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saint joseph's university

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20 February, 1980

Dr. Michael A. Lamastra
Material Licensing Branch
Division of Fuel Cycle and Material Safety
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

This is in reference to the application dated 12 February, 1979 from Saint Joseph's University for renewal of Materials License No. 37-01753-01 and to your letter dated 22 August, 1979 requesting additional information to support the application (Control No. 98676).

I submit the following responses to the items in your letter.

1. Name of Licensee and Concurrence of the Administration
Because of a change in status the name of the applicant is Saint Joseph's University. To assure that the administration concurs with the requested activities, this letter and all future license applications and amendment requests will be signed by the University President or his delegated representative.

2. Procedures for Opening Incoming Packages
   a. All packages containing radioactive materials must be opened in Room 106A of the Science Center. The individual opening the package must wear a laboratory coat, disposable gloves, a total body film badge, and a ring badge.
   b. Survey the unopened package with an appropriate detector to ascertain that the exposure rate is not harmful or does not exceed the level specified by the vendor, if such level is known. If a visual inspection of the package reveals physical damage, dampness, etc., notify the Radiation Protection Officer immediately.
   c. Open the package and remove the radioisotope. Check the carton and the packaging material for contamination. If not contaminated, obliterate the radiation labels before discarding in the regular trash. If contaminated, lock Room 106A and at once notify the Radiation Protection Officer who will notify both the vendor and the carrier.
   d. Visually inspect the vial containing the radioisotope. Using moistened filter paper or cotton swab held with forceps, perform a wipe test on the outside of the vial. If no contamination is detectable, dispose of the wipes in the regular trash. If contaminated, lock Room 106A and at once notify the Radiation Protection Officer who will notify both the vendor and the carrier.

3. Procedures for Ordering Radioactive Materials
   a. The Radiation Protection Officer must approve all requisitions to the Purchasing Department for purchase orders for licensed material and must ensure that the requested materials and quantities are authorized by licenses and that possession limits are not exceeded.
   b. During normal working hours, either the Radiation Protection Officer or Dr. Koob (normally the instructor for Radiochemistry Laboratory) must be notified immediately of the receipt of radioactive materials. Either the Radiation Protection Officer or Dr. Koob will transport the materials to Room 106A of the Science Center.

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CITY AVENUE AT 54TH STREET PHILADELPHIA, PENNSYLVANIA 19131 (215) 879-7350

c. If the package is wet or appears to be damaged, ask the carrier to remain at the University until it can be determined that neither he nor the delivery vehicle is contaminated.

d. Radioactive packages which arrive outside normal working hours will not be accepted by the University.

4. Instructions to Personnel

a. Housekeeping. The janitor has no keys for either Room 106A or 106B, where all licensed materials are stored. He has been instructed not to enter these rooms. He will be provided with a film badge on 10 April, 1980.

b. Security personnel. From time to time, security personnel are informed concerning the types, the location, the security, and the possible hazards of the radioactive materials which the University possesses.

c. Students. Please refer to Item No. 5.

5. General Laboratory Safety Instructions

a. Do not bring food (including chewing gum, chewing tobacco, etc.), drink, smoking paraphernalia, or cosmetics into the laboratory.

b. In general, keep hands away from the mouth and the nose.

c. All personnel engaged in experiments are required to wear film badges.

d. Pipetting or the performance of any similar operation must not be done by mouth.

e. Dispose of radioactive waste in specially designated receptacles only.

f. All wounds and spills must be reported to the instructor immediately.

g. Before leaving the laboratory monitor the hands and the clothing for contamination.

6. Emergency Procedures

In the event of any accident (spill, fire, ingestion, overexposure, etc.) involving radioactive materials notify the Radiation Protection Officer as promptly as possible.

Radiation Protection Officer - Dr. John P. Waldron
Room 333 Science Center
Telephones 7406 and 7458

1203 Pine Lane, Chester, PA 19013
Telephone 215-494-8581

The primary concern in any emergency must always be the protection of personnel from radiation hazards. The secondary concern is the confinement of contamination to the local area of the accident, if possible.

a. Minor spills involving nor radiation hazard to personnel
   1) Notify all other persons in the room at once.
   2) Permit only the minimum number of persons needed to deal with the spill to remain.
   3) Confine the spill immediately. Don protective gloves and drop absorbent paper on the spill.
   4) Permit no one to resume work in the area until the approval of the Radiation Protection Officer is obtained.

b. Major spills involving radiation hazards to personnel
   1) Instruct all persons to cover mouth and nose with a wet towel or to hold their breath, to vacate the room at once, to close all doors, and to remain close by until monitored by the Radiation Protection Officer.
   2) Central air conditioning or heating must be shut down immediately. Telephone 7330.
   3) Make no immediate attempt to clean up the spill. If the hands are protected, right the container.
   4) If the spill is on the skin, flush thoroughly with water. If the spill is on the clothing, discard the clothing.

