FORM NRC-313 I
(1-79)
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 21-00278-02

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

Michigan Technological University

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
906-487-2200

3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION

Donald A. Daavettila

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
906-487-2084

4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)*

Houghton, MI 49931

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

Main Campus
Houghton, MI 49931

(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.	Dr. Bertell K. Whitten	Prof. of Biological Sciences
b.	Prof. Donald A. Daavettila	Assoc. Prof. of Physics
c.	Dr. Gary P. Agin	Asst. Prof. of Physics

7. RADIATION PROTECTION OFFICER

Donald A. Daavettila

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) A	Hydrogen 3	Any		2 millicuries
(2) B	Carbon 14	Any		5 millicuries
(3) C	Phosphorus 32	Any		5 millicuries
(4) D	Calcium 45	Any		2 millicuries

DESCRIBE USE OF LICENSED MATERIAL (E)

(1) A	H3 thymidine, tissue cultures, for cell labelling
(2) B	C14 substrates used in *in vitro* analysis of metabolic function and in primary productivity studies
(3) C	P^{32} ($NaH_{2P}320_4$) -- used in plant uptake studies and in cycling experiments in aquaria microcosms
(4) D	Ca^{45} *in vitro* studies in isolated perfused hearts

Control No. 01853

FORM NRC 313 I (1-79) 7907250406 30pp Release from HOLD

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) G	Neutron generator, not in use Neutron generator	Technical Measurement Corp. Kaman Nuclear	TMC-201 A-801
(2) H	Lead source pig in locked safe	Nuclear Chicago	RR-60
(3) I	Lead source pig in locked safe	Tracer lab	RR-60
(4) J	Lead source pig in locked safe	Nuclear Chicago	RR-138-833512

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)	Monitoring	Victoreen	440	1	alpha, beta, gamma	3 mrem/hr
(2)	Monitoring	The Nucleus	S101	1	beta, gamma	0.5 mrem/hr
(3)	Measuring	The Nucleus		1	alpha	1 cpm
(4)	Measuring	The Nucleus	500	3	alpha, beta, gamma	5 cpm above background

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☒ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

Victoreen
5806 Hough Avenue Annual
Cleveland, Ohio

☐ b. CALIBRATED BY APPLICANT

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

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)*:	Searle Diagnostics Co. DesPlains, Illinois 60018	☒ 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.
☒ 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

If needed, Chem-Nuclear Systems, Inc., Bellevue, Washington

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)*	b. CERTIFYING OFFICIAL *(Signature)* E J Koepel
	c. NAME *(Type or print)* E. J. KOEPEL
(1) LICENSE FEE CATEGORY: EXEMPT	d. TITLE VICE-PRESIDENT OF OPERATIONS AND FINANCE
(2) LICENSE FEE ENCLOSED: $ NONE	e. DATE 6-7-79

ITEM 6 Continued

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
Dr. Thomas G. Ellis	Director of Continuing Education
Dr. Frederick Erbisch	Prof. of Biological Sciences
Dr. Jack Holland	Prof. of Biological Sciences
Dr. Charles E. Mandeville	Prof. of Physics
Dr. David E. Nevalainen	Assoc. Prof. of Biological Sciences
Dr. Vasant R. Potnis	Prof. of Physics

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ITEM 8 Continued

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
E	Iodine-125	Any		2 millicuries
F	Iodine-131	Any		5 millicuries
G	Hydrogen-3	Tritiated targets in neutron generators Kaman 801, TMC201		50 millicuries
H	Cobalt-60	Sealed Source (Nuclear Chicago #RR 60)*		1 millicurie
I	Cobalt-60	Sealed Source (Tracerlab model RR-30)*		1 millicurie
J	Cesium-137	Sealed Source (Nuclear Chicago Corp. Model RR 138 833512 or 8350233)*		500 millicuries
K	Cesium-137	Sealed Source (Minnesota Mining & Mfg. model #4F6B)*		1 curie
L	Americium 241	Sealed Source (Monsanto Drawing #NS-22-NC)*		30 millicuries
M	Iron-55	Any		100 millicuries
N	Silver-110	Any		5 millicuries
O	Silver-111	Any		20 millicuries
P	Cadmium 115m	Any		20 millicuries
Q	Thalium 170	Any		20 millicuries
R	Cobalt 60	Any		40 millicuries
S	Cesium 137	Any		10 millicuries
T	Mercury 203	Any		10 millicuries
U	Barium 133	Any		10 millicuries
V	Ytterbium 169	Any		20 millicuries
W	Antimony 122	Any		10 millicuries
X	Cerium 144	Any		20 millicuries
Y	Tellurium 132	Any		10 millicuries
Z	Lutetium 177	Any		10 millicuries
AA	Cadmium 109	Any		20 millicuries
BB	Gadolinium 153	Any		20 millicuries
CC	Selenium 75	Any		20 millicuries
DD	Tin 113	Any		20 millicuries
EE	Tantalum 182	Any		20 millicuries
FF	Cerium 139	Any		20 millicuries
GG	Cerium 141	Any		20 millicuries
HH	Gold 198	Any		55 millicuries
II	Gold 199	Any		20 millicuries
JJ	Iridium 192	Any		20 millicuries
KK	Terbium 60	Any		20 millicuries
LL	Chromium 51	Any		50 millicuries
MM	Ytterbium 169	Any		10 millicuries
NN	Bromine 82	Any		50 millicuries
OO	Neodymium 147	Any		10 millicuries

