manufacturer, model number, number of sources and maximum activity per source.)

A. Selenite (liquid-individual prepared doses) A. 2 millicuri

7. DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED. (If byproduct material is for "human use," supplement A (Form AEC-313a) must be completed in lieu of this item. If byproduct material is in the form of a sealed source, include the make and model number of the storage container and/or device in which the source will be stored and/or used.)

See supplement AEC Form 313a attached

(Continued on reverse side)

TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 *(Use supplemental sheets if necessary)*

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	Individuals will have appropriate training and experience prior to their approval by the Radioisotope Committee, Fitzsimons General Hospital and U. S. Army Medical Research and Nutrition Laboratory		Yes No	Yes No
b. Radioactivity measurement standardization and monitoring techniques and instruments			Yes No	Yes No
c. Mathematics and calculations basic to the use and measurement of radioactivity			Yes No	Yes No
d. Biological effects of radiation			Yes No	Yes No

9. EXPERIENCE WITH RADIATION. *(Actual use of radioisotopes or equivalent experience.)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
		SAME AS 8		

10. RADIATION DETECTION INSTRUMENTS *(Use supplemental sheets if necessary.)*

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mr/hr)	WINDOW THICKNESS (mg/cm²)	USE (Monitoring, surveying, measuring)
See radiation detection instruments attached. APPENDIX - 3					

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.
See application for renewal of byproduct material license No. 05-00046-13 dated 25 June 1968

12. FILM BADGES, DOSIMETERS, AND BIO ASSAY PROCEDURES USED *(For film badges, specify method of calibrating and processing, or name of supplier.)*
SAME as 11

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS IN DUPLICATE

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached. *(Circle answer)* Yes (No) SAME as 11 and attached protocol. APPENDIX - 1

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source. SAME as 11 and MRNL Regulation No. 40-14 attached. APPENDIX - 2

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved. Section 20.303 of 10 CRF 20. and MRNL Regulation No. 40-14 attached will complied with.

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Dept. of the Army, Fitzsimons Gen. Hosp. and USAMRNL, Denver, Colorado 80240
Applicant named in item 1

Date 5 Jan 1971

By: John B. Campbell
JOHN B. CAMPBELL, MD., LTC, MC
Chairman, Radioisotope Committee
Title of certifying official

WARNING.—18 U. S. C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

* U.S. GOVERNMENT PRINTING OFFICE : 1964 O—745-361

Form AEC-313 a (10-61)
PAGE 1

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

SUPPLEMENT A—HUMAN USE

Form approved.
Budget Bureau No. 38-R080.1

If byproduct material is for "human use" (internal administration of byproduct material, or the radiation therefrom to human beings), complete this supplement and attach to the application for byproduct material license.

1. (a) USING PHYSICIAN'S NAME
RAYMOND F. BURK, M.D.
CPT, MC

(b) NAME AND ADDRESS OF APPLICANT (If different from 1(a))
Same as Item 1(a) of Form AEC-313

2. THE USING PHYSICIAN INDICATED ABOVE IS LICENSED TO DISPENSE DRUGS IN THE PRACTICE OF MEDICINE BY A STATE OR TERRITORY OF THE UNITED STATES, THE DISTRICT OF COLUMBIA, OR THE COMMONWEALTH OF PUERTO RICO. CIRCLE ANSWER	(YES)	NO
3. A STATEMENT OF USING PHYSICIAN'S CLINICAL RADIOISOTOPE EXPERIENCE (PAGE 3 OF THIS SUPPLEMENT) IS SUBMITTED IN SUPPORT OF THIS APPLICATION. IF ANSWER IS NO, USE PAGE 2 OF THIS SUPPLEMENT TO EXPLAIN OR REFER TO OTHER APPLICATION OR RELATED DOCUMENTS ON WHICH THIS INFORMATION APPEARS. CIRCLE ANSWER	(YES)	NO

PROPOSED DIAGNOSIS OR TREATMENT

4. (a) DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED INCLUDING SPECIFIC CONDITIONS OR DISEASES TO BE DIAGNOSED OR TREATED (Use page 2 if necessary):

SEE PAGE 2

(b) CHEMICAL FORM ADMINISTERED:

SEE PAGE 2

(c) DESCRIBE PROCEDURES WHICH WILL BE OBSERVED TO MINIMIZE HAZARD FROM HANDLING, STORAGE, AND DISPOSAL OF THE BYPRODUCT MATERIAL:

See MRNL Regulation No. 40-14 Attached

(d) DESCRIPTION AND SKETCHES OF SPECIAL DEVICES TO BE USED FOR ADMINISTERING BYPRODUCT MATERIAL TO HUMAN BEINGS ARE (1) ATTACHED (LITERATURE REFERENCES WILL SUFFICE) CIRCLE ANSWER	YES	(NO)
(2) ON FILE WITH THE ISOTOPES EXTENSION REFER TO APPLICATION NO _____ CIRCLE ANSWER	YES	(NO)

5. (a) PROPOSED DOSAGE SCHEDULE.—In millicuries for internally administered byproduct material other than discrete fixed sources; and in roentgens or rads, as appropriate, for internal or external irradiation from discrete fixed sources (gold seeds, cobalt needles, etc.) state separately for each condition or disease (use page 2 if necessary):

SEE PAGE 2

(b) INVESTIGATIVE PROPOSAL FOR EXPERIMENTAL, NEW OR UNUSUAL HUMAN USES IS ATTACHED. (Attachment should include outline of conditions to be evaluated, including data from animal studies and/or abstract of literature reference if any, number and type of patients (i. e. age group, moribund, etc.)) CIRCLE ANSWER	(YES)	NO

SEE PROTOCOL ATTACHED

6. IF BYPRODUCT MATERIAL WILL NOT BE OBTAINED IN PRECALIBRATED FORM FOR ORAL ADMINISTRATION OR IN PRECALIBRATED AND STERILIZED FORM FOR PARENTERAL ADMINISTRATION, DESCRIBE IDENTIFICATION, PROCESSING, AND STANDARDIZATION PROCEDURES:

Obtained in precalibrated form, (sterile & pyrogen-free)

7. THE PROPOSED USE OF BYPRODUCT MATERIAL HAS BEEN, OR WILL BE, APPROVED BY THE MEDICAL ISOTOPE COMMITTEE. CIRCLE ANSWER	(YES)	NO

HOSPITAL FACILITIES FOR INDIVIDUAL PRACTICE USE ONLY

8. (a) THE APPLICANT HAS COMPLETED ARRANGEMENTS FOR A HOSPITAL TO ADMIT RADIOACTIVE PATIENTS WHENEVER ADVISABLE. CIRCLE ANSWER	YES	NO
(b) A COPY OF INSTRUCTIONS TO BE FURNISHED TO THE HOSPITAL AS TO RADIOLOGICAL SAFETY PRECAUTIONS TO BE TAKEN AND AVAILABLE RADIATION INSTRUMENTATION IS ATTACHED. CIRCLE ANSWER	YES	NO

Form AEC-313 a (10-61) PAGE 2	UNITED STATES ATOMIC ENERGY COMMISSION APPLICATION FOR BYPRODUCT MATERIAL LICENSE SUPPLEMENT A—HUMAN USE	Form approved. Budget Bureau No. 38-R080.1

This page may be used for providing additional information. Please cross reference to specific items.

Items 4a, 4b, and 5a

ISOTOPE	FORM	PURPOSE	DOSAGE RATES
Selenium-75	Selenite	Determine site and nature of selenium-protein bond in human plasma to evaluate nutritional liver disease	up to 200 microcuries

2430

U.S. GOVERNMENT PRINTING OFFICE : 1961 OF—615965

DA FORM 2028

DEPARTMENT OF THE ARMY

For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office.

REFERENCE OR OFFICE SYMBOL	SUBJECT
MEDEN-AR	Radioisotope User Certification

TO: Recorder, Radioisotope Committee of FGH and USAMRNL

FROM: Radioisotope Branch, USAMRNL

DATE: 29 Sep 70

CMT 1

SFC Abernathy/dml/26111

1. Request that Raymond F. Burk, Jr., CPT., MC, be certified as a user of radioisotopes in human subjects under the conditions outlined in "Request for Approval for Human Use of Radioisotopes in Tracer Amounts in Volunteer Subjects", also for non-human use.

2. The maximum amount of radioisotopes that the individual may possess is in parenthesis following the name of isotope.

"A"	"B"
^{42}Potassium	(2 mc)
^{14}Carbon	(1 mc)
^{3}Tritium	(1 mc)
^{75}Selenium	(2 mc)
^{35}Sulfur	(1 mc)
^{131}Iodine	(1 mc)
^{51}Chromium	(1 mc)

3. A summary of the training and experience of this individual is attached. It is requested that this approval be made a permanent part of individual's 201 file.

Robert L. Morrissey

ROBERT L. MORRISSEY
CPT, V.C.
Chief, Radioisotope Branch

Incl
as

MEDEO-X (29 Sep 70)

TO: Ch, Military Personnel Br, Officer Records Section

FROM: Chairman, Radioisotope Committee

DATE: 10 Nov 70

CMT 2

rek/26218

1. The above-requested certification in the case of Cpt Raymond F. Burk, MC, is granted by the Radioisotope Committee, as noted in the minutes of their meeting held 13 October 1970.

2. It is requested that this DF, together with the attached documentation of training and experience, be made a permanent part of Cpt Burk's 201 file.

1 Incl
nc

JOHN B. CAMPBELL, M.D.
LTC, MC
Chairman, Radioisotope Committee

7. TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 (Use supplemental sheets if necessary)

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	Vanderbilt Univ. Med. School	1 yr	(Yes) No	(Yes) No 1 Semester
b. Radioactivity measurement standardization and monitoring techniques and instruments	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 1 Semester
c. Mathematics and calculations basic to the use and measurement of radioactivity	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 1 Semester
d. Biological effects of radiation	Vanderbilt Univ. Med. School	4 yrs	(Yes) No	(Yes) No 2 Semesters

9. EXPERIENCE WITH RADIATION. (Actual use of radioisotopes or equivalent experience.)

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
^{75}Se	10 mc	Vanderbilt Univ.	5 yrs.	Human scans and metabolic studies, animal studies
^{35}S	5 mc	Vanderbilt Univ.	3 mos.	Human plasma protein turnover studies

10. RADIATION DETECTION INSTRUMENTS (Use supplemental sheets if necessary.)

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mr/hr)	WINDOW THICKNESS (mg/cm^2)	USE (Monitoring, surveying, measuring)

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.

12. FILM BADGES, DOSIMETERS, AND BIO ASSAY PROCEDURES USED. (For film badges, specify method of calibrating and processing, or name of supplier.)

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS IN DUPLICATE

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached. (Circle answer) Yes No

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source.

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved.

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Raymond F. Burk, Jr.
Applicant named in item 1 RAYMOND F. BURK, JR.

Date 6 Sept 1970

By: John E. Canham
Title of certifying official
JOHN E. CANHAM, COL, MC, Commanding, USAMRNL

WARNING.—18 U. S. C., Section 1001; Act of June 25, 1948, 62 Stat. 749; makes it a criminal offense to make a willful representation to any department or agency of the United States as to any matter within its jurisdiction.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1968 O—316-327

Form AEC-313 a (10-61) Page 3

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

SUPPLEMENT A—HUMAN USE

Form approved. Budget Bureau No. 38-R030.1

This page may be completed by the physician's preceptor (if any) in the medical use of radioisotopes. When the information is not furnished by the preceptor, the name and present address of the preceptor (if any) should be shown in item 12 below.

9. (a) USING PHYSICIAN'S NAME	(b) NAME AND ADDRESS OF APPLICANT (If different from 9(a))
Raymond F. Burk, Jr.	

10. CLINICAL TRAINING AND EXPERIENCE OF PHYSICIAN WHO WILL USE BYPRODUCT MATERIAL

(A) ISOTOPE	(B) CONDITION(S) DIAGNOSED OR TREATED	(C) NUMBER OF CASES	(D) TYPE OF PARTICIPATION FOR ALL CASES IN COLUMN B (circle applicable numbers of items in accordance with key set forth below)
I-131	Diagnosis of thyroid function	30	(1) (2) (3) 4
	Treatment of hyperthyroidism	2	(1) (2) 3 4
	Treatment of thyroid cancer		1 2 3 4
	Treatment of cardiac conditions		1 2 3 4
	Brain tumor localization	25	(1) 2 3 4
	Blood determinations	5	(1) 2 3 4
	Kidney function	5	(1) 2 3 4
	Others: Lung scans	25	(1) 2 3 (4)
P-32 Soluble	Treatment of polycythemia and leukemia	1	(1) 2 3 4
	Brain tumor localization		1 2 3 4
	Treatment of bone metastases		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
P-32 $CrPO_4$	Treatment of prostatic cancer		1 2 3 4
	Treatment of cervical cancer		1 2 3 4
	Treatment of pleural effusions and/or ascites		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Au-198 Colloid	Treatment of prostatic cancer		1 2 3 4
	Treatment of cervical cancer		1 2 3 4
	Treatment of pleural effusions and/or ascites		1 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Cr-51	Blood determinations	5	(1) 2 3 4
	Others:		1 2 3 4
			1 2 3 4
Other Isotopes	Liver scans with gold & I^{131}	40	(1) 2 3 4
	Parathyroid scan ^{75}Se-selenomethionine	1	(1) (2) 3 4
	Pancreas scan ^{75}Se-selenomethionine	5	(1) (2) (3) (4)
	Lymphoma scan $^{75}SeO_3$	1	(1) (2) 3 (4)

Key to above numbers (column D)

Active Participation and Discussion in the:

1. Examination of patients to determine suitability for radioisotope diagnosis and/or treatment and recommendations on dosage to be prescribed.
2. Collaboration in calibration and administration of dosages including related measurements and plotting of data.
3. Active period of training and experience of sufficient duration to permit followup of patients through treatment and posttreatment period including reevaluation as to effectiveness and complications.
4. Study and discussion of case histories to establish most efficacious diagnostic and/or therapeutic techniques for this radioisotope use.

11. TOTAL NUMBER OF HOURS OF PARTICIPATION IN CLINICAL TRAINING 200 hours

12. THE TRAINING AND EXPERIENCE INDICATED ABOVE WAS OBTAINED UNDER THE SUPERVISION OR GUIDANCE OF

A. B. Brill, M.D., Ph.D. (Name of physician (preceptor)) AT Vanderbilt Univ. (Institution)

Raymond F. Burk, Jr. (Signature)

CURRICULUM VITAE

Full Name: Raymond Franklin Burk, Jr.

Date of Birth: [redacted]
Height: [redacted]
Marital Status: [redacted]

Place of Birth: [redacted]
Weight: [redacted]
Children: [redacted]

Educational Record:

1963 B.A. University of Mississippi
1964 Johannes Gutenberg University in Mainz, Germany - 1 year (reside:
1968 MoD. Vanderbilt University

Research and Professional Experience:

1964-68 Summer and part-time research experience with Dr. W. N. Pearson in Nashville and Guatemala City

1968-69 Straight medical internship, Vanderbilt University

1969-70 1st year medical residency, Vanderbilt University

Administrative Background: None.

References: Dr. W. J. Darby, Nashville, Tennessee
Dr. Grant W. Liddle, Nashville, Tennessee

Publications:

R. F. Burk, W. N. Pearson and F. Viteri. Discussion of Selenium in Human Nutrition. Symposium: Selenium in Biomedicine, Avi Publ. Co., 1967.

R. F. Burk, W. N. Pearson, R. P. Wood II, and F. Viteri. Blood Selenium Levels and in vitro Red Blood Cell Uptake of ^{75}Se in Kwashiorkor. Am. J. Clin. Nutr., 20: 723-733, 1967.

R. F. Burk, R. Whitney, H. Frank, and W. N. Pearson. Tissue Selenium Levels during the Development of Dietary Liver Necrosis in Rats fed Torula Yeast Diets. J. Nutr., 95: 420-428, 1968.

Public Relations Experience: None.

Honors: Vanderbilt Borden Award in Nutrition, 1967.
Dean's Award for Student Research Presentation, 1968.

RADIATION DETECTION INSTRUMENTS - USAMRNL

[redacted]

TYPE OF INSTRUMENTS	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE(mr/hr)	WINDOW THICKNESS (mg/cm^2)	USE
1. Packard Mod. 314EX Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
2. Packard Mod. 3375 Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
3. Packard Mod. 314E Auto-Gamma Scintillation Counting System	1	Gamma	N/A	N/A	measuring
4. Nuclear-Chicago Mod. 6801 Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
5. Nuclear-Chicago Mod. Mark I Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
6. Tracerlab Versa matic V Scaler with GM tube or Sodium Iodide Crystal	1	Beta, Gamma	N/A	$150mg/cm^2$	measuring
7. Atomic Ass. Chromatograph Plate Scaner	1	Beta	N/A	N/A	measuring
8. Nuclear-Chicago Survey Meter Mod. 2612	1	Beta, Gamma	0-200mr/hr	$1.4mg/cm^2$	surveying
9. IM-154/PDR-54 with Beta Probe Mod. AC-21B	1	Beta	N/A	$0.85mg/cm^2$	surveying
10. Nuclear-Chicago Labitron Mod. 1619A	2	Beta, Gamma	N/A	$100mg/cm^2$	surveying
11. Nuclear-Chicago Mod. 4351 Tobar Gamma Counting System	1	Gamma	N/A	N/A	measuring

TYPE OF INSTRUMENTS	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE(mr/hr)	WINDOW THICKNESS (mg/cm^2)	USE
12. Beckman Low Beta II	1	Alpha, Beta	N/A	80 ug/cm^2	measuring
13. Eberline Mod. PAC Mod. AC-2B	1	Beta	N/A	0.85mg/cm^2	surveying
14. Thyac III Victoreen GM-Scintillation Survey Meter Model 490 with GM Probe Model 489-4	1	Beta, Gamma	0-800.000cpm & 0-200mr/hr	30mg/cm^2	surveying
15. Packard Mod. 331A Tri-Carb Liquid Scintillation Spectrometer System	1	Alpha, Beta	N/A	N/A	measuring
16. Packard, Liquid Scintillation, Spectrometer, Mod. 3380	2	Alpha, Beta	N/A	N/A	measuring
17. Dosimeter, Tracer-lab, Pocket Chamber Mod. K-112	2	X-ray, Gamma	1-200mr/hr	N/A	measuring
18. Nuclear-Chicago Mod. 722. Liquid Scintillation Counting System	1	Alpha, Beta	N/A	N/A	measuring
19. Radiation Monitor Model RM-14 Eberline with Hand Probe Model HP-190	2	Alpha, Beta & Gamma	0-50,000cpm	1.4 to 2mg/cm^2	monitoring & surveying
20. Nuclear-Chicago Scintillation System, Model 4420	1	Gamma	N/A	N/A	measuring
21. Whole Body Shadow Shield Counter, W/sodium-iodide crystal and multi channel analyzer	1	Gamma	N/A	N/A	measuring

APPENDIX 2

U. S. ARMY MEDICAL RESEARCH AND NUTRITION LABORATORY
FITZSIMONS GENERAL HOSPITAL
DENVER, COLORADO 80240

MRNL REGULATION
NUMBER 40-14

15 July 1970

CONTROL AND HANDLING OF RADIOACTIVE MATERIAL

This regulation supersedes USAMRNL Standing Operating Procedure entitled "Procedures for Use of Radioactive Material" dtd. 1 March 1969.

MRNL REGULATION
NUMBER 40-14

15 July 1970

1. Purpose. The purpose of this regulation is to provide direction and guidance to all persons and activities producing, procuring, receiving, storing, using, disposing or transferring material that produces ionizing radiation, to insure the safe handling of radioactive materials within the USAMRNL.

2. Applicability.

a. This regulation is applicable to all persons assigned to the USAMRNL who utilize isotopes and the facilities of the Radioisotope Branch in the conduct of research projects.

b. The procedures outlined in this regulation are published for local use and must not be construed to be an amendment or change to any existing federal regulation, Army regulation, or hospital regulation governing the use of radioactive material.

3. Definitions.

a. Post Radiological Protection Officer.

An individual designated by the Commanding General, Fitzsimons General Hospital to provide consultation and advice on the degree of hazards associated with ionizing radiation and the effectiveness of measures to control these hazards throughout the entire post.

b. Radiological Protection Officer - USAMRNL.

An individual appointed by the Commanding Officer, USAMRNL and having the same functions as the Post RPO as affects the USAMRNL.

c. Principal User.

Those responsible investigators whose qualifications have been certified by the joint (FGH - USAMRNL) Radioisotope Committee as being technically qualified by virtue of education, training and/or professional experience to conduct research studies using radioactive isotopes.

4. Responsibilities.

a. The Commanding Officer of the USAMRNL is responsible for ensuring that measures are established to control ionizing radiation from any source so that the radiation dose to those individuals under his command will be no greater than the amount prescribed in AR 40-14.

b. The joint (FGH - USAMRNL) Radioisotope Committee has the responsibility of technical supervision over the handling and use of radioactive isotopes.

c. The Chief, Supply and Services Branch, USAMRNL is responsible for the procurement and receipt of radioactive material through Fitzsimons General Hospital in accordance with HR 40-602. Upon notification of arrival on post, the material will be picked up and delivered to the Radioisotope Branch, USAMRNL.

d. The Chief, Radioisotope Branch will direct the storage and handling of the contents of each shipment of radioactive material after it has been delivered to him or his designated representative in the Radioisotope Branch and is responsible for the maintenance of the records pertaining thereto. He is responsible for the handling and disposition of radioisotope contaminated liquid and solid wastes; area monitoring and supervision of the decontamination procedures in all areas under USAMRNL jurisdiction where radioactive isotopes are used, in accordance with the recommended procedures specified in Part 20, Title 10, C.F.R. and applicable Army regulations.

e. Principal users (responsible investigators) of radiation sources have the following responsibilities:

(1) Become thoroughly familiar with the contents of applicable regulations prior to the use of radiation sources.

(2) Research projects utilizing radioisotopes will be covered by protocols approved under existing USAMRNL regulations. The type, quantity, and method in which they will be used will be described. A copy of the approved protocol will be provided the Radioisotope Branch.

(3) Obtain and use radiation sources only as authorized by these regulations.

(4) Take precautionary measures to protect himself and others from unwarranted exposure to radiation.

(5) Seek advice and assistance from the Radiological Protection Officer when in doubt concerning the safety of an operation.

(6) Report to the Radiological Protection Officer of known or suspected overexposures. The overexposed individual shall cooperate in any and all attempts to evaluate his radiation exposure.

(7) Supervise and instruct all co-workers in the proper uses of radiation sources to insure safe working procedures.

(8) Maintain a current inventory within his Division of the quantity of radioactive material on hand in fractions of curies, to be readily available to the Radiological Protection Officer conducting the quarterly physical inventory of radioactive material.

5. Procedures.

a. Radioisotope Committee.

(1) The U. S. Army Medical Research and Nutrition Laboratory operates jointly with Fitzsimons General Hospital under the same General Atomic Energy Commission License. Use of radioisotopes, within the limitations of the AEC License, is controlled by a joint installation Radioisotope Committee. The persons making up the Radioisotope Committee and the functions of the committee are outlined in AR 40-37 and HR 15-1. The functions of the Committee are:

(a) Review protocols and grant permission for, or disapproval of, the use of radioactive material.

(b) Certify individual users for each type of procedure with each individual radioisotope and insure that a copy of such certification is placed in the appropriate user's 201 file. Maintain current records of the approved users, documenting the qualifications and limitations of each.

(c) Prescribe special conditions which may be necessary to include and give advice concerning proposed studies where it is needed.

(d) Review records and receive reports from the Radiological Protection Officer and recommend corrective action when indicated.

(e) Make recommendations for improvement of present laboratory facilities and for expansion of the laboratories in accordance with needs.

(f) Hold meetings at the call of the Chairman and report in writing to the Commanding General, FGH, the results of its deliberation.

b. Hazard Control.

(1) Permission for the use of radioactive materials under AEC General License in USAMRNL is granted only by the Radioisotope Committee. This permission may be denied or withdrawn from any investigator who, in the opinion of the Radioisotope Committee or on the advice of the Radiological Protection Officer, is inadequately trained in the handling and use of radioactive materials, or is guilty of any breach of discipline in the handling and use of radioactive materials so as to incur real or possible hazard to himself or others.

(2) The Chief of the Radioisotope Branch, USAMRNL, will instruct, direct, and supervise all individuals at USAMRNL working with or near radioactive materials in the observance of radiological safety. Safety of routine operations is the responsibility of principal investigators.

(3) Each individual working with radioactive material will be issued a film badge. Before a film badge is issued, each individual must read both CFR, Title 10, Part 20, and USAMRNL Regulation 40-14, and certify in writing that he had read and understands both.

(4) The safety rules listed hereinafter are to be observed, but it is emphasized that mere following of the rules will not eliminate all possible hazards associated with the handling of radioactive materials.

(5) The protection rules are based upon assumed long-term whole-body exposure to ionizing radiation by personnel whose duties involve regular handling of radioactive materials or regular use of x-ray equipment. These rules apply to all persons occupationally employed using any source of ionizing radiation in a controlled area or those incidentally exposed as a result of such use. A controlled area is one in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of a Radiological Protection Officer. (This implies that a controlled area is one that requires control of access, occupancy and working condition for radiation protection purposes.)

c. Safety Rules.

(1) In order to avoid undue exposure to ionizing radiation, unauthorized personnel will not enter the Laboratory of the Radioisotope Branch except when accompanied by an authorized person.

21431

(2) Only persons specifically authorized to do so by the Radioisotope Committee will handle any shipment of radioactive material or any part thereof after it has been delivered to the Radioisotope Branch.

(3) Only persons specifically authorized to do so by the Radioisotope Committee will dispense or use a dose of any radioactive material.

(4) In all rooms where radioactive materials are being used, the following additional regulations are in effect:

(a) No eating or drinking, and no application of cosmetics.

(b) Smoking is not permitted while active material is being handled.

(c) Absolutely no mouth pipetting of radioactive material under any circumstances.

(d) Under no circumstances will radioactive waste be handled or disposed of by the janitorial staff.

(e) Rubber or protective gloves will be worn at all times when radioactive material is being handled, except sealed, or capped containers of radioactive materials.

(f) All gloves, protective clothing, instruments, and glassware will be placed in the appropriate receptacle to await decontamination.

(g) All contaminated glassware, instruments, pipettes, and waste incurred in any radioisotope experiment or study will be policed and placed in an appropriate receptable by the persons performing the experiment or study.

(h) At the end of each work period the hands will be carefully washed.

(i) Before placing radioactive material in any container, the container will be clearly labeled with radioactive caution tape of yellow and magenta to show the particular radioactive material, the concentration in microcuries or millicuries per unit volume or weight as of some particular date, and the identifying initials of the person preparing the material.

(j) Work surfaces will be covered with absorbent paper. The work in hoods will be similarly performed on absorbent paper. The work bench will be equipped with wiping papers for the prompt removal of spills.

(k) When using radioactive material, special equipment suitable for the type and level of activity being used will be used for each type of operation. This will include handling tools such as tongs, forceps, trays, and mechanical holders. When the isotopes concerned are beta emitters, efficient use can be made of transparent plastic shields.

(l) No individual will knowingly expose himself, or cause others to be unnecessarily exposed.

(m) All laboratory operations involving isotopes in Group III (below) will be conducted in hoods.

(5) Safe Handling Level For Some Representative Radioisotopes Authorized For Use in USAMRNL

GROUP I **No special handling required in normal laboratory procedures		GROUP II **Not dangerous, but unnecessary exposure is to be avoided		GROUP III **Dangerous, should be handled with utmost caution	
Isotope	Maximum Amount	Isotope	Maximum Amount	Isotope	Amount
Au^{198}	0.025 mc	Au^{198}	1.000 mc	Au^{198}	over 1.000 mc
Br^{82}	0.300 mc	Br^{82}	5.000 mc	Br^{82}	" 5.000 mc
Be^{7}	0.005 mc	Be^{7}	0.100 mc	Be^{7}	" 0.100 mc
* C^{14}Urea	0.050 mc	C^{14}Urea	1.000 mc	C^{14}Urea	" 1.000 mc
* C^{14} All Other	0.025 mc	C^{14} All other	1.000 mc	C^{14} All other	" 1.000 mc
Ca^{45}	0.005 mc	Ca^{45}	0.100 mc	Ca^{45}	" 0.100 mc
Co^{60}	0.025 mc	Co^{60}	1.000 mc	Co^{60}	" 1.000 mc
Cr^{51}	0.025 mc	Cr^{51}	1.000 mc	Cr^{51}	" 1.000 mc
Fe^{55}	0.005 mc	Fe^{55}	0.100 mc	Fe^{55}	" 0.100 mc
Fe^{59}	0.025 mc	Fe^{59}	1.000 mc	Fe^{59}	" 1.000 mc
* H^{3}Water	0.025 mc	H^{3}Water	10.000 mc	H^{3}Water	" 10.000 mc
* H^{3}Thymidine	0.001 mc	H^{3}Thymidine	0.050 mc	H^{3}Thymidine	" 0.050 mc
* H^{3}all other	0.005 mc	H^{3}all other	0.100 mc	H^{3}all other	" 0.100 mc
I^{131}	0.025 mc	I^{131}	1.000 mc	I^{131}	" 1.000 mc
Na^{22}	0.025 mc	Na^{22}	1.000 mc	Na^{22}	" 1.000 mc
P^{32}	0.025 mc	P^{32}	1.000 mc	P^{32}	" 1.000 mc

(Continued)

GROUP I **No special handling required in normal laboratory procedures		GROUP II **Not dangerous, but unnecessary exposure is to be avoided		GROUP III **Dangerous, should be handled with utmost caution		
Isotope	Maximum Amount	Isotope	Maximum Amount	Isotope		Maximum Amount
S^{35}	0.025 mc	S^{35}	1.000 mc	S^{35}	over	1.000 mc
Se^{75}	0.025 mc	Se^{75}	1.000 mc	Se^{75}	"	1.000 mc
Sr^{85}	0.025 mc	Sr^{85}	1.000 mc	Sr^{85}	"	1.000 mc
Sr^{89}	0.025 mc	Sr^{89}	1.000 mc	Sr^{89}	"	1.000 mc
Sr^{90}	0.005 mc	Sr^{90}	0.100 mc	Sr^{90}	"	0.100 mc
Zn^{65}	0.005 mc	Zn^{65}	0.100 mc	Zn^{65}	"	0.100 mc

* Group classification dependent upon chemical form.

** It must be remembered that these limits are by no means fixed and that any undue exposure is undesirable. Therefore, when working with the above radioisotopes, the physical characteristics, half-life, the internal and external hazard, and the radiative properties of the radioactive material must be considered. If in doubt, always consult the Chief, Radioisotope Branch.

d. Human Studies.

In the conduct of research studies involving the use of radioactive isotopes in humans, the principal investigator is guided by applicable government and military regulations, the current AEC license, U. S. Army Authorization and advice and counsel of the joint Radioisotope Committee.

e. Animal Studies.

Investigators conducting in vitro and/or animal studies involving the use of radioactive isotopes will be guided by applicable documents as above and in addition will provide, in their protocols, the specific areas in their divisions where isotopes are planned for use or storage, the housing area of animals, and waste disposition procedures.

f. Radioactive Waste.

(1) The Radiological Protection Officer is responsible for the disposal of all radioactive waste within USAMRNL. Such disposal

will be accomplished under all existing regulations listed in Part 20, Title 10, CFR, NBS Handbooks, and Army Regulations.

(2) Solid radioactive waste will be segregated into combustible and non-combustible. This waste includes such items as carcasses, fecal material, litter, scintillation counting vials, etc. It will be placed in a plastic waterproof disposable container then deposited in a second container marked with a radiation caution symbol with the wording, "Danger, Radioactive Material". When full, the outer container will be labelled as to content, isotope present, approximate amount of microcuries (millicuries), the date and investigators name. (The radiation level outside the container should not exceed 1.0 milliroentgens per hour). These waste containers will then be delivered to the Radioisotope Branch for disposition.

(3) Liquid waste including the pooled contents of the liquid scintillation counting vials will be placed in a plastic bottle and marked with radiation caution tape, isotope content, approximate amount of microcuries (millicuries) date of collection and investigators name. Pooling of vials maybe done in the individual sections; except, in those cases where the vapors from solutions may contain radioactivity, the pooling may be performed in the hood of the "high level" room in the Radioisotope Branch. These contaminated liquid waste bottles will then be delivered to the Radioisotope Branch for disposition.