5) Vacate the room and prohibit entrance to the contaminated area.
6) Permit no person to work in the area until the approval of the Radiation Protection Officer is obtained.
7) Under no circumstances should an untrained person attempt to examine or clean up the radioactive material.

c. Fires and/or Explosions involving radioactive materials
1) Notify all persons in the room and in the building.
2) Notify the Philadelphia Fire Department - Telephone: 9-911.
3) Attempt to put out fire if radiation hazard is not immediately present.
4) Govern emergency activities as directed by Fire Department.

d. Personnel Contamination should be treated as follows:
1) Remove all contaminated clothing.
2) Attempt to wash off any contamination from the skin.
3) It may be wise to induce vomiting in an individual who has ingested radioactive material.
4) Discard contaminated clothing.

e. If Area Contamination exists the following steps should be taken:
1) Immediately close the area to all personnel not needed to cope with the contamination.
2) No one should be permitted to leave the area with contaminated footwear unless removal of the footwear will involve an even greater hazard.
3) Immediate steps should be taken to prevent the spread of contamination by absorbing or restraining the flow of liquids, taking steps to decrease the spread of dust, etc. Be sure to ascertain the appropriate chemical and physical properties (solubility, volatility, etc.) of the contaminant before attempting to remove it, otherwise unnecessary spreading of the contaminant may occur.
4) If airborne contamination is possible or probable, personnel should cover mouth and nose with a wet towel or hold their breath. Shut all doors before leaving the area. Central air conditioning or heating should be shut down immediately. Telephone: 7330.

f. Injuries to Personnel involving radiation hazard
1) Wash minor wounds immediately under running water while spreading the edges of the gash.
2) If necessary, seek medical attention:
University Dispensary, Telephone: 7488

Philadelphia Medical Emergency, Telephone: 9-911

Lankenau Hospital Emergency Room, Telephone: 9 - 645 - 2285

3) Permit no person involved in a radiation injury to return to work without the approval of both the attending physician and the Radiation Protection Officer.

7. Use of Radioactive Materials in Animals
Licensed radioactive materials are not used in animals.

8. Bioassay Program
Normally, once a year a single shipment of about five millicuries of iodine-131 is received for use in the radiochemistry laboratory. Over a period of about three weeks the laboratory instructor makes about four dilutions of the I-131 to concentrations of the order of microcuries per milliliter for experiments performed by the students. Students are not present during the dilutions.

A bioassay will be performed on the instructor within two weeks prior to receiving the next shipment of millicurie quantities of I-131. Each time millicurie quantities of I-131 are used in this manner, the instructor for the radiochemistry laboratory will undergo a bioassay within 72 hours of his last handling millicurie quantities of I-131. These

bioassays will consist of in vivo measurements of the gamma radiation from the region near the thyroid and will be performed by Radiation Management Corporation, 3508 Market Street, Philadelphia, PA 19104.

Whenever the thyroid burden at the time of measurement exceeds 0.04 microcurie of I-131, the following actions will be taken:

a. An investigation of laboratory procedures will be carried out to determine the causes of exposure and to evaluate the potential for further exposure.

b. Corrective action will be implemented either to eliminate or to reduce the potential for further exposures.

c. A repeat bioassay will be taken within 2 weeks of the previous measurement in order to confirm the presence of internal radioiodine and to obtain an estimate of its effective half-life for use in estimating dose commitment.

d. Reports and notifications will be provided as required by Sections 20.405, 20.408, and 20.409 of 10 CFR, Part 20.

e. Refer the case to appropriate medical/health physics consultation for recommendations regarding therapeutic procedures that may be carried out to accelerate removal of radioactive iodine from the body.