ITEM 8 Continued

PP	Antimony 128	Any	10 millicuries
QQ	Iron 59	Any	30 millicuries
RR	Manganese-54	Any	30 millicuries
SS	Nickle	Any	15 millicuries
TT	Krypton 85	Any	10 millicuries

ITEM 8, Part E Continued

	DESCRIBE USE OF LICENSED MATERIAL E

E. Labeled proteins for competitive binding and RIA studies

F. NaI for biological research

G. Tritiated targets for neutron generator

H. CO-60 source. Not presently being used - stored in safe

I. CO-60 not presently being used - stored in safe

J. CS-137 not presently being used - stored in safe

K. CS-137 beam source for compton scattering experiments

L. Americium 241 sealed source in depth moisture gauge Nuclear Chicago 5810

M-RR. All nuclides are used for study of their nuclear decay schemes by the nuclear physics experiment group Dr. Agin, Dr. Potnis, Dr. Mandeville, except that AA and BB do have potential use as fluid (physical property) monitors with sources located external to system

TT. Engineering research on Kr gas detection sensitivity

SS. Hewlett Packard gas chomatograph radiation source

ITEM 9 Continued

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) K	Lead source pig kept in locked safe	Minnesota Mining	4F6B
(2) L	Depth Moisture Gauge	Nuclear Chicago	5810
(3) SS	Electron captured detector in a gas cromatograph	Hewlett Packard	18803 to 60520
(4)			

ITEM 11 Continued

The two monitoring instruments are calibrated by small check sources daily when in use by the RSO. Complete calibration and servicing by the manufacturer is done each year for the primary survey instrument. - VICTOREEN #440 (VICTOREEN, 5806 Hough Avenue, Cleveland, OH) This service includes accurate calibration with several radiation sources and a certification of calibration. All other instruments are check source tested by the user.

ITEM 13 Continued

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

Biological Science Department

Room 1001C in the Mechanical Engineering Building is used to receive and store all isotopes used in the biology department. Sketch in appendix.

Refrigerator-Freezer (see A)

Tritium and carbon-14 labelled substrates and I^{125} radioimmunossay kits are placed on receipt in a refrigerator or freezer depending on the nature of the isotope in question. The external doors of the refrigerator and freezer are marked with approved radiation caution stickers and the amount and type of isotope indicated. Individual containers are marked in a similar manner inside the refrigerator or freezer compartments.

Undercounter locked cabinet (see B)

Shipments containing $NaH_2P^{32}O_4$ and NaI^{131} are monitored for contamination (see Item 14, sect. B) on receipt and are stored in "lead pigs" in a locked cabinet. After dilution, material transferred to plastic or glass containers (volumetric Erlenmeyer flasks) etc. is maintained in lots of less than 100 uc in a lead brick enclosure in the same cabinet. This cabinet is under limited access key to Dr. Whitten. Proximity to hallway which is nearest unrestricted area is 10 feet.

Preparation and measurement of materials is done on a bench top in the same laboratory. A tray with plastic backed absorbent paper is used.

Physics Department

Work with radioisotopes takes place in two physics laboratories in Fisher Hall, G8 and G31, shown in the sketch in the appendix. In G8, which is the research room for nuclear energy level studies only, the source in question plus several calibration sources are present. Access to this room and operations in this room are under the direct supervision of either Dr. Agin, Dr. Potnis or Dr. Mandeville (who are all described in this license application). One or two graduate students work in the room.

In G31 is found the storage safe for all sealed sources and licensed radioisotopes. (Internal lead lining and less than 5 mR/M at surface). Only the physics personnel (Prof. Daavettila, Dr. Agin, Dr. Mandeville, Dr. Potnis) described in this license application know the combination. The licensed material is only used in one experiment each year for training students in room G31. This experiment under the supervision of Prof. Daavettila, is on the use of film for radiation detection. Room G31 contains a sink but no hood, and therefore, no source is ever opened.

ITEM 14 Continued

14. WASTE DISPOSAL

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

Low level liquid wastes will be disposed of by the laboratory supervisor in accordance with appropriate regulations (see 10 CFR, part 20, section 20-303). High level liquid waste for short lived isotopes will be held in an appropriate storage location depending on type of isotope for ten half lives and then disposed of as non-radioactive. Solid waste will be held in approved stainless steel floor containers in which are placed double strength plastic bags. When these are full they are transferred to a limited access storage area. Short lived isotopes are allowed to decay for ten half lives and material disposed as non-radioactive. Long lived isotopes are held in a disposal barrel and then shipped for burial (part a of this item). Handling animals involved with radioactive experiments includes collection the radioactive excreta on absorbent paper and then storing it in a limited access storage room (same area where radiation storage barrel is maintained) for ten half lives after which it is disposed of as non-radioactive. Animal carcasses are wrapped, labelled, frozen and stored in a limited access freezer properly labelled for ten half lives after which time they are disposed of as non-radioactive. Long half life materials are not used in the animal experiments.

ITEM 15

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.

A <u>Responsibility and Authority of the Radiation Safety Officer</u>

In order to establish and maintain standards for the utilization of sources of ionizing radiation on the campus of Michigan Technological University, a Radiation Safety Committee has been established by the MTU Safety Council. The Committee is responsible for the radiation safety of all machine sources, and the safe procurement, use and disposal of radioisotopes both licensed and unlicensed. The MTU Safety Council has appointed a Radiation Safety Officer (RSO) who is a member of and works closely with this committee and is directly responsible for administering the University standards with regard to the use of radiation and radiation-producing devices. The Committee and the RSO oversee the use of radiation and radioisotopes by all University personnel who wish to use byproduct material for teaching and research. Concerning byproduct material, the radiation safety officer is responsible for determining the competence and evaluating the training of users, overseeing procurement, use, and waste disposal. He reports to the General Manager of University Operations.

