NRC Form 313 I
(12-81)
10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

1. APPLICATION FOR:
(Check and/or complete as appropriate)

	a. NEW LICENSE
	b. AMENDMENT TO: LICENSE NUMBER
X	c. RENEWAL OF: LICENSE NUMBER 18-02774-01

2. APPLICANT'S NAME *(Institution, firm, person, etc.)*

The Jackson Laboratory

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

207-288-3371

3. NAME AND TITLE OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION

Wesley G. Beamer, Staff Scientist

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

207-288-3371 Ext. 218

4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)* *(Address to which NRC correspondence, notices, bulletins, etc., should be sent.)*

Otter Creek Road, Bar Harbor, ME 04609

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED *(Include Zip Code)*

Otter Creek Road, Bar Harbor, ME 04609

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	See Page 4	
b.		
c.		

7. RADIATION PROTECTION OFFICER

Wesley G. Beamer

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.

8. LICENSED MATERIAL

LINE NO.	ELEMENT AND MASS NUMBER A	CHEMICAL AND/OR PHYSICAL FORM B	NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)* C	MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME D
(1)	See Page 5			
(2)				
(3)				License Fee Information
(4)				on Next Page

	DESCRIBE USE OF LICENSED MATERIAL E
(1)	Biochemical tracer and *in vivo* studies in laboratory animals
(2)	
(3)	
(4)	

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9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)	Not Applicable		
(2)			
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED *(alpha, beta, gamma, neutron)* E	SENSITIVITY RANGE *(milliroentgens/hour or counts/minute)* F
(1)	See Page 7					
(2)						
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☒ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

See Page 8

☒ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

See Page 8

12. PERSONNEL MONITORING DEVICES

TYPE *(Check and/or complete as appropriate.)* A	SUPPLIER *(Service Company)* B	EXCHANGE FREQUENCY C
☒ (1) FILM BADGE ☐ (2) THERMOLUMINESCENCE DOSIMETER *(TLD)* ☐ (3) OTHER *(Specify)*:	R. S. Landauer, Jr. and Co. Glenwood Science Park Glenwood Park, IL 60425	☒ MONTHLY ☐ QUARTERLY ☐ OTHER *(Specify)*:

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☒ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS *(Include filtration, if any)*, ETC. See Page 9

☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING *(fixed and/or temporary)*, ETC.

☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC.

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

Interex Inc., 3 Strathmore Road, Natick, MA 01760

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

   a. Principles and practices of radiation protection.

   b. Radioactivity measurement standardization and monitoring techniques and instruments.

   c. Mathematics and calculations basic to the use and measurement of radioactivity.

   d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant.)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, 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.

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.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)* Type A Broadscope License Byproduct License	b. CERTIFYING OFFICIAL *(Signature)* [signature] c. NAME *(Type or print)* Barbara H. Sanford
(1) LICENSE FEE CATEGORY:	d. TITLE Director
(2) LICENSE FEE ENCLOSED: $ 150.00	e. DATE 12 April 1984

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ITEM 6.

Radioactive materials are to be used by or under the direct supervision of the following individuals designated by the radiation safety committee:

W. Beamer	Staff Scientist and Chairman, Radiation Safety Committee
J. Barker	Staff Scientist
P. Black	Research Assistant
H. Chen	Staff Scientist
H. Bedigian	" "
G. Carlson	Associate Staff Scientist
D. Coleman	Senior Staff Scientist
I. Egorov	" "
E. Eicher	" "
R. Evans	" "
D. Harrison	" "
A. Kandutsch	" "
L. Kozak	" "
E. Leiter	Staff Scientist
L. Mobraaten	Associate Staff Scientist
J. Nadeau	" "
L. Shultz	Staff Scientist
C. Sidman	Associate Staff Scientist
B. Taylor	Senior Staff Scientist
M. Taketo	Associate Staff Scientist

ITEM 8. The Jackson Laboratory requests the use of any by-produce material with atomic numbers 1 through 83. Table 1 provides specific requested information on isotopes utilized during current license period.

Table 1. Licensed Material

Element and mass number	Chemical and/or physical form	Regulatory limit (Ci)	Expected possession limit (Ci)	Ratio %
a. Barium-133	Sealed sources	1	2×10^{-6}	-
b. Calcium-45	Any	1	0.05	5.0
c. Carbon-14	Any	100	0.500	0.5
d. Carbon-14	Sealed sources	-	2×10^{-6}	-
e. Cesium-137	Sealed sources	0.1	2×10^{-6}	-
f. Chromium-51	Any	100	0.100	0.1
g. Copper-64	Any	10	0.010	0.1
h. Hydrogen-3	Any	100	1.0	1.0
i. Hydrogen-3	Sealed sources	-	2×10^{-6}	-
j. Iodine-125	Any	0.1	0.050	50.0
	Sealed source	-	0.200	See footnote
k. Iodine-129	Sealed source	-	2×10^{-6}	-
l. Iodine-131	Any	0.1	0.025	25.0
m. Iron-55	Any	10	0.010	0.1
n. Iron-59	Any	1	0.025	2.5
o. Nickel-63	Sealed source	1	0.015	1.5
p. Phosphorus-32	Any	1	0.100	10.0
q. Phosphorus-33	Any	-	0.010	-
r. Potassium-42	Any	1	0.010	1.0
s. Rubridium-86	Any	1	0.010	1.0
t. Sulfur-35	Any	10	0.050	0.5
	Totals	337.3	2.17 Ci	

Footnote, next page.

Footnote, Table 1.

The total requested possession limit for ^{125}I exceeds the Regulatory limit. Our current license was amended in 1983 to permit possession of a 200m Ci sealed source of ^{125}I for bone densitometry. We request continued use of the sealed source of ^{125}I. The request for the amount of ^{125}I to be used in biochemical tracer and *in vivo* studies is 50 mCi.

ITEM 10.

Table 2. Radiation Detection Instruments

Type of instrument	Manufacturer	Model	Number available	Radiation detected	Sensitivity
Survey meter	Nuclear Chicago	2650M	2	Beta and gamma	0.01-100 mR/hr
" "	Johnson	CSM-5	1	" "	0.0.-20 mR/hr
" "	Victoreen Instrument	493	1	" "	0.1-50 mR/hr
" "	Nuclear Equipment Corporation	H-572	1	Gamma	0.1-50 mR/hr
" "	Victoreen Instrument	470-A	1	Beta and gamma	0.01-1000 mR/hr
Research gamma	Nuclear Chicago	1185	2	Gamma	0.005 microcuries
" "	Beckman	5500	2	"	0.005 microcuries
" "	Beckman	8000	1	"	0.005 microcuries
Research beta	Nuclear Chicago	Isocap-300	3	Alpha, beta	0.005 microcuries
" "	Beckman	LS-800	1	" "	0.005 microcureis
" "	Packard	Tricarb 300 C	1	" "	0.005 microcuries
" "	LKB-Wallace	1211	1	" "	0.005 microcuries
" "	LKB-Wallace	1217	1	" "	0.005 microcuries

ITEM 11.

Calibration of survey instruments

A. Survey meters:

1. Nuclear Chicago 2650M, Johnson CSM-5, and Nuclear Equipment Corp. 493 are calibrated by Warington, Inc., 7801 North Lamor, D-111, Austin, TX 78752 (annually), License #NRC-6-3074.

2. Victoreen 470-A and 493 are calibrated by Victoreen Instrument Division, 10101 Woodland Ave., Cleveland OH 44104 (annually), License #NRC-34-00486-04.

B. Research gamma and beta counters:

1. Nuclear Chicago Model 1185 (Main Laboratory) - method, frequency and standards used in calibrating gamma counter for testing: (1) surface wipe samples and (2) thyroid bioassays.

a. Calibration of elevator-access deep well scintillation crystal through use of:

(1) Simulated ^{125}I (^{129}I; 0.1 μCi, Nuclear Chicago No. S-600)

(2) Simulated ^{131}I (^{133}Ba and ^{137}Cs; 0.28 μCi 10/14/74; New England Nuclear NES-214)

(3) ^{137}Cs (0.1 μCi ± 10%; 4/71; Amersham/Searle No. 184642)
Calibration is carried out for the deep well crystal at least once a year for the above source. Verification of at least one source is made each time the deep well crystal is used to check surface wipes for contamination.

b. Calibration of the special 5 cm (dia.) external scintillation crystal used for thyroid bioassays is accomplished with the same sealed sources described in 1 above. Each time thyroids are counted, calibration of the equipment is carried out with a phantom containing 2.5 cm water between the radioactive source and scintillation crystal.

2. Nuclear Chicago Isocap 300 (Main Laboratory) - Method, frequency, and standards used in calibrating beta counter for testing (1) surface wipes and (2) urine bioassays.

a. Calibration of dual channel crystals through use of:

(1) ^{3}H (0.045 μCi, 4/80, New England Nuclear, NES-209)

(2) ^{14}C (0.018 μCi, 4/80, New England Nuclear, NES-209)

b. Calibration is carried out multiple times monthly with one or both of the above standards during research use and during surveys of surface wipes or biological specimens for presence of radioactive contamination.

c. Dr. W. G. Beamer (RSO) has assembled the above equipment and supervises the use of that equipment and thyroid bioassays.

3. The other research gamma and beta scintillation counters are calibrated on site frequently with standard isotypes of known activity described in item 9 above. Calibration is carried out with one to two different isotopes (0.05-0.10 μCi). Calibration standards have been obtained from several vendors, including New England Nuclear (Boston, MA), Amersham/Searle (Downers Grove, IL), Nuclear Chicago (Chicago, IL) and LKB-Wallac (Gaithersburg, MD). In addition, service personnel from Gamma Sonics (Hopedale, MA 01747; Nuclear Chicago instruments), Beckman Instruments (Beckman Instruments), Packard Instruments) (Tricarb 300 C), and LKB-Wallac (Rock beta 1211 and 1217) make frequent visits to the Jackson Laboratory for the purpose of repairs and calibration of the respective vendors' instruments. These visits typically occur more frequently than once a year.