(4) All clothing that is known or suspected of being contaminated with isotopes will be placed in a separate plastic container, appropriately labelled, and delivered to the Radioisotope Branch for proper disposition.

g. Decontamination of Glassware.

(1) All glassware which is utilized directly with radioactive material will be deemed "contaminated". The decontamination of such glassware is important not only in the interests of radiation safety but also to prevent the unintentional invalidation of subsequent experiments.

(2) Contaminated glassware will be delivered to the Radioisotope Branch for removal of the radioactive contaminant by ultrasonic means.

h. Radioactive Spill.

(1) All radioactive material, when spilled, constitutes a hazard, either to personnel or to equipment. If a spill of radioactive material occurs with Group I [5c(5)] isotopes, turn off all fans in the immediate area and notify all other personnel in the controlled

area. If the spill is liquid, drop absorbent paper on the spill and mark off the area with chalk or cord. If the spill is dry, proceed in the same manner, but convert the dry spill to liquid by applying wet absorbent paper over the area.

(2) If a spill of radioactive material occurs with Group II isotopes [5c (5)], hazard control is of first importance. In order to accomplish this, the person responsible for the spill will:

(a) Notify the Radiological Protection Officer or his designated representative.

(b) Be prepared to evaluate the hazard by knowing at all times which radioisotope is being handled, its chemical form, and the approximate amount being used (in millicuries or microcuries).

(c) See that all personnel in the area are notified and that they leave the immediate area of the spill without delay.

(3) In the event of a spill of radioactive material in Group III [5c (5)], the procedure listed for Group II above, will be carried out, plus the following:

(a) Determine the extent of personal contamination by inspection and monitoring of the involved personnel.

(b) Remove contaminated clothing.

(c) Rinse the contaminated body parts with water or the emergency shower if the spill took place in the high level room of the Radioisotope Branch, and then wash with soap and water, collecting the water for proper disposition. Monitoring the contaminated body part after each washing will be performed by personnel of Radioisotope Branch.

(4) Decontamination of the area of the spill will be carried out under the supervision of the Radiological Protection Officer, but only after the personnel contamination problem has been resolved. As a general rule, the work associated with the decontamination is performed by the person responsible for the spill.

(5) If ingestion or inhalation is suspected from a spill of radioactive material, TB MED 232 will be complied with, and report to the Chief, Radioisotope Branch for further processing and reporting of the incident.

1. Personnel Monitoring:

(1) Film badges are provided for persons working with radioactive material in USAMRNL. These film badges will be worn during normal working hours and are not to be removed from USAMRNL. Care of the film badge will be the responsibility of the individual user.

(2) Badges will be delivered to Radioisotope Branch monthly for shipment to the Lexington Signal Depot, Lexington, Kentucky for processing and reading. The returned values will be permanently recorded in Radioisotope Branch files on DD Form 1141 as a duplicate of the original recording which is maintained by custodian of medical records.

(3) A thorough medical examination will be made of each individual potentially exposed to significant amounts of radiation before employment and annually thereafter.

(4) Those persons working with millicurie amounts of Tritium will have urine checks for radioactivity within 15 days of termination of each experiment.

6. Functions of Radioisotope Branch

a. Procurement, storage and administration.

(1) All radioactive materials for use in USAMRNL will be processed by personnel of the Radioisotope Branch through official supply channels.

(2) The Radiological Protection Officer will direct the storage and handling of the contents of each shipment of radioactive material after it has been delivered to him or his designated representative in the Radioisotope Branch, and is responsible for the records pertaining thereto.

(3) The storage area will be neat and segregated by type emission. Gamma emitting isotopes will be stored so that the radiation level at the edge of the storage area does not exceed one milliroentgen per hour.

(4) The Radiological Protection Officer is responsible for the handling and disposal of all radioisotope contaminated liquid and solid wastes in or delivered to the Radioisotope Branch in accordance with the recommended procedures found in Part 20, Title 10, CFR, and pertinent Army regulations.

b. Radiation Safety Monitoring.

(1) Area Monitoring:

(a) Routine monitoring will be accomplished according to the following time schedule:

Weekly

(1) Radioisotope Branch (according to diagram in Appendix 1).

Monthly

(1) Research Divisions within US Army Medical Research and Nutrition Laboratory (According to diagrams in Appendix 1).

(b) Other areas will be monitored when deemed necessary by the Radiological Protection Officer, i.e. - Pikes Peak Laboratory Facility.

(c) Readings obtained during the surveys will be recorded and retained as a permanent record.

(d) Routine monitoring in USAMRNL (including blowers on roof above Radioisotope Branch) will be done, using a portable PAC3G gas proportional counter with a beta detection probe and a GM counter. If contamination is detected, the area will be immediately decontaminated. If the activity with the GM counter, exceeds a value of 2.0 milliroentgens per hour, the Radiological Protection Officer will be notified. The area will be marked as to reading in milliroentgens/hour and the working time limit.

(e) Swipe tests will be conducted during area monitoring and when contamination is suspected. The swipes will be counted in the liquid scintillation counters for quantitative determinations. Any activity above background will be considered a contaminated area. Readings obtained will be recorded as a permanent record and responsible investigator notified.

(f) Any areas of previously undetected contamination will be promptly cleaned by those persons responsible for the contamination, under the supervision of the Radiological Protection Officer or his designated representative.

(2) Personnel Monitoring.

(a) In the event of a spill of radioactive material in Group III, the procedures outlined in par 5h(3) will be carried out and in addition, personnel of the Radioisotope Branch will perform the following procedures.

(1) Decontaminate the film badge (when necessary) and forward it by Air Mail Special Delivery to the Lexington Signal Depot; Liexington, Kentucky, with all data concerning the incident (i.e., isotope and its chemical form, amount involved, date, names, etc.).

(2) Carry out routine decontamination of clothing, work spaces, etc., which were involved.

(3) Notify the Surgeon General, Department of the Army, Washington, D. C., ATTN: MEDPS-PO, by telegram, of possible internal exposure. Complete DA Form 285 (Accident Report).

(4) In the event a potentially dangerous radioisotope is involved such as H^3, Ca^{45}, Fe^{55}, Sr^{90}, Y^{91}, Zr^{95}, Ce^{144}, Pm^{147}, or Bi^{210}, immediately notify The Surgeon General, Department of the Army, Preventive Medicine Division by telephone of:

(a) Time and date of incident.

(b) Millicurie strength of isotope and its chemical form.

(c) Name of individual and treatment already undertaken. Include a statement indicating the treatment rendered (or that no treatment has been rendered).

(d) Extent of individual contamination as determined by immediate monitoring.

(Telephone notifications will be confirmed by telegraphic notifications)

(5) A 24 hour urine sample will be collected under the direction of the Radiological Protection Officer from the person concerned. The collection shall be in a polyethylene liter bottle which will have a card attached containing the following data:

(a) Name, grade and SSAN

(b) Date of incident

(c) Inclusive dates of collection

(d) Isotope and chemical form

(6) The 24 hour urine sample will be collected as follows:

(a) Wash hands before collecting a portion of sample.

(b) Void urine at 0800 hrs (or any other convenient time) and discard it. Do not collect it in the bottle.

(c) Collect all urine from that time up to and including the corresponding hour the following day. ALL URINE MUST BE COLLECTED. LOSS OF A SIGNIFICANT AMOUNT WILL RENDER THE SAMPLE USELESS.

(7) Samples will be held until further instructions are received from the Surgeon General.

(8) If an overexposure to ionizing radiation occurs, DD Form 1141 (Report of Exposure to Ionizing Radiation) must be completed. A brief description of the condition of act which resulted in the overexposure will be attached to the DD Form 1141.

c. Decontamination of Glassware.

(a) Upon receipt of contaminated glassware in the Radioisotope Branch, it will be placed in the "hot" sink where it will be rinsed or washed with detergent if necessary then rinsed and placed in the ultrasonic bath. This includes pipettes and disassembled syringes although maximum use of disposable syringes and needles is suggested. Upon completion of the ultrasonic cleaning, the glassware may be oven or air dried.

(b) All glassware which has been decontaminated will be monitored by an appropriate detector. Always monitor after drying, never wet.

(c) All glassware which, upon monitoring, is still contaminated, will be recycled and will be properly discarded if decontamination is not complete after the second cleaning cycle.

d. Waste Disposal.

(1) Liquid waste disposition

(a) Contaminated liquid waste may be disposed of in the "hot" sink provided the quantity which, if diluted by the average daily quantity of sewage (sanitary sewage flow per 24 hours is 525,000 gallons) released into the sewer by the licensee, will not result in an average concentration in excess of values specified in Appendix B, Table I, Column 2 of CFR, Title 10, Part 20; (extracted applicale portion listed below); or

(b) Ten times the quantity of such material specified in Appendix C of same; and

(c) The gross quantity of licensed and other radioactive material released into the sewage system by the licensee does not exceed one curie per year.

Listed below is the quantity of any single radioactive isotope that may be released into the sewer in any one day. Daily maximums are listed for each isotope. In accordance with the Code of Federal Regulations, title 10, part 20.

Radioactive Material	Microcuries
Bromine-82	100
Calcium-45	100
Carbon-14	500
Chromium-51	500
Cobalt-60	10
Gold-198	100
Hydrogen-3	2500
Iodine-131	100
Iron-55	500
Iron-59	10
Phosphorus-32	100
Selenium-75	100
Strontium-85	10
Strontium-89	10
Strontium-90	1
Sulfur-35	500
Zinc-65	100

(d) Sewage disposal of liquid radioactive isotopes will be disposed of from the Radioisotope Section, Radiology Service, Fitzsimons General Hospital on Tuesdays and Fridays only, with all other days reserved for Radioisotope Branch, USAMRNL. Any deviation from this policy by either section will be cleared with the other Radioisotope Section before hand.

(e) All liquid radioactive waste disposal through the sanitary sewer at USAMRNL will be logged in Liquid Waste Disposal Log Book and activity listed in microcuries.

(2) Solid waste disposition

(a) Under no circumstances will waste be incinerated.

(b) Solid waste will be segregated into combustible and non-combustible waste and placed in properly labelled and lined fifty-five gallon sealable drums. These drums will comply with the requirements of the specific isotopes contained therein. See Code of Fed. Reg., Title 49, Jan 1969.

(c) Drums containing solid perishable waste, i.e. carcasses, tissues, etc., will be stored in a freezer prior to shipment.

(d) Instructions for shipping radioactive waste for proper disposition will be requested from:

Commanding Officer
U. S. Army Edgewood Arsenal
ATTN: SMUEA-ISDO
Edgewood, Maryland 21010

e. Logs and Records

(1) AEC Form 3 (Notice to Employees - Standards for Protection Against Radiation) will be posted in a conspicuous location.

(2) DD Form 1141 in accordance with AR 40-14 are prepared and maintained by the custodian of medical records, Fitzsimons General Hospital, duplicate copies for personnel in USAMRNL are retained in Radioisotope Branch.

(3) USAMRNL Regulation 40-14, the joint AEC license and U. S. Army authorization will be posted and readily available.

(4) Radioisotope inventory balance will be audited monthly. (Radioisotope inventory records are kept on Forms DA 8-235 and DA 8-212).

(5) Instrument logs will be maintained indicating calibration and maintenance of the portable survey instruments.

(6) Records of surveys (including swipe tests) will be kept.

(7) Caution signs, labels, and signals will be utilized according to CFR, Title 10, Part 20, para. 20.203.

(8) A report covering the period of each calendar quarter is prepared by the Commander of Fitzsimons General Hospital in accordance with AR 40-37. This report is dispatched to The Surgeon General, ATTN: MEDPS-PO, by the fifteenth working day following the close of the report period and contains the following information as a minimum:

(a) Copy of minutes of each Radioisotope Committee meeting, including a record of all actions taken by the Committee.

(b) Copy of the training and experience of each newly approved user of radioisotopes or any change in qualifications or certifications of previously approved users (for human use, AEC Form 313a, page 3).

(c) Radioisotope inventory, including data on quantities of radioisotopes procured, used, or disposed of, or currently in storage.

(d) Information on unsolved problems, new or improved developments, or other comments of interest to, or having a bearing on, support rendered by The Surgeon General.

(e) Notification of all changes in membership of Radioisotope Committee.

f. Other Routine Radioisotope Branch Procedures.

(1) Neatness in the laboratory is a prime requisite for elimination of the spread of contamination. The work area should be free of equipment and materials not required for the experiment at hand, and equipment used will be decontaminated and stored in a controlled location after use.

(2) At the end of each work period the hands will be washed and tested for contamination with an instrument of suitable sensitivity.

(3) The sinks in the laboratory portion of the Radioisotope Branch will not be used for purposes of performing personal toilet, except that the non-contaminated sinks may be used for the purpose of hand washing after the removal of protective gloves.

(4) No water for drinking purposes will be obtained from the laboratory portion of the Radioisotope Branch.

(5) Floors in the Radioisotope Branch will be cleaned frequently by wet mopping. Brooms and mops will not be transferred to other areas.

(6) Table tops, equipment, or any surface within the Radioisotope Branch will be kept clean. Under no circumstances will there be an accumulation of dust and/or possible contamination.

(7) Floors will be waxed and buffed on a monthly basis.

(8) Air conditioner filters, glove box filters, and hood filters will be checked quarterly and properly cleaned or replaced when necessary.

(9) Desiccant in the liquid scintillation counter will be checked weekly and changed when necessary.

(10) The emergency shower will be checked weekly.

(11) The portable survey meters will be calibrated at least every six months and after every maintenance procedure or battery change.

(12) Batteries in the portable survey meters will be checked monthly, and changed when necessary.

7. References:

Title 10 Code of Federal Regulations, Part 20

Title 49 Code of Federal Regulations

AR 40-14, 40-37, 70-25, 385-30, 700-15, 700-52, 711-16, 755-15

TB MED 232

FGH Reg. 15-1, 40-602, 40-604

USAMRNL Reg. 40-3

National Bureau of Standards Handbooks

No. 42 Safe Handling of Radioactive Isotopes

No. 47 Recommendations of the International Commission on Radiological Protection

No. 48 Control and Removal of Radioactive Contamination in Laboratories

MRNL REGULATION
NUMBER 40-14

15 July 1970

No. 49 Recommendations for Waste Disposal of Phosphorus-32 and Iodine-131 for Medical Users

No. 51 Radiological Monitoring Methods and Instruments

No. 52 Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water

No. 53 Recommendations for the Disposal of Carbon-14 wastes

No. 56 Safe Handling of Cadavers Containing Radioactive Isotopes

No. 59 Permissible Dose From External Sources of Radiation

FOR THE COMMANDER:

Marvin G. Kieca

1 Incl
as

MARVIN G. KIECA
CPT, MSC
Adjutant

DISTRIBUTION
C
C, Radioisotope Br.
C, Sup & Svc Br.
Each Investigator

MRNL REGULATION
NUMBER 40-14

15 July 1970

APPENDIX I

Attached are the floor plans which are within jurisdiction of USAMRNL where Radioisotopes are planned to be used. The below listed areas and Divisional responsibilities follow:

Building 600

1st floor east - Chemistry Division
2nd floor east - Chemistry Division
2nd floor west - Physiology Division

Building 601

1st floor east - Surgery (Pathology)
1st floor west - Physiology Division
2nd floor east - Pathology Division
2nd floor west - Microbiology Division

Building 602

1st floor east - Bioenergetics Division
1st floor west - Animal Facility (Pathology)
2nd floor east - Chemistry Division
2nd floor west - Chemistry Division

Building 603

1st floor east - Radioisotope Branch

Building 619

1st floor west - Metabolic Division

Pikes Peak Lab Facility

Entire Laboratory - Division conducting experiment

Incl 1

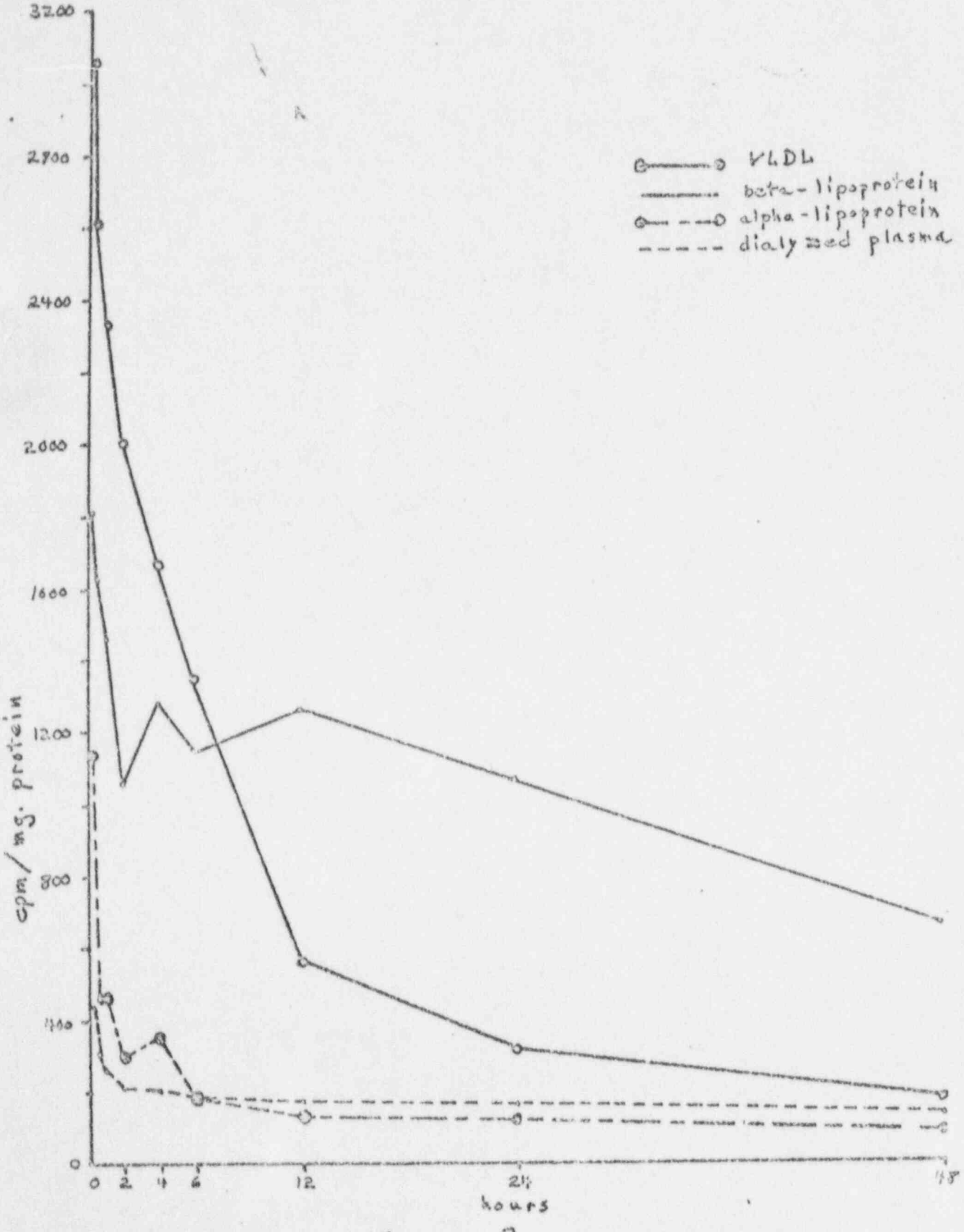

3200
2800
2400
2000
1600
1200
800
400
0
cpm/mg. protein
0
2
4
6
12
24
48
hours
VLDL
beta-lipoprotein
alpha-lipoprotein
dialyzed plasma

Figure 3

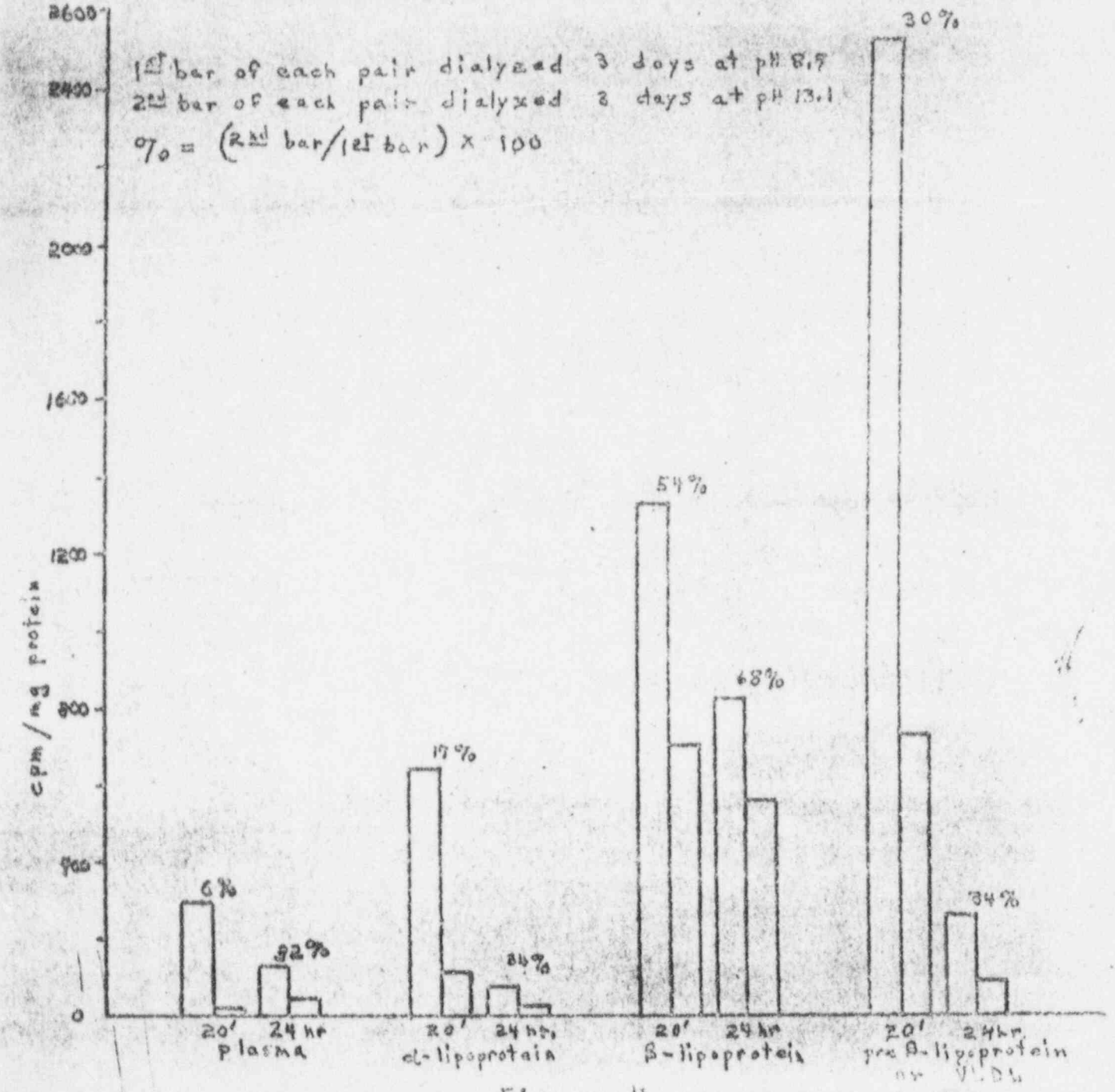

1st bar of each pair dialyzed 3 days at pH 8.5
2nd bar of each pair dialyzed 3 days at pH 13.1
% = (2nd bar/1st bar) x 100
cpm / mg protein
2600
2400
2000
1600
1200
800
400
0
6%
92%
19%
84%
54%
68%
30%
34%
20'
24 hr
plasma
α-lipoprotein
β-lipoprotein
pre β-lipoprotein

Figure 4

VOLUNTARY CONSENT STATEMENT

Military_____ Mil Patient _____ Civilian _____ Civ Patient _____

I, _____, having the capacity to consent, voluntarily and without force or duress consent to participate in research involving the use of tracer amounts of radioisotopes. I have been informed of, and understand, the nature, duration, and purpose of the experiment, the method and means by which it is to be conducted, the inconveniences and hazards to be expected, and the effects upon my health and person which may possibly come from participation in the experiment.

Specifically, I agree to receive intravenously up to 300 microcuries of ^{75}Se. I also agree to furnish blood and urine samples for the following 3-day period.

I understand that I may at any time during the course of the experiment revoke my consent and withdraw from the experiment without prejudice.

I do not at this time have any physical diseases, except the following: _____, or mental disease, to the best of my knowledge.

_____ _____

DATE SIGNATURE

_____

SIGNATURE OF WITNESS

APPROVAL

I have personally ascertained that the quality of the foregoing consent is sufficient to permit the volunteer to participate in the experiment.

_____ _____

ATTENDING PHYSICIAN PROJECT LEADER

APPENDIX II

CURRICULUM VITAE

RAYMOND FRANKLIN BURK, JR. 12 August 1970

Personal

Born: [redacted]
Height and Weight: [redacted]
Marital Status: [redacted]

Educational Institutions Attended

1963 - B.A. - University of Mississippi
1964 Johannes Gutenberg University, Mainz, Germany
(1 year residence)
1968 - M.D. - Vanderbilt University, Nashville, Tennessee

Educational Background

1968-69 - Straight medical internship, Vanderbilt University.
1969-70 - 1st year medical residency, Vanderbilt University.

Research Background

1964-68 - Summer and part-time research experience with Dr. W.N. Pearson in Nashville, Tennessee and Guatemala City.

Administrative Background

None

Professional and Scientific Societies

Associate member of Society of the Sigma XI

References

Dr. W. J. Darby, Vanderbilt University, Nashville, Tennessee
Dr. Grant W. Liddle, Vanderbilt University, Nashville, Tennessee

Public Relations Experience

None

APPENDIX III

Curriculum Vitae - Raymond Franklin Burk, Jr., M. D.

Honors and Fellowships Received

1967 - Vanderbilt Borden Award in Nutrition
1968 - Dean's Award for Student Research Presentation

Publications

Burk, R. F., Jr., W. N. Pearson, and F. Viteri. Discussion of Selenium in Human Nutrition. Symposium: Selenium in Biomedicine, Avi Publishing Company, 1967.

Burk, R. F., Jr., W. N. Pearson, R. P. Wood II, and F. Viteri. Blood Selenium Levels and in vitro Red Blood Cell Uptake of ^{75}Se in Kwashiorkor. Am. J. Clin. Nutr. 20:723-733, 1967.

Burk, R. F., Jr., R. Whitney, H. Frank, and W. N. Pearson. Tissue Selenium Levels During the Development of Dietary Liver Necrosis in Rats Fed Torula Yeast Diets. J. Nutr. 95:420-428, 1968.

Sandstead, H.H., R.F. Burk, Jr., G.H. Booth, Jr. and W.J. Darby. Current Concepts of Trace Minerals: Clinical Considerations. Med. Clin. N. Am. 54:1509-1531, 1970.

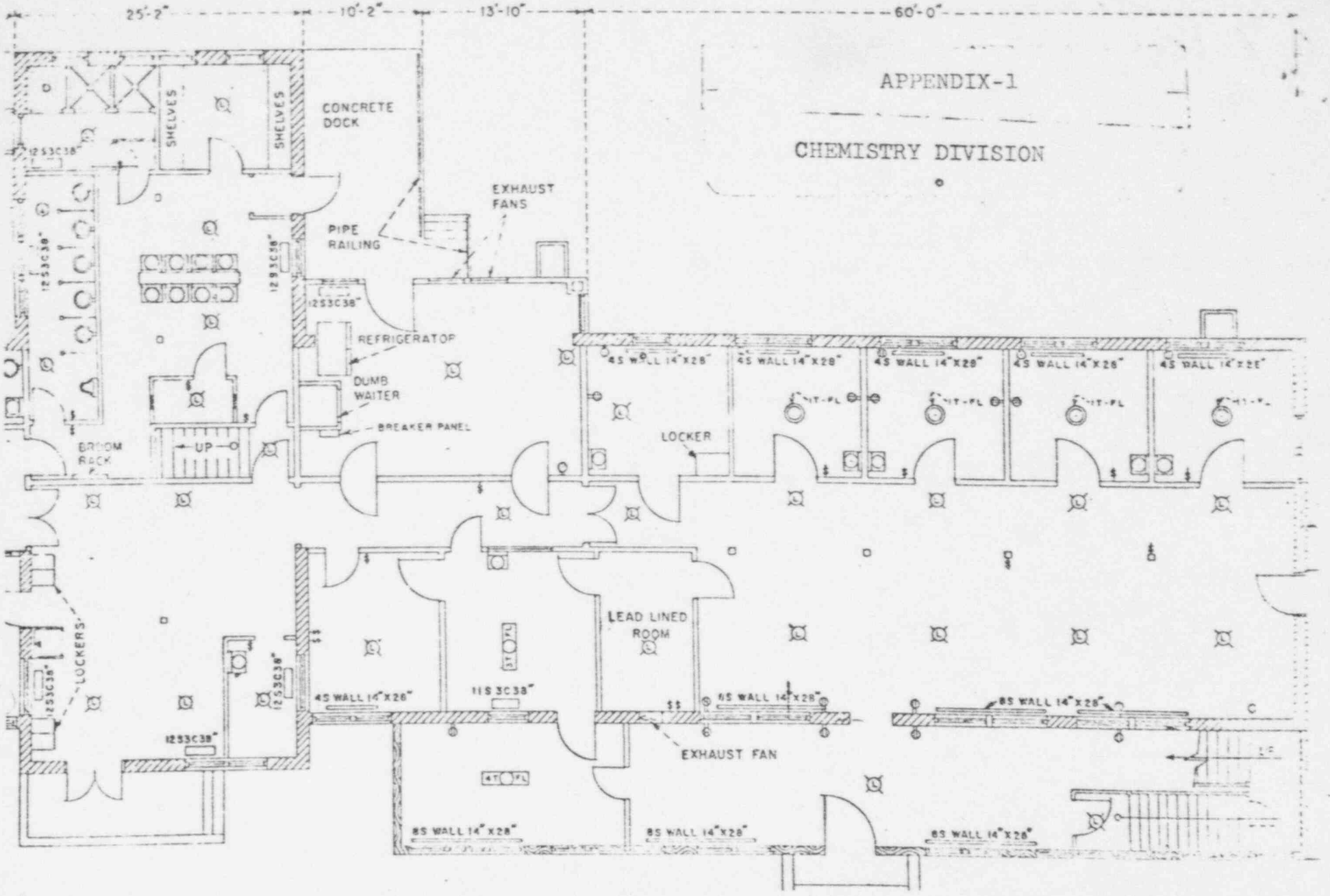
INVESTIGATOR'S ISOTOPE EXPERIENCE

The investigator had a formal one-semester course on the use of radioisotopes in medicine and biology in 1965 at Vanderbilt University. The course was a graduate course, oriented toward research and was conducted by the biochemistry department.

Since 1965, the investigator has used ^{75}Se continuously in research activity and has administered it to human beings as indicated in APPENDIX I. Also, he has used ^{35}S similarly.

He holds the M.D. degree, and has practical experience with the clinical use of ^{131}I and ^{51}Cr, as well as Schilling tests and various scanning procedures.