B <u>Requisitions</u>

(1) All purchase requisitions for radioisotopes, whether or not they are licensed nuclides, shall be submitted to the RSO for processing. These will include requisitions, (a) for radioisotopes covered in the licenses, (b) for those smaller quantities which are exempt from license requirements, and (c) for any other radioisotopes which are not covered by the license requirement because they are produced by methods not under NRC control. The RSO shall ascertain that the limits specified in the appropriate license are not exceeded. If the project, facility (including equipment), and personnel have not been approved by the Radiation Safety Committee for this work, it will be necessary that such approval be secured before the isotope order will be placed.

(2) Copies of the NRC licenses and special order forms pertaining to radioisotope procurement will be held by RSO and supplied to the Purchasing Department as needed. The RSO will maintain a current inventory.

(3) All purchase requisitions, purchase orders, and other forms pertaining to the purchase of isotopes shall direct the shipment of the isotope to:

Central Receiving
Michigan Technological University
Attention: Radiation Safety Officer

ITEM 15 Continued

C Receipt and Shipment

(1) All radioisotope shipments shall be received at Central Receiving. The RSO shall be responsible for transporting the material on campus.

(2) Upon receipt and recording of an isotope shipment, the RSO will notify the individual user, and supervise the opening of the primary shipping container and swipe testing the source container, before turning the source over to the responsible user.

Transfer and Shipment of Radioactive Material

Transfers of radioactive material shall not be made from one user to another at Michigan Technological University except through the RSO who will accept such material from one user, check it and reassign it to the new user.

D Training

Each person, whether staff or student, who works with radioactive materials must have taken or be taking the equivalent of one of the three univeristy radiation courses. Two of the courses are standard full-length courses covering a wide variety of topics about radiation detection and uses. Briefly they are PH 417, Nuclear Radiations Measurements, which is primarily a laboratory course obtaining the interpreting data from all the kinds of radiation instruments we have on campus. BL 419 Radioisotope Techniques in Biological Sciences, which is a course designed to enable the students to use the unique properties of radioactive tracers in studies of biology. A necessary part of each of these two courses is a thorough understanding of working with and around radioactive materials.

The third course more directly regarding rules and techniques taught by public service is mainly designed to give staff and students who will work with and around radioactive materials an understanding of the associated hazards and emergency procedures. The course has 6 lectures and a tour with demonstrations in the physics and biology nuclear laboratories. This seminar course is under the direction of Dr. Tom Ellis. The lectures are:

1. Nuclear Radiation, its origin, nature, properties, and hazards.
2. Nuclear Radiation, its interaction with material and shielding.
3. Radiological health, radiation effects on living things, flux, dose.
4. Radiation measurements and dosimetry techniques.
5. Laboratory rules and Federal and State Regulations and the individual's rights.
6. Course review followed by a test over the essentials.
7. Tour of the University laboratories and demonstration of instruments.

ITEM 15 Continued

E <u>General Regulations for Work in Radioisotope Laboratories</u>
(No sources will be opened or pipeted in the Physics Laboratory in Fisher Hall)

1. Before starting any work involving radioactivity, all personnel shall submit to the Radiation Safety Officer (RSO) a complete history of significant previous exposures. This will include a record of the kinds of isotopes used, dates of usage, and times involved. In addition, the experimenter will present an outline of the proposed experiment to include type and amount of isotope to be used, who will use it, where it will be used and appropriate safety precautions. This must be approved by the RSO. The RSO has the authority to dissapprove a purchase order or require training prior to approval. The amount of isotope will vary with the individual experiments, but in no case will students be allowed to handle millicurie quantities of "open" isotopes. Students involved in using small millicurie quantities of sealed sources will do so under the direct supervision of one of the persons named in section 6.

2. Laboratory protective clothing (gloves, laboratory coats or aprons, shoes, etc.) shall be worn while working with any unsealed source and shall be left in the laboratory and not removed until thorough monitoring reveals a complete lack of contamination.

   Remote pipettes (propipette or equivalent) will be used for all transfers of liquid in the radioisotope laboratory.

3. All experimental procedures shall be executed so as to permit easy decontamination in case of accident. Thus, absorbent paper with waterproof backing will be used as a cover for all tables wherever radioisotopes are to be used experimentally in any way. Rubber gloves and a laboratory coat or plastic apron are to be worn by all personnel directly involved in experimental work involving the use of radioisotopes. In all cases, operations involving radioactive materials will be performed over water-tight trays bedded down with disposable absorbent paper.

   If there is any chance for volatilization of an isotope the procedure will be carried out under a chemical fume hood with an appropriate trap. Iodine compounds and carbon-14 oxidation are of particular concern with respect to volatilization. However, no procedures are contemplated at this time in which this will be a problem.

4. Use of radioactive materials will be confined to work trays. Paper disposal containers will be available and labelled appropriately for disposal of solid waste (gloves, dispostible pipettes). A single sink properly labelled will be used for washing radioactive glassware. These areas will be surveyed daily. No student or investigator will leave the laboratory without checking his hands and clothing for contamination.