9. Safety Procedures for Using Phosphorous-32
Normally, about once a year a single shipment of five millicuries of phosphorous-32 is received for use in the radiochemistry laboratory. The instructor dilutes the P-32 to concentrations of the order of microcuries per milliliter for experiments performed by the students. The students are not present during these dilutions. When performing the dilutions the instructor must follow these procedures:

a. Wear a laboratory coat.

b. Wear disposable gloves at all times when handling the radioactive material.

c. Wear total body film badge and ring badge.

d. Wear protective eyeglasses, made preferably from lucite.

e. Do not eat, drink, smoke, or apply cosmetics.

f. In general, keep hands away from the mouth or the nose.

g. Do not pipette by mouth.

h. Confine radioactive solutions in covered containers, plainly identified and labeled with the name of the compound, radionuclide, date, and activity.

i. Dispose of contaminated waste in specially designated receptacles only.

j. Monitor hands and clothing for contamination when finished the dilution.

10. Survey instruments will be calibrated by Radiation Management Corporation, 3508 Market Street, Philadelphia, PA 19104 (Telephone 215-243-2950). Their calibration procedures are incorporated into the conditions of their Nuclear Regulatory Commission License No. 37-13129-01.

11. On 10 November, 1976 the 33.5 millicuries of nickel-63 used in the gas chromatograph were transferred for disposal to Teledyne Isotopes, 50 Van Buren Avenue, Westwood, NJ 07674 (Telephone, 201-664-7070).

12. Kaman Model 710A Neutron Generator
The following information is submitted with reference to the guide entitled "Information for Evaluation of a Neutron Generator Utilizing Tritium Targets".

(1) The unit is a Kaman Model 710-A neutron generator which produces approximately 10^{10} 14.3-MeV neutrons per second by means of the $H^3(d,n)He^4$ reaction. Positive

deuterium ions extracted from a Penning Ion Gauge source are accelerated into a grounded target assembly. The target consists of a layer of titanium in which tritium and deuterium are absorbed. The target backing, made of oxygen-free copper, is cooled by Freon 113 (boiling point, 47.7°C) to maintain a temperature sufficiently low to prevent loss of gas from the target. The Freon 113 is, in turn, water cooled. Because the Freon 113 system is completely enclosed, there is no problem of radioactive waste as would be the case with direct water cooling. The accelerator assembly is illustrated in Figure 1.

(2) The irradiation vault is shown in Figure 2. The vault is located below ground level and its walls are composed of poured concrete, one-foot thick.

(3) Samples will be transferred to the irradiation vault be means of a pneumatic transfer system, which is yet to be purchased. When slow neutrons are desired, paraffin blocks will be used as a moderator.

(4) The control console for the neutron generator is located immediately adjacent to the door to the irradiation vault. Safety precautions include the following:

a. Power can be turned on only by use of a key at the control console.

b. Lights on the control panel indicate the status of interlocks and high voltage.

c. The door to the irradiation vault is secured by an electric lock which must be energized before the neutron generator can be energized.

d. An interlock on the door to the irradiation vault will de-energize the neutron generator if this door is not closed.

e. A "kill switch" is located on the junction box about five feet from the head of the accelerator. A second "kill switch" will be installed immediately inside the door to the irradiation vault.

f. The door to the irradiation vault also has a mechanical lock requiring a key so that the irradiation vault can be secured when the generator is not in use.

g. Provision will be made so that both the electric lock and the standard key-operated lock can be opened from inside the irradiation room.

h. Signal warning lights have been installed. One is located directly above the door to the irradiation vault; the other is located near the accelerator head. The electrical system is so designed that neutron generation cannot be initiated unless these warning lights are illuminated.

i. The door to the irradiation vault will be posted with the proper caution signs.

(5) Unauthorized operation of the unit will be avoided through the need to possess three different keys: one to the outer door of the laboratory, one to the irradiation vault, and the third to the control console. Only authorized persons will possess all three keys.

(6) A copy of "Operating Instructions for Neutron Generator" is enclosed.

(7) A copy of "Neutron Generator, Emergency Procedure" to be posted near the control console is enclosed.

(8) The irradiation vault is underground so one need consider shielding provided by the roof and by the labyrinth only. Specifications for the roof provide a minimum of one foot of concrete plus three feet eight inches of earth. In addition, access to the area directly above the irradiation vault is achieved only by scaling a five foot concrete wall. By use of equation (13) on page 84 of N.B.S. Handbook 63, "Protection Against Neutron Radiation up to 30 Million Electron Volts", it is estimated that an individual who has scaled the wall would have to lie on the ground directly above the generator during periods when it is in operation for a minimum of one hundred twenty hours per year to accumulate the annual allowable dose of 0.5 rems as provided in Section 20.105 (a), 10 CFR 20.