ITEM 13.

Facilities and Equipment

The radioisotopes requested in this license application are used for studies in vitro and in small laboratory aniamls at the Jackson Laboratory, Otter Creek Road, Bar Harbor, ME.

Low-level tracer laboratories. Most studies utilizing small amounts of radioisotopes are conducted in the laboratories of individual investigators at the Jackson Laboratory. Individual laboratories are equipped with sinks, stand-up and sit-down workbenches, refrigerators, etc., and many also have fume hoods. Refrigerators and freezers associated with individual laboratories are authorized for storage of small amounts of radioisotopes (permissible quantities are given in Item 4 below). All storage sites are appropriately identified with standard labels stating "Caution-Radioactive Materials". Isotopes emitting gamma radiation are required to be stored in lead containers in such refrigerators or freezers.

The basic criteria for personnel working in low-level tracer laboratories are:

1. All personnel who work with radioisotopes must have basic knowledge of what radioisotopes are, understand the concept of shielding and distance for self-protection from radiation, recognize the symbol for radiation, and be informed about the Laboratory's Radiation Safety Committee and Radiation Safety Officer as sources of information and guidance on questions associated with radioisotopes.

2. All personnel are required to wear personnel radiation monitoring film badges, laboratory coats, and disposable gloves while working with radioisotopes.

3. Research Staff members who receive approval for the use of radioisotopes are responsible for training their personnel in the proper and safe use of radioisotopes in their research activities.

4. All personnel, permanent and transient, who work with radioisotopes are expected to be familiar with the Laboratory's Rules Governing the Use of Radioisotopes that are provided to every research laboratory (copy appended).

In vivo studies laboratories. Living animals treated with radioisotopes must be housed in the Radioisotopes Suite in the area next to the Hot Lab in the Main Laboratory. The first room is the Hot Laboratory and is available for making stock solutions and solutions for injections into mice. Three small rooms are available for housing laboratory animals treated with radioisotopes. Space is assigned in these rooms upon consultation with the Radioisotopes Supervisor. The mice can be taken to the investigator's laboratory for brief periods of time in order to perform whole body counts or other metabolic and physiological studies requiring the use of specialized equipemnt located elsewhere in the Main Laboratory. Otherwise, no animals, used or unused, which have been brought into the radioisotopes area for experimental purposes are to leave this area alive. Dead animals are set aside for incineration (see Item 14 on "Waste Disposal"). The fifth room serves as the temporary radioactive waste collection and storage room.

Basic criteria for personnel working in the in vivo studies facilities include the four criteria for low-level tracer laboratories, plus observing the specific rules for In Vivo Radioisotope Studies, a copy of which is provided in the Appendix.

Radioisotopes Hot Laboratory. This laboratory is located on the second floor of the Main Laboratory and is designated as Room 1 on the Floor Plan provided in the Appendix. It is used for procedures yielding volatile ^{125}I or ^{131}I, for preparing dilute solutions of radioisotopes from more concentrated stock solutions, and, in so far as possible, storage of concentrated solutions of gamma-emitting (^{51}Cr, ^{131}I, ^{125}I, ^{59}Fe) isotopes. Stock solutions are to be properly labeled and shielded by each Research Staff member.

The hood in the Hot Lab is an outside ventilating device in operation 24 hr/day. The Hot Lab also contains workbench space, stainless steel sink, freezer for storage of chemicals or contaminated animal carcasses, and a small well-shielded storage area for lead pigs containing stock solutions of radioisotopes. Special equipment available for use during execution of procedures in the Hot Lab consist of:

A. Air Sampling Devices

1. Variable rate of flow (1 to 20 l/min air pump (Bendix Model 19102) with in-line device that holds activated charcoal filters.

2. Fixed rate of flow (2 l/min) air pump (Fisher Scientific Model 18-309X) with in-line device that holds activated charcoal filter.

B. Nuclear Equipment Chemical Corporation survey meter Model H-572 assigned solely to the Hot Lab for monitoring contamination.

In addition to the basic criteria for low-level tracer laboratories, personnel utilizing ^{125}I and ^{131}I in their work in the Hot Lab or elsewhere will:

1. Conduct procedures involving volatile phases of iodine in the Hot Laboratory. Such personnel will be instructed in the purpose, function, environmental monitoring procedures, and records required by the Radiation Safety Officer. Initial use of the Hot Laboratory must be supervised by the

Radiation Safety Officer or the suitably trained and experienced Research Staff member.

2. All personnel who use 100 or more microcuries of ^{125}I or ^{131}I in a single experiment must submit a report of thyroid bioassay to the RSO within 48 hours of exposure. Personnel who use an accumultaed amount of 100 or more microcuries of ^{125}I or ^{131}I in a 6-month period are also expected to submit a report of thyroid bioassay to the RSO approximately every 6 months.

The Jackson Laboratory is a restricted-access facility for health and safety reasons. Thus, further specific security arrangements for radioisotopes are not provided. However, the Hot Lab (site of storage for concentrated radioisotope stock solutions) is locked at all times. The key is available from the Laboratory Operations Office or the RSO upon request by authorized investigators or their research support personnel.

ITEM 14.

Radioactive waste disposal

The copies of regulations established by the NRC and DOT for the transfer, packaging, and transport of low-level radioactive waste are maintained by the Radiation Safety Officer. In addition, requirements established by Agreement States that are provided by our radioactive waste disposal vendor (Interex Corp., U.S. Ecology, Inc.) are also maintained and verified prior to any shipment of waste.

Research Staff and their Research Support personnel are rsponsible for safe transfer of radioactive waste to temporary waste storage room 5 in the Radioisotope Suite (floor plan provided). The Radiation Safety Officer and the Laboratory Safety Officer are responsible for the safe packaging and transport of low-level radioactive wastes to the disposal vendor (Interex Corp.). All requirements set by the NRC, DOT, and Agreement States hosting land-fill sites are followed when shipments are prepared. Training for this task is provided by review of appropriate regulations and telephone communication with the Interex Corp. personnel prior to final packaging and shipment. This assures that all of the latest changes are incorporated in our shipment preparations.

The procedures for disposal of radioactive wastes are as follows.

A. Volatile or potentially volatile radioactive wastes are appropriately treated with strong alkali, detergent or acid whenever possible so as to render radioactive material non-volatile. Trapping media is then be disposed of by one of the following methods (B-E), depending on the isotope. It is expected that biochemical procedures could result in release of ^{3}H-water, $^{14}CO_2$, or isotopes of iodine to the atmosphere. $^{3}H_2O$ or $^{14}CO_2$ levels would be in the picocurie or less range. The use of ^{125}I and ^{131}I under volatile conditions is restricted to the Radioisotope Suite Hot Laboratory. Measurements show that such releases have ranged from 1×10^{-13} µCi/ml air/week to 4×10^{-11} µCi/ml air/week. Records of Hot Lab release of ^{125}I or ^{131}I are maintained for inspection.

B. Organic solvents containing less than 0.05 μCi ^{3}H or ^{14}C/g solvent are collected in steel safety cans and transferred to a 10,000 gallon no. 6 fuel oil tank for combustion at 1800-2100° F in Main Laboratory boilers. The fuel oil in this tank turns over every 2-4 weeks, depending on heating demands. Boiler ashes obtained during maintenance cleaning are checked for evidence of residual radioactivity. Records of isotopes and amounts disposed of are kept and calculations made to insure that gaseous effluent release does not exceed NRC specifications in 10 CFR Part 20, Table 2, Appendix B. Table 3 presents summarized records for 1983 that may be taken as estimates of expected annual release rates during the 1984-1989 license period.

C. Solid, combustible waste (animal carcasses, paper, plasticware, pine bedding) is segregated by isotope (isotopes of iodine, ^{32}P and all other isotopes) and placed in 55 gallon steel barrels. Log books for each barrel record date, person, isotope and quantity of isotope placed in barrels. Waste containing ^{125}I, ^{131}I, and ^{32}P is held until half-life decay has reduced the radioactivity to approximately 0.1 mCi. Subsequently, these wastes are burned in a Burn-zol pathologic waste incinerator (model LB-200) at 1800° F. Ash from this incinerator consists solely of bone and samples are saved for evaluation of residual radioactive contamination. The bone mineral contains very low but measurable ^{40}K, yielding counts about 3-fold above background. Ash samples with more than 5-fold counts above background are held for decay. All other bone ash is discarded. Records of incinerator ash counts are retained and calculations made to insure that gaseous effluent release does not exceed NRC specification (see Table 3).

D. Solid, non-combustible waste (glassware, metals) is collected in a DOT type 7A 55 gallon steel drum and periodically shipped to Interex Corporation, Natick MA, for disposal in a NRC-approved landfill burial site. Log books contain detailed records (dates, isotopes and amounts) of materials disposed of within barrels.

E. Aqueous solutions containing trace amounts of waste are disposed of in domestic sewerage system. Monthly records of such disposals are kept and calculations made to insure that discharge levels of radioactivity from research activity do not exceed NRC specifications in 10 CFR Part 20 (see Table 3).