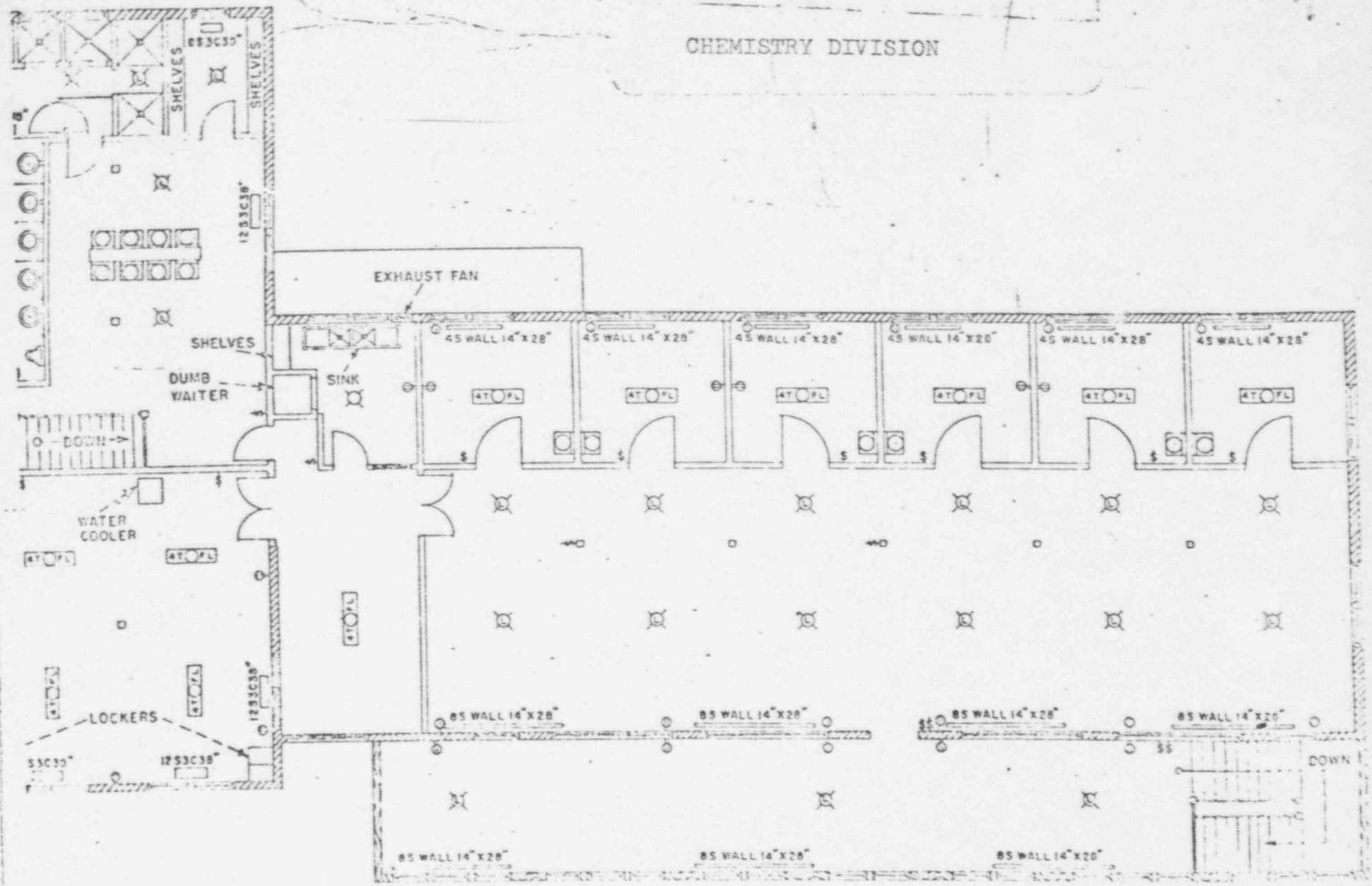
While at his present duty station, he has administered ^{42}K to human beings to calibrate the whole-body counter in this division.



1st FLOOR FAST BLDG. 600

APPENDIX-1

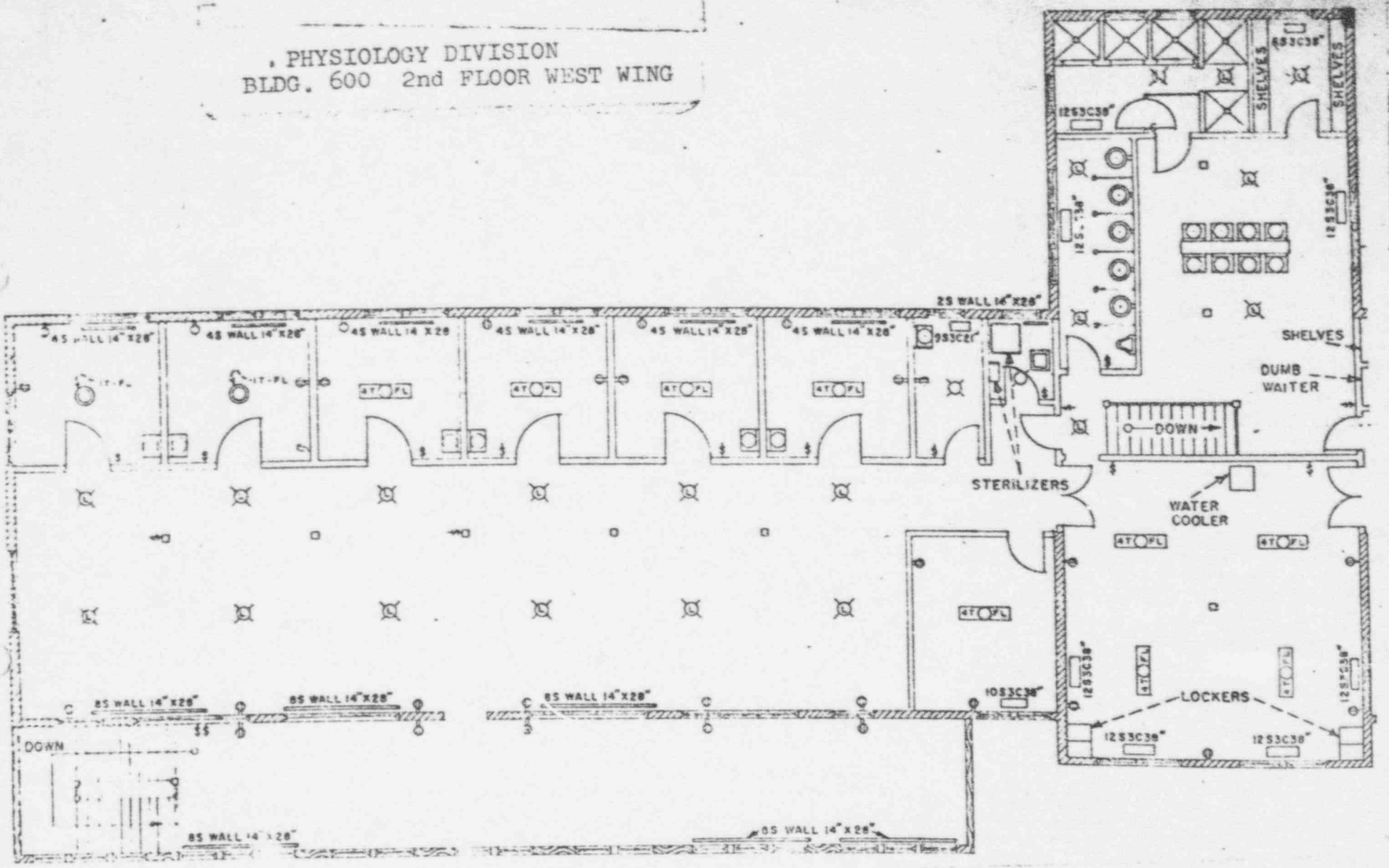
CHEMISTRY DIVISION



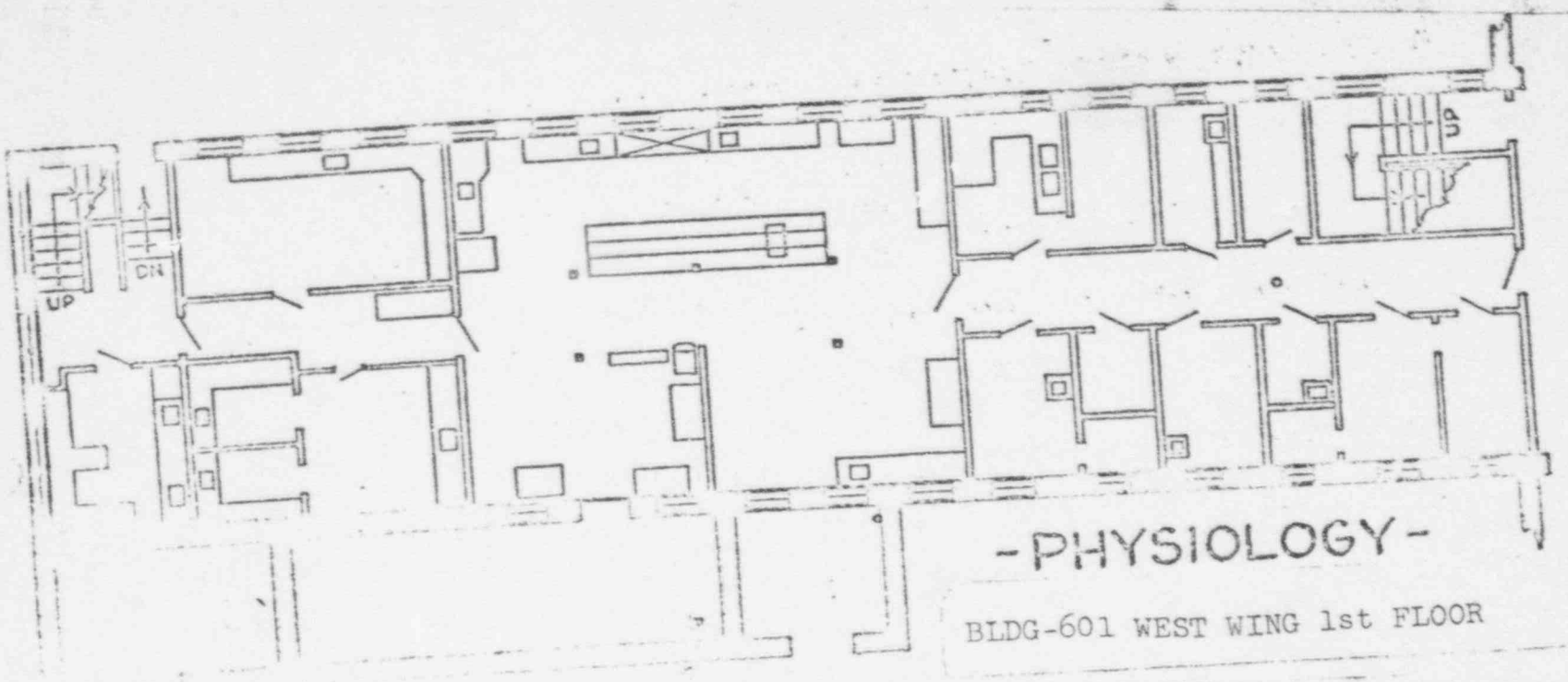
2nd FLOOR EAST BLDG. 600

APPENDIX-1

PHYSIOLOGY DIVISION
BLDG. 600 2nd FLOOR WEST WING

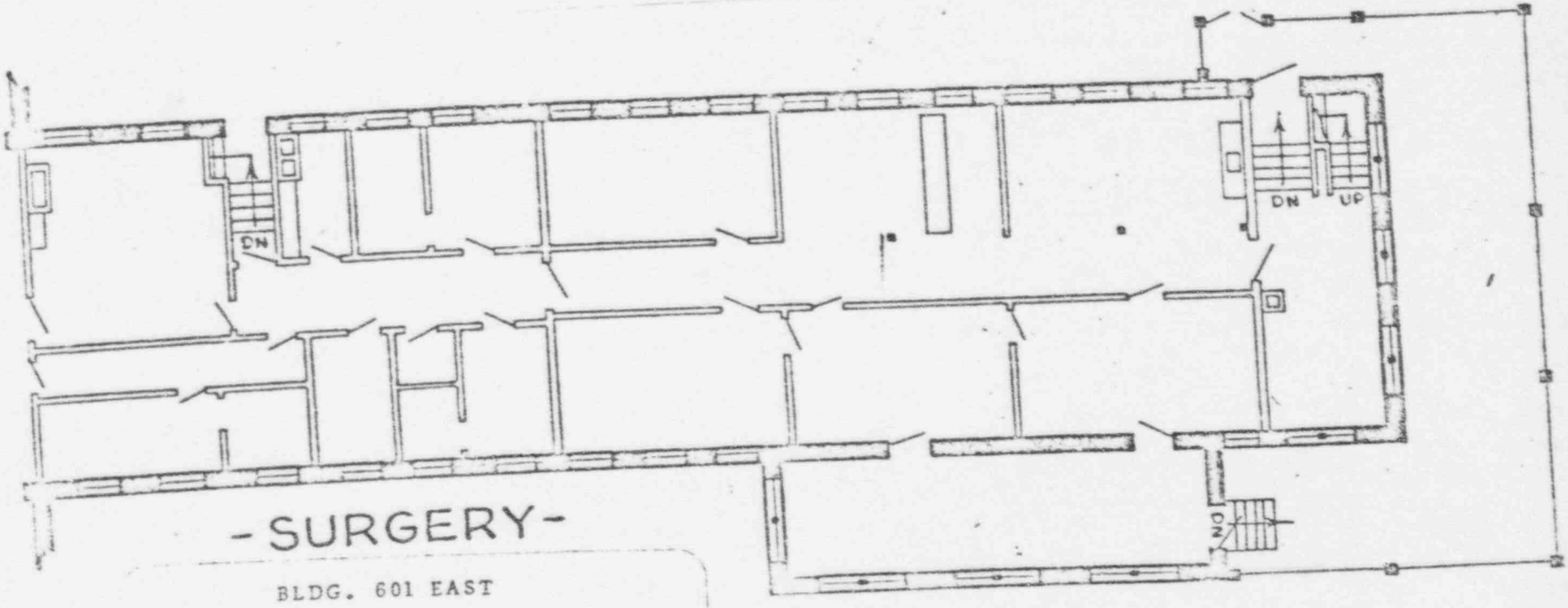


SECOND FLOOR



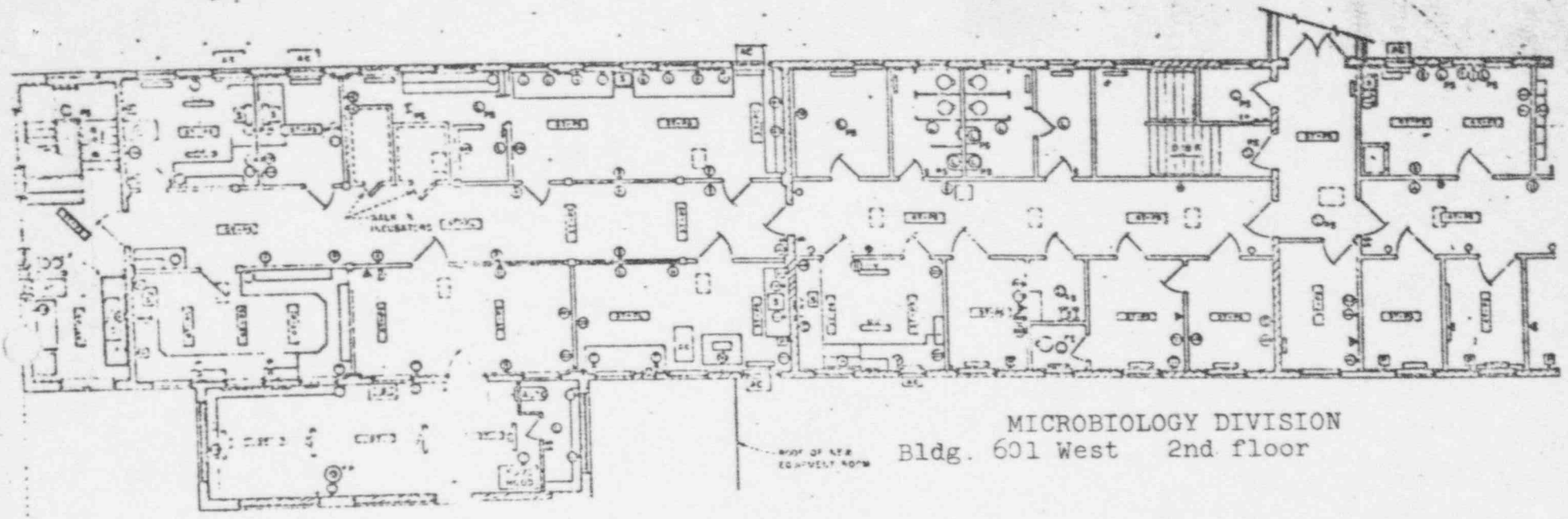
-PHYSIOLOGY-

BLDG-601 WEST WING 1st FLOOR

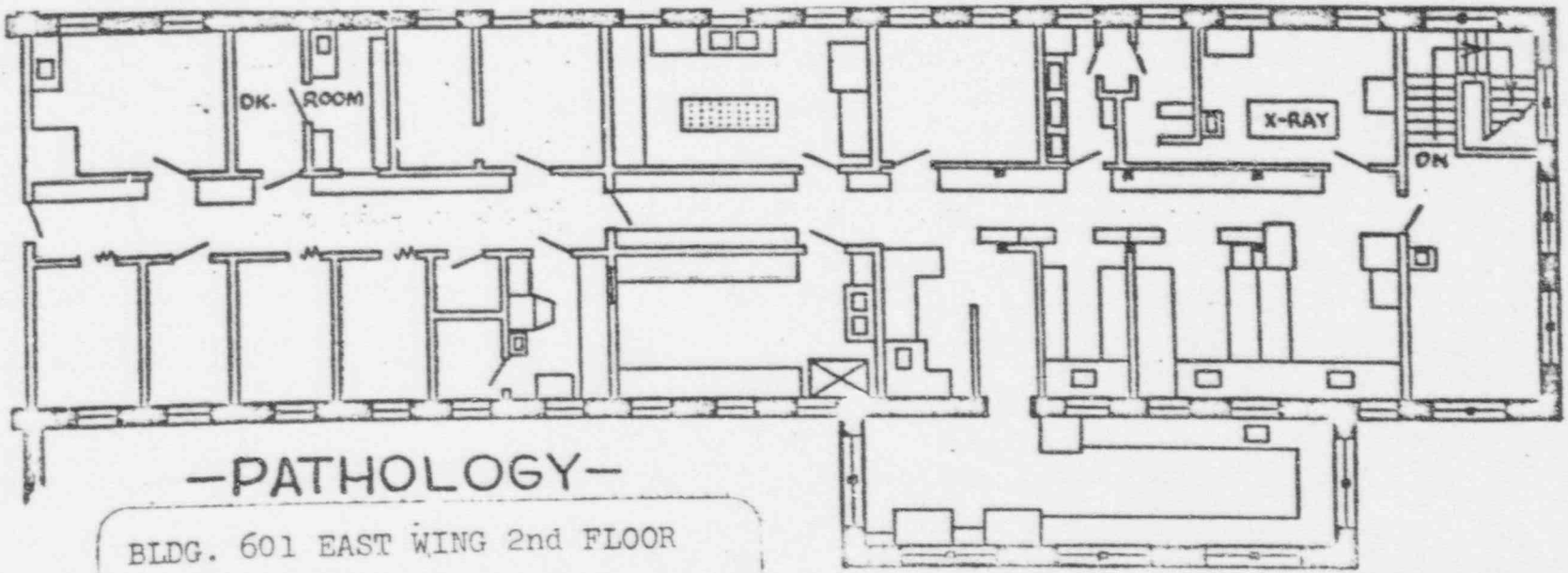


-SURGERY-

BLDG. 601 EAST
1st Floor



MICROBIOLOGY DIVISION
Bldg. 601 West 2nd floor



-PATHOLOGY-

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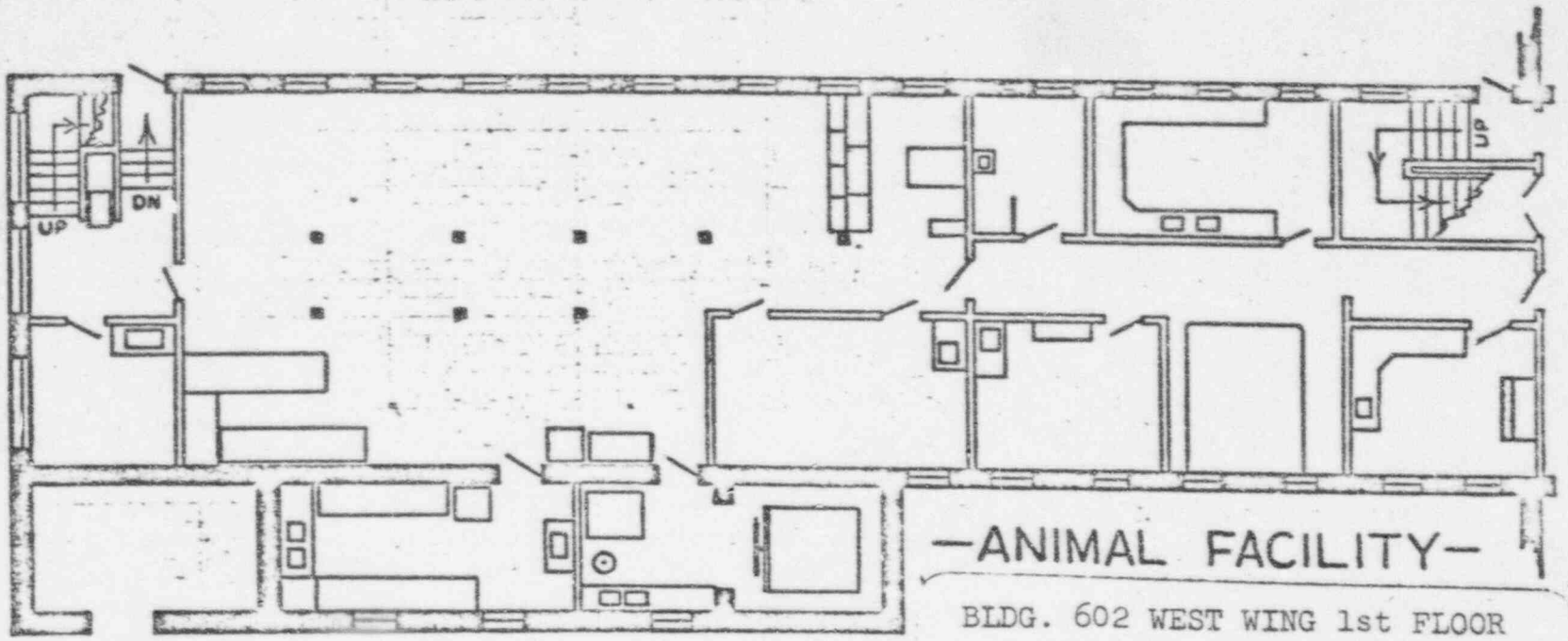

-ANIMAL FACILITY-

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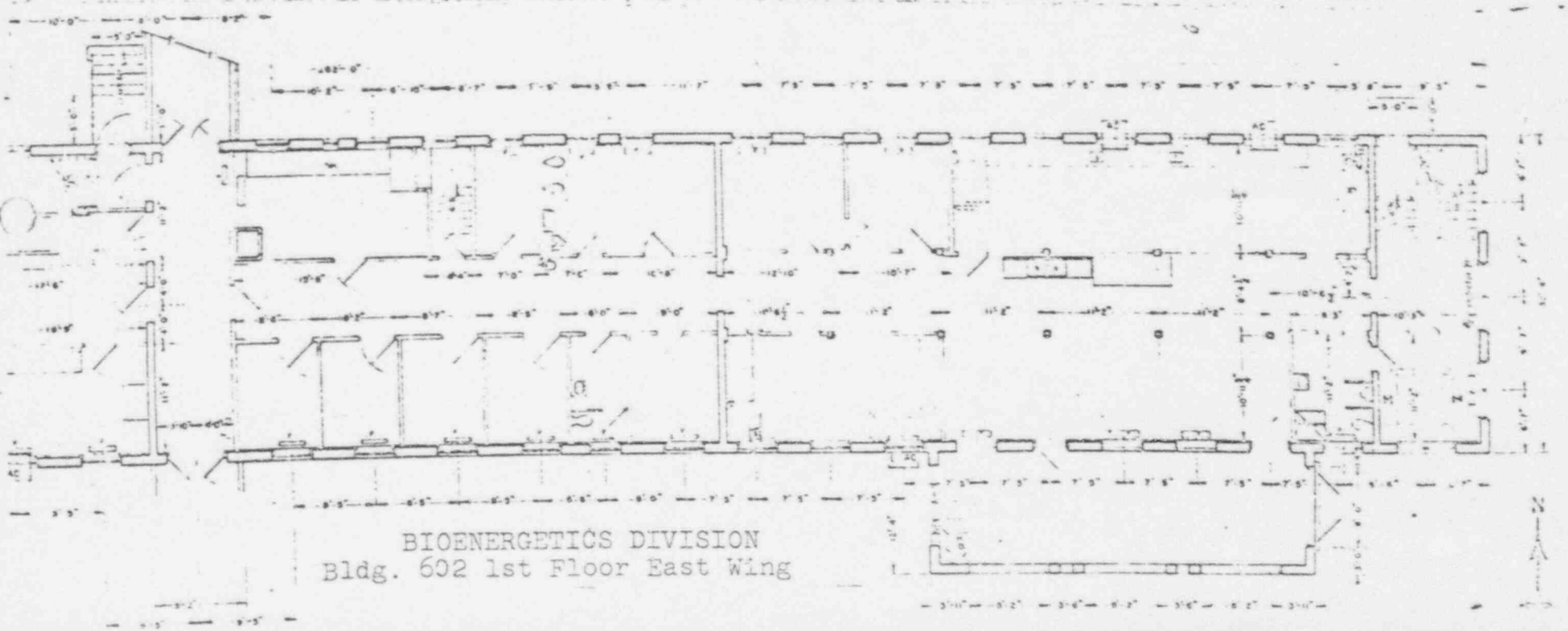
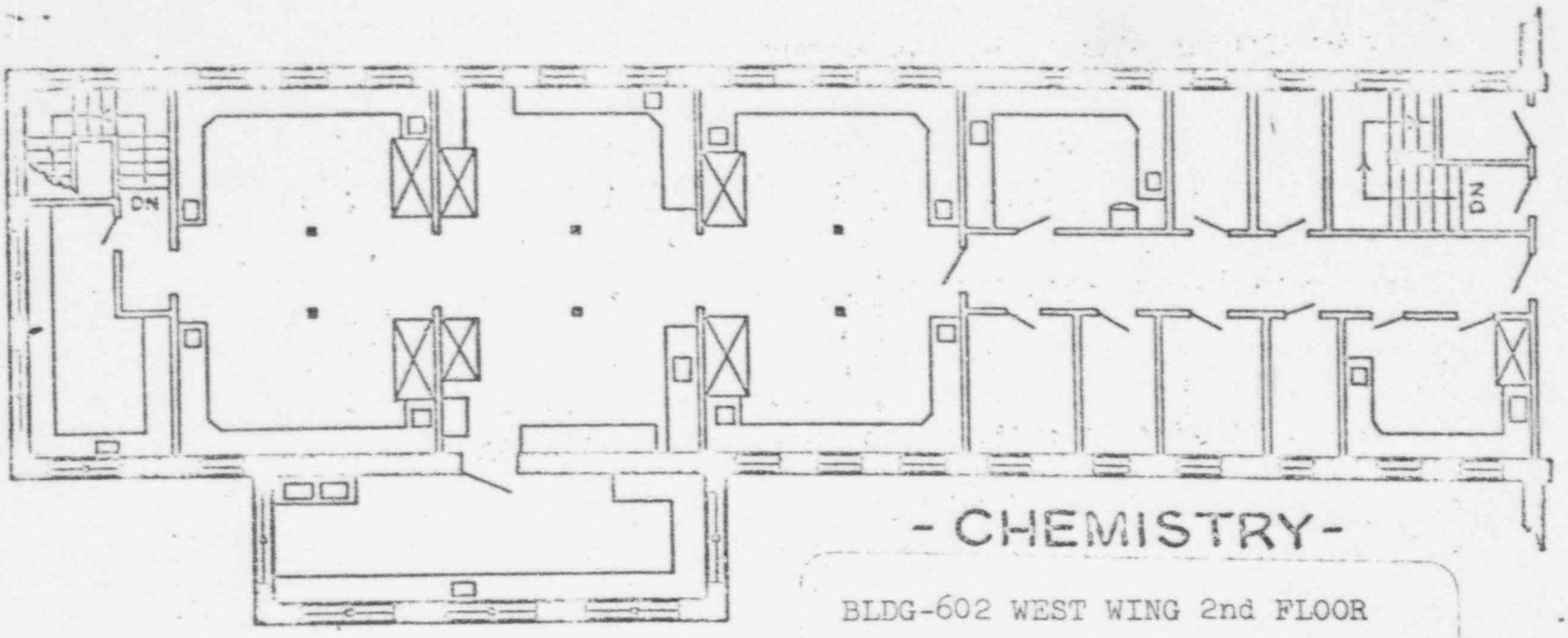
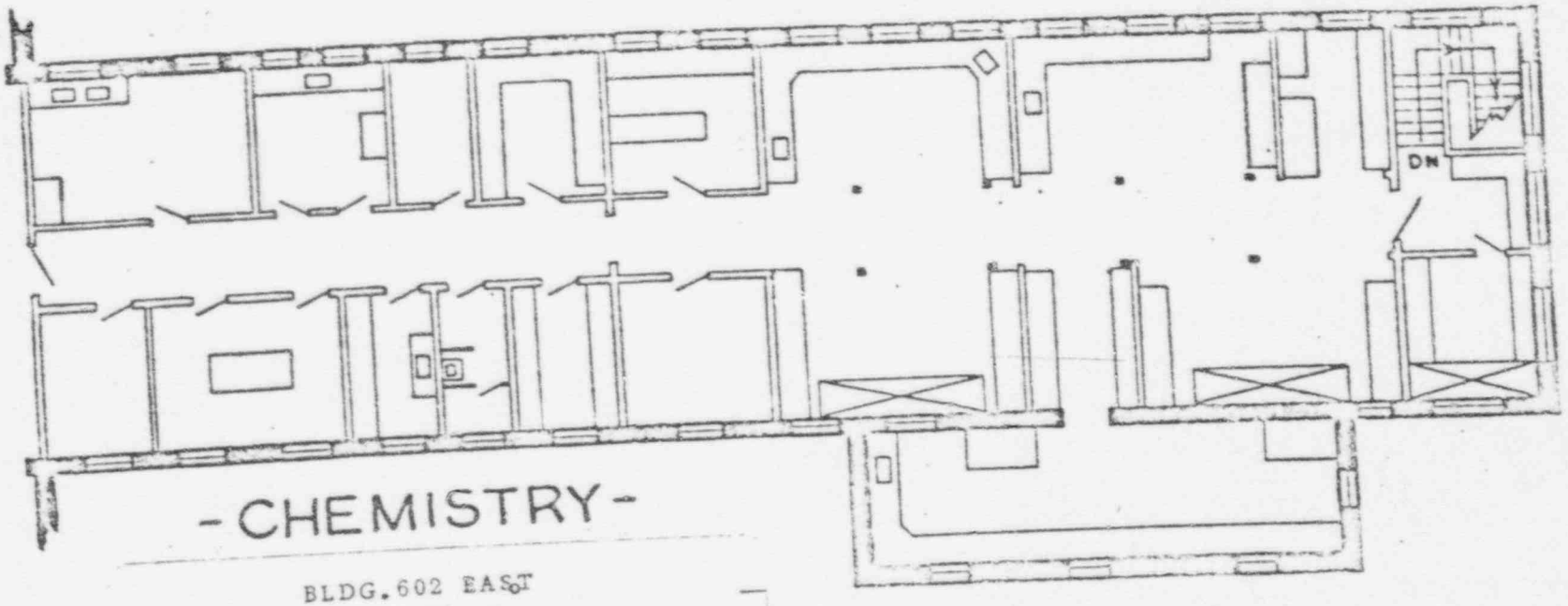