5. Movement of radioactive materials between rooms, in halls and corridors is to be discouraged. When necessary, material to be moved will be carried in a plastic container or on a tray covered with absorbent paper.

ITEM 15 Continued

6. In general, active materials are to be retained at specific points within the Laboratory and are to be kept in appropriate protective vessels except under conditions where brief removal may become necessary. All hard beta emitters and gamma emitters are to be stored in lead chambers as supplied.

Except for properly enclosed samples, no transfer of active materials shall be made. Thus, pouring of active solutions is specifically prohibited. In no instance msut an active sample be allowed to come in contact with a radiation monitor or any other measuring device.

All containers with radioactive materials will be labelled with approved labels on which will be recorded the type and amount of radiation with the users name and the date. Contaminated articles and glassware will be either disposed of as solid waste or decontaminated by appropriate measures (washing with "count off" etc.). Decontamination procedures will be carried out under the direct supervision of one of the persons listed in section 6.

7. Film badges will be worn at all times when working with hard beta and gamma emitting radioisotopes. Film badges are to be requested from RSO. The RSO may require film badges to be worn whenever he deems it necessary. Survey meters shall also be employed to predetermine the dosages in any given experiment and to check the dosages during an experiment. Records of expo ures will be kept of all exposures received. In no case will the student or experimentor be permitted to receive more than 10 millirem/week (whole body radiation). It is anticipated that far less than 10 millirem/week will actually be received. The maximum radiation level for any portion of the body will be limited to 100 millirem/hr.

8. Children and unauthorized personnel are specifically prohibited from entering Radioisotope laboratories.

9. Because of the radiation hazard and the danger of contamination, all eating drinking, smoking and use of cosmetics are specifically forbidden in the areas prescribed for radioactivity studies. No food containers or eating utensils are to be taken into or used in the Laboratory. Do not place books or clothes anywhere except on the racks provided.

10. Good technique and "good housekeeping" is to be maintained at all times. All procedures involving any degree of activity must first be practiced with non-radioactive materials until facility is gained with the procedure. Pipetting techniques, for instance, should be learned with water or any similar non-radioactive solution until exact deliveries can be exercised at will. Dissection or handling of unfamiliar animals or other biological substances must first involve non-radioactive materials.

11. In case spillage of radioisotopes occurs immediately notify the person in charge. Carefully note the area in which the activity becomes transferred. The decontamination procedure which will generally be followed by the Laboratory Director will involve:

   a) Blotting up the material with absorbent paper with waterproof backing (while wearing rubber gloves).

ITEM 15 Continued

b) A survey of the area for contamination with a counter-type detector.

c) Decontamination by means of limited area scrubbing (with appropriate chelator such as ethylene-diamine tetra-acetate in case of cations) until a background reading is obtained with the detector.

d) All disposable materials contaminated by the spill or cleaning shall be placed in a water-tight jar or can clearly marked "radioactivity, contamination". The date, type of activity, approximate amount, cpm at the surface and mr/hr emitted at the surface of the container are to be clearly labeled. In no instance shall any given contamination container be filled with so much activity so as to constitute a radiation hazard. In any given working area, no materials shall be stored so as to constitute a dosage greater than 1 mr/hr to any part of the body.

12. If an accident occurs with a radioisotope, turn off laboratory fans, evacuate all excess persons, (those not involved with the situation) from the room and have someone call the radiation safety officer or one of the following persons. Ordinarily it would be best to step out into the hall and guard the door until one of the persons listed arrives to take charge.

	OFFICE		HOME
Prof. Donald A. Daavettila	487-2084	or	482-5787
Dr. Bertell K. Whitten	487-2033	or	482-7099
Dr. Gary P. Agin	487-2084	or	482-4105
Dr. Thomas G. Ellis	487-2270	or	337-0566
Dr. Vasant R. Potnis	487-2085	or	482-7517
Dr. C. E. Mandeville	487-2086	or	482-4380

F <u>Waste Disposal</u>

Animals used for isotope studies are maintained in a separate area by the students or experimentors involved (Room 1001C) and are not subject to animal caretaker handling or the normal animal housing facility. No more than six animals are used at any one time and the maximum length they are radioactive is 24 hours. In the one experiment where an isotope is used <u>In Vivo</u>, the isotope in question is I^{131}.

ITEM 15 Continued

When sources are no longer needed or desired, they are placed into the radioactive waste storage barrel in the room S013 of the ME-EM Building. The barrel is located in a small locked room in the sub-basement of the ME-EM Building.

Waste disposal is by storage in NRC a-proved disposal barrels until sufficient number, 1 or more are ready for shipment. Only one such shipment has been made in the past 10 years and this was in February of 1972 to NUCLEAR ENGINEERING CO., INC., P. O. Box 146, Morehead, Kentucky, (Main address is P. O. Box 594, Walnut Creek, CA).

In the Biology Laboratory on occasion liquid waste is released into a sanitary sewer in conformance with 10CFR, part 20, section 20-303 as follows:

C^{14}	2×10^{-2} uc/ml
P^{32}	5×10^{-4} uc/ml
I^{131}	6×10^{-5} uc/ml

USE OF BADGES

G It will be the responsibility of each project leader, group leader or major professor in charge of investigations which involve the use of isotopes or of other radiation sources to submit the names of all individuals involved in these investigations to the radiation safety officer (RSO). It will be the responsibility of the persons in charge of projects involving radiation to see that each of the individuals working on the project has and uses a film badge as provided by the RSO The Safety Committee upon the recommendation of the RSO, may order a medical examination at any time it is deemed necessary. In addition the radiation safety officer has the authority to shut down any project where film badges should be used but are either not being used or are being used improperly. Film badge reports will be issued through the RSO to the individuals responsible for the project.