Table 3. Average monthly disposal of radioactive waste on-site at the Jackson Laboratory for 1983

	Combustion					
	Burnable solids (8.05×10^8/ml/day)[a]		Organic solvents (7.55×10^8 ml/day)[b]		Domestic Sewerage (1.68×10^8 ml/day)[c]	
Isotope	max permitted (mCi)	actual disposal (mCi)	max permitted (mCi)	actual disposal (mCi)	max permitted (mCi)	actual disposal (mCi)
^{3}H	27.25	1.56	25.62	0.197	1.5×10^4	1.27
^{14}C	135.75	0.16	127.60	0.030	4.0×10^3	1.01
^{32}P	3.26	3.61	3.06	0.001	100.0	0.17
^{35}S	1.22	0.19	1.15	0.042	300.0	0.26
^{45}Ca	0.14	0.09	0.13	0.012	45.0	6×10^{-3}
^{51}Cr	653.0	0.07	613.82	0	1.0×10^4	1.39
^{59}Fe	0.67	0.09	0.63	0	300.0	1.7×10^{-4}
^{75}Se	4.44	0.05	4.17	0	1.5×10^3	0
^{125}I	0.13	0.004	0.12	0	1.0	5.0×10^{-4}
^{131}I	0.16	0.01	0.15	0	1.5	0

[a]Volume of gas emission from incinerator.

[b]Volume of gas emission from one of three #6 fuel oil fired boilers in the Main Laboratory.

[c]Volume of water flow from Jackson Laboratory into domestic sewerage system.

ITEM 15.

Radiation protection program (see Appendix for Laboratory policy statement)

A. Radiation Safety Committee

The radiation protection activities of the Jackson Laboratory are administered by a seven-member Radiation Safety Committee composed of Laboratory personnel drawn from several different areas of job responsibility associated with employees and animal care. The committee is appointed by the Director of the Laboratory and has the requisite authority to insure that all phases of radioisotope usage at the Laboratory are conducted in ways commensurate with the NRC radioisotopes license conditions and other relevant NRC regulations that may be instituted during the term of the license.

The committee is composed of the following people:

Radiation Safety Officer (RSO) and Committee Chairship, W. G. Beamer, Staff Scientist; qualifications in alphabetical listing for items 16 and 17.

Laboratory Safety Officer (LSO), A. Peach, qualifications: 20 years Operations Supervisor, Animal Resources, The Jackson Laboratory; 6 years as LSO for the Jackson Laboratory.

Staff Supervisor of Radioisotopes, H. W. Chen, Staff Scientist; qualifications in alphabetical listing for items 16 and 17.

Staff Supervisor of Cesium Irradiator, D. E. Harrison, Senior Staff Scientist; qualifications in alphabetical listing for items 16 and 17.

Laboratory Veterinarian, T. L. Cunliffe-Beamer; qualifications: Maine State Licensed Veterinarian, Diplomate American College Laboratory Animal Medicine; Supervisor of The Jackson Laboratory Animal Clinical Health Program.

Laboratory Personnel Health Specialist, K. Hagberg; qualifications: certified Nurse Practicioner.

Research Staff Representative, E. H. Leiter, Staff Scientist; qualifications in alphabetical listing for items 16 and 17.

The responsibilities of the Radiation Safety Committee are:

1. To oversee the radiation safety program at the Laboratory;

2. To review and recommend to the Director changes in Jackson Laboratory policies regarding safe use of radioisotopes;

3. To insure that all pertinent records associated with radioisotope usage are maintained; and,

4. To make personnel recommendations to the Director for appointments to the Radiation Safety Committee.

The duties of the Radiation Safety Committee are:

1. To have regular meetings at least quarterly to review and discuss any and all phases of radiation safety at the Laboratory.

2. To supervise all training activities of personnel (i) who use radioisotopes in their work or (ii) who may come into contact with radioisotopes indirectly through their jobs. Individuals in the former group include Research Staff, Research Support Personnel and transients who hold advanced research degrees (Visiting Investigators, Postdoctoral fellows). Training includes the receipt of complete copies of all instructions for use of radioisotopes (including general Laboratory policies, in vitro and in vivo requirements, purchase order system, waste management, Hot Lab rules, personnel monitoring systems), annual review sessions to learn of updated NRC regulatory requirements, and the throughout the year individual instruction on any radioisotope-related subject for new or currently employed personnel.

The first group (i) of workers consists of college graduates, all of whom have had fundamental training in biology, chemistry and physics along with varying amounts of laboratory experience. Some of these have had advanced training. All are competent to absorb written or orally presented material and are able to put such information to practical use. Records of formal training sessions (dates, subject material, attendence) are maintained and every research laboratory is provided with updated copies of all instructions pertaining to isotope usage. All personnel within an individual laboratory are required to sign and date each set of instructions. Information receipt and conduct of proper practices are verified by Radiation Safety Committee inspections. The Research Staff Supervisor of each laboratory is charged with ascertaining that research support personnel are given specific instructions on safe use of radioisotopes in their unique research programs.

The second (ii) group includes individuals in Health and Safety, Animal Care, Maintenance, Shipping Room, Custodial Care, and any other group of workers identified by the Radiation Safety Committee as requiring training in radioisotope safety. Training of workers indirectly in contact with radioisotopes includes basic lectures on radioisotopes and radiation, radiation monitoring procedures and instrumentation, familiarity with NRC and DOT signs and shipping labels and the administrative structure of the Laboratory associated with radiation safety, how to contact such personnel, legal protection of workers and their rights regarding radiation safety practices, and special instruction suited to specific occupations.

The second group (ii) of workers consists basically of high school graduates who will not work directly with radioisotopes in their jobs, but who may be in or near areas where isotopes are used or stored. Their level of competency is basic and consists of recognition of yellow and magenta radiation symbol, knowing the administrative structure responsible for radioisotope safety, knowing how to contact responsible personnel about Radiation Safety and being familiar with basic safety equipment and precautions relevant to their jobs (i.e. wear the issued film badge, use disposable gloves, keep a safe distance from sources of radiation). Records of formal training sessions (dates, subject matter, attendance, basic quizzes) are maintained.

3. To inspect individual research laboratories for basic equipment and procedures related to proper usage of radioisotopes are place. Measures are taken to prevent radioactive contamination of both the working environment and personnel. Such measures include wearing the laboratory gowns and disposable gloves, covering work surfaces with absorbent paper backed with plastic, closing isotope containers between use, and thoroughly cleaning work area and equipment after completion of experimental procedures.

4. To obtain and evaluate experimental protocols that involve radioisotopes prior to actual conduct of experiments. The Radiation Safety Committee approves or disapproves an experimental protocol if conditions specified are inadequate for safe usage (i.e. inappropriate use of radioisotopes, insufficient equipment, lack of personnel training). Typical evaluation of radioisotope usage begins with a discussion of the nature of the proposed research, quantity of radioactive materials desired, amount of animal space required (if any), nature of laboratory facilities, and instructions on waste disposal system. This discussion is followed by provision of a brief written statement to the Radioisotopes Supervisor outlining, in general terms, the specific aims of the research to be conducted with radioisotopes, the type and amount of radio isotope to be used, and the amount of animal room space required. Following Radiation Safety Committee action on the protocol, an isotope can be ordered and work begun. These statements are kept on file with the Radioisotopes Supervisor.

5. To establish controls over the purchase and storage of isotopes. At the time of each order for radioisotopes, the purchaser must obtain the signature of the Staff Supervisor of Radioisotopes or, in his absence, the RSO or, in his absence, the Staff Supervisor of Cesium Irradiator, on the purchase requisition. The Supervisor of Radioisotopes records the purchaser, isotope and quantity of radioisotope desired. This system produces a continuous record of the isotopes coming into the Laboratory and verification that experimental protocols are on file before work starts. For the purpose of establishing limits on the quantities of isotopes that may be stored or utilized in an individual laboratory, radioisotopes have been classified according to relative radiotoxicity per unit activity (NIH Radiation Safety Guide, DHEW Pub. no. (NIH) 73-18). Copies are provided to each Research Staff member for reference purposes. Isotopes of high toxicity may be present for storage and use in quantities not greater than two percent of the amount permitted in the license. Isotopes of moderate toxicity may be stored in quantities up to ten percent of the license limit; however, use at any one time in an experimental procedure should not exceed 1 mCi. Isotopes of slight toxicity may be stored in quantities up to twenty percent of the license limit; however, quantities in use at any one time in an experimental procedure should not exceed 10 mCi. These quantitative limits may be subject to such modifying procedural factors as: 1) complex wet operations with risk of spills,2) simple dry operations or 3) dry and complex operations. Such modifying factors may be utilized in individual cases to reduce the maximum allowable isotope that can be stored or used in a staff member's laboratory. Isotope in quantities exceeding the above described limits are stored or utilized in the Hot Lab.

6. To maintain records of committee actions. The Safety Office for the Laboratory serves as the site for maintaining records of all activities associated with use of radioisotopes at the Jackson Laboratory. On an annual basis, the Radiation Safety Committee reviews the year's records to see that all are in order.

B. Radiation Safety Officer (RSO)

The RSO for the Jackson Laboratory is Dr. W. G. Beamer, Staff Scientist. The RSO is appointed by the Director of the Laboratory and has the necessary authority to carry out the assigned responsibilities and duties of the position. The responsibilities of the RSO are:

1. To chair the Radiation Safety Committee and take primary responsibility for insuring that the Committee meets its obligations as defined in item 15a of the NRC license application.

2. To insure that all personnel utilizing radioisotopes comply with relevant NRC regulations and license particulars. This is accomplished through a variety of mechanisms including lectures to groups, individual consultations and written notices to those working with radioisotopes.

3. To supervise the system of receiving and opening radioisotope shipments. When a package containing radioisotopes arrives at the Receiving Room, the receiving clerk monitors the unopened package with a broad-range survey meter and records the amount of observed radiation. If more than 0.5 mR/hr is found, the clerk immediately notifies the Radiation Safety Officer for further handling of such packages. Otherwise, the Receiving clerk delivers the unopened package to the Research Staff member who ordered the radioisotopes, for verification of package contents.