BIOENERGETICS DIVISION
Bldg. 602 1st Floor East Wing

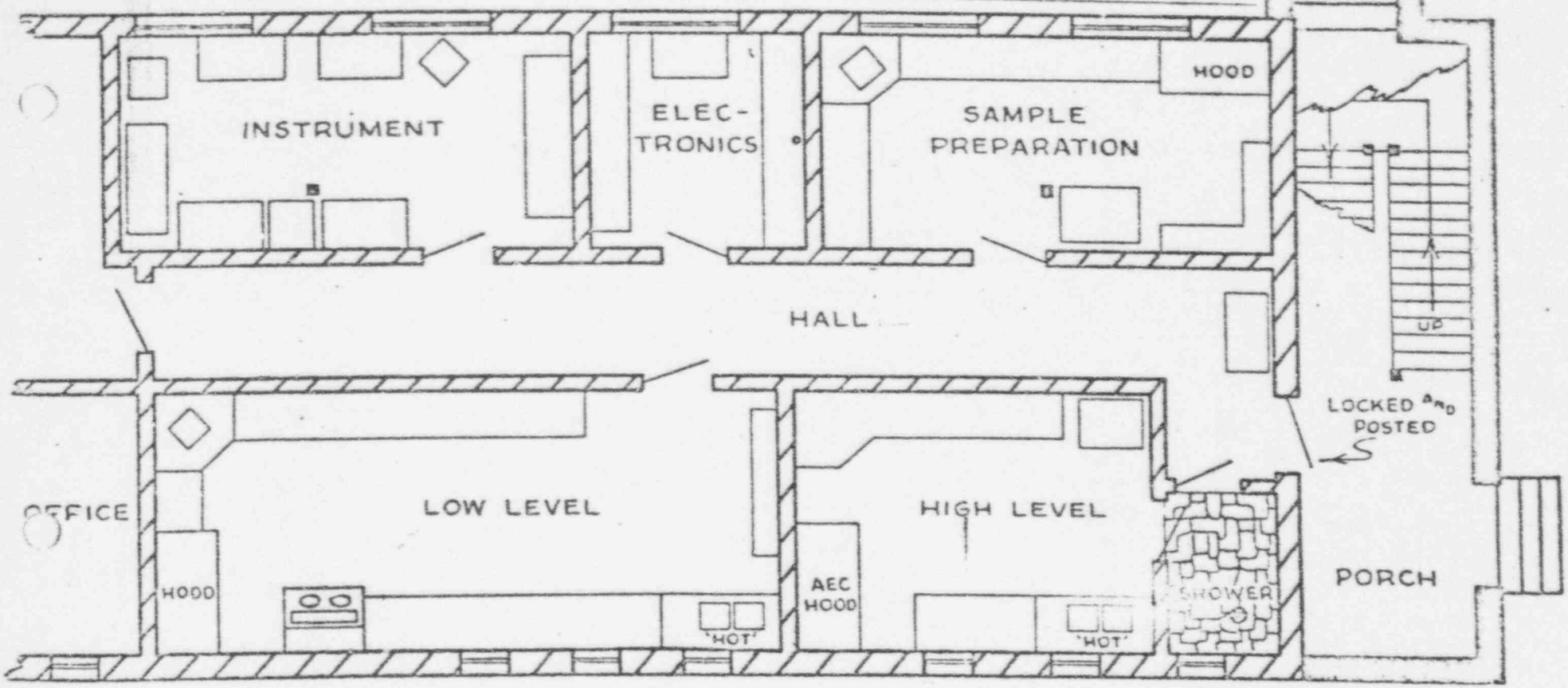


BLDG-602 WEST WING 2nd FLOOR



BLDG. 602 EAST
2nd Floor

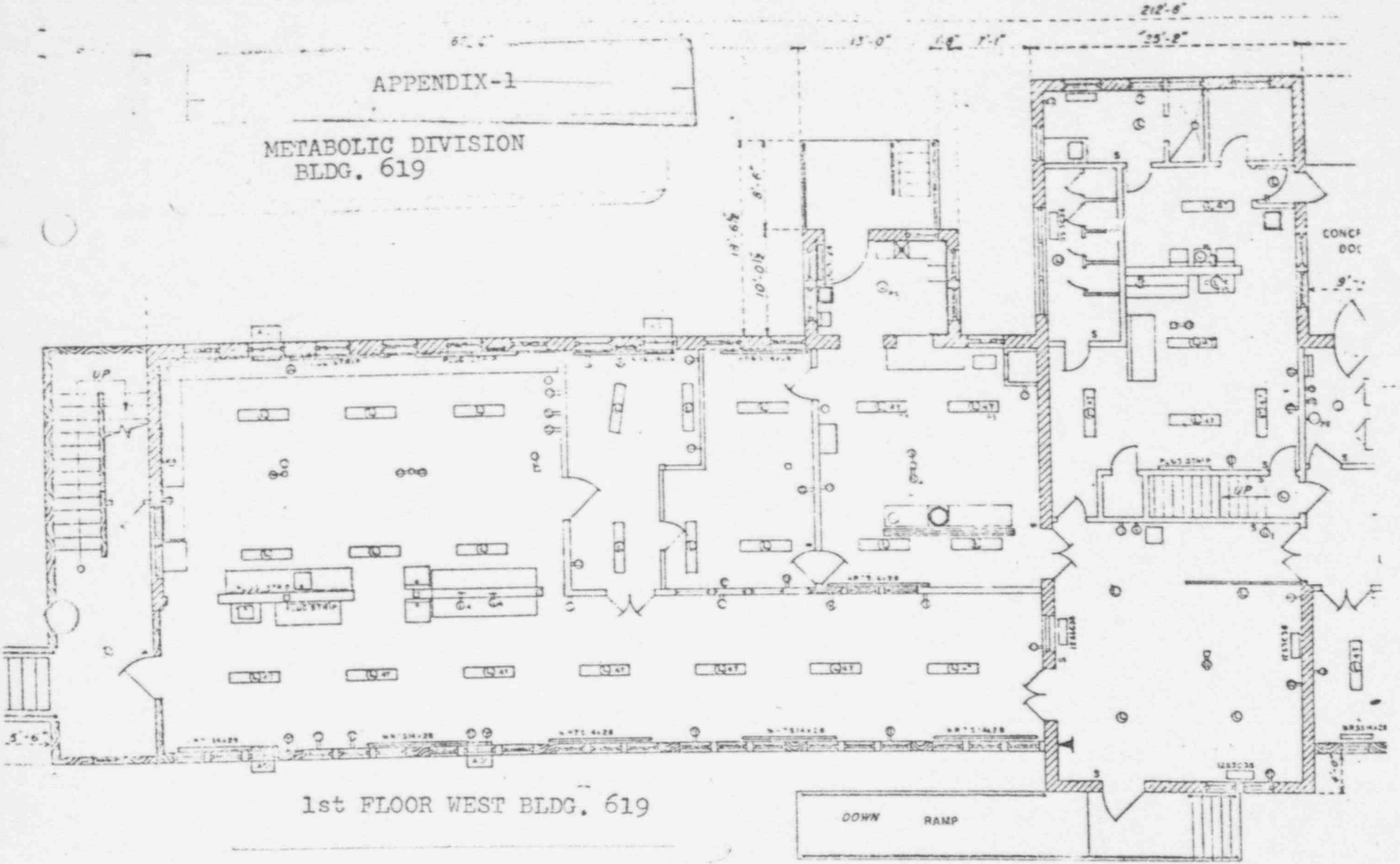
RADIOISOTOPE BRANCH
USAMRNL
BLDG 603



APPENDIX-1

APPENDIX-1

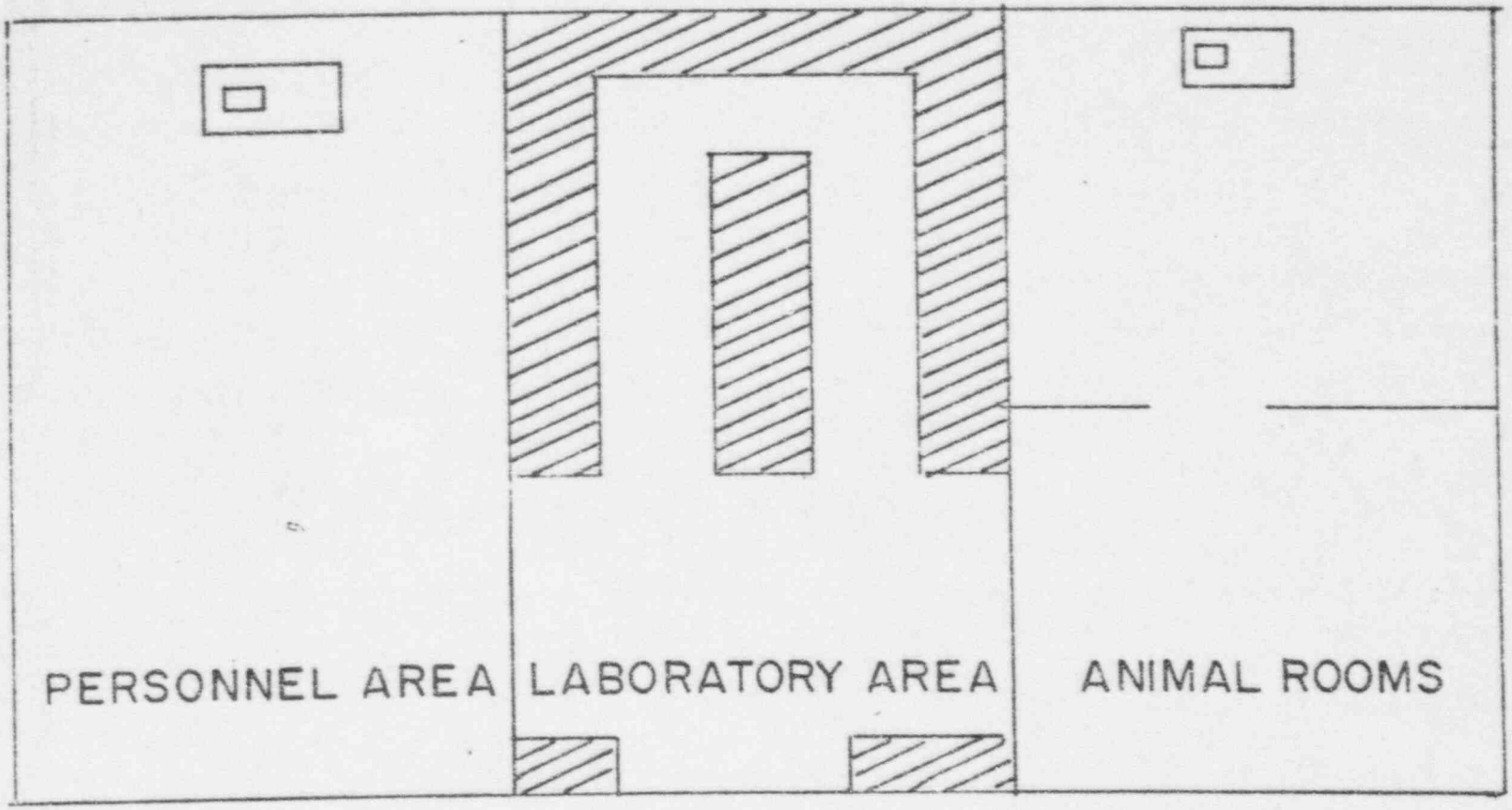
METABOLIC DIVISION
BLDG. 619



1st FLOOR WEST BLDG. 619

SECOND FLOOR
SCALE 1/8" = 1'-0"

FIRST FLOOR
SCALE 1/8" = 1'-0"



PIKES PEAK LABORATORY FACILITY
(24' x 60')

APPENDIX I.

HHE Nq. X-1

USAMRML - Bioenergetics 11 January 1971

FINAL PROTOCOL

Project: 3A061102B71P Basic Research in Support of Military Medicine

Task: 01 Biochemistry

Work Unit: 061 Mineral Metabolism

ST-6: Selenium Metabolism

EX-3: Selenium in Human Plasma Proteins

INTRODUCTION

The preceding protocol outlined a study to determine the site and nature of the selenium-protein bond in rabbit plasma. This protocol outlines a similar study on human plasma. It is hoped that a specific protein can be isolated and that the protein-selenium bond can be studied.

Unpublished data (Appendix I) indicate that after an intravenous injection of $Na_2{}^{75}SeO_3$ into a human being, the ^{75}Se concentrates in the beta-lipoprotein fraction reaching a specific activity eight times that of the alpha-lipoprotein fraction at 48 hours. Furthermore, when the beta-lipoprotein fraction is dialyzed against an alkaline bath, which is known to release selenium (1), it retains 68% of its activity whereas the alpha-lipoprotein fraction and the total plasma protein fraction retain only 32-34% of their activities. The activity is in the protein portion of each fraction. These observations indicate that there is a protein in the beta-lipoprotein fraction of human plasma which binds selenium to a greater extent than other proteins do, and that the type of bond in this protein is not the same as those in the others. The aim of this study is to isolate and study that protein.

ST-6; EX-3 11 January 1971

OBJECTIVE

The objective of this series of studies is to determine the roles of selenium and vitamin E in the prevention of nutritional liver disease and to apply the knowledge gained to the treatment of human liver disorders. At the present time, it would appear that the best way to approach the problem of the specific role of selenium is to study its metabolism. Therefore, this experiment is aimed at trying to localize the selenium in the plasma and to isolate and study selenium compounds that are found.

JUSTIFICATION

Liver disease, especially hepatitis, has been recognized as a major health problem of armies since antiquity. Today, the U.S. Army carries out a large amount of clinical research on hepatitis.

Selenium can prevent several nutritional liver disorders in animals (2,3), and has been shown to stimulate regeneration of rat liver after partial hepatectomy (4) and damage by a virus (5). Basic research into the metabolism of selenium may lead to advances in the treatment of hepatitis and nutritional liver disease.

EXPERIMENTAL DESIGN

A. Subjects. The subjects chosen will have cancer. The reason for this is twofold. First, it will limit the giving of radioactivity to healthy persons. Second, it will afford the opportunity for evaluating ^{75}Se-selenite as a tumor-scanning agent. At least one promising report of such use has already appeared (6), and more studies are needed. The scans will be performed by the Fitzsimons General Hospital Radioisotope Service.

The subjects will be chosen from the patients at Fitzsimons General Hospital. No pregnant women will be studied. They must have no liver or intestinal disease, and minimal or no constitutional symptoms. Serum protein and lipoprotein electrophoresis must be normal.

The subjects will be informed as to the reasons for the study, and the potential risk. Written consent will be obtained (see Appendix II- Voluntary Consent Statement). Medical care of the subjects will be provided by their attending physicians who will most likely aid in the identification of prospective subjects. There are no plans to administer other isotopes as part of this study. At most, ten subjects will be needed. (See Protocol Addendum pertaining to patient selection and patient care support.)

The complete study of each patient will require three to four weeks of laboratory work so the entire study should take about one year. If the results justify study in normal human beings, a suitable protocol will be prepared. Otherwise, a report on the completed work will be made.

B. Dose of $^{75}SeO_3^{=}$. The following calculations are derived from the REPORT OF THE ICRP COMMITTEE ON PERMISSIBLE DOSE FOR INTERNAL RADIATION, 1959 (6):

$$R = \frac{q \times 3.7 \times 10^{4} \times 1.6 \times 10^{-6} \times e \times 1 \text{ rem/rad}}{100 \times m}$$

where

R - dose rate in rem/sec

q = activity of radionuclide in uci

3.7×10^{4} = dis/sec per uci

1.6×10^{-6} ergs/Mev

100 = ergs/g per rad

m = mass of the critical organ in grams

e = effective absorbed energy per disintegration of the radionuclide.

The ICRP gives a value for e of 0.2 Mev/dis for ^{75}Se in the whole body. The value of m is taken as 7×10^4 to represent whole body distribution. If we arbitrarily set q as 300 uci, then the maximum dose rate becomes:

$$R = \frac{300 \times 3.7 \times 10^4 \times 1.6 \times 10^{-6} \times 0.2 \times 1 \text{ rem/rad}}{100 \times 7 \times 10^4}$$

$$R = 5.1 \times 10^{-7} \text{ rem/sec}$$

To obtain the total absorbed dose, the dose rate must be integrated over time. Dose rate expressed as a function of time is:

$$R(t) = R e^{-\lambda t}$$

where

$\lambda = 0.693/T$ (T is the effective half-life of the radionuclide - 10.1 days for ^{75}Se)

$\lambda = 6.86 \times 10^{-2}$

The total absorbed dose to time t_1, is expressed by:

$$D = R \int_0^{t_1} e^{-\lambda t} dt$$

$$D = 5.1 \times 10^{-7} \text{ rem/sec} \times 8.6 \times 10^4 \text{ sec/day} \int_0^{t_1} e^{-6.86 \times 10^{-2} \times t} dt$$

$$D = 4.39 \times 10^{-2} \text{ rem/day} \times \frac{1}{-6.86 \times 10^{-2}} \int_0^{t_1} e^{-6.86 \times 10^{-2} \times t} (-6.86 \times 10^{-2} dt)$$

$$D = -6.40 \times 10^{-1} \left[e^{-6.86 \times 10^{-2} \times t} \right]_0^{t_1} \text{ as } t_1 \to \infty$$

$$D = -6.40 \times 10^{-1} \times (-1)$$

$$D = 6.40 \times 10^{-1} \text{ rem}$$

This is the total body dose (0.64 rem) absorbed by a 70 kg man from 300 uci of ^{75}Se. Using the same formula, the dose to the liver would be 1.85 rem and that to the kidneys would be 1.71 rem. The ICRP allows a total body dose of 5 rem per year to persons exposed to radiation by their occupations and an organ such as the liver or kidneys would be allowed 15 rem per year (8). No definite dose limit has been set for diagnostic tests, but it is stated that the limits to those exposed due to their occupations should be a guide. Adjustments of dose will be made in accordance with the subject's weight.

C. Methods. One objective of this study will be to confirm the unpublished observations of Appendix I. To that end, a subject will be given an intravenous injection of about 200 uc of sterile and pyrogen-free $^{75}SeO_3$ and blood samples will be taken at 5 and 30 minutes; and 1, 2, 4, 6, 12, 24, 48 and 72 hours, and anticoagulated with EDTA. Approved procedures will be used in handling radioactive material. An aliquot of whole blood will be set aside for counting. Plasma aliquots will be preserved for gel filtration, electrophoresis, dialysis and lipoprotein separation by preparative ultracentrifugation (9). Specific activities will be reported as cpm/mg of protein as determined by the Lowry method (10). Time curves of specific activies of the fractions separated will be prepared.

Fractions identified as having high specific activity will be subjected to other procedures to further increase the activity. Thus, the beta-lipoprotein fraction in which the ^{75}Se specific activity is greatest

will be subjected to electrophoresis and gel filtration. Other methods will be used as they become applicable.

Once the selenium-containing protein has been obtained in as pure a form as possible, it will be subjected to alkaline dialysis, denaturation, and other processes to determine the nature of the selenium-protein bond.

ADMINISTRATIVE DETAILS

A. This will be a Bioenergetics Division study with the collaboration of the Radioisotope Service of Fitzsimons General Hospital for tumor scanning, and the Radioisotope Division of USAMRNL for sample counting.

B. The project leader will be CPT Raymond F. Burk, Jr., M.D., M.C.

C. Costs:

(1) Personnel:

CPT Burk, 70% of time for 3 months

EM (1), 100% of time for 3 months

(2) Equipment.....$0

(3) Supplies.....$500.00

(4) Selenium-75 (sterile and pyrogen-free) $500.00

Total $1000.00

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Raymond F. Burk, Jr.

RAYMOND F. BURK, JR., M.D.
CPT, M.C.
Bioenergetics Division

4 Incls
1. APP I - Prog Rpt
2. APP II - Vol Consent State
3. APP III - Curriculum Vitae
4. APP IV - Experience of Inves

PROGRESS REPORT

ASSOCIATION OF $^{75}SeO_3^=$ WITH HUMAN PLASMA LIPOPROTEINS

BY

Raymond F. Burk, Jr.

April 19, 1968

APPENDIX I

Introduction:

A preliminary report entitled "Simultaneous Incorporation Studies of ^{75}Se-l-selenomethionine and ^{35}S-l-methionine into Human Lipoproteins" (1) gave the rationale for the belief that selenium plays a special role in the beta-lipoproteins, perhaps as a carrier for d-alpha-tocopherol. The study of simultaneous incorporation of ^{75}Se-l-selenomethionine and of ^{35}S-l-methionine into plasma lipoproteins of one human subject yielded similar activity curves for ^{75}Se and ^{35}S over a 24-hour period in dialyzed plasma, chylomicron plus very low density lipoprotein (VLDL or prebeta--lipoprotein), beta-lipoprotein, and alpha-lipoprotein fractions. This finding does not support the hypothesis that selenium has a separate role from that of sulfur in the lipoproteins.

It is well known, however that the metabolic pathways of organic and inorganic selenium differ and that this is the case, particularly in the immediate period following intravenous administration of selenium. Therefore, it was deemed advisable to conduct a similar experiment with selenite ($SeO_3^=$) instead of selenomethionine. This is a report of that experiment.

Experimental:

The subject studied was a 77-year old white male with a histologic diagnosis of reticulum cell sarcoma involving cervical and retroperitoneal lymph nodes by x-ray studies. Although the patient weighed only 45 kg, he had not lost weight and had few symptoms. Lipoprotein electrophoresis, plasma protein electrophoresis, cholesterol, carotene, vitamin A and vitamin E determinations were within normal limits. Red cell morphology was normal, and the hematocrit varied from 35 to 41. The administration of $^{75}SeO_3$ was performed for diagnostic purposes.

After the patient had fasted for 14 hours, 190 uc of $^{75}SeO_3^=$ was given intravenously. The patient was allowed to eat ad libitum 4 hours later. Whole body counting and tumor scan were performed, and urine and feces were collected for counting. Results of these studies will be reported on a separate sheet. Blood samples were taken at 20, 40 and 60 min., and at 2, 4, 6, 12, 24 and 48 hours. The anticoagulant used was EDTA - 2 mg/ml blood. The plasma was removed by centrifugation, and the cells were washed twice with 0.15 M NaCl. Unless specifically designated, all dialyses were

for 24 hours against 0.15 M NaCl at 4°C. The adequacy of this dialysis was demonstrated by adding $^{75}SeO_3^{=}$ to plasma and observing the almost complete loss of counts with dialysis. VLDL (density < 1.006), beta-lipoprotein (density < 1.063), and alpha-lipoprotein (density < 1.21) fractions were isolated from 10 ml plasma samples by modification of the ultracentrifugal method of Havel, et al. (2) and then dialyzed. Counting was done in a Packard Auto Gamma Counter and protein was determined by the method of Lowry, et al. (30).

Results:

Figure 1 demonstrates the ^{75}Se activity in whole blood and in plasma and red cells. There is a rapid loss of radioactivity from the blood until 2 hours at which time a second phase of a slower loss of activity becomes evident. Nearly all of the activity is found in the plasma. Indeed, if a correction for the trapping of plasma in the red cell mass is made, all the counts would appear to be in the plasma. No increase in red cell activity is seen with time.

Figure 2 compares the specific activity of dialyzed and undialyzed plasma. The loss of counts on dialysis decreases steadily to 12 hours from which point on all ^{75}Se is non-dialyzable.

Figure 2a shows the specific activities of plasma protein fractions separated by paper electrophoresis. The paper strips were cut into albumin, alpha-1, alpha-2, beta, and gamma pieces and each piece was counted separately. The protein content of each piece was determined from the densitometric tracing of the strip. Alpha-2-globulin and beta-globulin have the highest specific activities, and albumin has the lowest.

The specific activities of the lipoprotein fractions and dialyzed plasma are seen in figure 3. With the exception of the very early values, the alpha-lipoprotein and dialyzed plasma activities are similar. The VLDL specific activity is the highest for the first 6 hours, but then rapidly drops below that of the beta-lipoprotein and at 48 hours approximates that of the dialyzed plasma and alpha-lipoprotein. The beta lipoprotein maintains a distinctly higher specific activity than the other lipoproteins after 12 hours. Its specific activity at 48 hours is 8 times that of the alpha-lipoprotein.

In order to determimine whether the ^{75}Se was in the lipid or protein portion of the lipoproteins, they were extracted 3 times with ethanol-diethyl ether (1:1 v/v). This was done both in samples precipitated and washed twice with 10% TCA, and in samples which had not been precipitated. The two extractions yielded similar results, but the ones precipitated with TCA were more consistent. They are seen in TABLE 1. No more than 10% of the counts were extracted - in fact the extraction usually did not exceed 5%. Thus, these data indicate that the ^{75}Se is associated almost exclusively with the protein.

Cummins and Martin (4) recently reported that "protein bound" selenium can be removed by dialysis for several days at pH 12. In order to determine whether the ^{75}Se in this experiment could be released by alkaline dialysis, two dialysis procedures were carried out. Both consisted of 0.15 M NaCl solutions and to one sufficient NaOH was added to give a pH of 13.1. The pH of the other bath was 8.9. Identical aliquots (0.5 ml) of 20 minute and 24 hour samples of dialyzed plasma, alpha-lipoprotein, beta-lipoprotein, and VLDL were put into each bath (500 ml/sample), and dialyzed 3 days at 4°C. The samples were then removed and counted, and a protein analysis was done so specific activities could be calculated. Figure 4 shows the results. The specific activities of the lipoproteins dialyzed in 0.15 M NaCl are less than those in figure 3 indicating that some counts were lost. This may have been the result of denaturation of the protein during previous counting at room temperature (4). Much more striking, however, is the loss of counts by the samples dialyzed at pH 13.1 when compared with those dialyzed at pH 8.9. The loss was more marked in the 20' sample in each case. The loss of counts on dialysis at pH 13.1 was far less in the beta-lipoproteins than in any other sample.

Discussion:

Figures 1, 2 and 3 all show decreases in specific activity with time. This is in marked contrast to results obtained with ^{75}Se-l-selenomethione was given (1). In the latter instance, curves of rising activity to 6 hours were obtained suggesting a synthetic process. Imbach and Sternberg (5) reported an early decrease of rat plasma activity following injection of $^{75}SeO_3^{=}$ and a later slow increase beginning at about 10 hours and persisting past 48 hours. No such increase was noted in this experiment.

It is possible that much of the red cell activity seen in Fig 1 is an artifact caused by red cell uptake of $^{75}SeO_3^=$ from trapped plasma during saline washing. In unreported experiments, we have observed a marked *in vitro* uptake of $^{75}SeO_3^=$ by red cells washed in saline.

Fig 3 clearly shows that selenium is preferentially bound to beta-lipoprotein and VLDL. The rapid turnover of VLDL may be responsible for its rapidly decreasing activity. No explanation is available as to why its initial specific activity is greater than that of beta-lipoprotein. The biologic half-life of both alpha- and beta-lipoprotein has been found to be 4 days (8) and their pool sizes are comparable. Thus, if $^{75}SeO_3^=$ binding were nonspecific, specific activity curves would lie close together. They lie far apart indicating the specific binding of selenium by the beta-lipoproteins. Furthermore, as seen in Fig 4, the type of binding in the beta-lipoproteins is probably different because much less selenium is lost in alkaline dialysis than is lost by the other lipoproteins and dialyzed plasma under identical conditions. A hypothesis which would fit the observations is: there are two types of selenium binding -- one not affected by alkaline dialysis which is found in the beta-lipoproteins, and another which is disrupted by alkaline dialysis and is found in all proteins studied.

Hircska and Galambos (7) reported higher specific activity in total human lipoprotein than in other plasma proteins following injection of $^{75}SeO_4^=$ but studied only total lipoproteins and not the individual classes. A further augmentation of specific activity in the lipoproteins was noted in a man with cirrhosis and fatty liver. Fig 3 indicates that the increased specific activity resides in the beta-lipoproteins of the patient with cirrhosis and fatty liver could have been due to selective increase in beta-lipoprotein and VLDL, increased avidity of all lipoproteins for selenium, or selective increase in selenium binding by one class of lipoprotein - perhaps beta. It is possible that the patient with cirrhosis and fatty liver had reduced selenium stores which might be expected to cause increased selenium binding.

In these studies, virtually all of the ^{75}Se is attached to the protein moiety of the lipoproteins (see TABLE 1). It has long been known that under certain conditions in the first 30 minutes after intravenous

injection of $^{75}SeO_3^=$ or $^{75}SeO_4^=$ dimethyl selenide is produced in the liver and carried dissolved in the blood lipids to the lungs where it is exhaled. This might spuriously raise the lipoprotein specific activity but the failure to find appreciable quantities of ^{75}Se in the lipid moiety of the lipoprotein would appear to rule out this possibility here.

Selenium deficiency was reported to be a causative factor in nutritional liver necrosis in rats in 1957 (8). More recently, it has been implicated in the development of cirrhosis in pigs in conjunction with vitamin E and protein deficiencies. The observation recorded here that selenium has a special association with the beta-lipoproteins (which also carry d-alpha-tocopherol (6)) may perhaps serve as a clue in the further investigation of the metabolism of this trace element.

Summary:

The specific activities of various blood proteins have been studied for 48 hours following intravenous injection of $^{75}SeO_3^=$.

(1) Whole blood, plasma and lipoprotein specific activities decrease with time.

(2) Plasma is responsible for nearly all the whole blood activity.

(3) Dialyzable ^{75}Se is present in plasma until 12 hours after injection.

(4) Over 90% of the ^{75}Se in the lipoproteins is "attached" to the protein portion of the molecule.

(5) The specific activities of beta-lipoprotein and VLDL are much higher than those of alpha lipoprotein and dialyzed plasma.

(6) ^{75}Se in the beta lipoprotein is less susceptible to removal by alkaline dialysis than that in other proteins studied. This finding and the higher specific activity suggest a different type of selenium binding in the beta-lipoproteins.