Calculation of dose on the roof of irradiation vault

$$D = \frac{S\ B\ q\ e^{-\Sigma T}}{4\ \pi\ R^2}$$

D = dose rate in rem/hr

S = source strength = 10^{10} neutrons/sec

B = buildup factor = 5 (approximately)

q = dose per unit flux of neutrons of energy 10 to 14 MeV

$$q = \frac{1 \text{ rem}}{14 \times 10^6 \text{ neutron cm}^{-2}}$$ Section 20.4, 10 CFR 20

$$q = 7.14 \times 10^{-8} \frac{\text{rem}}{\text{neutron cm}^{-2}} = \frac{(7.14 \times 10^{-8} \text{ rem sec}^{-1})(3.6 \times 10^3 \text{ sec hr}^{-1})}{\text{neutron cm}^{-2}\ \text{sec}^{-1}}$$

$$q = 2.57 \times 10^{-4} \frac{\text{rem hr}^{-1}}{\text{neutron cm}^{-2}\ \text{sec}^{-1}}$$

Σ = 0.0942 cm^{-1} for ordinary concrete (Table 8, NBS Handbook 63)

Σ = 0.05cm^{-1} for earth (estimated from data on Nevada Test Site soil Nucleonics 21, No. 8, 120 (1963))

T = 30 cm for one foot of concrete

T = 112 cm for 3' 8" of earth

R = 234 cm = 3' 8" + 1' + 3' = 7' 8"
(Based upon 3' 8" of earth plus 1' of concrete plus 3' between ceiling of the vault and the generator)

$$D = \frac{(10^{10})(5)2.57 \times 10^{-4})\ e^{-(0.0942)(30)}\ e^{-(0.05)(112)}}{(4)\ (3.1416)\ (234)^2}$$

D = 4.09×10^{-3} rem/hr.

t = time required to accumulate 0.5 rem above the irradiation vault

$$t = \frac{0.5 \text{ rem}}{4.09 \times 10^{-3} \text{ rem/hr}} = 122 \text{ hr.}$$

Calculation of dose at the control console

T = 91 cm for three feet of earth

T = 61 cm for two feet of concrete

R = 518 cm = 17 feet

$$D = \frac{(10^{10})\ (5)\ (2.57 \times 10^{-4})\ e^{-(0.0942)(61)}\ e^{-(0.05)(61)}}{(4)\ (3.1416)\ (518)^2}$$

$$D = 1.29 \times 10^{-4} \text{ rem/hr}$$

(9) This facility uses a sealed unit. Therefore there should be no radiation hazard from tritium released from pumping.

(10) The tritium target has been factory-installed in the accelerator assembly. When depleted the entire accelerator assembly will be returned, sealed and intact, to the manufacturer for replacement of the target.

(11) A Nuclear Chicage survey meter, Model No. 2112 with DN3 Neutron Probe, will be used for detection of both slow and fast neutrons. This survey meter will have been calibrated within six months of its use by Radiation Management Corporation. Following each use of the neutron generator, a beta-gamma survey will be made of the irradiation vault using either an Eberline Model E-120 or a Nuclear Chicago Model 2612 survey meter. These meters will have been calibrated within six months of their use by Radiation Management Corporation. Tritium levels are expected to be trivial with the sealed tube target but the air will be monitored by means of a flow-through ion-chamber-type tritium monitor. Personnel will be required to wear film badges sensitive to both x-ray, beta, and gamma and slow and fast neutrons. R. S. Landauer Gardray service is used.

(12) Does not apply.

Thank you for the consideration that you have given to our application. I shall be pleased to provide you with any additional information that may be required.