Nuclear Regulatory Commission regulations set forth in 10 CFR Part 20:205 require that packages containing more than certain amounts of specific isotopes must be checked for surface contamination. The following isotopes are exempt because our license does not permit quantitites (100 mCi or more) that require surface wipes for contamination: ^{32}P, ^{33}P, ^{42}K, ^{51}Cr, ^{64}Cu, ^{86}Rb, and ^{131}I. Packages must be checked for surface contamination if they (a) contain 10 or more mCi of ^{3}H, ^{14}C, ^{35}S, ^{125}I; or (b) contain 1 or more mCi of ^{45}Ca, ^{55}Fe, ^{59}Fe. The check for surface contamination consists of a filter paper wipe of 100 sq. cm. and subsequent count. If radiation levels in excess of 200 mR/hr are found on the external surface of the package, the RSO is notified immediately. The RSO will isolate the package and contact the appropriate NRC Region I office for further instructions.

The Research Staff member who orders the isotopes is responsible for opening and verifying package contents and for monitoring package surface contamination, if necessary, as outlined above. Records from monitoring for surface contamination must be submitted promptly to the RSO.

4. To supervise the management of radioactive wastes and their safe disposal. The in-place system combines the on-site and off-site commercial waste disposal, proceudres described in detail in item 14 of this license application.

5. To supervise the personnel monitoring programs consisting of film badges for all personnel exposed directly or indirectly to radioisotopes and bioassays for those using radioisotopes of iodine or ^{3}H-nuclides. Film badge records are examined monthly and any individual showing modest, but measurable exposure (<100 mRem) is contacted to review laboratory procedures to reduce exposure. If exposure greater than 100 mRem is recorded, the RSO

will seek to determine the source of exposure and will notify the NRC Region I office for further action.

Research procedures requiring the use of volatile or gaseous isotopes are restricted to the fume hood of the Main Laboratory's Hot Lab. Workers using the Hot Lab wear protective lab gowns, personnel film badges and gloves. Hot Lab work areas are surveyed during each use by taking environmental wipes (sink, bench top, hood surfaces, floor) for counting. While work is being carried out, airborne radioacitivty inside the fume hood and outside the hood at the researcher's breathing zone is monitored by independent air sampling devices equipped with filters appropriate for entrapment of radioactive particles. Immediate survey of hands, glassware and equipment, clothing, work areas, etc. for contamination is carried out by use of the Nuclear Equipment Model H-572 survey instrument assigned to the Hot Lab. Workers using 0.1 mCi or more of ^{125}I or ^{131}I in volatile or dispersible form are subject to thyroid bioassays. The bioassay consists of a pre- and post-experimental procedure thyroid count; the latter thyroid count to take place within 24 hr after experimental procedures are carried out in the Hot Lab. Individuals who use an accumulated amount of 100 or more microcuries of ^{125}I or ^{131}I in a 6-month period are expected to have thyroid assays and submit a report on the results at less frequent intervals, usually every 6 months.

Bioassays for ^{3}H are carried out if individuals used 10 mCi or more of ^{3}H-nucleotide precursor or ^{3}H-water mixed with more than 10 Kg of inert water or other substance at any one time or that total amount within 1 month. The bioassay consists of urinalysis before and following the exposure to the above quantities of ^{3}H. In addition to the above sampling times, if routine exposure to the above levels of tritium is anticipated or becomes fact, urinalysis for ^{3}H is carried out at 2-week intervals during such work. If the urinary ^{3}H excretion rate exceeds 5 μCi/liter, the Radiation Safety Committee will meet to review experimental procedures, see that reasonable corrective actions to reduce exposure to ^{3}H are implemented, and continue close monitoring of the urinalysis program until the exposed individual demonstrates excretion rates less than 5 μCi/liter.

6. To <u>supervise monthly surveys</u> for <u>laboratory contamination</u>. Benchtops, hoods, sinks and equipment in laboratories where isotopes are in use are monitored monthly. Monitoring is carried out both with a Victoreen 470-A survey meter and by wiping surfaces with a filter paper. The wipes are counted in toluene-based scintillation fluid in a beta scintillation counter with a wide window setting. Research Staff members are notified if evidence of contaminated workspace is found and appropriate clean-up measures are instituted.

7. To <u>gather data</u> on <u>leak tests</u> of the following sealed sources. The Hewlett-Packard gas chromatograph detector (^{63}Ni) is leak tested at 6-month intervals. Wipes are made of the surfaces surrounding the ^{63}Ni foil holder and counted in a toluene-based scintillation fluid with a beta counter capable of detecting 5 nCi. Records of leak test results are maintained. If removable ^{63}Ni is found, the ^{63}Ni foil will either be repaired or replaced and the NRC Region I office will be notified within one week of the leak detection.

The Norland Corporation sealed ^{125}I source, model 178A519A, is tested upon arrival and prior to being returned to the manufacturer for disposal. Wipes are made of surfaces that may be expected to exhibit contamination. Counting of test wipes are done with a Nuclear Chicago model 1185 gamma counter that will detect 5 nCi. Records are maintained on test wipes. If removable ^{125}I contamination is found, the NRC Region I office will be notified within one week of leak detection. The sealed source will be taken out of use and isolated until manufacturer's instructions are received regarding repair and return shipment.

8. To arrange for and/or conduct continuing education sessions for employees regarding all phases of radioisotope usage at the Jackson Laboratory. The level of training will be directed toward the occupation and degree of contact with radioisotopes as previously described under "Duties of Radiation Safety Committee." Personnel in regular contact with radioisotopes receive refresher update sessions at least annually. Personnel not working directly with radioisotopes receive appropriate training on a less frequent, routine basis, but individual or small group consultation will be available at any time.

9. To establish emergency procedures and make available names and telephone numbers of appropriate people to be called in the event of an emergency (spill resulting in facilities or personnel contamination, fire or theft involving radioisotopes). Upon assessment of the emergency, the RSO will notify NRC Region I personnel regarding all particulars within the reference times specified in the CFR.

If, in the course of work with radioisotopes, contamination is suspected, a survey with a suitable monitor is made immediately, followed by the required cleaning. Gloves and other items of protective clothing are used whenever personal contamination can occur easily. The following procedure must be used in the event of spillage:

(1) The liquid must be blotted up with absorbent material; disposable gloves must be worn.

(2) All disposable materials contaminated by the spill and clean-up procedures must be disposed of as solid radioactive waste.

(3) The RSO or Supervisor of Radioisotopes must be notified immediately.

In case of fire, loss or theft of radioactive material, the RSO, the Supervisor of Radioisotopes, and the Laboratory Safety Officer must be notified immediately.

10. To supervise the maintenance of records associated with the use of radioisotopes at the Jackson Laboratory.

11. To serve as spokesman for the Jackson Laboratory with respect to external governmental agencies and private groups concerned with use of radioisotopes at the Jackson Laboratory.

Organizational Chart

(pertaining to use of irradiation equipment and radioisotopes at

The Jackson Laboratory

Director

Chief Administrative Officer

Radiation Protection Officer

Supervisor,
Radioisotopes Service

Individual users of
tracer isotopes

Supervisor,
Irradiation Service

Individual users of
x-ray equipment and
sealed-source irradiator

ITEMS 16 AND 17.

Formal Training and Experience in Radiation Safety

Radiaton Safety Officer: Wesley G. Beamer, Ph.D.*

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Univ. of California The Jackson Laboratory	5 years 8 years	Yes Yes	No No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	Univ. of California	0.5 year	Yes	No
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	5 millicuries	The Jackson Laboratory	9 years	Life animal studies,
Iodine 131	10 millicuries	Above and Univ. of California	12 years	(sheep, horses, rats,
Iodine 125	5 millicuries	As above	11 years	mice), in vitro
Phosphorus 32	2 milllicuries	The Jackson Laboratory	7 years	assays, chemical and
Calcium 45	2 millicuries	As above	3 years	immunological hormone
250 KVP 30 mA G.E. Maxitron X-ray machine, The Jackson Laboratory			1 year	assays

*Dr. Beamer has been Radiation Protection Officer at the Jackson Laboratory for 8 years and is so described on NRC By-product Material License #18-17876-01 which authorizes use of the Shepherd Mark I 137-Cs irradiator.

Name of user: Jane E. Barker, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	NIH (NRC License)	9 years	Yes	Yes
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	Yes
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	Yes
d. Biological effects of radiation	As above	As above	Yes	Yes

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	1 millicurie	NIH	9 years	*In vitro* assays,
Phosphorus 32	2 millicuries	NIH and The Jackson Laboratory	10 years	chemical assays
Iron 59	2 mCi	As above	10 years	
Sulfur 35	0.5 mCi	As above	10 years	
Carbon 14	0.5 mCi	As above	10 years	

Name of user: Hendrick G. Bedigian, Ph.D.