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TABLE 1

Percentages of Counts Extractable by Ethanol-Diethy Ether
After TCA Precipitation

Time	Alpha-Lipoprotein	Beta-Lipoprotein	VLDL
20'	9.6	0.9	3.2
40'	7.7	1.7	3.4
60'	3.4	3.5	0.8
2 hr.	2.0	3.5	2.3
4 hr.	8.4	2.9	3.7
6 hr.	7.5	2.0	0
12 hr.	9.6	0	0
24 hr.	0	5.3	2.7
48 hr.	2.6	6.0	6.1

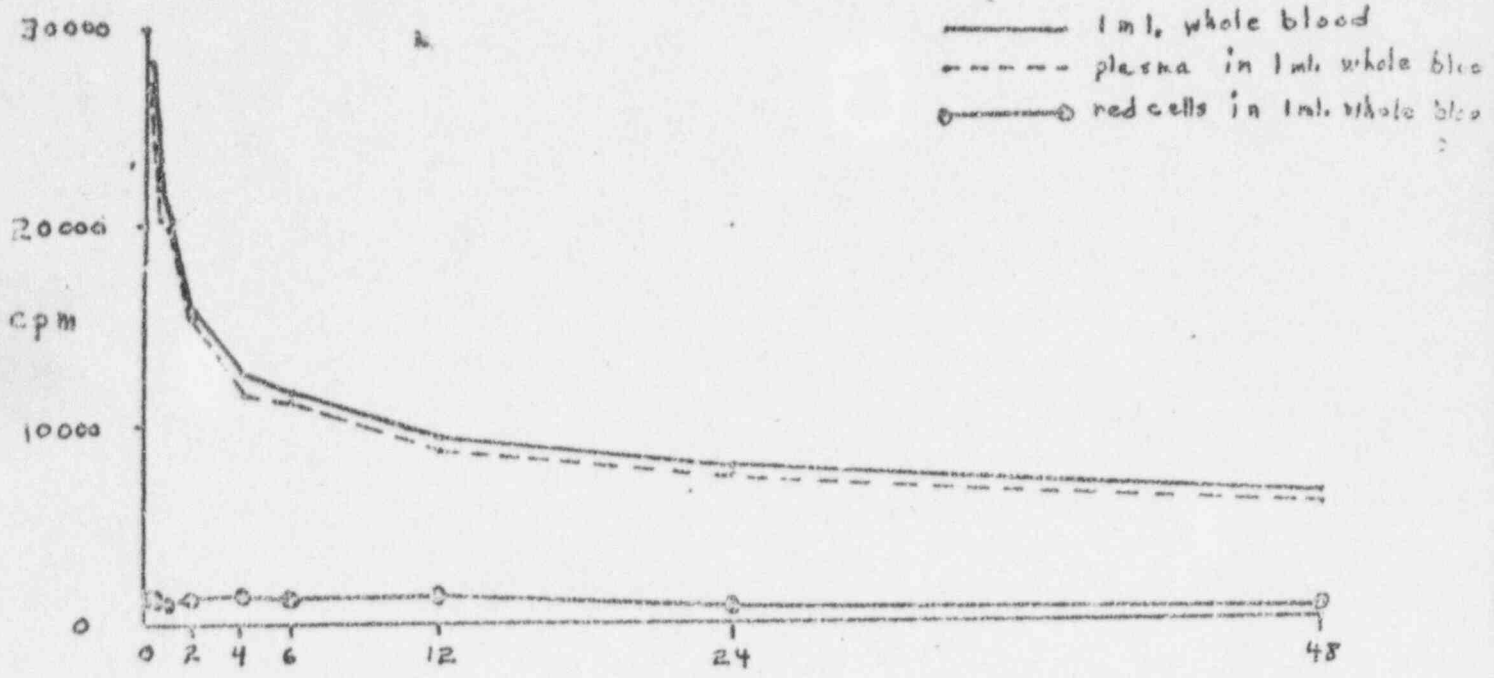


Figure 1

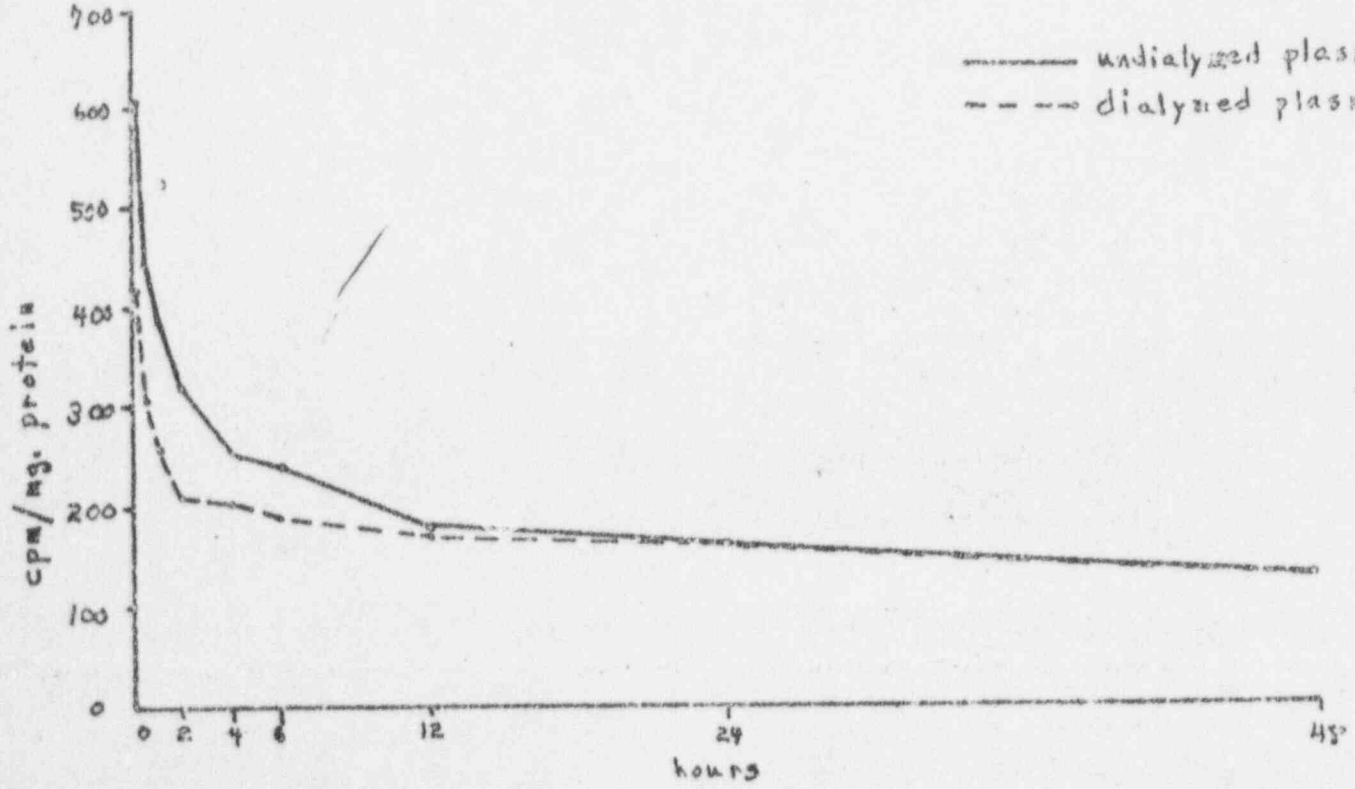


Figure 2

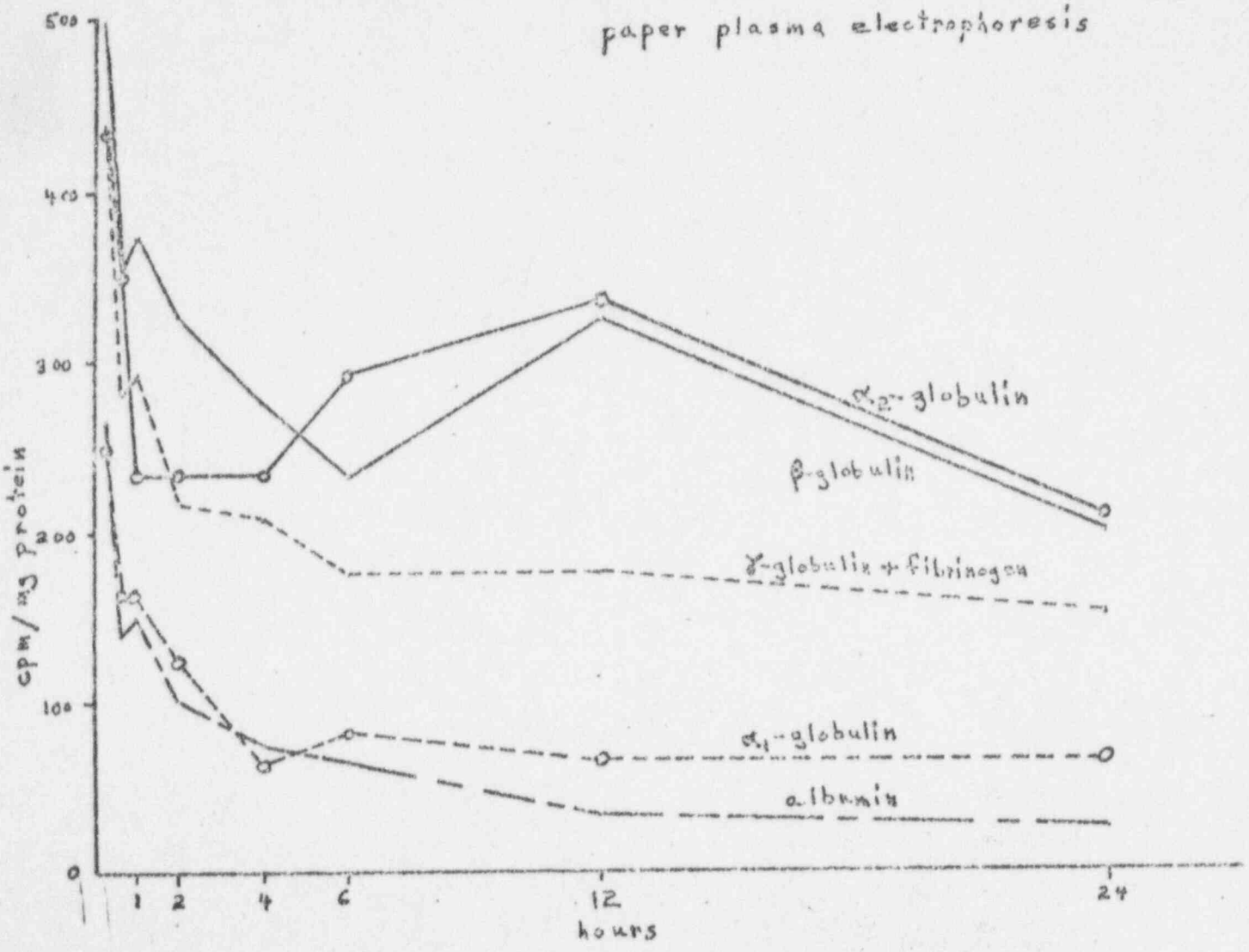

paper plasma electrophoresis
500
400
300
200
100
0
cpm/mg protein
α_2-globulin
β-globulin
γ-globulin + fibrinogen
α_1-globulin
albumin
1
2
4
6
12
24
hours

Figure 2a

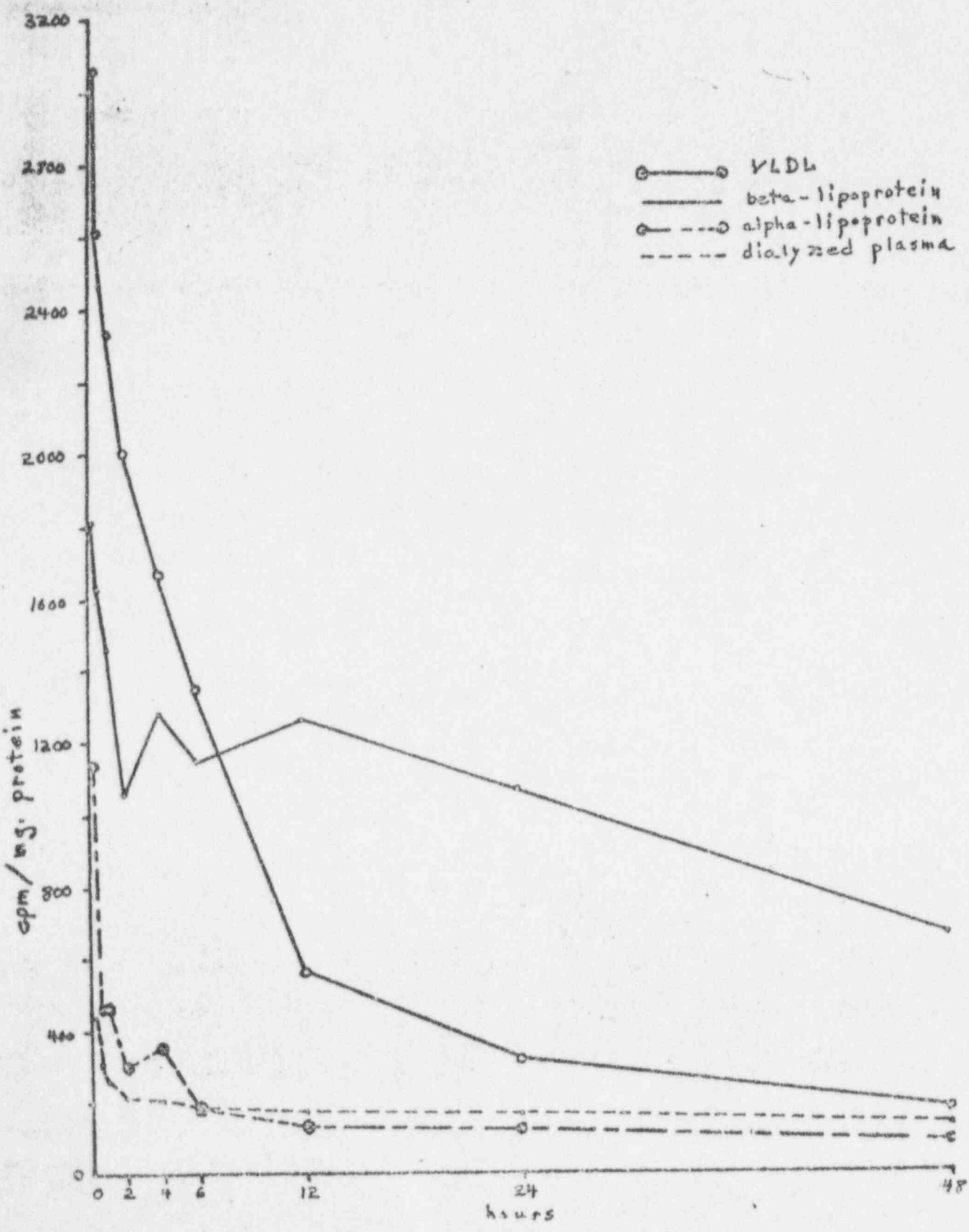

3200
2800
2400
2000
1600
1200
800
400
0
cpm/mg. protein
0
2
4
6
12
24
48
hours
VLDL
beta-lipoprotein
alpha-lipoprotein
dialyzed plasma

Figure 5

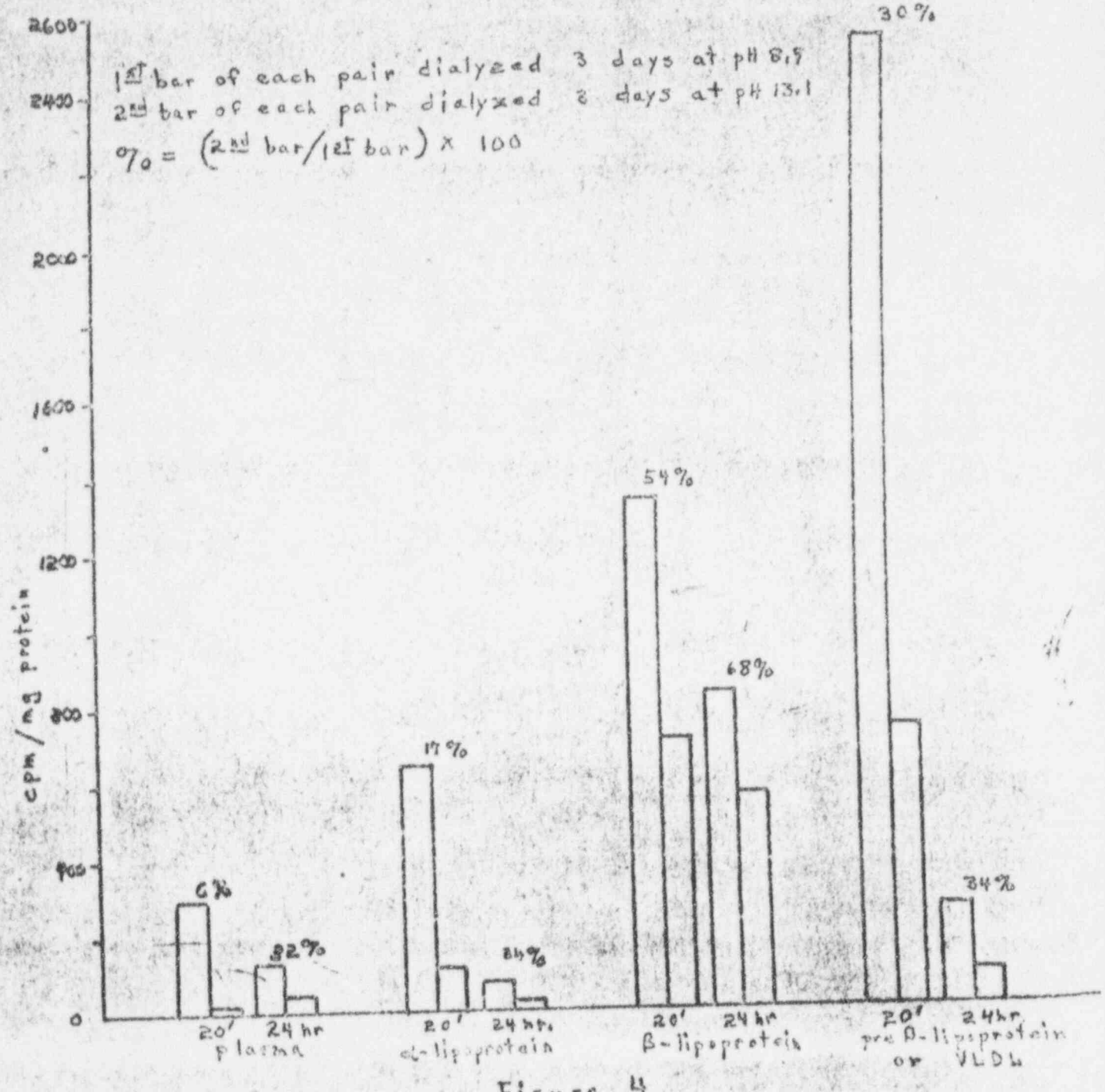

1st bar of each pair dialyzed 3 days at pH 8.9
2nd bar of each pair dialyzed 3 days at pH 13.1
% = (2nd bar/1st bar) x 100
cpm / mg protein
2600
2400
2000
1600
1200
800
400
0
6%
82%
17%
84%
54%
68%
30%
34%
20'
24 hr
plasma
α-lipoprotein
β-lipoprotein
pre β-lipoprotein
or VLDL

Figure 4

VOLUNTARY CONSENT STATEMENT

Military_____ Mil Patient _____ Civilian _____ Civ Patient _____

I, _____, having the capacity to consent, voluntarily and without force or duress consent to participate in research involving the use of tracer amounts of radioisotopes. I have been informed of, and understand, the nature, duration, and purpose of the experiment, the method and means by which it is to be conducted, the inconveniences and hazards to be expected, and the effects upon my health and person which may possibly come from participation in the experiment.

Specifically, I agree to receive intravenously up to 300 microcuries of ^{75}Se. I also agree to furnish blood and urine samples for the following 3-day period.

I understand that I may at any time during the course of the experiment revoke my consent and withdraw from the experiment without prejudice.

I do not at this time have any physical diseases, except the following: _____, or mental disease, to the best of my knowledge.

_____ _____

DATE SIGNATURE

_____

SIGNATURE OF WITNESS

APPROVAL

I have personally ascertained that the quality of the foregoing consent is sufficient to permit the volunteer to participate in the experiment.

_____ _____

ATTENDING PHYSICIAN PROJECT LEADER

APPENDIX II

CURRICULUM VITAE

RAYMOND FRANKLIN BURK, JR. 12 August 1970

Personal

Born: [redacted]
Height and Weight:
Marital Status:

Educational Institutions Attended

1963 - B.A. - University of Mississippi
1964 Johannes Gutenberg University, Mainz, Germany
(1 year residence)
1968 - M.D. - Vanderbilt University, Nashville, Tennessee

Educational Background

1968-69 - Straight medical internship, Vanderbilt University.
1969-70 - 1st year medical residency, Vanderbilt University.

Research Background

1964-68 - Summer and part-time research experience with Dr. W.N. Pearson in Nashville, Tennessee and Guatemala City.

Administrative Background

None

Professional and Scientific Societies

Associate member of Society of the Sigma XI

References

Dr. W. J. Darby, Vanderbilt University, Nashville, Tennessee
Dr. Grant W. Liddle, Vanderbilt University, Nashville, Tennessee

Public Relations Experience

None

APPENDIX III

Curriculum Vitae - Raymond Franklin Burk, Jr., M. D.

Honors and Fellowships Received

1967 - Vanderbilt Borden Award in Nutrition
1968 - Dean's Award for Student Research Presentation

Publications

Burk, R. F., Jr., W. N. Pearson, and F. Viteri. Discussion of Selenium in Human Nutrition. Symposium: Selenium in Biomedicine, Avi Publishing Company, 1967.

Burk, R. F., Jr., W. N. Pearson, R. P. Wood II, and F. Viteri. Blood Selenium Levels and *in vitro* Red Blood Cell Uptake of ^{75}Se in Kwashiorkor. Am. J. Clin. Nutr. 20:723-733, 1967.

Burk, R. F., Jr., R. Whitney, H. Frank, and W. N. Pearson. Tissue Selenium Levels During the Development of Dietary Liver Necrosis in Rats Fed Torula Yeast Diets. J. Nutr. 95:420-428, 1968.

Sandstead, H.H., R.F. Burk, Jr., G.H. Booth, Jr. and W.J. Darby. Current Concepts of Trace Minerals: Clinical Considerations. Med. Clin. N. Am. 54:1509-1531, 1970.

INVESTIGATOR'S ISOTOPE EXPERIENCE

The investigator had a formal one-semester course on the use of radioisotopes in medicine and biology in 1965 at Vanderbilt University. The course was a graduate course, oriented toward research and was conducted by the biochemistry department.

Since 1965, the investigator has used ^{75}Se continuously in research activity and has administered it to human beings as indicated in APPENDIX I. Also, he has used ^{35}S similarly.

He holds the M.D. degree, and has practical experience with the clinical use of ^{131}I and ^{51}Cr, as well as Schilling tests and various scanning procedures.

While at his present duty station, he has administered ^{42}K to human beings to calibrate the whole-body counter in this division.

USAMRNL - Bioenergetics Division 19 February 1971

PROTOCOL ADDENDUM

Project: 3A061102B71P Basic Research in Support of Military Medicine

Task: 01 Biochemistry

Work Unit: 061 Mineral Metabolism

ST-6: Selenium Metabolism

EX-3: Selenium in Human Plasma Proteins

The hematology service at Fitzsimons General Hospital regularly subjects patients with Hodgkin's Disease to exploratory laparatomy with splenectomy and biopsy of the liver and lymph nodes for the purpose of staging.

It has been suggested that these patients would be ideal candidates for ^{75}Se scanning to determine the extent of their disease inasmuch as scan findings could be correlated directly with anatomic findings. In addition, tissues such as liver, spleen and lymph nodes would be available for study in regard to their content of selenium. Several such patients will be studied, and they will be included in the total number of ten. Except for the collection of tissues at operation, the experimental design will be the same as that described in the body of the protocol dated 11 Jan 71.

ADMINISTRATIVE DETAILS

The Department of Medicine, Fitzsimons General Hospital, will provide administrative and patient care support. Col. Bergin will provide assistance in patient selection and overall planning. No additional funds will be needed.

Raymond F. Burk, Jr.

RAYMOND F. BURK, JR., M.D.
CPT, M.C.
Bioenergetics Division

APPENDIX 2

U. S. ARMY MEDICAL RESEARCH AND NUTRITION LABORATORY
FITZSIMONS GENERAL HOSPITAL
DENVER, COLORADO 80240

MRNL REGULATION
NUMBER 40-14

15 July 1970

CONTROL AND HANDLING OF RADIOACTIVE MATERIAL

This regulation supersedes USAMRNL Standing Operating Procedure entitled "Procedures for Use of Radioactive Material" dtd. 1 March 1969.

MRNL REGULATION
NUMBER 40-14

15 July 1970

1. Purpose. The purpose of this regulation is to provide direction and guidance to all persons and activities producing, procuring, receiving, storing, using, disposing or transferring material that produces ionizing radiation, to insure the safe handling of radioactive materials within the USAMRNL.

2. Applicability.

a. This regulation is applicable to all persons assigned to the USAMRNL who utilize isotopes and the facilities of the Radioisotope Branch in the conduct of research projects.

b. The procedures outlined in this regulation are published for local use and must not be construed to be an amendment or change to any existing federal regulation, Army regulation, or hospital regulation governing the use of radioactive material.

3. Definitions.

a. Post Radiological Protection Officer.

An individual designated by the Commanding General, Fitzsimons General Hospital to provide consultation and advice on the degree of hazards associated with ionizing radiation and the effectiveness of measures to control these hazards throughout the entire post.

b. Radiological Protection Officer - USAMRNL.

An individual appointed by the Commanding Officer, USAMRNL and having the same functions as the Post RPO as affects the USAMRNL.

c. Principal User.

Those responsible investigators whose qualifications have been certified by the joint (FGH - USAMRNL) Radioisotope Committee as being technically qualified by virtue of education, training and/or professional experience to conduct research studies using radioactive isotopes.

4. Responsibilities.

a. The Commanding Officer of the USAMRNL is responsible for ensuring that measures are established to control ionizing radiation from any source so that the radiation dose to those individuals under his command will be no greater than the amount prescribed in AR 40-14.

b. The joint (FGH - USAMRNL) Radioisotope Committee has the responsibility of technical supervision over the handling and use of radioactive isotopes.

c. The Chief, Supply and Services Branch, USAMRNL is responsible for the procurement and receipt of radioactive material through Fitzsimons General Hospital in accordance with HR 40-602. Upon notification of arrival on post, the material will be picked up and delivered to the Radioisotope Branch, USAMRNL.

d. The Chief, Radioisotope Branch will direct the storage and handling of the contents of each shipment of radioactive material after it has been delivered to him or his designated representative in the Radioisotope Branch and is responsible for the maintenance of the records pertaining thereto. He is responsible for the handling and disposition of radioisotope contaminated liquid and solid wastes; area monitoring and supervision of the decontamination procedures in all areas under USAMRNL jurisdiction where radioactive isotopes are used, in accordance with the recommended procedures specified in Part 20, Title 10, C.F.R. and applicable Army regulations.

e. Principal users (responsible investigators) of radiation sources have the following responsibilities:

(1) Become thoroughly familiar with the contents of applicable regulations prior to the use of radiation sources.

(2) Research projects utilizing radioisotopes will be covered by protocols approved under existing USAMRNL regulations. The type, quantity, and method in which they will be used will be described. A copy of the approved protocol will be provided the Radioisotope Branch.

(3) Obtain and use radiation sources only as authorized by these regulations.

(4) Take precautionary measures to protect himself and others from unwarranted exposure to radiation.

(5) Seek advice and assistance from the Radiological Protection Officer when in doubt concerning the safety of an operation.

(6) Report to the Radiological Protection Officer of known or suspected overexposures. The overexposed individual shall cooperate in any and all attempts to evaluate his radiation exposure.

(7) Supervise and instruct all co-workers in the proper uses of radiation sources to insure safe working procedures.

(8) Maintain a current inventory within his Division of the quantity of radioactive material on hand in fractions of curies, to be readily available to the Radiological Protection Officer conducting the quarterly physical inventory of radioactive material.

5. Procedures.

a. Radioisotope Committee.

(1) The U. S. Army Medical Research and Nutrition Laboratory operates jointly with Fitzsimons General Hospital under the same General Atomic Energy Commission License. Use of radioisotopes, within the limitations of the AEC License, is controlled by a joint installation Radioisotope Committee. The persons making up the Radioisotope Committee and the functions of the committee are outlined in AR 40-37 and HR 15-1. The functions of the Committee are:

(a) Review protocols and grant permission for, or disapproval of, the use of radioactive material.

(b) Certify individual users for each type of procedure with each individual radioisotope and insure that a copy of such certification is placed in the appropriate user's 201 file. Maintain current records of the approved users, documenting the qualifications and limitations of each.

(c) Prescribe special conditions which may be necessary to include and give advice concerning proposed studies where it is needed.

(d) Review records and receive reports from the Radiological Protection Officer and recommend corrective action when indicated.

(e) Make recommendations for improvement of present laboratory facilities and for expansion of the laboratories in accordance with needs.

(f) Hold meetings at the call of the Chairman and report in writing to the Commanding General, FGH, the results of its deliberation.

b. Hazard Control.

(1) Permission for the use of radioactive materials under AEC General License in USAMRNL is granted only by the Radioisotope Committee. This permission may be denied or withdrawn from any investigator who, in the opinion of the Radioisotope Committee or on the advice of the Radiological Protection Officer, is inadequately trained in the handling and use of radioactive materials, or is guilty of any breach of discipline in the handling and use of radioactive materials so as to incur real or possible hazard to himself or others.

(2) The Chief of the Radioisotope Branch, USAMRNL, will instruct, direct, and supervise all individuals at USAMRNL working with or near radioactive materials in the observance of radiological safety. Safety of routine operations is the responsibility of principal investigators.

(3) Each individual working with radioactive material will be issued a film badge. Before a film badge is issued, each individual must read both CFR, Title 10, Part 20, and USAMRNL Regulation 40-14, and certify in writing that he had read and understands both.

(4) The safety rules listed hereinafter are to be observed, but it is emphasized that mere following of the rules will not eliminate all possible hazards associated with the handling of radioactive materials.

(5) The protection rules are based upon assumed long-term whole-body exposure to ionizing radiation by personnel whose duties involve regular handling of radioactive materials or regular use of x-ray equipment. These rules apply to all persons occupationally employed using any source of ionizing radiation in a controlled area or those incidentally exposed as a result of such use. A controlled area is one in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of a Radiological Protection Officer. (This implies that a controlled area is one that requires control of access, occupancy and working condition for radiation protection purposes.)

c. Safety Rules.

(1) In order to avoid undue exposure to ionizing radiation, unauthorized personnel will not enter the Laboratory of the Radioisotope Branch except when accompanied by an authorized person.

(2) Only persons specifically authorized to do so by the Radioisotope Committee will handle any shipment of radioactive material or any part thereof after it has been delivered to the Radioisotope Branch.

(3) Only persons specifically authorized to do so by the Radioisotope Committee will dispense or use a dose of any radioactive material.

(4) In all rooms where radioactive materials are being used, the following additional regulations are in effect:

(a) No eating or drinking, and no application of cosmetics.

(b) Smoking is not permitted while active material is being handled.

(c) Absolutely no mouth pipetting of radioactive material under any circumstances.

(d) Under no circumstances will radioactive waste be handled or disposed of by the janitorial staff.

(e) Rubber or protective gloves will be worn at all times when radioactive material is being handled, except sealed, or capped containers of radioactive materials.

(f) All gloves, protective clothing, instruments, and glassware will be placed in the appropriate receptacle to await decontamination.

(g) All contaminated glassware, instruments, pipettes, and waste incurred in any radioisotope experiment or study will be policed and placed in an appropriate receptable by the persons performing the experiment or study.

(h) At the end of each work period the hands will be carefully washed.

(i) Before placing radioactive material in any container, the container will be clearly labeled with radioactive caution tape of yellow and magenta to show the particular radioactive material, the concentration in microcuries or millicuries per unit volume or weight as of some particular date, and the identifying initials of the person preparing the material.

(j) Work surfaces will be covered with absorbent paper. The work in hoods will be similarly performed on absorbent paper. The work bench will be equipped with wiping papers for the prompt removal of spills.

(k) When using radioactive material, special equipment suitable for the type and level of activity being used will be used for each type of operation. This will include handling tools such as tongs, forceps, trays, and mechanical holders. When the isotopes concerned are beta emitters, efficient use can be made of transparent plastic shields.

(l) No individual will knowingly expose himself, or cause others to be unnecessarily exposed.

(m) All laboratory operations involving isotopes in Group III (below) will be conducted in hoods.

(5) Safe Handling Level For Some Representative Radioisotopes Authorized For Use in USAMRNL

GROUP I **No special handling required in normal laboratory procedures		GROUP II **Not dangerous, but unnecessary exposure is to be avoided		GROUP III **Dangerous, should be handled with utmost caution	
Isotope	Maximum Amount	Isotope	Maximum Amount	Isotope	Amount
Au^{198}	0.025 mc	Au^{198}	1.000 mc	Au^{198} over	1.000 mc
Br^{82}	0.300 mc	Br^{82}	5.000 mc	Br^{82} "	5.000 mc
Be^{7}	0.005 mc	Be^{7}	0.100 mc	Be^{7} "	0.100 mc
* C^{14}Urea	0.050 mc	C^{14}Urea	1.000 mc	C^{14}Urea "	1.000 mc
* C^{14} All Other	0.025 mc	C^{14} All other	1.000 mc	C^{14} All other	1.000 mc
Ca^{45}	0.005 mc	Ca^{45}	0.100 mc	Ca^{45} "	0.100 mc
Co^{60}	0.025 mc	Co^{60}	1.000 mc	Co^{60} "	1.000 mc
Cr^{51}	0.025 mc	Cr^{51}	1.000 mc	Cr^{51} "	1.000 mc
Fe^{55}	0.005 mc	Fe^{55}	0.100 mc	Fe^{55} "	0.100 mc
Fe^{59}	0.025 mc	Fe^{59}	1.000 mc	Fe^{59} "	1.000 mc
* H^{3}Water	0.025 mc	H^{3}Water	10.000 mc	H^{3}Water "	10.000 mc
* H^{3}Thymidine	0.001 mc	H^{3}Thymidine	0.050 mc	H^{3}Thymidine "	0.050 mc
* H^{3}all other	0.005 mc	H^{3}all other	0.100 mc	H^{3}all other "	0.100 mc
I^{131}	0.025 mc	I^{131}	1.000 mc	I^{131} "	1.000 mc
Na^{22}	0.025 mc	Na^{22}	1.000 mc	Na^{22} "	1.000 mc
P^{32}	0.025 mc	P^{32}	1.000 mc	P^{32} "	1.000 mc

(Continued)

GROUP I **No special handling required in normal laboratory procedures		GROUP II **Not dangerous, but unnecessary exposure is to be avoided		GROUP III **Dangerous, should be handled with utmost caution		
Isotope	Maximum Amount	Isotope	Maximum Amount	Isotope		Maximum Amount
S^{35}	0.025 mc	S^{35}	1.000 mc	S^{35}	over	1.000 mc
Se^{75}	0.025 mc	Se^{75}	1.000 mc	Se^{75}	"	1.000 mc
Sr^{85}	0.025 mc	Sr^{85}	1.000 mc	Sr^{85}	"	1.000 mc
Sr^{89}	0.025 mc	Sr^{89}	1.000 mc	Sr^{89}	"	1.000 mc
Sr^{90}	0.005 mc	Sr^{90}	0.100 mc	Sr^{90}	"	0.100 mc
Zn^{65}	0.005 mc	Zn^{65}	0.100 mc	Zn^{65}	"	0.100 mc

* Group classification dependent upon chemical form.