Sincerely yours,

D. I. MacLean

(Rev.) Donald I. MacLean, S. J.
President

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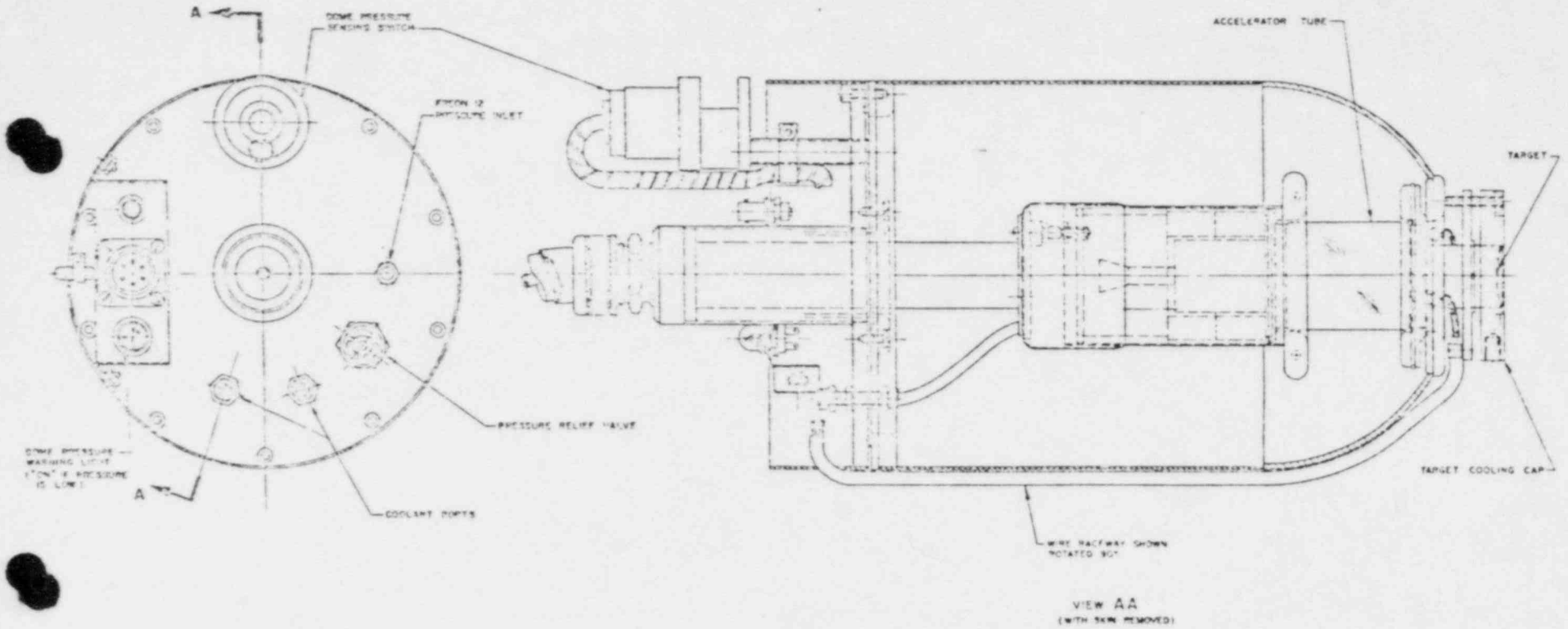
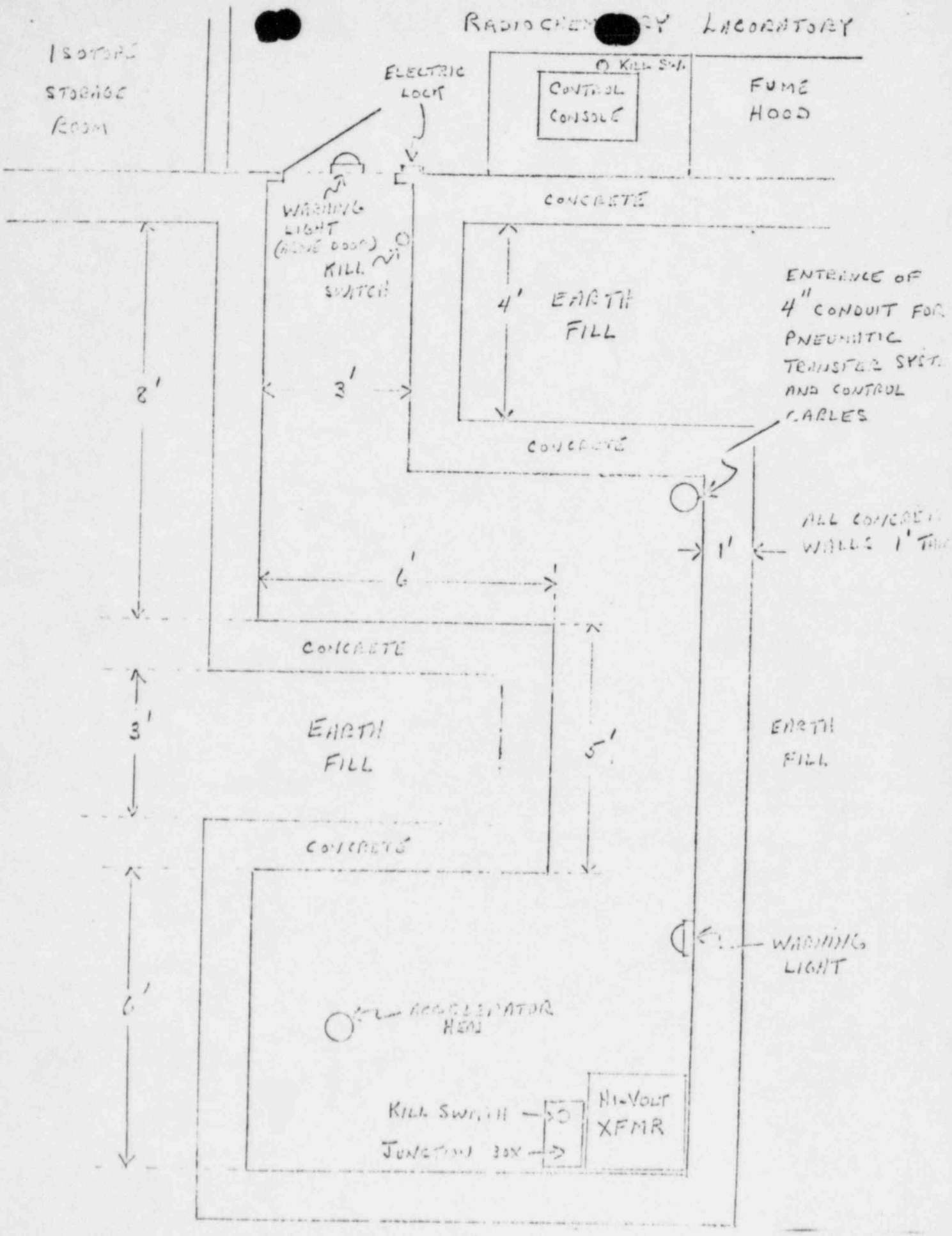