16. Type of Training

Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Univ. of Mass. The Jackson Laboratory	5 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	0.5 year	Yes	No
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	15 millicuries	The Jackson Laboratory	9 years	*In vitro* assays
Iodine 125	2 "	As above	1 year	and molecular
Phosphorus 32	30 "	As above	4 years	biology

Name of user: Pauline M. Black, Research Assitant

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	The Jackson Laboratory	21 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Chromim 51	10 millicuries	The Jackson Laboratory	21 years	In vitro assays

Name of user: George A. Carlson, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Tufts Univ., Boston	5 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Biological effects of radiation	As above, research	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	5 millicuries	Univ. of Alberta	5 years	Live animal studies
Iodine 131	5 "	As above, Tufts Univ. & TJL	13 years	(mice), *in vitro*
Iodine 125	10 "	As above	13 years	assays, chemical &
Strontium 89	2 "	The Jackson Laboratory	8 years	immunologic assays
Iron 59	1 mullicurie	As above	1 year	& hematologic

Name of user: Harry W. Chen, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Univ. of Kansas The Jackson Laboratory	6.5 years 1.5 years	Yes Yes	No No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	Univ. of Kansas	0.5 year	Yes	Yes
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	5 millicuries	Univ. of Kansas	15 years	Live animal stuides (mice), *in vitro* assays, chemical & immunologic hormone assays
Carbon 14	10 "	Above & The Jackson Laboratory	15 years	

Name of user: Douglas L. Coleman, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Univ. of Wisconsin The Jackson Laboratory	3 years 26 years	Yes Yes	No No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	Univ. of Wisconsin	1 year	Yes	Yes
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	100 "	The Jackson Laboratory	26 years	Live animal studies (rats, mice), *in vitro* assays, chemical & immunologic hormone assays
Carbon 14	10 "	As above	26 years	
Iodine 131	1 millicurie	As above	15 years	
Iodine 125	2 millicuries	As above	15 years	

Name of user: Igor K. Egorov, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	The Jackson Laboratory	Ongoing since 1972	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	No
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
^{3}H	1 mCi	The Jackson Laboratory	1980 to present	Cell culture
^{51}Cr	1 mCi	As above	As above	labelling
Cesium-139	12,000 Ci	As above	As above	Cell irradiation

Name of user: Eva M. Eicher, Ph.D.

16. Type of Training

Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Univ. of Rochester	3 years	Yes	No
	The Jackson Laboratory	13 years	Yes	No
	Oak Ridge Natl. Lab.	1 year	Yes	Yes
	Univ. of California	11 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	No
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	5 millicuries	Univ. of Rochester	3 years	Live animal studies
"	5 "	Oak Ridge Natl. Lab.	1 year	(mice), *in vitro*
"	5 "	The Jackson Laboratory	12 years	assays
"	5 "	Univ. of California	11 years	
Phosphorus 32	2 "	The Jackson Laboratory	3 years	

Name of user: John J. Eppig, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Oak Ridge Natl. Lab.	4 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	0.5 years	Yes	Yes
d. Biological effects of radiation	N/A			

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	5 millicuries	ORNL, Brooklyn College, TJL	16 years	*In vitro* assays, immunologic hormone assays
Carbon 15	10 "	As above	4 years	

Name of user: Robert Evans, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Chester Beatty Res. Inst. The Jackson Laboratory	10 years 6 years	Yes Yes	No No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	Yes
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	0.5 year	Yes	Yes
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
^{3}HTdR ^{125}IUdR	2 μCi 5 μCi	The Jackson Laboratory Chester Beatty Res. Inst. The Jackson Laboratory	6 years 10 years 6 years	Live animal studies (mice), *in vitro* assays, immunologic assays

Name of user: David E. Harrison, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	The Jackson Laboratory	1 year	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	1 year	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	1 year	Yes	No
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
^{59}Fe	2 mCi	The Jackson Laboratory	1969 to present	Tracer
^{51}Cr	1 mCi	As above	As above	Tracer
^{3}H	2 mCi	As above	As above	Tracer
^{14}C	1 mCi	As above	As above	Tracer
X-ray	250 KVP	As above	Past 9 years	Irradiation
Cosium-139	12,000 Ci	As above (as Supervisor of Cesium Source Irradiator)	Past 2 years	Irradiation

Name of user: Hans J. Heiniger*, Dr. med. vet.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Inst. for Nuclear Med. Nuclear Research Ctr., Julich, West Germany	3 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	Yes
d. Biological effects of radiation	As above	As above	Yes	Yes

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
$^{3}H/^{14}C$	20 mCi	Inst. for Nuclear Medicine,	3 years	Cell labeling and
^{125}I	30 mCi	West Germany	As above	decay studies
^{131}I	30 mCi	As above	As above	As above
^{137}Cs	10,000 Ci	As above (therapeutic source)	As above	Radiotherapy
^{60}Co	12,000 Ci	As above (therapeutic source)	As above	As above

*Dr. Heiniger also has experience with the following:
Nuclear Dynamics "Dynagen 300" 300 KV mA linear Neutron Accelerator, Experimental Radiotherapy, Institue of Nuclear Medicine, Julich, West Germany.

250 KVP 30 mA G.E. Maxitron X-ray machine, Supervisor of Radiation Service, The Jackson Laboratory 1973-77.

Cesium-139 12,000 Ci, The Jackson Laboratory 1979-80. For irradiation.

Name of user: Andrew A. Kandutsch*, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Univ. of Wisconsin	0.5 year	Yes	Yes
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	Yes
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	Yes
d. Biological effects of radiation	As above	As above	Yes	Yes

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	20 millicuries	The Jackson Laboratory	27 years	Biochemical tracers
Carbon 14	5 "	As above	27 "	
Iodine 131	2 "	As above	27 "	
Rubidium 86	2 "	As above	27 "	
Chromium 51	2 "	As above	27 "	

*Served 10 years as Radiation Safety Officer at the Jackson Laboratory

Name of user: Leslie P. Kozak, Ph.D.

16. Type of Training

Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
Principles and practices of radiation protection	Univ. of Notre Dame	4 years	Yes	No
	Michigan State Univ.	2 years	Yes	No
	The Jackson Laboratory	14 years	Yes	No
Radiotracer Methodology in Biological Sciences	Univ. of Notre Dame (1967)	0.5 years	Yes	Yes
Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	Yes
Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	2 millicuries	The Jackson Laboratory	14 years	Live animal studies
Iodine 125	2 "	As above	3 years	(mice), in vitro
Phosphorus 32	2 "	As above	20 years	assays, chemical &
Calcium 45	2 "	As above	3 years	immunologic protein
				assays

Name of er: Edward H. Leiter, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Univ. of Texas/Austin The Jackson Laboratory	3 years 9 years	Yes Yes	No No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculation basic to the use and measurement of radioactivity	As above	0.5 year	Yes	No
d. Biological effects of radiation	Emory Univ., Atlanta	0.5 year	Yes	Yes

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	1 millicurie	Univ. of Texas, Austin	13 years	*In vitro* incorporation of labeled precursors by cells in culture; radioimmunoassay
Iodine 125	100 microcuries	The Jackson Laboratory	9 years	
Carbon 14	1 millicurie	As above	13 years	
Sulphur 35	1 "	As above	2 years	

Name of user: Larry E. Mobraaten, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Course in Radiation Biology, San Francisco State College, CA	1 semester 1962	No	Yes
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	No	Yes
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	No	Yes
d. Biological effects of radiation	As above	As above	No	Yes

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
^{51}Cr	1 mCi	The Jackson Laboratory	1975 to present	Quantitative measurement of release from cells
^{3}H	1 mCi	As above	As above	Label of DNA synthesis
X-ray	250 KVP	As above	As above	Irradiation
Cesium-139	12,000 Ci	As above	1979-1980	As above

Name of user: Joseph H. Nadeau, Ph.D.

16\. Type of Training

Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	The Jackson Laboratory	2 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	No
d. Biological effects of radiation	As above	As above	Yes	No

17\. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Phosphorus 32	2 millicuries	The Jackson Laboratory	2 years	Molecular biology; DNA labeling

Name of user: Charles L. Sidman, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	1) Harvard Univ.	4 years	Yes	No
	2) Harvard Medical Sch.	6 years	Yes	No
	3) Basel Inst. Immunol.	4 years	Yes	No
	4) The Jackson Lab.	2 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	No
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
^{3}H	5 mCi	1-4 above	16 years	*In vitro*, chemical,
^{14}C	1 mCi	1-4 above	16 years	biochemical, & im-
^{32}P	5 mCi	1, 3, & 4 above	10 years	munological methods
^{35}S	5 mCi	3 & 4 above	6 years	
^{125}I	c mCi	2-4 above	12 years	

Name of user: Leonard D. Shultz, Ph.D.

16. Type of Training

Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	The Jackson Laboratory	10 years	Yes	No
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above Northeastern Univ.	As above 1 semester	Yes No	No Yes
c. Mathematics and calculations basic to the use and measurement of radioactivity	Univ. of Massachusetts	0.5 year	Yes	Yes
d. Biological effects of radiation	As above	As above	Yes	No

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	5 millicuries	The Jackson Laboratory	10 years	Live animal studies (mice) and *in vitro* assays
Iodine 115	1 millicurie	As above	1 year	As above
Cesium-137	12,000 Ci	As above	5 years	Irradiation

Name of user: Benjamin A. Taylor, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Univ. of Wisconsin	0.5 year	No	Yes
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	5 years	Yes	No
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	0.5 year	Yes	Yes
d. Biological effects of radiation	As above	5 years	Yes	Yes

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Cadmium 109	5 millicuries	The Jackson Laboratory	1 year	Live animal studies
Carbon 14	5 "	As above	1 year	" " "
Phosphorus 32	1 millicurie	As above	1.5 years	Labeling DNA *in vitro*

Name of user: Makoto Taketo, Ph.D.