** It must be remembered that these limits are by no means fixed and that any undue exposure is undesirable. Therefore, when working with the above radioisotopes, the physical characteristics, half-life, the internal and external hazard, and the radiative properties of the radioactive material must be considered. If in doubt, always consult the Chief, Radioisotope Branch.

d. Human Studies.

In the conduct of research studies involving the use of radioactive isotopes in humans, the principal investigator is guided by applicable government and military regulations, the current AEC license, U. S. Army Authorization and advice and counsel of the joint Radioisotope Committee.

e. Animal Studies.

Investigators conducting in vitro and/or animal studies involving the use of radioactive isotopes will be guided by applicable documents as above and in addition will provide, in their protocols, the specific areas in their divisions where isotopes are planned for use or storage, the housing area of animals, and waste disposition procedures.

f. Radioactive Waste.

(1) The Radiological Protection Officer is responsible for the disposal of all radioactive waste within USAMRNL. Such disposal

will be accomplished under all existing regulations listed in Part 20, Title 10, CFR, NBS Handbooks, and Army Regulations.

(2) Solid radioactive waste will be segregated into combustible and non-combustible. This waste includes such items as carcasses, fecal material, litter, scintillation counting vials, etc. It will be placed in a plastic waterproof disposable container then deposited in a second container marked with a radiation caution symbol with the wording, "Danger, Radioactive Material". When full, the outer container will be labelled as to content, isotope present, approximate amount of microcuries (millicuries), the date and investigators name. (The radiation level outside the container should not exceed 1.0 milliroentgens per hour). These waste containers will then be delivered to the Radioisotope Branch for disposition.

(3) Liquid waste including the pooled contents of the liquid scintillation counting vials will be placed in a plastic bottle and marked with radiation caution tape, isotope content, approximate amount of microcuries (millicuries) date of collection and investigators name. Pooling of vials maybe done in the individual sections; except, in those cases where the vapors from solutions may contain radioactivity, the pooling may be performed in the hood of the "high level" room in the Radioisotope Branch. These contaminated liquid waste bottles will then be delivered to the Radioisotope Branch for disposition.

(4) All clothing that is known or suspected of being contaminated with isotopes will be placed in a separate plastic container, appropriately labelled, and delivered to the Radioisotope Branch for proper disposition.

g. Decontamination of Glassware.

(1) All glassware which is utilized directly with radioactive material will be deemed "contaminated". The decontamination of such glassware is important not only in the interests of radiation safety but also to prevent the unintentional invalidation of subsequent experiments.

(2) Contaminated glassware will be delivered to the Radioisotope Branch for removal of the radioactive contaminant by ultrasonic means.

h. Radioactive Spill.

(1) All radioactive material, when spilled, constitutes a hazard, either to personnel or to equipment. If a spill of radioactive material occurs with Group I [5c(5)] isotopes, turn off all fans in the immediate area and notify all other personnel in the controlled

area. If the spill is liquid, drop absorbent paper on the spill and mark off the area with chalk or cord. If the spill is dry, proceed in the same manner, but convert the dry spill to liquid by applying wet absorbent paper over the area.

(2) If a spill of radioactive material occurs with Group II isotopes [5c (5)], hazard control is of first importance. In order to accomplish this, the person responsible for the spill will:

(a) Notify the Radiological Protection Officer or his designated representative.

(b) Be prepared to evaluate the hazard by knowing at all times which radioisotope is being handled, its chemical form, and the approximate amount being used (in millicuries or microcuries).

(c) See that all personnel in the area are notified and that they leave the immediate area of the spill without delay.

(3) In the event of a spill of radioactive material in Group III [5c (5)], the procedure listed for Group II above, will be carried out, plus the following:

(a) Determine the extent of personal contamination by inspection and monitoring of the involved personnel.

(b) Remove contaminated clothing.

(c) Rinse the contaminated body parts with water or the emergency shower if the spill took place in the high level room of the Radioisotope Branch, and then wash with soap and water, collecting the water for proper disposition. Monitoring the contaminated body part after each washing will be performed by personnel of Radioisotope Branch.

(4) Decontamination of the area of the spill will be carried out under the supervision of the Radiological Protection Officer, but only after the personnel contamination problem has been resolved. As a general rule, the work associated with the decontamination is performed by the person responsible for the spill.

(5) If ingestion or inhalation is suspected from a spill of radioactive material, TB MED 232 will be complied with, and report to the Chief, Radioisotope Branch for further processing and reporting of the incident.

i. Personnel Monitoring:

(1) Film badges are provided for persons working with radioactive material in USAMRNL. These film badges will be worn during normal working hours and are not to be removed from USAMRNL. Care of the film badge will be the responsibility of the individual user.

(2) Badges will be delivered to Radioisotope Branch monthly for shipment to the Lexington Signal Depot, Lexington, Kentucky for processing and reading. The returned values will be permanently recorded in Radioisotope Branch files on DD Form 1141 as a duplicate of the original recording which is maintained by custodian of medical records.

(3) A thorough medical examination will be made of each individual potentially exposed to significant amounts of radiation before employment and annually thereafter.

(4) Those persons working with millicurie amounts of Tritium will have urine checks for radioactivity within 15 days of termination of each experiment.

6. Functions of Radioisotope Branch

a. Procurement, storage and administration.

(1) All radioactive materials for use in USAMRNL will be processed by personnel of the Radioisotope Branch through official supply channels.

(2) The Radiological Protection Officer will direct the storage and handling of the contents of each shipment of radioactive material after it has been delivered to him or his designated representative in the Radioisotope Branch, and is responsible for the records pertaining thereto.

(3) The storage area will be neat and segregated by type emission. Gamma emitting isotopes will be stored so that the radiation level at the edge of the storage area does not exceed one milliroentgen per hour.

(4) The Radiological Protection Officer is responsible for the handling and disposal of all radioisotope contaminated liquid and solid wastes in or delivered to the Radioisotope Branch in accordance with the recommended procedures found in Part 20, Title 10, CFR, and pertinent Army regulations.

b. Radiation Safety Monitoring.

(1) Area Monitoring:

(a) Routine monitoring will be accomplished according to the following time schedule:

Weekly

(1) Radioisotope Branch (according to diagram in Appendix 1).

Monthly

(1) Research Divisions within US Army Medical Research and Nutrition Laboratory (According to diagrams in Appendix 1).

(b) Other areas will be monitored when deemed necessary by the Radiological Protection Officer, i.e. - Pikes Peak Laboratory Facility.

(c) Readings obtained during the surveys will be recorded and retained as a permanent record.

(d) Routine monitoring in USAMRNL (including blowers on roof above Radioisotope Branch) will be done, using a portable PAC3G gas proportional counter with a beta detection probe and a GM counter. If contamination is detected, the area will be immediately decontaminated. If the activity with the GM counter, exceeds a value of 2.0 milliroentgens per hour, the Radiological Protection Officer will be notified. The area will be marked as to reading in milliroentgens/hour and the working time limit.

(e) Swipe tests will be conducted during area monitoring and when contamination is suspected. The swipes will be counted in the liquid scintillation counters for quantitative determinations. Any activity above background will be considered a contaminated area. Readings obtained will be recorded as a permanent record and responsible investigator notified.

(f) Any areas of previously undetected contamination will be promptly cleaned by those persons responsible for the contamination, under the supervision of the Radiological Protection Officer or his designated representative.

(2) Personnel Monitoring.

(a) In the event of a spill of radioactive material in Group III, the procedures outlined in par 5h(3) will be carried out and in addition, personnel of the Radioisotope Branch will perform the following procedures.

(1) Decontaminate the film badge (when necessary) and forward it by Air Mail Special Delivery to the Lexington Signal Depot; Liexington, Kentucky, with all data concerning the incident (i.e., isotope and its chemical form, amount involved, date, names, etc.).

(2) Carry out routine decontamination of clothing, work spaces, etc., which were involved.

(3) Notify the Surgeon General, Department of the Army, Washington, D. C., ATTN: MEDPS-PO, by telegram, of possible internal exposure. Complete DA Form 285 (Accident Report).

(4) In the event a potentially dangerous radioisotope is involved such as H^3, Ca^{45}, Fe^{55}, Sr^{90}, Y^{91}, Zr^{95}, Ce^{144}, Pm^{147}, or Bi^{210}, immediately notify The Surgeon General, Department of the Army, Preventive Medicine Division by telephone of:

(a) Time and date of incident.

(b) Millicurie strength of isotope and its chemical form.

(c) Name of individual and treatment already undertaken. Include a statement indicating the treatment rendered (or that no treatment has been rendered).

(d) Extent of individual contamination as determined by immediate monitoring.

(Telephone notifications will be confirmed by telegraphic notifications)

(5) A 24 hour urine sample will be collected under the direction of the Radiological Protection Officer from the person concerned. The collection shall be in a polyethylene liter bottle which will have a card attached containing the following data:

(a) Name, grade and SSAN

(b) Date of incident

(c) Inclusive dates of collection

(d) Isotope and chemical form

(6) The 24 hour urine sample will be collected as follows:

(a) Wash hands before collecting a portion of sample.

(b) Void urine at 0800 hrs (or any other convenient time) and discard it. Do not collect it in the bottle.

(c) Collect all urine from that time up to and including the corresponding hour the following day. ALL URINE MUST BE COLLECTED. LOSS OF A SIGNIFICANT AMOUNT WILL RENDER THE SAMPLE USELESS.

(7) Samples will be held until further instructions are received from the Surgeon General.

(8) If an overexposure to ionizing radiation occurs, DD Form 1141 (Report of Exposure to Ionizing Radiation) must be completed. A brief description of the condition of act which resulted in the overexposure will be attached to the DD Form 1141.

c. Decontamination of Glassware.

(a) Upon receipt of contaminated glassware in the Radioisotope Branch, it will be placed in the "hot" sink where it will be rinsed or washed with detergent if necessary then rinsed and placed in the ultrasonic bath. This includes pipettes and disassembled syringes although maximum use of disposable syringes and needles is suggested. Upon completion of the ultrasonic cleaning, the glassware may be oven or air dried.

(b) All glassware which has been decontaminated will be monitored by an appropriate detector. Always monitor after drying, never wet.

(c) All glassware which, upon monitoring, is still contaminated, will be recycled and will be properly discarded if decontamination is not complete after the second cleaning cycle.

d. Waste Disposal.

(1) Liquid waste disposition

(a) Contaminated liquid waste may be disposed of in the "hot" sink provided the quantity which, if diluted by the average daily quantity of sewage (sanitary sewage flow per 24 hours is 525,000 gallons) released into the sewer by the licensee, will not result in an average concentration in excess of values specified in Appendix B, Table I, Column 2 of CFR, Title 10, Part 20; (extracted applicale portion listed below); or

(b) Ten times the quantity of such material specified in Appendix C of same; and

(c) The gross quantity of licensed and other radioactive material released into the sewage system by the licensee does not exceed one curie per year.

Listed below is the quantity of any single radioactive isotope that may be released into the sewer in any one day. Daily maximums are listed for each isotope. In accordance with the Code of Federal Regulations, title 10, part 20.

Radioactive Material	Microcuries
Bromine-82	100
Calcium-45	100
Carbon-14	500
Chromium-51	500
Cobalt-60	10
Gold-198	100
Hydrogen-3	2500
Iodine-131	100
Iron-55	500
Iron-59	10
Phosphorus-32	100
Selenium-75	100
Strontium-85	10
Strontium-89	10
Strontium-90	1
Sulfur-35	500
Zinc-65	100

(d) Sewage disposal of liquid radioactive isotopes will be disposed of from the Radioisotope Section, Radiology Service, Fitzsimons General Hospital on Tuesdays and Fridays only, with all other days reserved for Radioisotope Branch, USAMRNL. Any deviation from this policy by either section will be cleared with the other Radioisotope Section before hand.

(e) All liquid radioactive waste disposal through the sanitary sewer at USAMRNL will be logged in Liquid Waste Disposal Log Book and activity listed in microcuries.

(2) Solid waste disposition

(a) Under no circumstances will waste be incinerated.

(b) Solid waste will be segregated into combustible and non-combustible waste and placed in properly labelled and lined fifty-five gallon sealable drums. These drums will comply with the requirements of the specific isotopes contained therein. See Code of Fed. Reg., Title 49, Jan 1969.

(c) Drums containing solid perishable waste, i.e. carcasses, tissues, etc., will be stored in a freezer prior to shipment.

(d) Instructions for shipping radioactive waste for proper disposition will be requested from:

Commanding Officer
U. S. Army Edgewood Arsenal
ATTN: SMUEA-ISDO
Edgewood, Maryland 21010

e. Logs and Records

(1) AEC Form 3 (Notice to Employees - Standards for Protection Against Radiation) will be posted in a conspicuous location.

(2) DD Form 1141 in accordance with AR 40-14 are prepared and maintained by the custodian of medical records, Fitzsimons General Hospital, duplicate copies for personnel in USAMRNL are retained in Radioisotope Branch.

(3) USAMRNL Regulation 40-14, the joint AEC license and U. S. Army authorization will be posted and readily available.

(4) Radioisotope inventory balance will be audited monthly. (Radioisotope inventory records are kept on Forms DA 8-235 and DA 8-212).

(5) Instrument logs will be maintained indicating calibration and maintenance of the portable survey instruments.

(6) Records of surveys (including swipe tests) will be kept.

(7) Caution signs, labels, and signals will be utilized according to CFR, Title 10, Part 20, para. 20.203.

(8) A report covering the period of each calendar quarter is prepared by the Commander of Fitzsimons General Hospital in accordance with AR 40-37. This report is dispatched to The Surgeon General, ATTN: MEDPS-PO, by the fifteenth working day following the close of the report period and contains the following information as a minimum:

(a) Copy of minutes of each Radioisotope Committee meeting, including a record of all actions taken by the Committee.

(b) Copy of the training and experience of each newly approved user of radioisotopes or any change in qualifications or certifications of previously approved users (for human use, AEC Form 313a, page 3).

(c) Radioisotope inventory, including data on quantities of radioisotopes procured, used, or disposed of, or currently in storage.

(d) Information on unsolved problems, new or improved developments, or other comments of interest to, or having a bearing on, support rendered by The Surgeon General.

(e) Notification of all changes in membership of Radioisotope Committee.

f. Other Routine Radioisotope Branch Procedures.

(1) Neatness in the laboratory is a prime requisite for elimination of the spread of contamination. The work area should be free of equipment and materials not required for the experiment at hand, and equipment used will be decontaminated and stored in a controlled location after use.

(2) At the end of each work period the hands will be washed and tested for contamination with an instrument of suitable sensitivity.

(3) The sinks in the laboratory portion of the Radioisotope Branch will not be used for purposes of performing personal toilet, except that the non-contaminated sinks may be used for the purpose of hand washing after the removal of protective gloves.

(4) No water for drinking purposes will be obtained from the laboratory portion of the Radioisotope Branch.

(5) Floors in the Radioisotope Branch will be cleaned frequently by wet mopping. Brooms and mops will not be transferred to other areas.

(6) Table tops, equipment, or any surface within the Radioisotope Branch will be kept clean. Under no circumstances will there be an accumulation of dust and/or possible contamination.

(7) Floors will be waxed and buffed on a monthly basis.

(8) Air conditioner filters, glove box filters, and hood filters will be checked quarterly and properly cleaned or replaced when necessary.

(9) Desiccant in the liquid scintillation counter will be checked weekly and changed when necessary.

(10) The emergency shower will be checked weekly.

(11) The portable survey meters will be calibrated at least every six months and after every maintenance procedure or battery change.

(12) Batteries in the portable survey meters will be checked monthly, and changed when necessary.

7. References:

Title 10 Code of Federal Regulations, Part 20

Title 49 Code of Federal Regulations

AR 40-14, 40-37, 70-25, 385-30, 700-15, 700-52, 711-16, 755-15

TB MED 232

FGH Reg. 15-1, 40-602, 40-604

USAMRNL Reg. 40-3

National Bureau of Standards Handbooks

No. 42 Safe Handling of Radioactive Isotopes

No. 47 Recommendations of the International Commission on Radiological Protection

No. 48 Control and Removal of Radioactive Contamination in Laboratories

MRNL REGULATION
NUMBER 40-14

15 July 1970

No. 49 Recommendations for Waste Disposal of Phosphorus-32 and Iodine-131 for Medical Users

No. 51 Radiological Monitoring Methods and Instruments

No. 52 Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water

No. 53 Recommendations for the Disposal of Carbon-14 wastes

No. 56 Safe Handling of Cadavers Containing Radioactive Isotopes

No. 59 Permissible Dose From External Sources of Radiation

FOR THE COMMANDER:

Marvin G. Kieca

1 Incl
as

MARVIN G. KIECA
CPT, MSC
Adjutant

DISTRIBUTION
C
C, Radioisotope Br.
C, Sup & Svc Br.
Each Investigator

MRNL REGULATION
NUMBER 40-14

15 July 1970

APPENDIX I

Attached are the floor plans which are within jurisdiction of USAMRNL where Radioisotopes are planned to be used. The below listed areas and Divisional responsibilities follow:

Building 600

1st floor east - Chemistry Division
2nd floor east - Chemistry Division
2nd floor west - Physiology Division

Building 601

1st floor east - Surgery (Pathology)
1st floor west - Physiology Division
2nd floor east - Pathology Division
2nd floor west - Microbiology Division

Building 602

1st floor east - Bioenergetics Division
1st floor west - Animal Facility (Pathology)
2nd floor east - Chemistry Division
2nd floor west - Chemistry Division