H BIO-ASSAY

The need for and order of bioassays will be determined by the Radiation Safety Committee or the radiation safety officer depending on the time, circumstances and the availability of the individuals. Ordinarily the decision for bioassay would be made at a regular meeting of the committee when they consider the requested project and notice to the individual concerned would be via the radiation safety officer. We do not anticipate at this time a need for bioassays. Although the maximum amount for Hydrogen 3, I-125 and I-131 are 2 mc, 5 mc, and 5mc respectively (Section 6-B), amounts used at any given time in any given experiment are not more than 100 microcuries. In addition the form and experimental use of these isotopes is such that hazzard from internal ingestion or inhalation (Iodine vapors) is minimized to the greatest possible extent. (No internal hazzard is present as far as can be ascertained at present).

ITEM 15 Continued

I Leak Test of Sealed Sources

Sealed sources containing byproduct material shall not be opened and no repair or servicing of a source would ever be attempted. If trouble occurs, the source would be taken out of service, locked and completely sealed in wax and plastic and held for disposal at the next arranged shipment. (When our standard approved barrel is full). Byproduct material shall not be used in or on human beings or in products distributed to the public, nor in field applications where activity is released.

Each sealed source containing by product material, other than Hydrogen 3, with a half-life greater than thirty days and in any form other than gas shall be tested for leakage and/or contamination at intervals not to exceed six months. In the absence of a certificate from a transferor indicating that a test has been made within six months prior to the transfer, the sealed source shall not be put into use until tested. Each test is by alcohol, acetone, and water wipe tests and then counting the wiping paper.

The test is capable of detecting the presence of 0.005 microcuries of radioactive material on test sample. The test sample is taken from the sealed source or from the surfaces of the device in which the sealed source is permanently mounted or stored and which one might expect contamination to accumulate. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Nuclear Regulatory Commission.

If the test reveals the presence of 0.005 microcuries or more of removable contamination, we shall immediately withdraw the sealed source from use and shall decontaminate it or dispose of it in accordance with Commission regulations. A report shall be filed within 5 days of the test with the Director, Division of Materials Licensing, Nuclear Regulatory Commission, Washington, D. C., 20555, describing the equipment involved, the test results, and the corrective action taken. A copy of such report shall also be sent to the Director, Region III, Division of Compliance, USAEC, 799 Roosevelt Road, Glen Ellyn, IL 60137.

Tests for leakage and or contamination shall be performed by the RSO Mr. Donald A. Daavettila. The training and experience of the RSO is detailed in Sections 16 and 17

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.

Dr. Bertwell K. Whitten (Chairman, Radiation Safety Committee)

TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles and practices of radiation protection	See Below	1962	(Yes) No	(Yes) No
b. Radioactivity measurement standardization and monitoring techniques and instruments	"		(Yes) No	(Yes) No
c. Mathematics and calculations basic to the use and measurement of radioactivity	"		(Yes) No	(Yes) No
d. Biological effects of radiation	"	Present	(Yes) No	(Yes) No

1. B. K. Whitten, Prof. of Physiology, Dept of Biological Sciences

2. Formal training in Bionucleonics via course work at Purdue University.

3. Extensive research experience over sixteen years at Purdue University, Lafayette, IN; Fitzsimmons General Hospital, Denver, CO; Natick Army Laboratories, Natick, MA; and Michigan Technological University, Houghton, MI.

Item 16 (continued)

Donald A. Daavettila (Radiation Safety Officer)

TYPE OF TRAINING	WHERE TRAINED*	DURATION OF TRAINING *	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles and practices of radiation protection	Argonne Nat'l Lab. Argonne, IL	~6 yr	(Yes) No	(Yes) No
b. Radioactivity measurement standardization and monitoring techniques and instruments	"	"	(Yes) No	(Yes) No
c. Mathematics and calculations basic to the use and measurement of radioactivity	"	"	(Yes) No	(Yes) No
d. Biological effects of radiation	"	"	(Yes) No	(Yes) No

* Since 1964 I have been directly involved with the teaching and research aspects of catagories a, b, and c described above.

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Item 16 (continued)

Dr. Gary P. Agin

TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles and practices of radiation protection	Kansas State Univ.	1964-68	(Yes) No	Yes (No)
b. Radioactivity measurement standardization and monitoring techniques and instruments	Kansas State Univ.	1964-68	(Yes) No	(Yes) No
c. Mathematics and calculations basic to the use and measurement of radioactivity	Univ. of Kansas Kansas State Univ.	1959-68	(Yes) No	(Yes) No
d. Biological effects of radiation	Kansas State Univ.	1964-68	(Yes) No	(Yes) No

Dr. Thomas G. Ellis

TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles and practices of radiation protection	USAF Michigan Tech Iowa State	2 yr 22 yr 2 yr	(Yes) No	(Yes) No
b. Radioactivity measurement standardization and monitoring techniques and instruments	"	"	(Yes) No	(Yes) No
c. Mathematics and calculations basic to the use and measurement of radioactivity	"	"	(Yes) No	(Yes) No
d. Biological effects of radiation	"	"	(Yes) No	(Yes) No