16. Type of Training	Where Trained	Duration of Training	On the Job?	Formal Course?
a. Principles and practices of radiation protection	Kyoto Univ., Japan Rockefeller Univ.	10 years	Yes	Yes
b. Radioactivity measurement standardization and monitoring techniques and instruments	As above	As above	Yes	Yes
c. Mathematics and calculations basic to the use and measurement of radioactivity	As above	As above	Yes	Yes
d. Biological effects of radiation	As above	As above	Yes	Yes

17. Experience with Radiation

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Hydrogen 3	5 millicuries	Kyoto Univ., Japan	10 years	*In vitro* assays,
Carbon 14	1 millicurie		12 years	chemical & immuno-
Phosphorus 32	1 "	Roche Inst. Molec. Biol.	2.5 years	logic assays
Sulfur 35	5 millicuries	The Jackson Laboratory	3 years	

APPENDIX

1. Excerpts from Jackson Laboratory Manual of Polices and Procedures
2. Floor plan for Radioisotope Suite, Main building, Jackson Laboratory
3. Rules for <u>In Vivo</u> Radioisotope Studies

MOP 15-60.004 03/30/83

SUBJECT: REGULATIONS FOR RADIOISOTOPE USE

FILING INSTRUCTIONS: SUPERSEDES MPAP 60-81, 02/15/79

CONTACT: RADIATION SAFETY OFFICER

The use of radioactive isotopes introduces certain unique potential hazards which make it mandatory that specific rules and regulation governing such usage be established. Improper or careless handling of radioisotopes poses the following hazards:

1. The health of personnel could conceivably be affected by over-exposure as a result of ingestion, inhalation, skin absorption of radioisotopes or of external exposure to the radiation emanating from these isotopes.

2. The integrity of the inbred mouse stocks could be affected in the event that radioactive contamination were spread to the animal colony.

3. Contamination of counting equipment and photographic supplies by radioactive materials might lead either to the interruption of scientific investigations or to spurious and possibly misleading results.

4. The Laboratory's public relations might be embarrassed by by an incident involving serious contamination of any area or overexposure of any individual.

5. Loss of the Laboratory's licensing agreement for the procurement of isotopes would inevitably, and quite properly, result from repeated episodes of contamination or overexposure. The Staff should be aware of the fact that by the **Code of Federal Regulations** the Laboratory's required to report immediately to the Nuclear Regulatory Commission any incident involving the loss or theft of radioactive material, radioactive spills of specified seriousness, or overexposure of personnel to by-product material.

The Nuclear Regulatory Commission requires that the Jackson Laboratory establish a Radiation Safety Committee consisting of a Chairman, Radiation Safety Officer and others with separate safety responsibilities. The current Committee composition can be obtained from the office of the Director or the Laboratory Safety Officer.

The rules and regulations for the handling of radioisotopes will conform to those published in the **Code of Federal Regulations** as amended in pertinent issues of the **Federal Register**, the State of Maine Rules and Regulations of the Department of Health and Welfare and the various handbooks of the National Council on Radiation Protection and Measurement.

The Radiation Safety Committee has the requisite delegated authority to modify these regulations to meet local conditions. Modifications may be made, however, only in the direction of making the rules more stringent. Where specific points are not covered in this document, it is understood that the

pertinent regulations cited above will apply. Copies of these regulations are on file in the Office of Laboratory Safety, the Library, and with the Radiation Safety Officer.

The duties of the Radiation Safety Officer are: (1) to monitor work areas periodically to determine that safe working conditions are maintained; (2) to maintain film badge exposure records on individuals working with radioactive material; (3) to implement a bioassay program for radioisotope users; (4) to observe the techniques employed by radioisotope users to ensure that proper methods are used and to provide instructions as needed; (5) to file reports to the Nuclear Regulatory Commission on any over-exposure of personnel to by-product material and on any losses or spills of licensed material as required; (6) to file reports to the State Department of Health and Welfare on radiation sources on hand as required; (7) to supervise decontamination procedures; (8) to supervise the receiving, delivering and opening of all radioactive material arriving at the Jackson Laboratory, and the receiving, packaging and shipping of all radioactive material leaving the Laboratory; (9) to post radiation warning signs and other radiation safety information; (10) to file or authorize applications for renewal or amendment of the Laboratory's licensing agreements; (11) to submit any required reports concerning the use or disposal of radioisotopes to any authorized requersting agency; (12) to supervise disposal of radioisotopes.

Duties of the Staff Advisor for Radioisotopes are: (1) to determine that the rules for safe usage are not inadvertently broken; (2) to review all contemplated new projects involving the use of radioisotopes in order to determine wqhether the proposed usage is within the limits of the license and whether the available facilities and experience of the investigator provide adequate safeguards for usage of the source strengths requested; and (3) to maintain a permanent file of the receipt, use, inventory, export and disposal of isotopes.

In the unlikely event that an investigator repeatedly or flagrantly violates the rules for safe handling of radiation sources, the Staff Advisor is authorized to revoke or deny the investigator's privilege to use such sources pending an appeal to the Radiation Safety Committee. In the event an agreement cannot be reached with the Staff Advisor or the Committee, the investigator may appeal for a reversal of their decisions to the Director.

Duties of the Staff Advisor of Radiation Source Equipment are: (1) to regulate the use of irradiation equipment as described in MOP 15-60.003; (2) to monitor radiation to ascertain that no leakage has occurred; (3) to ascertain that the irradiation exposure to users is within approved limited.

Our current licensing agreement with the NRC is a Type A Broad Scope license that permits use of any radioisotope with atomic number 1 - 83. Copies are posted in the Hot Lab, on the bulletin board near mailboxes, and on the bulletin board outside room 338-340, Main Laboratory building.

Investigators are to observe the following regulations for ordering radioisotopes: (1) Discuss with the Staff Advisor for Radioisotopes the nature of the proposed research, quantity of radioactive material desired, number of mouse pens required and the nature of the facilities to be employed; (2) submit a brief written statement to the Staff Advisor for Radioisotopes

outlining, in general terms, the specific aims of the research to be conducted with radioisotopes, the type and amount of radioisotopes to be used, and the amount of animal room space required. (3) Procure the signature of the Staff Advisor for Radioisotopes or, in his/her absence, the signature of the Radiation Safety Officer or, in his/her absence, the signature of the Staff Advisor for Radiation Source Equipment on the requisition form for ordering radioisotopes.

When a package containing radioisotopes arrives at the Laboratory, the receiving room clerk will monitor the unopened package with a broad-range survey meter and record the amount of radiation. If more than 0.5 mR/hr is found, the clerk will immediately notify the Radiation Safety Officer for further handling of such packages. Otherwise, the receiving clerk will deliver the unopened package to the Research Staff member who ordered the radioisotopes for verification of package contents. Nuclear Regulatory Commission regulations set forth in 10 CFR Part 20.205 require that packages containing more than certain amounts of specific isotopes must be checked for surface contamination. The following isotopes are exempt because the Laboratory's license does not permit quantities (100 mCi or more) that require checking for surface contamination: ^{32}P, ^{33}P, ^{42}K, ^{51}Cr, ^{64}Cu, ^{86}Rb and ^{131}I. Isotope-containing packages must be checked for surface contamination if (a) they contain 10 or more mCi of ^{3}H, ^{14}C, ^{35}S, ^{125}I; or (b) they contain 1 or more mCi of ^{45}Ca, ^{55}Fe, or ^{59}Fe. The check for surface contamination shall consist of a filter paper wipe of 100 sq. cm. and subsequent count. If radiation levels are found on the external surface of the package in excess of 200 mR/hr, the Radiation Safety Officer must be notified immediately.

The Research Staff member who ordered the isotopes is responsible for opening and verifying isotope-package contents and for monitoring package surface contamination, if necessary, as outlined above. Records of monitoring for surface contamination must be submitted promptly to the Radiation Safety Officer.

Insofar as possible, all stock solutions of gamma-emmitting (^{51}Cr, ^{131}I, ^{125}I, ^{59}Fe) radioisotopes will be stored in the Hot Laboratory in the Main Laboratory. This lab has been specifically remodeled for the use of radioisotopes. Stock solutions, properly labeled, should be stored in the hood. Each investigator will be responsible for the proper shielding of these stock solutions.

Living animals containing radioisotopes must be housed in the Radioisotope suite rooms in the area next to the Hot Lab in the Main Laboratory. Three small rooms are available for housing animals treated with radioisotopes. The Hot Lab is available for making stock solutions and solutions for injection. Animal space is assigned upon consultation with the Staff Advisor for Radioisotopes. Animals can be taken to the investigator's laboratory for brief periods of time in order to inject radioisotopes and to perform whole body counts or other metabolic and physiological studies requiring the use of specialized equipment located elsewhere in the Main Laboratory. Otherwise, no animals, used or unused, which have been brought in to the radioisotopes area for experimental purposes are to leave this area alive. Dead animals are to be set aside for incineration (see section on "waste disposal").

There are specific limits on the amount of radioisotopes that may be used and stored in individual investigators' laboratories. The NRC license permits usage of radioisotopes with atomic numbers of 1 to 83. The complete listing may be found in 10 CFR 33.100 Table A; copies may be obtained from the Radiation Safety Officer or Staff Supervisor of Radioisotopes. Those radioisotopes commonly used in research have been classified into four categories based upon radiotoxicity and are shown in Table 1 (taken from **NIH Radiation Safety Guide**, DHEW Publ. No. 73-18). Isotopes of high toxicity may be present for storage and use in quantities not greater than two percent of the amount permitted in the license. Isotopes of moderate toxicity may be stored in quantities up to ten percent of the license limit; however, use at any one time in an experimental procedure should not exceed 1 mCi. Isotopes of slight toxicity may be stored in quantities up to twenty percent of the license limit; however, quantities in use at any one time in an experimental procedure should not exceed 10 mCi. These quantitative limits may be subject to such modifying procedural factors as: (1) complex wet operatons with risk of spills, (2) simple dry operations, or (3) dry and complex operations. Such midifying factors may be utilized in individual cases to reduce the maximum allowable isotope that can be stored or used in a staff member's laboratory. Isotopes in quantities exceeding the above described limits are stored or utilized in the Hot Lab.

All investigators working with radioisotopes should become familiar with the National Bureau of Standards Handbook 92, **Safe Handling of Radioactive Materials**, available from the Radiation Safety Officer. Pertinent excerpts are presented below.