Building 603

1st floor east - Radioisotope Branch

Building 619

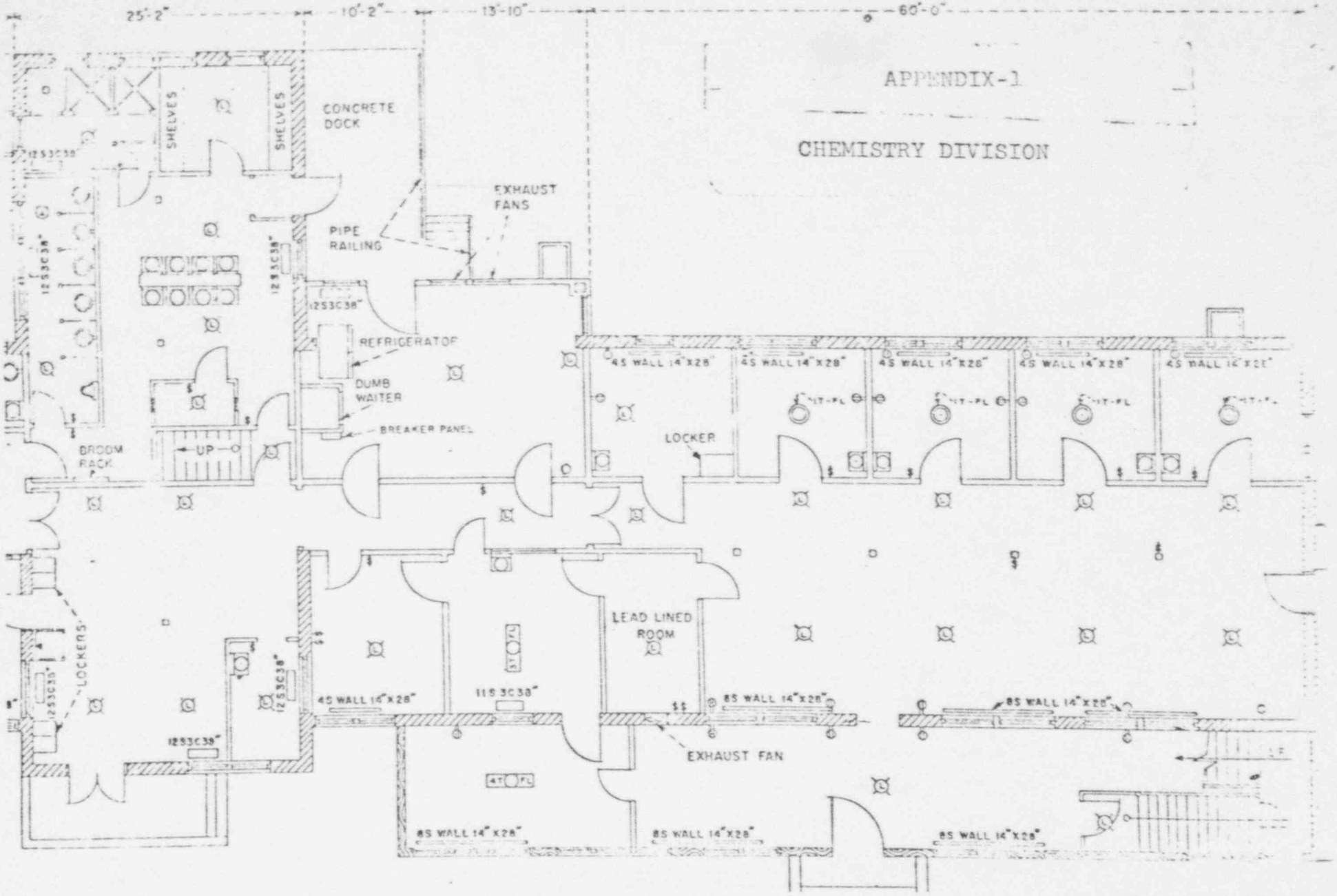
1st floor west - Metabolic Division

Pikes Peak Lab Facility

Entire Laboratory - Division conducting experiment

APPENDIX-1

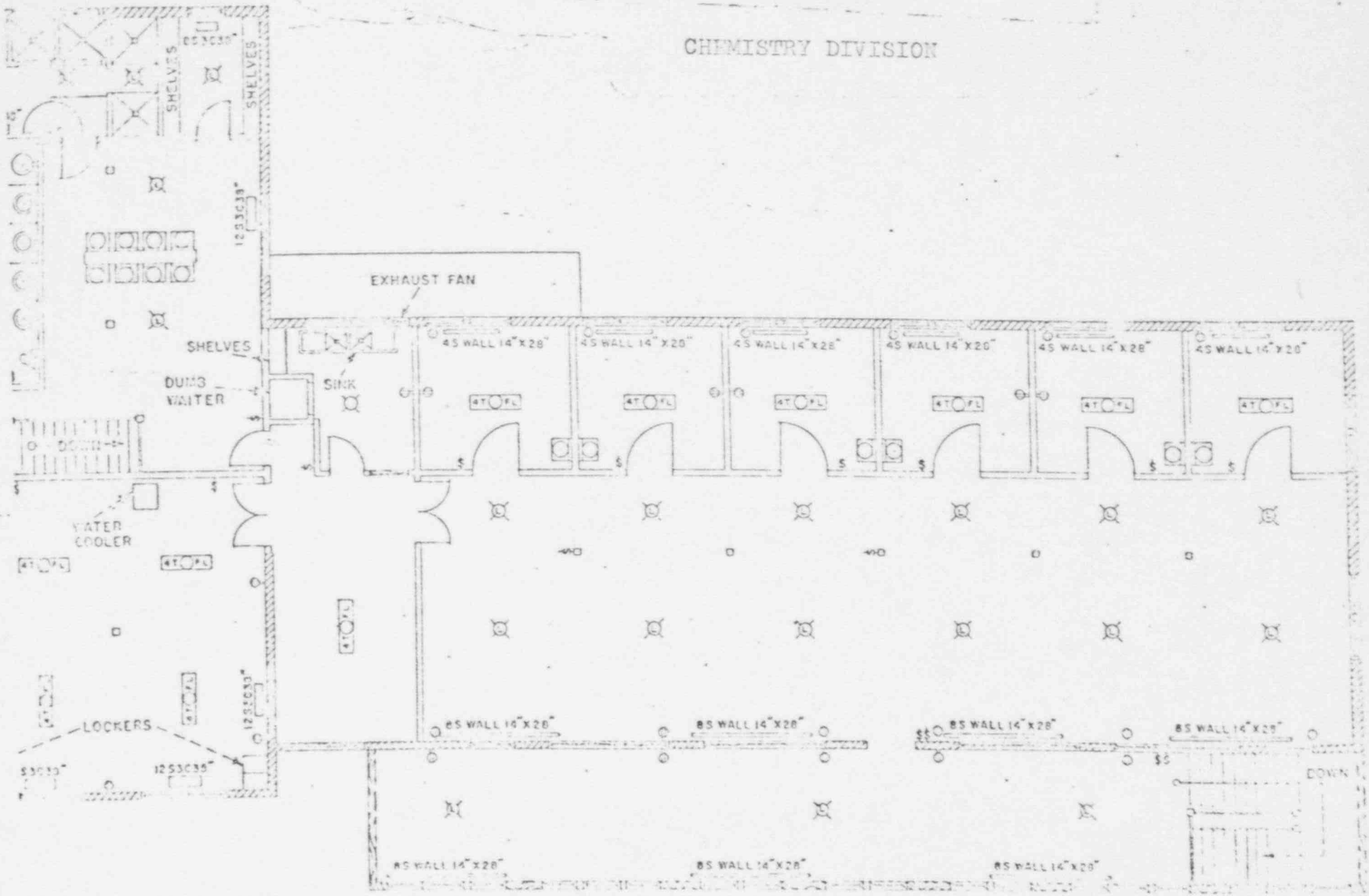
CHEMISTRY DIVISION



1st FLOOR EAST BLDG. 600

APPENDIX-1

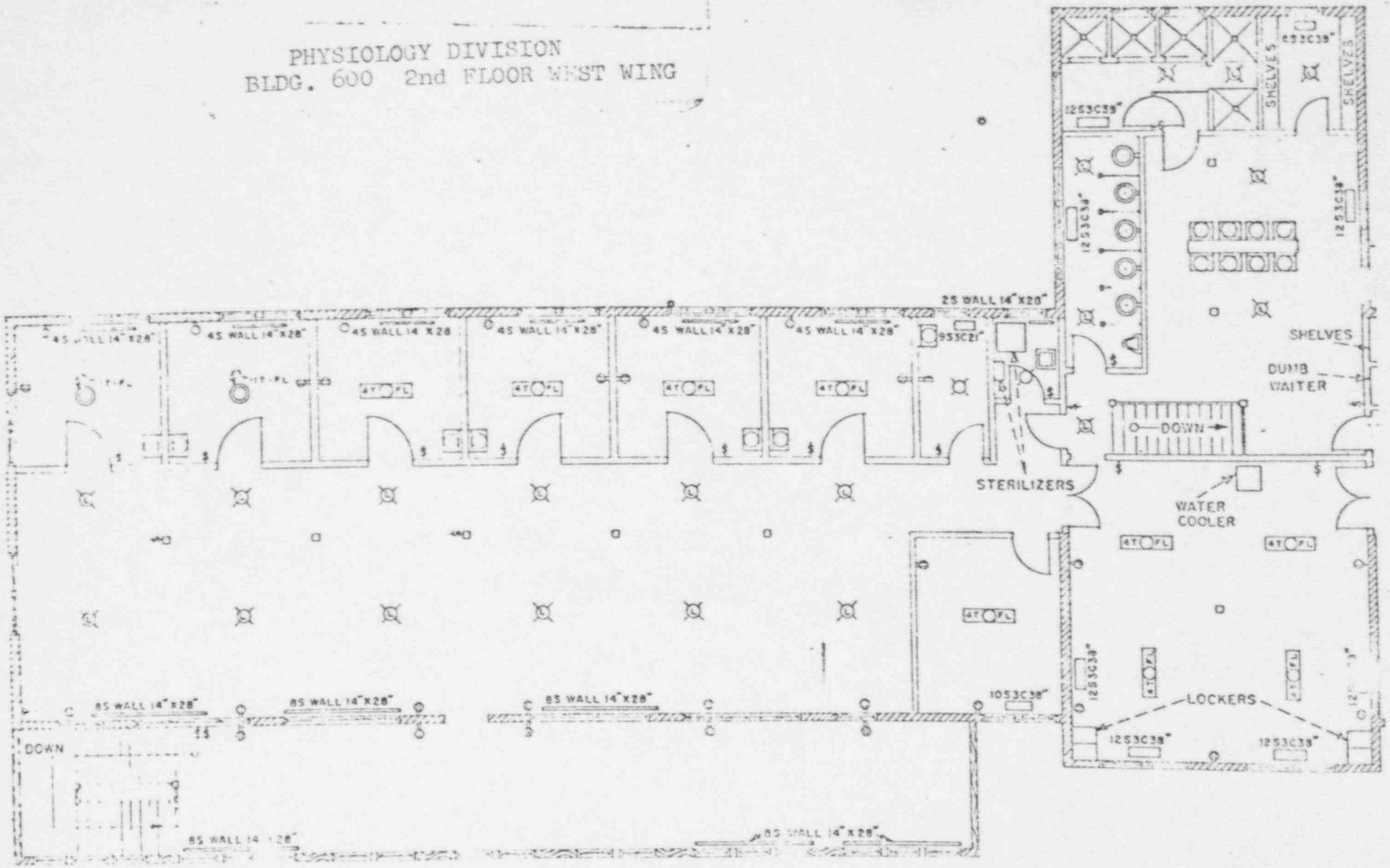
CHEMISTRY DIVISION



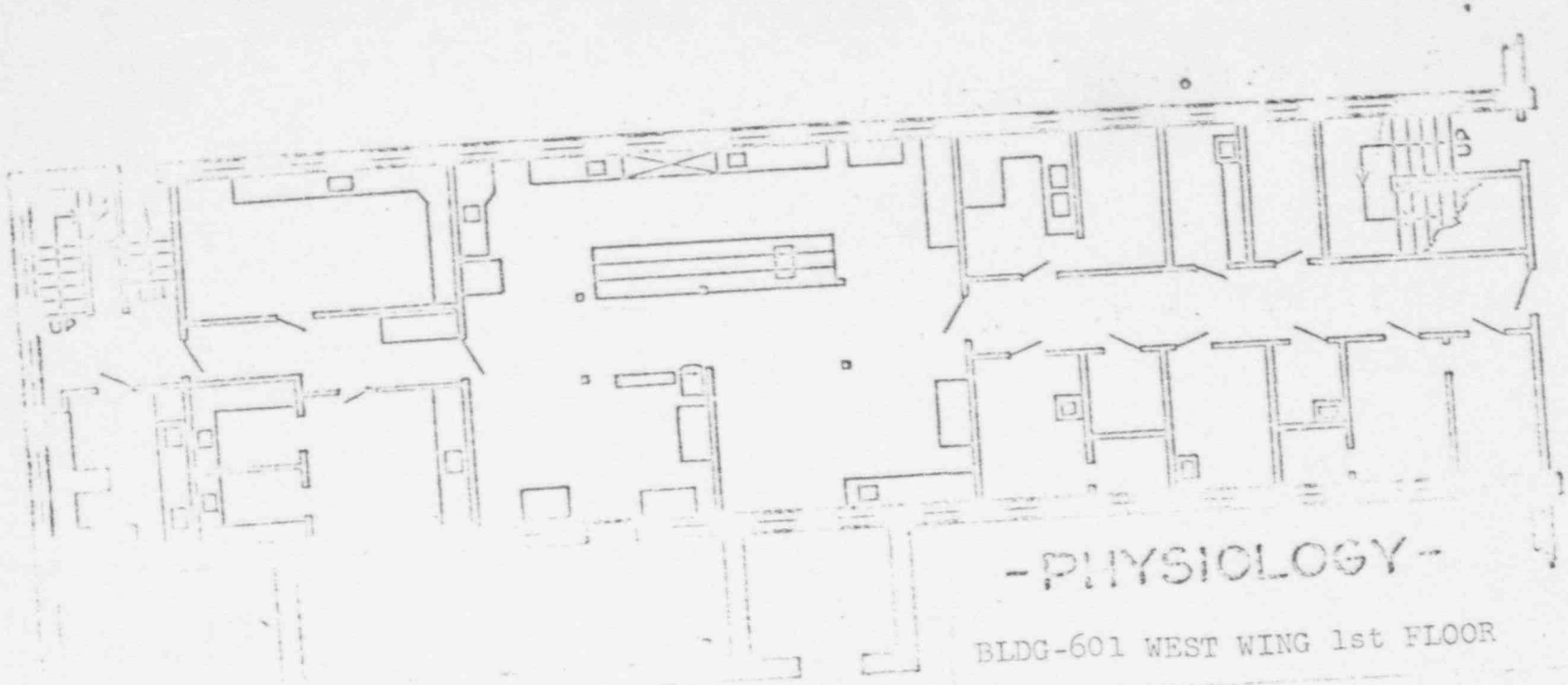
2nd FLOOR EAST BLDG. 600

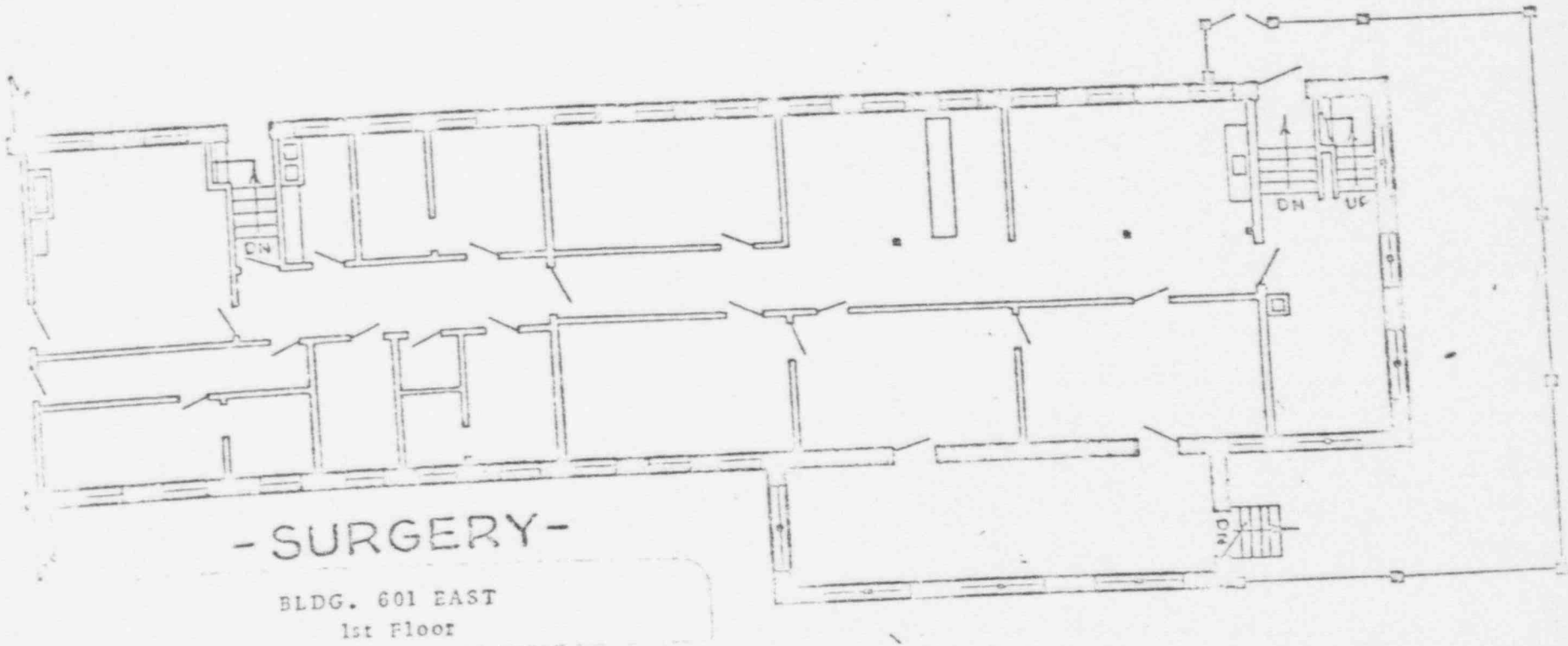
APPENDIX-1

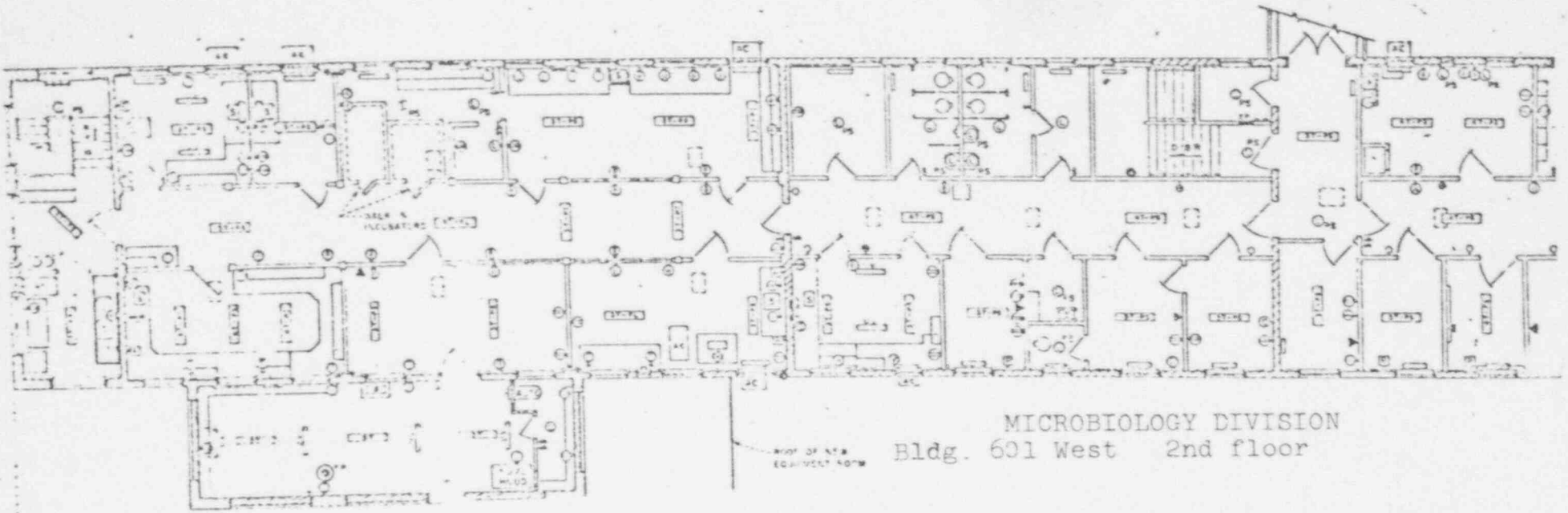
PHYSIOLOGY DIVISION
BLDG. 600 2nd FLOOR WEST WING



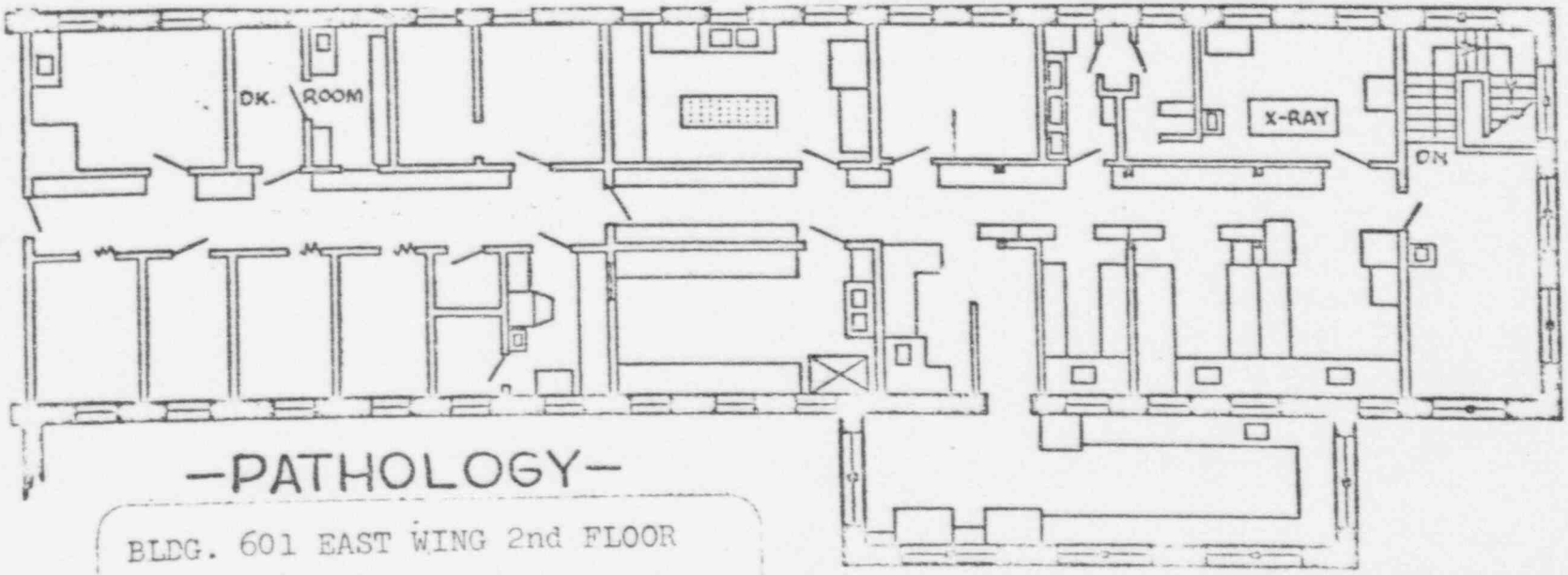
SECOND FLOOR


-PHYSIOLOGY-
BLDG-601 WEST WING 1st FLOOR


DN
DN
UP
-SURGERY-
BLDG. 601 EAST
1st Floor

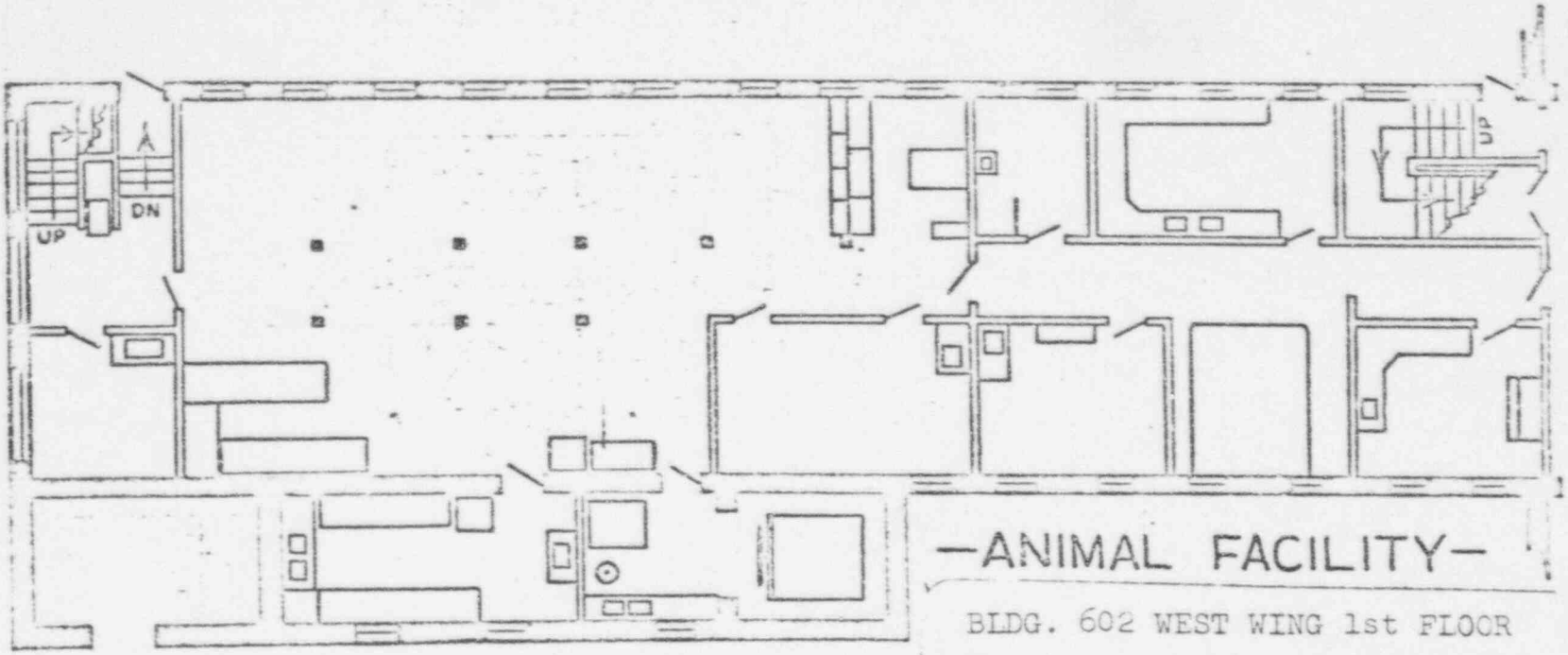


MICROBIOLOGY DIVISION
Bldg. 601 West 2nd floor



-PATHOLOGY-

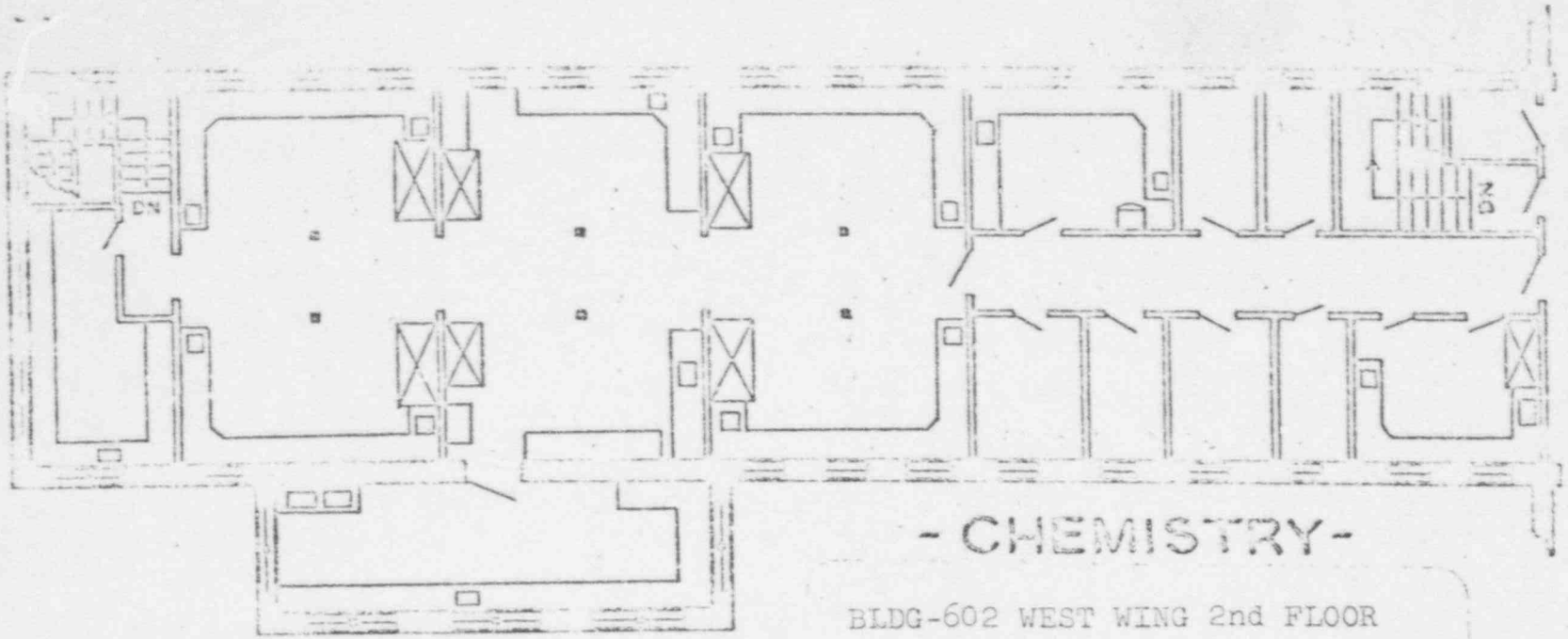
BLDG. 601 EAST WING 2nd FLOOR



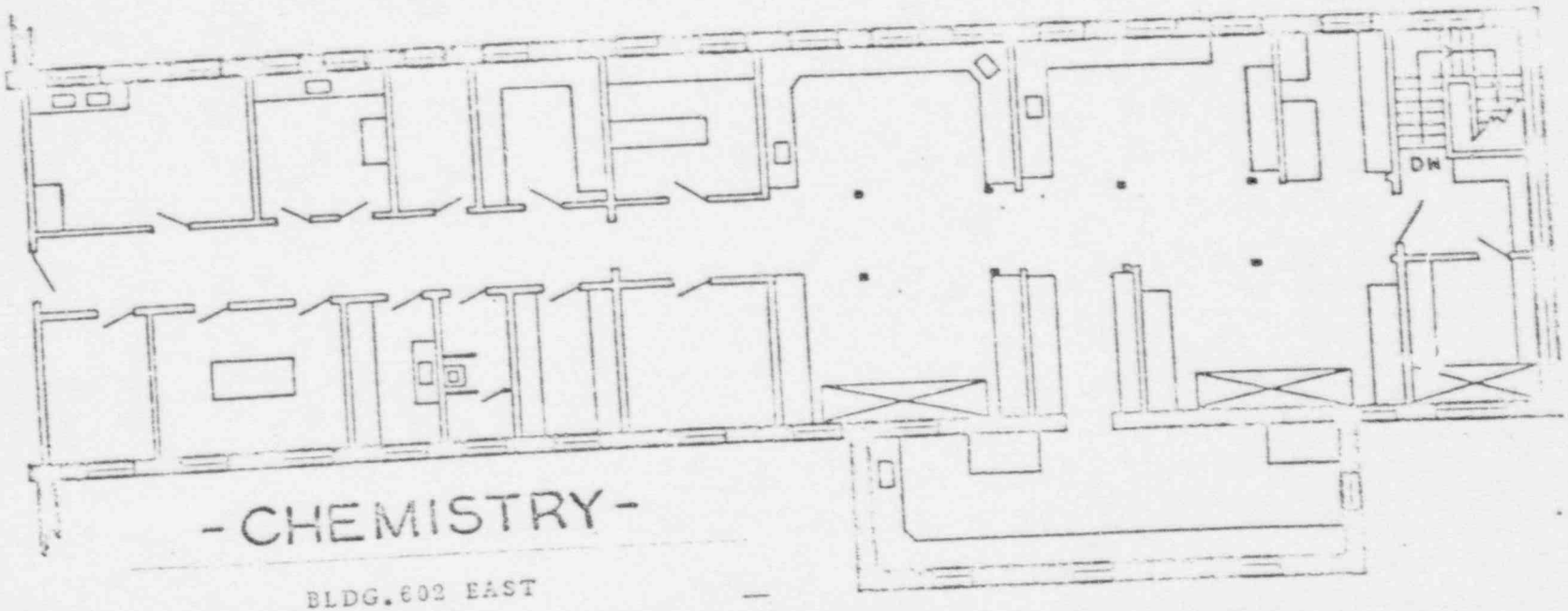
—ANIMAL FACILITY—

BLDG. 602 WEST WING 1st FLOOR

BIOENERGETICS DIVISION
Bldg. 602 1st Floor East Wing

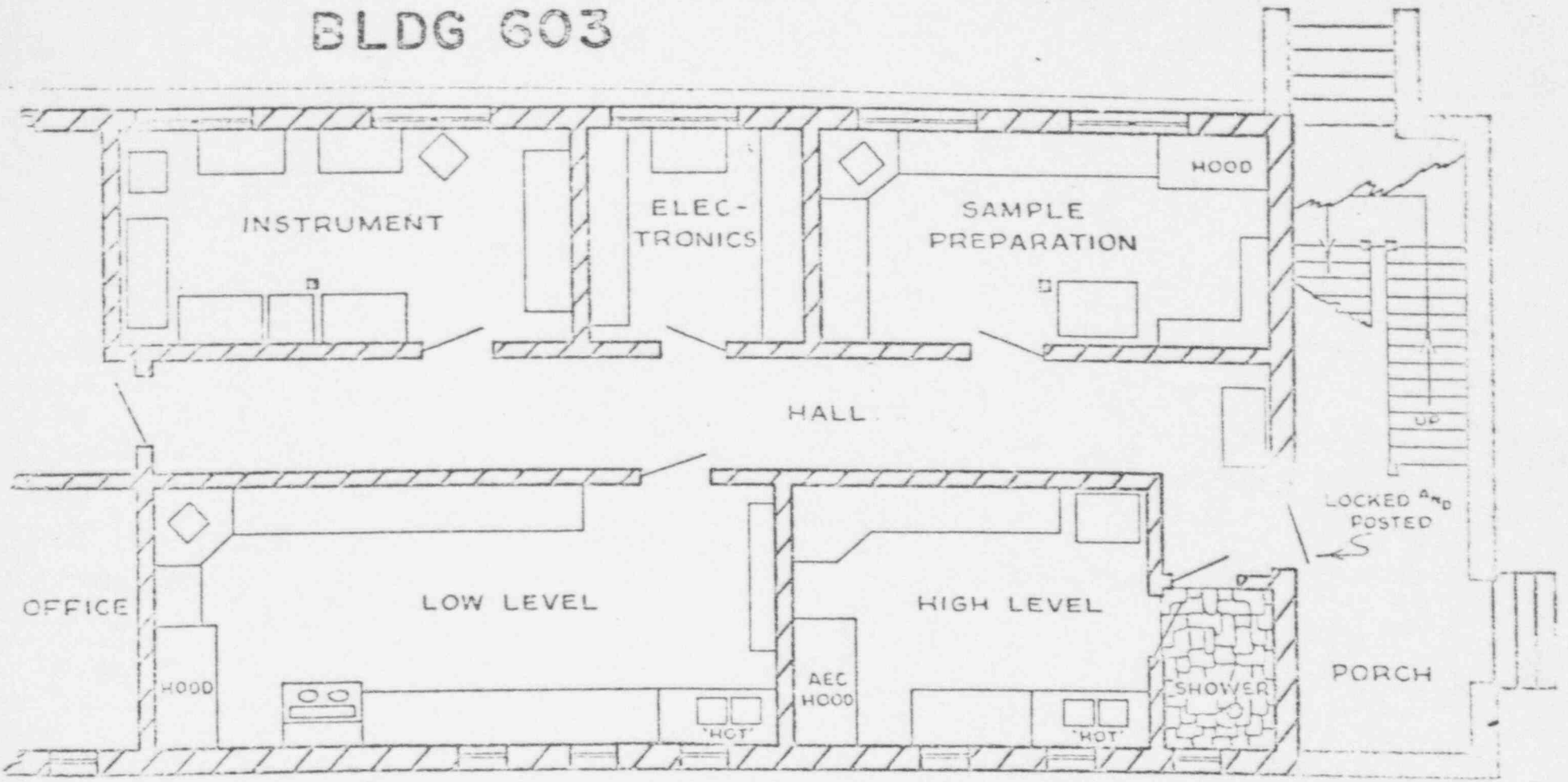


BLDG-602 WEST WING 2nd FLOOR



BLDG. 602 EAST
2nd Floor

RADIOISOTOPE BRANCH
USAMRNL
BLDG 603

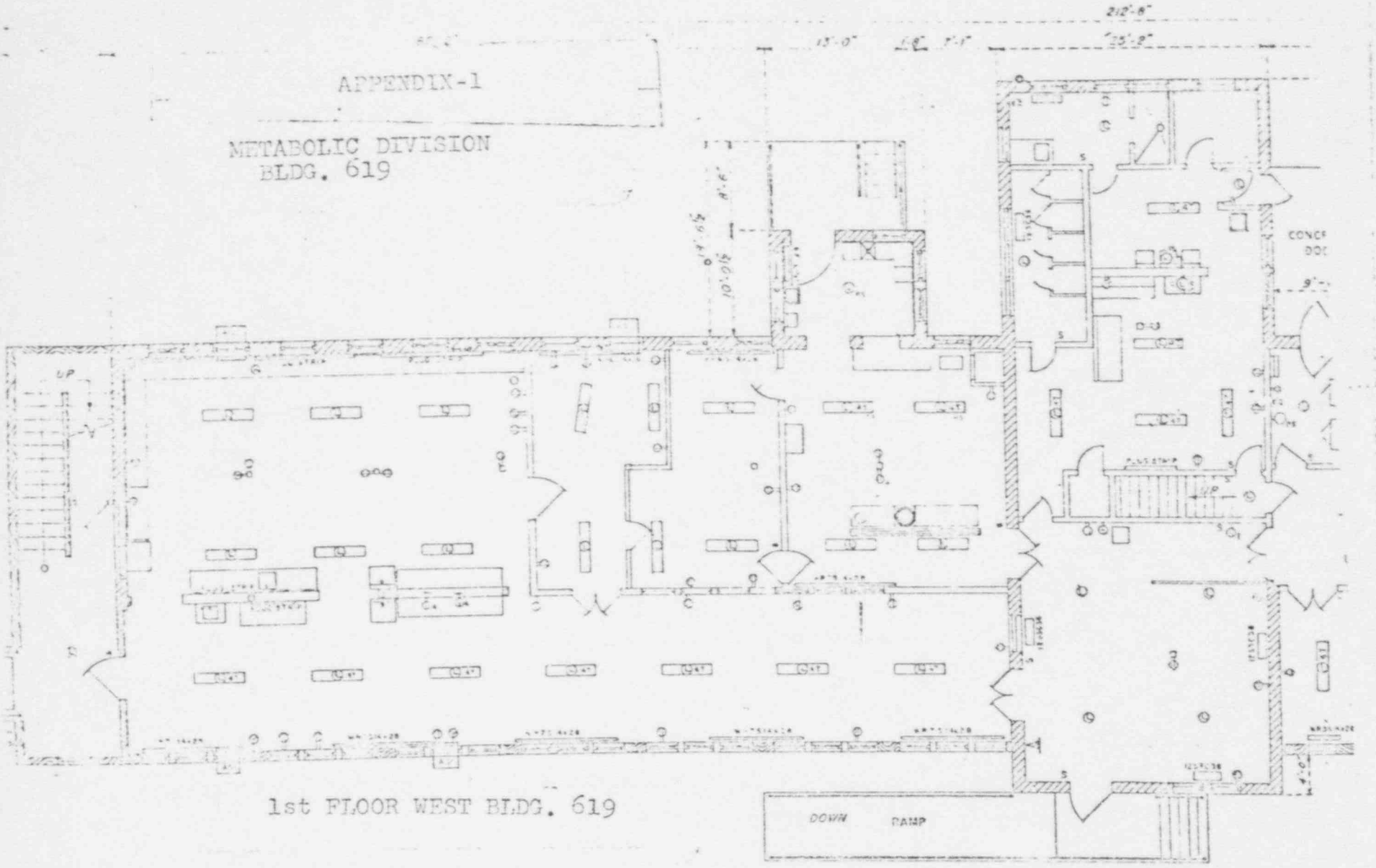


APPENDIX-1

SECOND FLOOR
SCALE 1/8" = 1'-0"

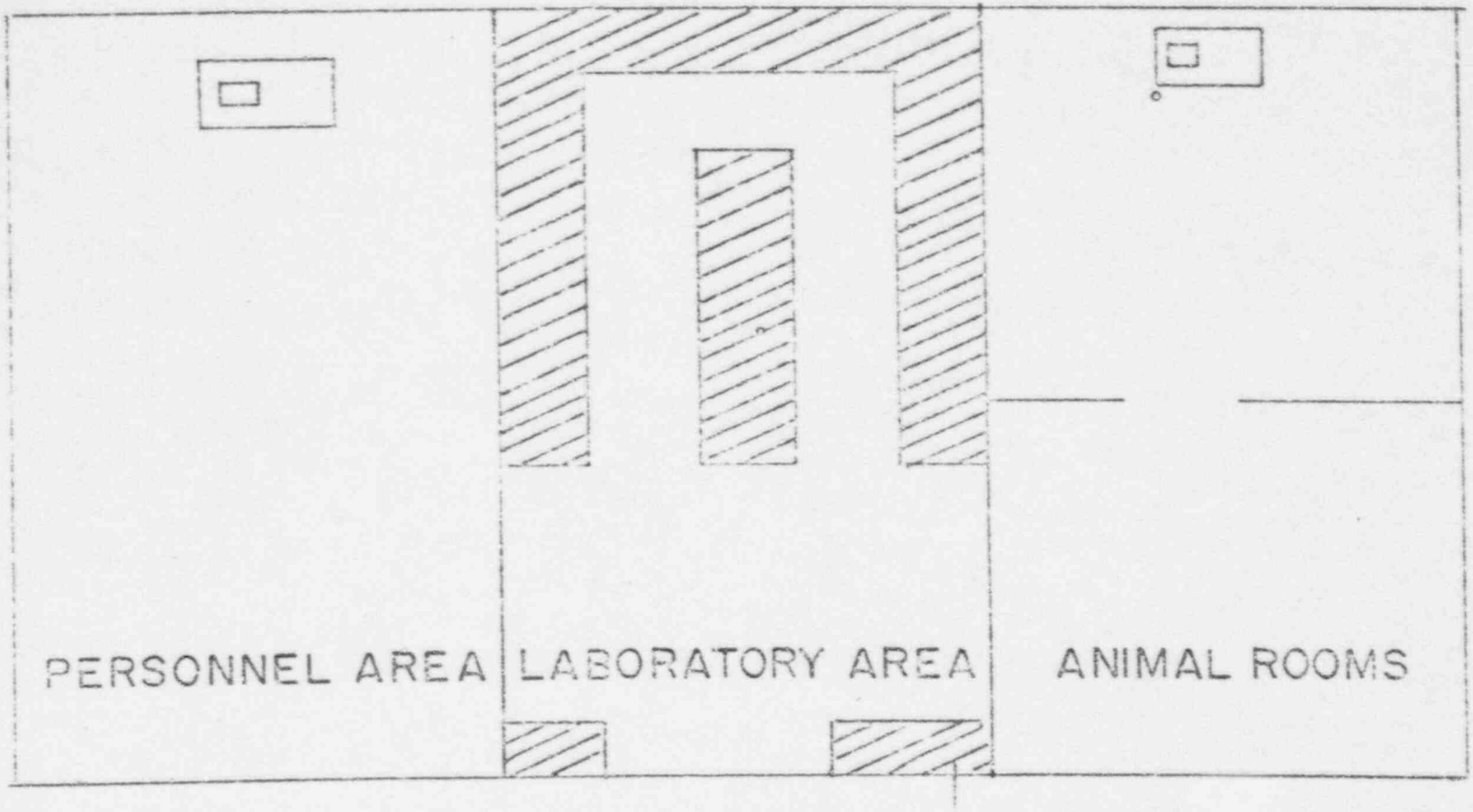
APPENDIX-1

METABOLIC DIVISION
BLDG. 619



1st FLOOR WEST BLDG. 619

FIRST FLOOR
SCALE 1/8" = 1'-0"



PIKES PEAK LABORATORY FACILITY
(24' x 60')

APPENDIX I.

ST-6; EX-3 11 January 1971

OBJECTIVE

The objective of this series of studies is to determine the roles of selenium and vitamin E in the prevention of nutritional liver disease and to apply the knowledge gained to the treatment of human liver disorders. At the present time, it would appear that the best way to approach the problem of the specific role of selenium is to study its metabolism. Therefore, this experiment is aimed at trying to localize the selenium in the plasma and to isolate and study selenium compounds that are found.

JUSTIFICATION

Liver disease, especially hepatitis, has been recognized as a major health problem of armies since antiquity. Today, the U.S. Army carries out a large amount of clinical research on hepatitis.

Selenium can prevent several nutritional liver disorders in animals (2,3), and has been shown to stimulate regeneration of rat liver after partial hepatectomy (4) and damage by a virus (5). Basic research into the metabolism of selenium may lead to advances in the treatment of hepatitis and nutritional liver disease.