Item 16 (continued)

Frederick Erbisch

TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles and practices of radiation protection	Mich. Tech. Univ.	1968/present	(Yes) No	Yes (No)
b. Radioactivity measurement standardization and monitoring techniques and instruments	"	"	(Yes) No	Yes (No)
c. Mathematics and calculations basic to the use and measurement of radioactivity	"	"	(Yes) No	Yes (No)
d. Biological effects of radiation	"	"	(Yes) No	Yes (No)

Jack C. Holland

TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles and practices of radiation protection	Formal course work at the Duluth Clinic - 1958	1 yr	(Yes) No	(Yes) No
b. Radioactivity measurement standardization and monitoring techniques and instruments	"	"	(Yes) No	(Yes) No
c. Mathematics and calculations basic to the use and measurement of radioactivity	"	"	(Yes) No	(Yes) No
d. Biological effects of radiation	"	"	(Yes) No	(Yes) No

Item 16 (continued)

Dr. Charles E. Mandeville

TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles and practices of radiation protection	Rice Univ. 1940-43	1940	(Yes) No	(Yes) No
b. Radioactivity measurement standardization and monitoring techniques and instruments	MIT Radiation lab 1946-53	35 years up	(Yes) No	(Yes) No
c. Mathematics and calculations basic to the use and measurement of radioactivity	Lecturer in Radiological Physics at Philadelphia	to 1975	(Yes) No	(Yes) No
d. Biological effects of radiation	Kansas State 1951-67 College 1950-60		(Yes) No	(Yes) No

Dr. David E. Nevalainen

TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles an practices of radiation protection	Univ. of Minn	2.5 yrs.	(Yes) No	Yes (No)
b. Radioactivity measurement standardization and monitoring techniques and instruments	Univ. of Minn.	1.0 yrs.	(Yes) No	Yes (No)
c. Mathematics and calculations basic to the use and measurement of radioactivity	Univ. of Minn.	1 wk	(Yes) No	(Yes) No
d. Biological effects of Radiation	Univ. of Minn.	3 yrs.	(Yes) No	(Yes) No

Item 16 (continued)

Dr. Vasant K. Potnis

TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (circle answer)	FORMAL COURSE (circle answer)
a. Principles and practices of radiation protection	Bartol Research Foundation Swarthmore, PA	1954-60	(Yes) No	Yes (No)
b. Radioactivity measurement standardization and monitoring techniques and instruments	Same/above		(Yes) No	Yes (No)
c. Mathematics and calculations basic to the use and measurement of radioactivity	Bartol Agraun, India	1950-52	(Yes) No	(Yes) No
d. Biological effects of radiation	Bartol Res. Foundation	1954-60	(Yes) No	Yes (No)

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.

Dr. Bertwell K. Whitten Chairman, Radiation Safety Committee

ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
C^{14}	2 mc	FGH; NL; MTU	9 years	Animal & human metabol studies, in v. " and i vitro
H^3	2 mc	FGH; MTU	7 years	Animal & human metabol studies, in vivo and i vitro
I^{125}	5 mc	MTU	5 years	metabolic studies & RIA procedures
I^{131}	5 mc	MTU	5 years	"
P^{32}	5 mc	FGH; NL; MTU; PU	12 years	animal studies in vivo & in vitro
Ca^{45}	2 mc	PU	4 years	aquatic ecological uptake studies
Z_n^{65}	1 mc	PU	"	"
Co^{60}	1 mc	PU	"	"
Sr^{89}	500 uc	PU	"	"
Sr^{90}	500 uc	PU	"	"
C_s^{137}	500 uc	PU	"	"

FGH - Fitzsimmons Gen. Hospital, Denver, CO
PU - Purdue University, LaFayette, IN
NL - Natick Army Laboratories, Natick, MA
MTU - Michigan Technological University, Houghton, MI

Chairman of Radiation Safety Committee - A technical radiation safety committee has been established by the University Safety Council. This committee in conjunction with the radiation safety officer oversees the use of byproduct material by all university personnel.

Item 17 (continued)

Donald A. Daavettila Radiation Safety Officer

ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
Fiss Products	0.1 mc at one time	Argonne Nat'l Lab Atomic Power Dev. As.	6 years	Reactor Parameter Measurements
Cs137	1 curie	MTU	5 years	Beam Source
Co-60	mc & also with a 970 curie Cobalt Processing Irradiator		10 years	Radiation

Many small training experiment sources for counting studies with various detectors

Additional Detail on the Nuclear Radiation Related Training of
Donald A. Daavettila

1957 One course in Nuclear Chemistry at Michigan Technological University in addition to a number of Physics courses that touched this area.

1957-1964 With the exception of one 9 month period absent for high school teaching the work was continuously with and around nuclear reactors and nuclear radiation at the Argonne National Laboratory. Included is one academic year of formal course work in the Argonne International School taking courses in radiation safety and closely related subjects. Handled fuel elements (low power reactor), many irradiated foils, worked with radiation detection instruments as a matter of daily routine.

1964 One nine month period at the Enrico Fermi reactor for Atomic Power Development Associates, working with and around nuclear radiation as part of the Nuclear Test Group.

1964 to present at Michigan Technological University teaching courses in Nuclear Power and Nuclear Radiation in addition to general physics and chemistry courses. Serve as radiation safety officer.