> "Radioactive isotopes must be treated like other poisonous substances. Extreme personal cleanliness in the laboratory is, therefore, desired. The material must not be spilled or scattered, and must not come into contact with the hands or clothing to any appreciable extent. At the end of each period, the hands must be carefully washed. No edibles of any kind ... shall be brought into the laboratoreis, nor shall (edibles) be touched before removing all washable traces of radioisotopes from the hands. The use of cigarettes or application of cosmetics in the laboratory may result in transference of activity to the lips. Radioisotopes burned on a cigarette may be drawn into the lungs."

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

> "The supervisor of a work group (responsible investigator) ... has a responsibility for seeing that the radiation work under his guidance is performed in a safe manner. The (responsible investigator) ... is required to see that the established rules regarding food handling, checks of personnel activity, waste disposal, etc. are maintained."

"... skill in radiation protection is as necessary as skill in chemical or biological manipulations. Persons failing to develop such skills should be advised to transfer to other occupations.

In addition to the general rules cited above, the following specific rules apply.

1. Pipetting of radioactive material or the performance of any similar operation by mouth suction is prohibited.

2. If, in the course of work, personal contamination is suspected, a survey with a suitable instrument (monitor) shall be made immediately, to be followed by the required cleaning. Gloves and other items of protective clothing should be used whenever personal contamination can occur easily.

3. Spillage should be prevented, but the following procedure must be used in the event a spillage does occur:

a. The liquid should be blotted up with an absorbent material (e.g., Kleenex); liquid impermeable gloves should be worn;

b. all disposable materials contaminated by the spill and cleaning must be disposed of as solid radioactive waste;

c. in case of spillage or fire, the Staff Advisor for Radioisotopes or the Radiation Safety Officer must be notified immediately.

4. Individuals who use 100 or more microcuries of Iodine-125 or Iodine-131 in a single experiment must submit a report that includes the results of a personal thyroid radioactivity assay to the Radiation Safety Officer within 24 hours of exposure. Individuals who use an accumulated amount of 100 or more microcuries of Iodine-125 or Iodine-131 in a 6-month period are expected to assay their thyroids and submit a report on the results to the Radiation Safety Officer at less frequent intervals, usually every 6 months.

5. A bioassay for Hydrogen-3 will be required for individuals utilizing 10 mCi or more of ^{3}H-nucleotide precursor or ^{3}H-water mixed with more than 10 kg of inert water or other substance at any one time, or that total amount within 1 month. The bioassay will be urinalysis before and following the individual's exposure to the above quantities of Hydrogen-3. In addition, if routine exposure to the above levels of tritium is anticipated or becomes a fact, urinalysis for Hydrogen-3 will be carried out at 2-week intervals during such work. The results of such bioassays are to be given to the Radiation Safety Officer within 24 hours of completion. If the urinary excretion rate exceeds 5 microcuries/liter, this fact must be reported to the Radiation Safety Committee for appropriate action.

6. All persons working with radioisotopes must wear a personnel radiation monitoring device (film badges). Film badges are ordered by the Radiation Safety Officer upon notice from Staff members, who are responsible for requesting badges for themselves, their assistants and their students. Additional film services or pocket dosimeters may be used at the discretion of

individual investigators. The values for maximum exposure doses recommended by the National Council on Radiation Protection and Measurement and endorsed by NRC and the Rederal Radiation Council will be employed. These values are for whole-body exposure, either: 100 millirem per week or 1.25 rem per 3-month period due to exposure to byproduct material. In the event of an overexposure, the affected individual will be restricted from further use of radiation sources until such time as his average dose from the time of exposure to the end of the restricton falls below the limit stated above.

7. No pregnant women or person under the age of 18 shall work with radioisotopes. The reason for this rule is that such personnel come under much more stringent monitoring requirements.

8. Staff members who receive approval for the use of radioisotopes shall not delegate this responsibility to their assistants or students without the expressed consent of the assistant or student and the Staff Advisor for Radioisotopes.

9. Work areas where radioisotopes are used are monitored monthly by an agent of the Radiation Safety Officer. Staff members are responsible for non-routine monitoring for contamination and for providing gloves and other protective clothing for personnel working in the laboratory.

The following are the regulations for waste disposal.

1. Volatile or potentially volatile radioactive wastes are appropriately treated with strong alkali, detergent or acid whenever possible so as to render radioactive material non-volatile. Trapping media is then to be disposed of by one of the following methods (2-6), depending on the isotope. It is expected that biochemical procedures could result in release of ^{3}H-water, $^{14}CO_2$, or isotopes of iodine to the atmosphere. $^{3}H_2O$ or $^{14}CO_2$ levels would be in the picocurie or less range. The use of ^{125}I and ^{131}I under volatile conditions is restricted to the Radioisotope Suite Hot Laboratory. Records of Hot Lab release of ^{125}I or ^{131}I are to be obtained and sent to the Radiation Safety Officer within 48 hours after performing experiments.

2. Organic solvents containing less than 0.05 µCi ^{3}H or ^{14}C/g solvent are collected in steel safety cans and transferred to a 10,000 gallon no. 6 fuel oil tank for combustion at 1800-2100°F in Main Laboratory boilers. Records of isotopes and amounts disposed of are kept by each investigator, collected at the time of safety can pickup, and used for calculations made to insure that gaseous effluent release does not exceed NRC specifications.

3. Solid, combustible waste (animal carcasses, paper, plasticware, pine bedding) is segregated by isotope (isotopes of iodine, ^{32}P and all other isotopes) and placed in 55 gallon steel barrels. Log books for each barrel record source identification and date, isotope and quantity of isotope placed in barrels. Waste containing ^{125}I, ^{131}I, and ^{32}P is held until half-life decay has reduced the radioactivity to approxiamtely 0.1 mCi. Subsequently, these wastes are burned.

4. Solid, non-combustible waste (glassware, metals) is collected in a DOT type 7A 55 gallon steel drum and periodically shipped to Interex Corporation, Natick, MA, for disposal in a NRC-approved landfill burial site. Log

book entires are required for dates, isotopes and amounts of materials disposed of within barrels.

5. Aqueous solutions containing trace amounts of waste are disposed of in the domestic sewerage system. Monthly records of such disposals must be kept for calculations made to insure that discharge levels of radioactivity from research activity do not exceed NRC specificaitons.

The following are required records for radioisotope use:

1. Each vial of radioisotopes must be tagged on receipt with amount, date of arrival and name of the principal investigator.

2. The amount removed for direct use or for making working solutions must also be recorded on the same tag. The date of removal, amount remaining and ititials of user (not necessarily the principal investigator) should also be recorded on this tag.

3. Working dilutions must be labeled showing the total original amount in a vial and must be stored in an area where a "Caution, Radioactive Materials" sign is displayed. The amounts taken from these vials for experimental use need not be recorded on the vial itself, but instead are recorded on the require monthly report form available from the Staff Advisor for Radioisotopes.

4. A record of all radioisotope activity (including license-exempt quantities) is written on a monthly report sheet available from the Supervisor. A separate report must be filed for each different radioisotope used. This report should show the amount of radioisotope on hand at the beginning of the month, the amount received, the amounts disposed of and the amounts used for experimental purposes. Decay should be calculated each time the radioisotope is used and the total decay entered in this log. For ease in record keeping, decay is not calculated on amounts of radioisotope injected into live animals; i.e., the total dose is presumed to remain with the animal until the time for disposal of the dead animal. At the end of the month the information is summarized and turned in promptly to the Staff Advisor for Radioisotopes. The amounts of radioisotopes remaining, shown in the column, "Balance on Hand," should be entered on the form for the following month.

5. All vials, stock solutions, and standards, etc. not properly labeled will be disposed of at the discretion of the Staff Advisor for Radioisotopes or the Radiation Safety Officer.

In general the same rules and regulations apply to visiting personnel except that is some cases more restrictive policies must be applied.

1. No individual under the age of 18 shall be permitted to use radioisotopes.

2. The Staff Sponsor must ascertain whether a Visiting Investigator wishes to use radioisotopes and provide the Staff Advisor for Radioisotopes with a copy of the Visiting Investigator's written research proposal. This proposal should state the nature of the problem, the kinds and amounts of the radioisotopes, the counting equipment and the space required. Comments on the investigator's experience with radioisotopes would also be of value.

3. No radioisotopes will be brought to the Jackson Laboratory from the Visiting Investigator's home institution without written permission from the Staff Advisor for Radioisotopes or the Radiation Safety Officer. Once radioisotopes are admitted to this institution they are subject to the rules, regulations and licensing agreement of this institution.

4. Some Visiting Investigators have had the Nuclear Regulatory Commission modify their personal licenses in order that they may do work with radioisotopes not specifically covered by our licensing agreement. These agreements shall not be considered valid by the Jackson Laboratory unless prior consent is given for each particular case by the Director of the Jackson Laboratory. In no case does such an approved agreement exempt the Visiting Investigator from the local regulations.

5. The staff sponsor will assume all responsibility for the Visiting Investigator and the equipment that he will use; thereafter, the sponsor must be familiar with the operation and limitations of all specialized equipment involved and must be prepared to instruct the investigator on the proper usage of the equipment to be used in the proposed study.

6. Failure to comply with any of the above regulations will result in the loss of the privilege of using radioisotopes during the Visiting Investigator's stay.

Table 1 here
Xerox, page 45, from NIH Radiation Safety Guide

FROM: NIH Radiation Safety Guide, DHEW Publ. no. 73-18.

CLASSIFICATION OF ISOTOPES ACCORDING TO RELATIVE RADIOTOXICITY PER UNIT ACTIVITY

(Based on Published Data and NIH User Experience)

Class 1 (very high toxicity)

Sr-90 + Y-90, *Pb-210 + Bi-210(Ra D + E), Po-210, At-211, *Ra-226 + 55% *daughter products, Ac-227, *U-233, Pu-239, *Am-241, Cm-242, plus other transuranium isotopes.