EXPERIMENTAL DESIGN

A. Subjects. The subjects chosen will have cancer. The reason for this is twofold. First, it will limit the giving of radioactivity to healthy persons. Second, it will afford the opportunity for evaluating ^{75}Se-selenite as a tumor-scanning agent. At least one promising report of such use has already appeared (6), and more studies are needed. The scans will be performed by the Fitzsimons General Hospital Radioisotope Service.

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The subjects will be chosen from the patients at Fitzsimons General Hospital. No pregnant women will be studied. They must have no liver or intestinal disease, and minimal or no constitutional symptoms. Serum protein and lipoprotein electrophoresis must be normal.

The subjects will be informed as to the reasons for the study, and the potential risk. Written consent will be obtained (see Appendix II -Voluntary Consent Statement). Medical care of the subjects will be provided by their attending physicians who will most likely aid in the identification of prospective subjects. If a subject should have no attending physician, Captain Raymond F. Burk will be responsible, as physician for this research study. There are no plans to administer other isotopes as part of this study. At most, ten subjects will be needed.

The complete study of each patient will require three to four weeks of laboratory work so the entire study should take about a year. If the results justify study in normal human beings, a suitable protocol will be prepared. Otherwise, a report on the completed work will be made.

B. Dose of $^{75}SeO_3^{=}$. The following calculations are derived from the REPORT OF THE ICRP COMMITTEE ON PERMISSIBLE DOSE FOR INTERNAL RADIATION, 1959 (6).

$$R = \frac{q \times 3.7 \times 10^{4} \times 1.6 \times 10^{-6} \times e \times 1 \text{ rem/rad}}{100 \times m}$$

where

R = dose rate in rem/sec

q = activity of radionuclide in uci

3.7×10^{4} = dis/sec per uci

1.6×10^{-6} ergs/Mev

100 = ergs/g per rad

m = mass of the critical organ in grams

e = effective absorbed energy per disintegration of the radionuclidde.

The ICRP gives a value for e of 0.2 Mev/dis for ^{75}Se in the whole body. The value of m is taken as 7×10^4 to represent whole body distribution. If we arbitrarily set q as 300 uci, then the maximum dose rate becomes:

$$R = \frac{300 \times 3.7 \times 10^4 \times 1.6 \times 10^{-6} \times 0.2 \times 1 \text{ rem/rad}}{100 \times 7 \times 10^4}$$

$$R = 5.1 \times 10^{-7} \text{ rem/sec}$$

To obtain the total absorbed dose, the dose rate must be integrated over time. Dose rate expressed as a function of time is:

$$R(t) = R e^{-\lambda t}$$

where

$\lambda = 0.693/T$ (T is the effective half-life of the radionuclide - 10.1 days for ^{75}Se)

$\lambda = 6.86 \times 10^{-2}$

The total absorbed dose to time t_1, is expressed by:

$$D = R \int_0^{t_1} e^{-\lambda t} dt$$

$$D = 5.1 \times 10^{-7} \text{ rem/sec} \times 8.6 \times 10^4 \text{ sec/day} \int_0^{t_1} e^{-6.86 \times 10^{-2} \times t} dt$$

$$D = 4.39 \times 10^{-2} \text{ rem/day} \times \frac{1}{-6.86 \times 10^{-2}} \int_0^{t_1} e^{-6.86 \times 10^{-2} \times t} (-6.86 \times 10^{-2} dt)$$

$$D = -6.40 \times 10^{-1} \left[e^{-6.86 \times 10^{-2} \times t} \right]_0^{t_1} \text{ as } t_1 \to \infty$$

$$D = -6.40 \times 10^{-1} \times (-1)$$

$$D = 6.40 \times 10^{-1} \text{ rem}$$

This is the total body dose (0.64 rem) absorbed by a 70 kg man from 300 uci of ^{75}Se. Using the same formula, the dose to the liver would be 1.85 rem and that to the kidneys would be 1.71 rem. The ICRP allows a total body dose of 5 rem per year to persons exposed to radiation by their occupations and an organ such as the liver or kidneys would be allowed 15 rem per year (8). No definite dose limit has been set for diagnostic tests, but it is stated that the limits to those exposed due to their occupations should be a guide. Adjustments of dose will be made in accordance with the subject's weight.

C. Methods. One objective of this study will be to confirm the unpublished observations of Appendix I. To that end, a subject will be given an intravenous injection of about 200 uc of sterile and pyrogen-free $^{75}SeO_3^{=}$ and blood samples will be taken at 5 and 30 minutes; and 1, 2, 4, 6, 12, 24, 48 and 72 hours, and anticoagulated with EDTA. Approved procedures will be used in handling radioactive material. An aliquot of whole blood will be set aside for counting. Plasma aliquots will be preserved for gel filtration, electrophoresis, dialysis and lipoprotein separation by preparative ultracentrifugation (9). Specific activities will be reported as cpm/mg of protein as determined by the Lowry method (10). Time curves of specific activies of the fractions separated will be prepared.

Fractions identified as having high specific activity will be subjected to other procedures to further increase the activity. Thus, the beta-lipoprotein fraction in which the ^{75}Se specific activity is greatest

will be subjected to electrophoresis and gel filtration. Other methods will be used as they become applicable.

Once the selenium-containing protein has been obtained in as pure a form as possible, it will be subjected to alkaline dialysis, denaturation, and other processes to determine the nature of the selenium-protein bond.

ADMINISTRATIVE DETAILS

A. This will be a Bioenergetics Division study with the collaboration of the Radioisotope Service of Fitzsimons General Hospital for tumor scanning, and the Radioisotope Division of USAMRNL for sample counting.

B. The project leader will be CPT Raymond F. Burk, Jr., M.D., M.C.

C. Costs:

(1) Personnel:

CPT Burk, 70% of time for 3 months

EM (1), 100% of time for 3 months

(2) Equipment.....$0

(3) Supplies.....$500.00

(4) Selenium-75 (sterile and pyrogen-free) $500.00

Total $1000.00

BIBLIOGRAPHY

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2. Burk, R.F., Jr., et al. Tissue selenium levels during the development of dietary liver necrosis in rats fed Torula yeast diets. J. Nutr. 95:420, 1968.

3. Reid, I.M., et al. Methionine-responsive liver damage in young pigs fed a diet low in protein and vitamin E. J. Nutr. 95:499, 1968.

4. Maros, T.N., et al. Effect of selenium and vitamin E on the regeneration of rat liver. J. Nutr. 90:219, 1966.

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6. Cavalieri, R.R., et al. Selenite (^{75}Se) as a tumor-localizing agent in man. J. Nuc. Med. 7:197, 1966.

7. Report of ICRP Committee II on Permissible Dose for Internal Radiation (1959). Health Physics 3:1-380, 1960.

8. Spiers, F.W. Radioisotopes in the Human Body. Academic Press (New York and London, 1968).

9. Havel, R.J., et al. The distribution and chemical composition of ultracentrifugally separated lipoproteins in human serum. J. Clin. Invest. 34:1345, 1955.

10. Lowry, O.H., et al. Protein measurement with the Folin phenol reagent. J. Bio. Chem. 193:265, 1951.

Raymond F. Burk, Jr.

RAYMOND F. BURK, JR., M.D.
CPT, M.C.
Bioenergetics Division

4 Incls
1. APP I - Prog Rpt
2. APP II - Vol Consent State
3. APP III - Curriculum Vitae
4. APP IV - Experience of Inves

PROGRESS REPORT

ASSOCIATION OF $^{75}SeO_3^{=}$ WITH HUMAN PLASMA LIPOPROTEINS

BY

Raymond F. Burk, Jr.

April 19, 1968

APPENDIX I

Introduction:

A preliminary report entitled "Simultaneous Incorporation Studies of ^{75}Se-l-selenomethionine and ^{35}S-l-methionine into Human Lipoproteins" (1) gave the rationale for the belief that selenium plays a special role in the beta-lipoproteins, perhaps as a carrier for d-alpha-tocopherol. The study of simultaneous incorporation of ^{75}Se-l-selenomethionine and of ^{35}S-l-methionine into plasma lipoproteins of one human subject yielded similar activity curves for ^{75}Se and ^{35}S over a 24-hour period in dialyzed plasma, chylomicron plus very low density lipoprotein (VLDL or prebeta--lipoprotein), beta-lipoprotein, and alpha-lipoprotein fractions. This finding does not support the hypothesis that selenium has a separate role from that of sulfur in the lipoproteins.

It is well known, however that the metabolic pathways of organic and inorganic selenium differ and that this is the case, particularly in the immediate period following intravenous administration of selenium. Therefore, it was deemed advisable to conduct a similar experiment with selenite ($SeO_3^{=}$) instead of selenomethionine. This is a report of that experiment.

Experimental:

The subject studied was a 77-year old white male with a histologic diagnosis of reticulum cell sarcoma involving cervical and retroperitoneal lymph nodes by x-ray studies. Although the patient weighed only 45 kg, he had not lost weight and had few symptoms. Lipoprotein electrophoresis, plasma protein electrophoresis, cholesterol, carotene, vitamin A and vitamin E determinations were within normal limits. Red cell morphology was normal, and the hematocrit varied from 35 to 41. The administration of $^{75}SeO_3$ was performed for diagnostic purposes.

After the patient had fasted for 14 hours, 190 uc of $^{75}SeO_3^{=}$ was given intravenously. The patient was allowed to eat ad libitum 4 hours later. Whole body counting and tumor scan were performed, and urine and feces were collected for counting. Results of these studies will be reported on a separate sheet. Blood samples were taken at 20, 40 and 60 min., and at 2, 4, 6, 12, 24 and 48 hours. The anticoagulant used was EDTA - 2 mg/ml blood. The plasma was removed by centrifugation, and the cells were washed twice with 0.15 M NaCl. Unless specifically designated, all dialyses were

for 24 hours against 0.15 M NaCl at 4°C. The adequacy of this dialysis was demonstrated by adding $^{75}SeO_3^=$ to plasma and observing the almost complete loss of counts with dialysis. VLDL (density < 1.006), beta-lipoprotein (density < 1.063), and alpha-lipoprotein (density < 1.21) fractions were isolated from 10 ml plasma samples by modification of the ultracentrifugal method of Havel, et al. (2) and then dialyzed. Counting was done in a Packard Auto Gamma Counter and protein was determined by the method of Lowry, et al. (30).

Results:

Figure 1 demonstrates the ^{75}Se activity in whole blood and in plasma and red cells. There is a rapid loss of radioactivity from the blood until 2 hours at which time a second phase of a slower loss of activity becomes evident. Nearly all of the activity is found in the plasma. Indeed, if a correction for the trapping of plasma in the red cell mass is made, all the counts would appear to be in the plasma. No increase in red cell activity is seen with time.

Figure 2 compares the specific activity of dialyzed and undialyzed plasma. The loss of counts on dialysis decreases steadily to 12 hours from which point on all ^{75}Se is non-dialyzable.

Figure 2a shows the specific activities of plasma protein fractions separated by paper electrophoresis. The paper strips were cut into albumin, alpha-1, alpha-2, beta, and gamma pieces and each piece was counted separately. The protein content of each piece was determined from the densitometric tracing of the strip. Alpha-2-globulin and beta-globulin have the highest specific activities, and albumin has the lowest.

The specific activities of the lipoprotein fractions and dialyzed plasma are seen in figure 3. With the exception of the very early values, the alpha-lipoprotein and dialyzed plasma activities are similar. The VLDL specific activity is the highest for the first 6 hours, but then rapidly drops below that of the beta-lipoprotein and at 48 hours approximates that of the dialyzed plasma and alpha-lipoprotein. The beta lipoprotein maintains a distinctly higher specific activity than the other lipoproteins after 12 hours. Its specific activity at 48 hours is 8 times that of the alpha-lipoprotein.

In order to determimine whether the ^{75}Se was in the lipid or protein portion of the lipoproteins, they were extracted 3 times with ethanol-diethyl ether (1:1 v/v). This was done both in samples precipitated and washed twice with 10% TCA, and in samples which had not been precipitated. The two extractions yielded similar results, but the ones precipitated with TCA were more consistent. They are seen in TABLE 1. No more than 10% of the counts were extracted - in fact the extraction usually did not exceed 5%. Thus, these data indicate that the ^{75}Se is associated almost exclusively with the protein.

Cummins and Martin (4) recently reported that "protein bound" selenium can be removed by dialysis for several days at pH 12. In order to determine whether the ^{75}Se in this experiment could be released by alkaline dialysis, two dialysis procedures were carried out. Both consisted of 0.15 M NaCl solutions and to one sufficient NaOH was added to give a pH of 13.1. The pH of the other bath was 8.0. Identical aliquots (0.5 ml) of 20 minute and 24 hour samples of dialyzed plasma, alpha-lipoprotein, beta-lipoprotein, and VLDL were put into each bath (500 ml/sample), and dialyzed 3 days at 4°C. The samples were then removed and counted, and a protein analysis was done so specific activities could be calculated. Figure 4 shows the results. The specific activities of the lipoproteins dialyzed in 0.15 M NaCl are less than those in figure 3 indicating that some counts were lost. This may have been the result of denaturation of the protein during previous counting at room temperature (4). Much more striking, however, is the loss of counts by the samples dialyzed at pH 13.1 when compared with those dialyzed at pH 8.0. The loss was more marked in the 20' sample in each case. The loss of counts on dialysis at pH 13.1 was far less in the beta-lipoproteins than in any other sample.

Discussion:

Figures 1, 2 and 3 all show decreases in specific activity with time. This is in marked contrast to results obtained with ^{75}Se-l-selenomethione was given (1). In the latter instance, curves of rising activity to 6 hours were obtained suggesting a synthetic process. Imbach and Sternberg (5) reported an early decrease of rat plasma activity following injection of $^{75}SeO_3^=$ and a later slow increase beginning at about 10 hours and persisting past 48 hours. No such increase was noted in this experiment.

It is possible that much of the red cell activity seen in Fig 1 is an artifact caused by red cell uptake of $^{75}SeO_3^=$ from trapped plasma during saline washing. In unreported experiments, we have observed a marked *in vitro* uptake of $^{75}SeO_3^=$ by red cells washed in saline.

Fig 3 clearly shows that selenium is preferentially bound to beta-lipoprotein and VLDL. The rapid turnover of VLDL may be responsible for its rapidly decreasing activity. No explanation is available as to why its initial specific activity is greater than that of beta-lipoprotein. The biologic half-life of both alpha- and beta-lipoprotein has been found to be 4 days (6) and their pool sizes are comparable. Thus, if $^{75}SeO_3^=$ binding were nonspecific, specific activity curves would lie close together. They lie far apart indicating the specific binding of selenium by the beta-lipoproteins. Furthermore, as seen in Fig 4, the type of binding in the beta-lipoproteins is probably different because much less selenium is lost in alkaline dialysis than is lost by the other lipoproteins and dialyzed plasma under identical conditions. A hypothesis which would fit the observations is: there are two types of selenium binding -- one not affected by alkaline dialysis which is found in the beta-lipoproteins, and another which is disrupted by alkaline dialysis and is found in all proteins studied.

Hirooka and Galambos (7) reported higher specific activity in total human lipoprotein than in other plasma proteins following injection of $^{75}SeO_4^=$ but studied only total lipoproteins and not the individual classes. A further augmentation of specific activity in the lipoproteins was noted in a man with cirrhosis and fatty liver. Fig 3 indicates that the increased specific activity resides in the beta-lipoproteins of the patient with cirrhosis and fatty liver could have been due to selective increase in beta-lipoprotein and VLDL, increased avidity of all lipoproteins for selenium, or selective increase in selenium binding by one class of lipoprotein - perhaps beta. It is possible that the patient with cirrhosis and fatty liver had reduced selenium stores which might be expected to cause increased selenium binding.

In these studies, virtually all of the ^{75}Se is attached to the protein moiety of the lipoproteins (see TABLE 1). It has long been known that under certain conditions in the first 30 minutes after intravenous

injection of $^{75}SeO_3^{=}$ or $^{75}SeO_4^{=}$ dimethyl selenide is produced in the liver and carried dissolved in the blood linids to the lungs where it is exhaled. This might spuriously raise the lipoprotein specific activity but the failure to find appreciable quantities of ^{75}Se in the lipid moiety of the lipoprotein would appear to rule out this possibility here.

Selenium deficiency was reported to be a causative factor in nutritional liver necrosis in rats in 1957 (8). More recently, it has been implicated in the development of cirrhosis in pigs in conjunction with vitamin E and protein deficiencies. The observation recorded here that selenium has a special association with the beta-lipoproteins (which also carry d-alpha-tocopherol (6)) may perhaps serve as a clue in the further investigation of the metabolism of this trace element.

Summary:

The specific activities of various blood proteins have been studied for 48 hours following intravenous injection of $^{75}SeO_3^{=}$.

(1) Whole blood, plasma and lipoprotein specific activities decrease with time.

(2) Plasma is responsible for nearly all the whole blood activity.

(3) Dialyzable ^{75}Se is present in plasma until 12 hours after injection.

(4) Over 90% of the ^{75}Se in the lipoproteins is "attached" to the protein portion of the molecule.

(5) The specific activities of beta-lipoprotein and VLDL are much higher than those of alpha lipoprotein and dialyzed plasma.

(6) ^{75}Se in the beta lipoprotein is less susceptible to removal by alkaline dialysis than that in other proteins studied. This finding and the higher specific activity suggest a different type of selenium binding in the beta-lipoproteins.

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TABLE 1

Percentages of Counts Extractable by Ethanol-Diethy Ether
After TCA Precipitation

Time	Alpha-Lipoprotein	Beta-Lipoprotein	VLDL
20'	9.6	0.9	3.2
40'	7.7	1.7	3.4
60'	3.4	3.5	0.8
2 hr.	2.0	3.5	2.3
4 hr.	8.4	2.9	3.7
6 hr.	7.5	2.0	0
12 hr.	9.6	0	0
24 hr.	0	5.3	2.7
48 hr.	2.6	6.0	6.1

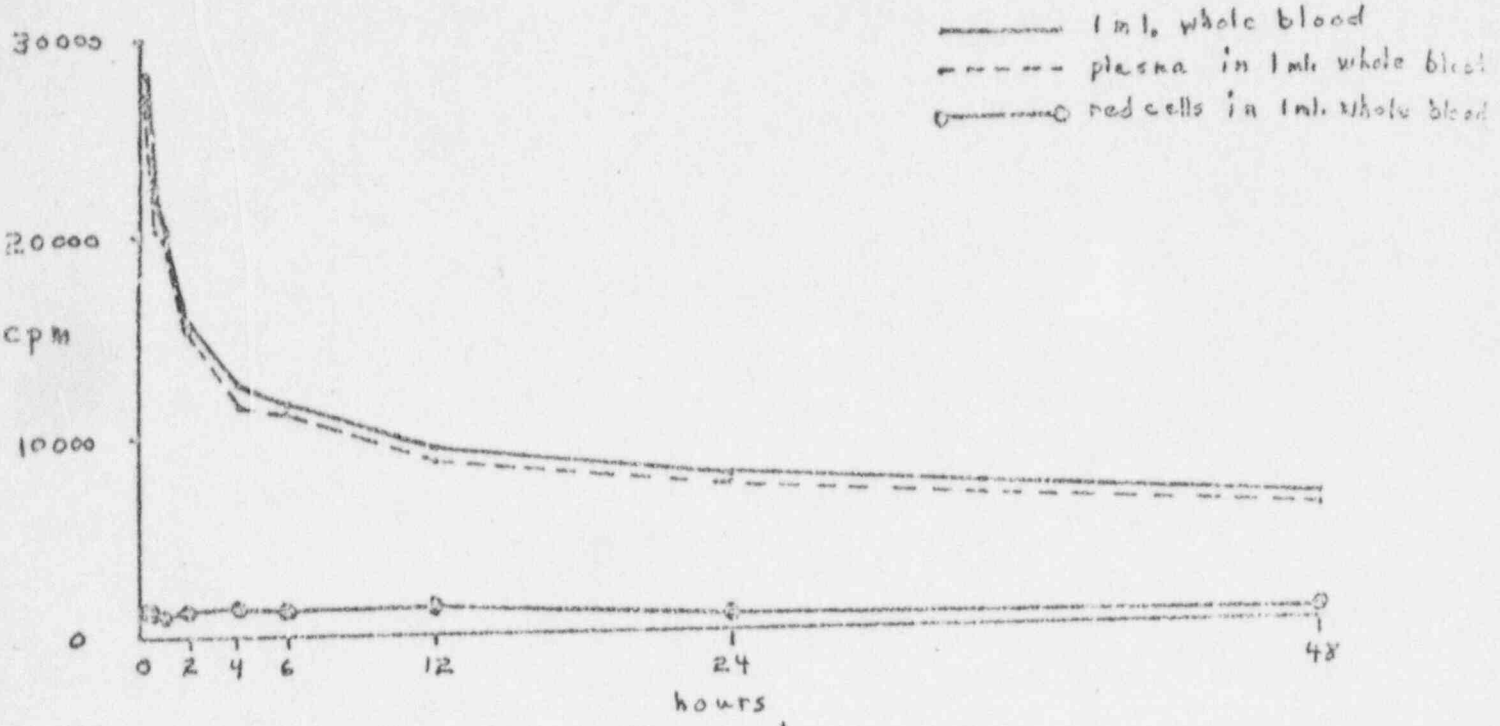

Figure 1

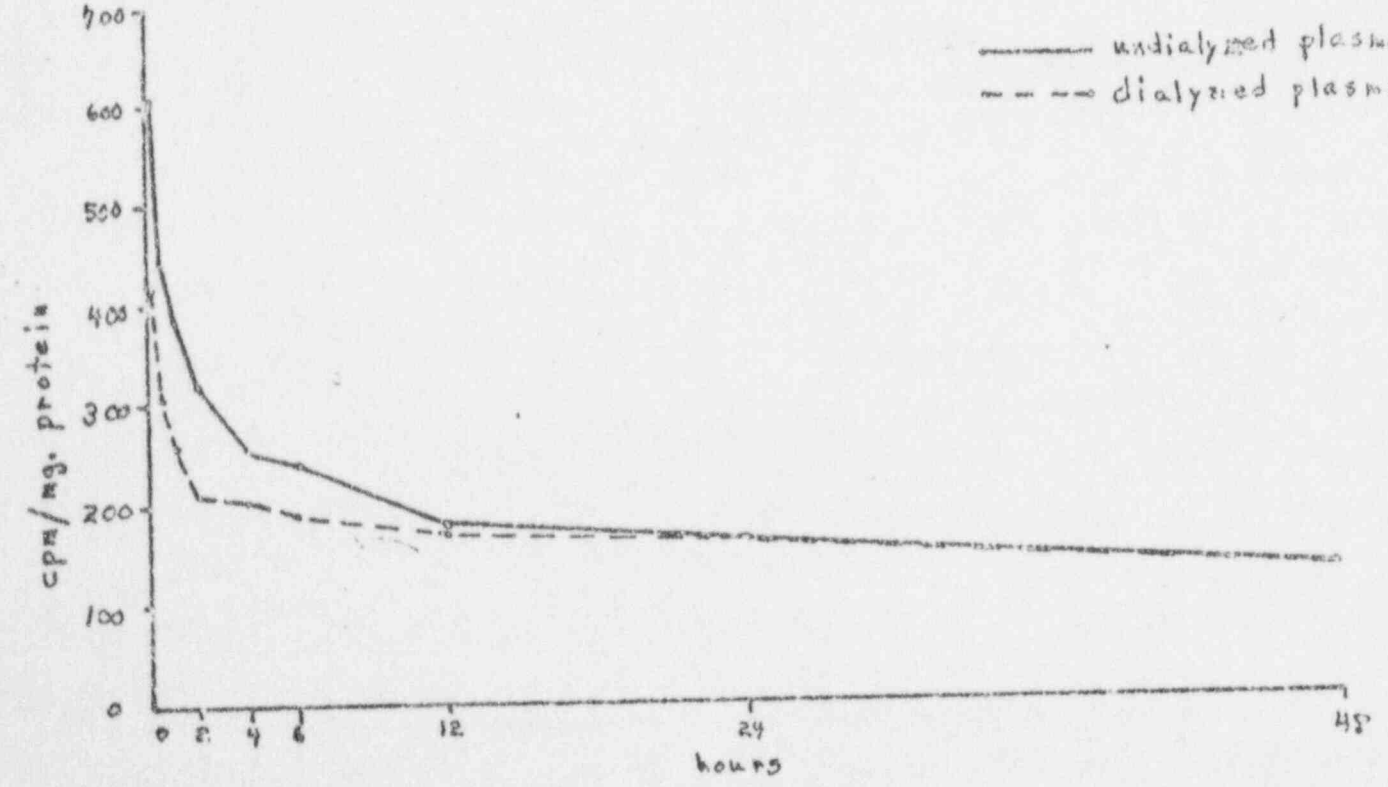

Figure 2

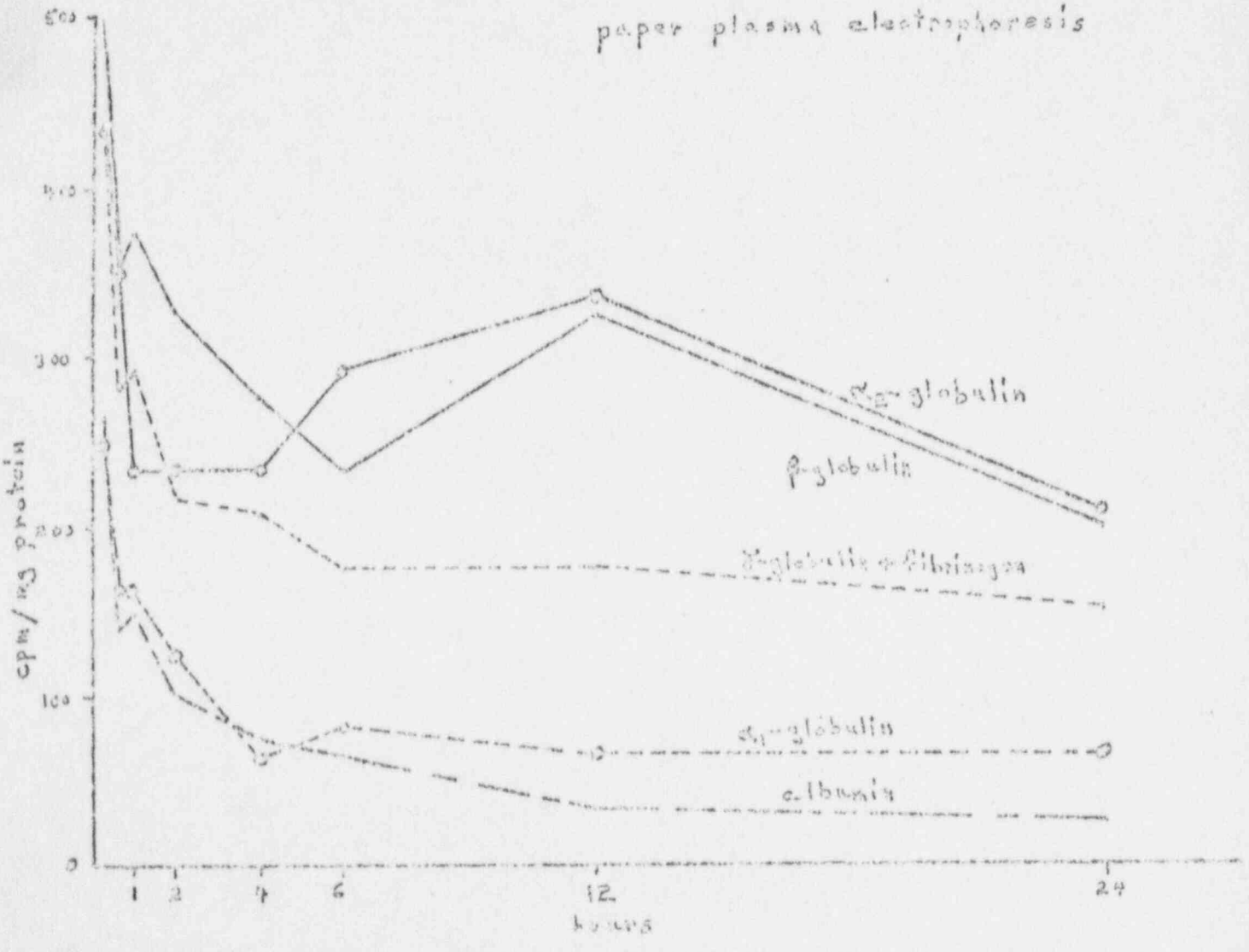
paper plasma electrophoresis
500
400
300
200
100
0
cpm/mg protein
1
2
4
6
12
24
hours
γ_2-globulin
β-globulin
β_2-globulin + fibrinogen
α_2-globulin
albumin

Figure 2a

INSTRUMENT MODELS AND SPECIFICATIONS

-VICTOREEN-

740 series (cutie pie)	up to 10r/hr
740 A	up to 5r/hr
740 B	up to 2.5r/hr
440	up to 300mr/hr
592 B	up to 1r/hr
EP 271	up to 500mr/hr
Thyroc II-489	up to 20mr/hr
491	up to 100mr/hr (200 mr with special probe)
666	up to 30,000r/hr (for x-ray units)

-NUCLEAR-CHICAGO-

2650 series	100mr/hr
2500 series (cutie pie)	
# 2526	up to 2500mr/hr } ion chamber
# 2520	up to 250r/hr } ion chamber
# 2586-S	2500mr/hr
# 2586-T	250r/hr
2612	up to 20mr/hr

-PICKER-NUCLEAR-

# 655-001 (cutie pie)	up to 2.5r/hr
600, 655-180	50mr/hr
-181	50mr/hr
2980	up to 50mr/hr
25-2001 (cutie pie)	25, 250, 2500mr/hr
PSM-700?	

-BAIRD-ATOMIC-

904-121, 122	up to 100mr/hr
904-700	up to 50mr/hr
904-715	500r/hr
414	over 1r/hr
4-415	over 1r/hr

-Atomic Assoc.- (subsidary of Baird-Atomic)

BA-420 E	up to 100mr/hr
-420 S	up to 100mr/hr

-Texas Nuclear- (subsidary of Nuclear-Chicago)

2500 series (cutie pie)	
2588	up to 2500mr/hr
2511	up to 250r/hr
2514	up to 250r/hr
log-series survey	
9101	0-200mr/hr
9103	0.2-2000mr/hr
9105	2-20,000mr/hr

CDV
(Victoreen Civil Defense)

700 (6B)	0-50mr/hr GM
710	0-50r/hr survey meters
715 (1A)	0-500r/hr "
720	0-500r/hr "
717	0-500r/hr " (remote)
730	0-20r/hr dosimeter
740	0-100r/hr "
742	0-200r/hr "

720 is also Victoreen #3

715 is also Victoreen #1A

Landers, Frary, & Clark	CD V-715 Model 1A	0-500r/hr

-LUDLUM MEASUREMENTS, INC.-

14A	up to 200mr/hr
14B	up to 2r/hr

-TRACERLAB-KELEKET-

Model SU-14, SU-14TW	0.25, 2.5, 25mr/hr
SU-1A (cutie pie)	15, 150, 1500mr/hr
-1B	25-2500mr/hr
SU-1H (cutie pie)	up to 1.5r/hr
SU-3D Ratemeter & lab monitor	200; 2,000; 20,000 cpm

NRD

Model CS-40 (cutie pie)

-AMERICAN NUCLEAR CORP.- ANC-100 XL

must specify range (also higher ranges available)		0-100mr/hr 0-1000mr/hr
Eberline Model PIC-6A		ion chamber up to 1,000r/hr
Model E 120 G	GM	up to 1r/hr
Model E 500 A	GM	up to 200mr/hr
Model E 510 N	GM	up to 20mr/hr
Model E 500 B	GM	up to 2r/hr
Model E 112 B-1	GM	20mr/hr
Model E 112 H	GM	2r/hr

-NUCLEAR CORPORATION OF AMERICA-

Nu-Tec pocket monitor	RM-100	1mr-100 R
Model No. CS-40A (cutie pie)		5mr-50R/hr
Model No. CS-145	GM survey	1mr-1000R/hr
Model No. CS-155	GM survey	1mr-1R/hr