Item 17 (continued)

Dr. Gary P. Agin

ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
^{103}Ru	10 mc.	Kansas State Univ.	1 year	Spectroscopy
^{155}Sm	30 mc.	Kansas State Univ.	2 years	Spectroscopy
^{191}Os	10 mc.	Kansas State Univ.	1 year	Spectroscopy
^{193}Os	10 mc.	Kansas State Univ.	1 year	Spectroscopy
^{171}Er	10 mc.	Kansas State Univ.	1 year	Spectroscopy
^{97}Zr	20 mc.	Kansas State Univ.	1 year	Spectroscopy
^{144}Ce	5 mc.	Michigan Tech Univ.	1 year	Spectroscopy
^{116m}In	5 mc.	Michigan Tech Univ.	1 year	Spectroscopy
^{169}Yb	10 mc.	Michigan Tech Univ.	1 year	Spectroscopy
^{115m}Cd	5 mc.	Michigan Tech Univ.	1 year	Spectroscopy
^{111}Ag	20 mc.	Michigan Tech Univ.	1 year	Spectroscopy

Dr. Thomas G. Ellis

ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
Cs 137 Co60	50 millicuries	Michigan Tech Univ.		
Many Others	Teaching laboratories in radiation measurements, radioisotope techniques, radiation chem, and radiological monitoring in Civil Defense at MTU and Iowa State since 1957			

Dr. Frederick Erbisch

ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
P^{32}	2mc	MTU	1968/present	Uptake in plants
C^{14} Carbonate	1mc	MTU	1968/present	Photosynthesis studies

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Item 17 (continued)

Dr. Jack C. Holland

ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
P^{32}	1 mc	Duluth Clinic-MTU	1958/present	Various chemical experiments
Co^{60}	1 mc	Duluth Clinic	1958-1964	Shilling Assays
I^{125}	1 mc	MTU	1970-present	RIA
I^{131}	1 mc	Duluth Clinic-MTU	1958-present	Uptake studies in humans & animals

Dr. Charles E. Mandeville

ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE

Small millicuries amounts of more than 25 nuclides starting in 1942 with Na^{24} until the present.

Dr. David E. Nevalainen

ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
$T-H^3$	5 mc	Univ. of Minnesota	4 yrs.	Experimental:animals
I^{131}	1 mc	Univ. of Minnesota	4 yrs.	Clinical workups

Dr. Vasant R. Potnis

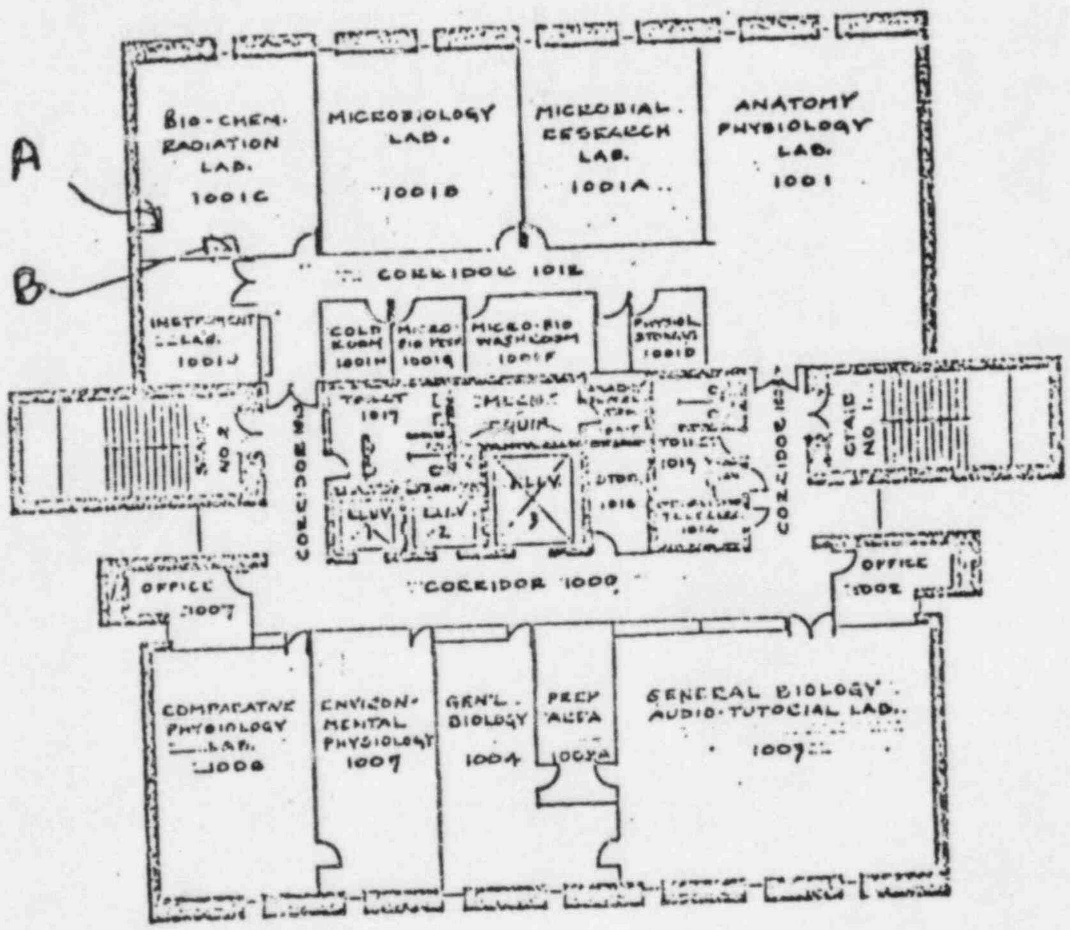
ISOTOPE	MAX. AMT. (at any one time)	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
Ce^{144}	5 mc	Mich. Tech. Univ.	1-2 yr each	Study, and radiation properties
In^{116m}	5 mc	" " "		
Yb^{169}	10 mc	" " "		
Cd^{115m}	5 mc	" " "		
Ag^{111}	20 mc	" " "		

@ Bartol Research Foundation (1954-60)

^{185}W, ^{187}W, ^{188}Re, ^{191}Pt, ^{195m}Pt, ^{197}Pt, ^{195}Au, ^{196}Au, ^{193m}Pt All in a few mc range.