Class 2 (high toxicity)

Ca-45, *Ca-47, *Fe-59, *Sr-85, Sr-89, Y-91, *Ru-106 + Rh-106, *I-125, *I-131, *Ba-140 + *La-140, Ce-144 + *Pr-144, Sm-151, *Eu-154, *Tm-170, *Hg-203, *Th-234 + *Pa-234, *natural uranium.

Class 3 (moderate toxicity)

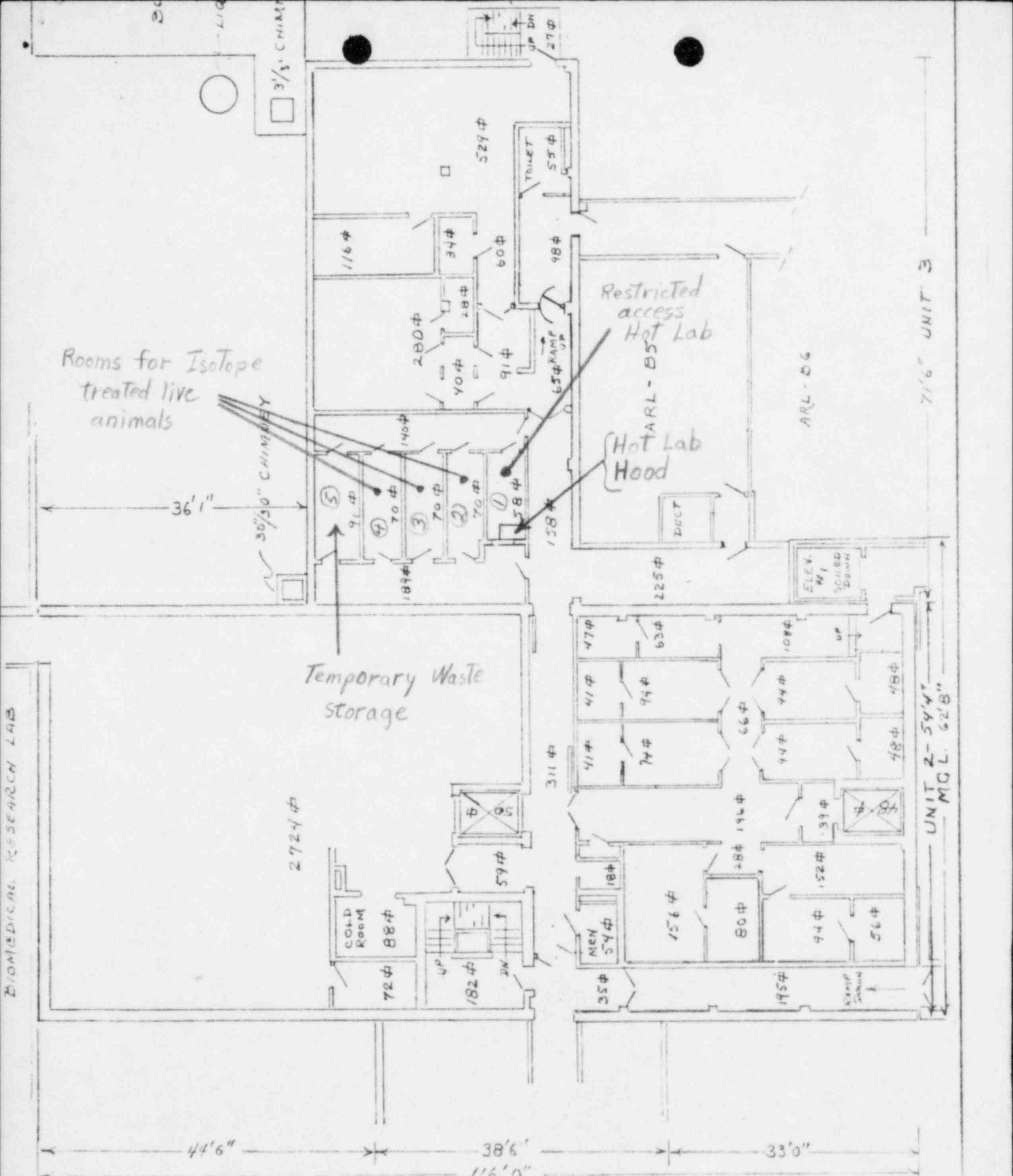
*Na-22, *Na-24, P-32, P-33, S-35, Cl-36, *K-42, *Sc-46, *Sc-47, *Sc-48, *V-48, *Mn-52, *Mn-54, *Mn-56, Fe-55, *Co-57, *Co-58, *Co-60, Ni-59, *Cu-64, *Cu-67, *Zn-65, *Ga-67, *Ga-72, *As-74, *As-76, *Br-82, *Kr-85, *Rb-84, *Rb-86, *Zr-95 + *Nb-95, *Nb-95, *Mo-99, Tc-98, *Rh-105, Pd-103 + Rh-103, *Ag-105, *Ag-111, Cd-109 + *Ag-109, *Sn-113, *Te-127, *Te-129, *I-132, *Xe-133, *Cs-137 + *Ba-137, *La-140, Pr-143, Pm-147, *Ho-166, *Lu-177, *Ta-182, *W-181, *Re-183, Ir-190, *Ir-192, Pt-191, *Pt-193, *Au-196, *Au-198, *Au-199, Tl-200, Tl-202, Tl-204, *Pb-203, *Hg-197.

Class 4 (slight toxicity)

H-3, Be-7, C-14, *F-18, *Cr-51, Ge-71, *Sr-87m, *Tc-99m, *Tl-201.

*Gamma emitter and/or associated photon emitter.

Floor plan of Hot Laboratory, special facilities for <u>in vivo</u> studies, and room for temporary storage of radioactive waste.



THE JACKSON LABORATORY

UNITS 1, 2 & 3 FIRST FLOOR

Rules for *In Vivo* Radioisotope Studies

CLOTHING

All personnel working where isotope treated animals are housed must wear a long sleeved surgical gown, disposable gloves and a radiation badge.

RESPONSIBILITIES OF RESEARCH STAFF

1. In advance, submit brief experimental protocol and request for animal room space to the Radiation Safety Officer (RSO) and Supervisor, Radioisotopes.

(a) Isotope treated rodents must be housed in radioisotope rooms in disposable cages covered with filter caps. Cages and covers are kept in Room 2. Staff using these cages are expected to replace them.

(b) Cages must be labeled with a radiation label indicating the isotope used, amount per mouse and date administered, and the Staff member's name.

(c) Cage changing schedules will be individually tailored for the isotope and experimental design by the Radiation Safety Officer. However, bedding must be changed at least once a week if 3-5 mice per cage or every two weeks if 1-2 mice per cage. Cages must be replaced once a month. Clean bedding is stored in a plastic pail in the animal room. Disposable cages and bedding are discarded in the radioactive waste storage barrel in Isotope Room 5.

A dump station designed to trap dust is provided in the evacuation corridor. When isotope contaminated bedding is dumped, use the chamber, instructions for use are on the front.

(d) Water bottles must be replaced once a week. Cage lids usually remain in place throughout the experiment. Dirty water bottles, sipper tubes and cage lids must be rinsed with hot water in the sink in the evacuation corridor before they are placed in cases or on pallets. The special sipper tubes and corks are removed before the water bottles are sent to the wash area. These sipper tubes and corks must be washed in chlorine solution and drained dry or autoclaved before they are returned to Room 2 for reuse.

2. Disposition of carcasses. Isotope treated mice may not be returned to conventional mouse rooms. Carcasses are to be double bagged and identified by Staff member, isotope used, amount administered per mouse, and date administered. The bags are placed in the freezer in the hot lab.

3. Clean up. Staff members and assistants are expected to cover the bench with an absorbent pad in order to minimize contamination by radioactive solutions or mouse urine and to clean up bedding, feces, etc. In addition, "wipes" of the bench, mouse rack and floor are taken at intervals designated by the Radiation Safety Officer (RSO) and results must be reported to the RSO within 24 hours.

RESPONSIBILITIES OF ANIMAL CARE SERVICE

1. Clean the room and corridors, including cage racks, floors, lights, walls, sinks, etc., following schedules used in conventional mouse rooms.

2. Prepare disinfectants, order and provide supplies such as feed, bedding, soap, paper towels, CO_2 cylinders, pallets and transport used materials from the evacuation corridor to the wash area.

3. Once a week, replace dirty gowns with clean ones. Place dirty gowns in plastic bags and transport them to the laundry area.

10 April 1981

Radiation Safety Officer
Veterinary Staff TCBarnes

OPERATION OF THE DUMP STATION

1. Place a 55 gallon drum under the table.

2. Insert a large plastic bag through the hole in the top of the table until the bottom of the bag touches the bottom of the barrel. The top of the bag is spread open so that it covers the flanges around the hole.

3. Secure the bag to the flanges with an elastic band. Place the aluminum bumper across the top of the hole.

4. Turn on the fan before dumping bedding.

5. Empty the contents of the cage into the barrel and scrape the inside of the cage with a putty knife. Fill each barrel as full as possible.

6. After dumping is completed, wash the outside and then the inside of the hood with N-dit and water (3 oz/gallon). Discard wet paper towels into the barrel.

7. When the barrel is full, remove the elastic band and tape the bag shut. Remove the barrel from under the table. Put on the cover and tighten the cover ring. At the end of the work period, full barrels from A-4 are placed beside the freezer outside A-4. Full barrels from the Radioistope Rooms are placed in Room 5.

8. Replace the fan filter once a month.

10 April 1981