^{97}Zr, ^{103}Ru, ^{115}Cd, ^{129}Te, ^{143}Ce, ^{149}Nd, ^{159}Sm, ^{171}Er,

^{191}Os, ^{193}Os, ^{192}Ir, ^{194}Ir, ^{197}Pt All in a few mc range



TENTH FLOOR

MECHANICAL ENGINEERING — ENGINEERING MECHANICS

BLDG NO.-20

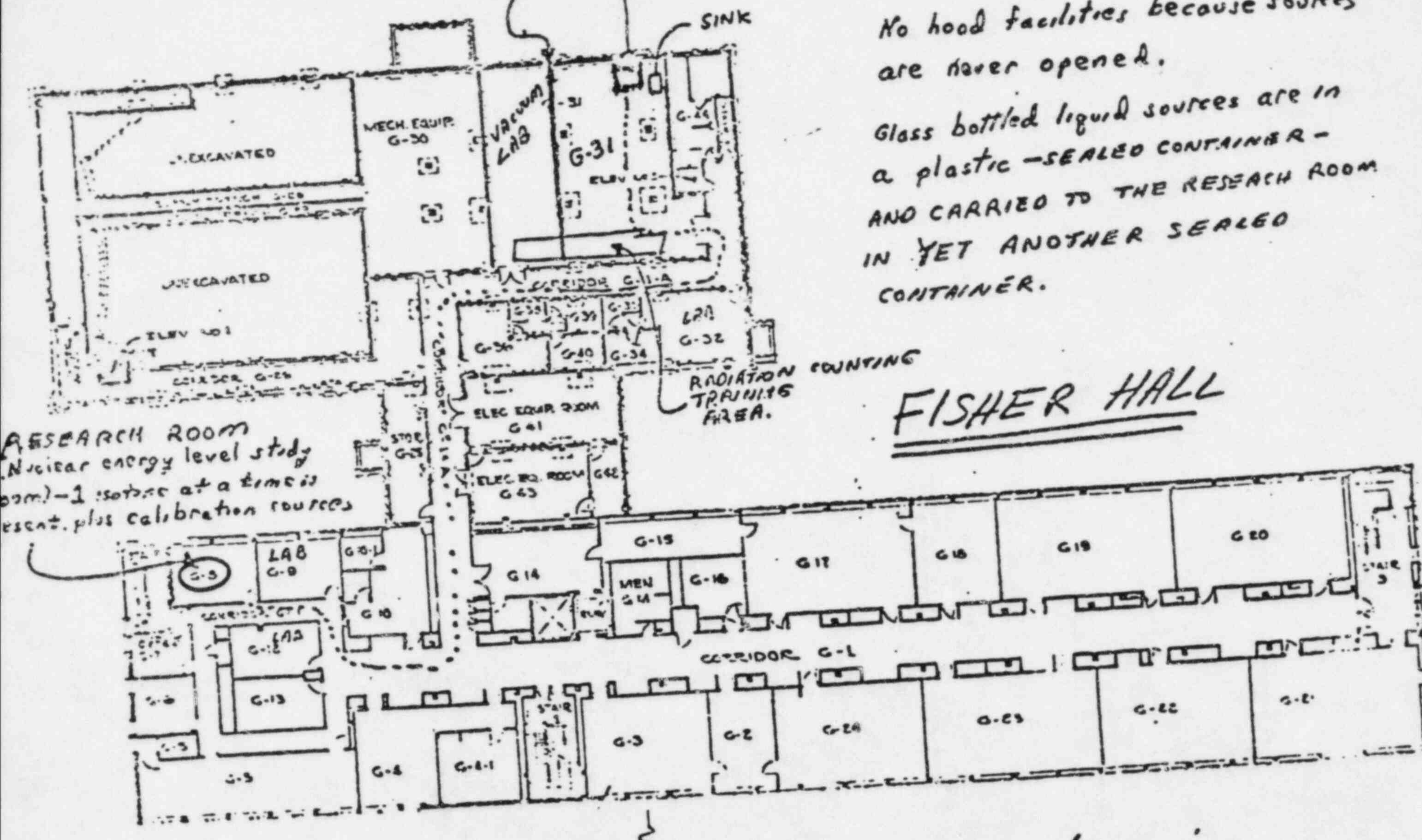
ISOLATION BARRICADE OF WALL CABINETS

LOCKED, SEALED, storage safe (COMBINATION LOCK) for radioisotopes.

No hood facilities because sources are never opened.

Glass bottled liquid sources are in a plastic-SEALED CONTAINER - AND CARRIED TO THE RESEARCH ROOM IN YET ANOTHER SEALED CONTAINER.

FISHER HALL



GROUND FLOOR

Ground floor shown is essentially all laboratories