FIGURE I

ACCELERATOR ASSEMBLY PRINCIPAL COMPONENTS



Neutron Irradiation Vault - Room 106B, Science Center
Saint Joseph's University

Figure 2

NEUTRON GENERATOR

EMERGENCY PROCEDURE

1. TURN OFF MAIN POWER SWITCH BY TURNING KEY COUNTERCLOCKWISE TO 'OFF' POSITION.

2. DO NOT ENTER THE IRRADIATION VAULT UNLESS YOU MONITOR WITH A SURVEY METER.
   RADIATION LEVEL MAY BE EXCESSIVE IMMEDIATELY FOLLOWING NEUTRON IRRADIATION.

3. IMMEDIATELY REPORT ANY ACCIDENTS TO:

   DR. JOHN P. WALDRON
   ROOM 333 SCIENCE CENTER, TELEPHONES 7406, 7458
   1203 PINE LANE, CHESTER, PA, TELEPHONE 215-494-8581

   AND/OR DR. ROBERT P. KOOB
   ROOM 426 SCIENCE CENTER, TELEPHONES 7437, 7345
   600 TURNER AVENUE, DREXEL HILL, PA, TELEPHONE 215-CL9-1094

4. IF MEDICAL ASSISTANCE IS NEEDED PLEASE CALL

   PHILADELPHIA MEDICAL EMERGENCY, TELEPHONE 9-911

   AND UNIVERSITY SECURITY, TELEPHONE 7600

   AND/OR LANKENAU HOSPITAL EMERGENCY ROOM, TELEPHONE 645-2285

Operating Instructions

for

Neutron Generator

A. INITIAL SAFETY CHECK

1. Examine the transformer, junction box and accelerator head visually for any obvious defects, leaks in water lines or other signs of moisture.

2. Be sure all cables are properly connected and secure.

3. BE SURE NO ONE IS PRESENT IN THE IRRADIATION VAULT.

4. Place sign "CAUTION - NEUTRON GENERATOR ON" on door of irradiation vault.

B. INITIAL ADJUSTMENTS

1. Turn valve of cooling water supply "on."

2. Turn HIGH VOLTAGE ADJUST to extreme counter clockwise position.

3. Turn key in MAIN POWER switch 90° clockwise to its "on" position. The MAIN POWER light should illuminate.

   a. After a lapse of approximately 45 seconds, the TIME DELAY light and the light above the HIGH VOLTAGE OFF switch should illuminate.

   b. Within an interval of 30-90 seconds, the INTERLOCK light on the control console and the RED WARNING LIGHT above the door to the irradiation vault, as well as the RED WARNING LIGHT in the irradiation vault, should light. The electric lock on the door to the irradiation vault will also be activated. If the lights fail to illuminate, then one or more interlock conditions are not satisfied. The following items in the interlock circuits should be checked: door interlock switch, coolant temperature and flow, dome pressure.

4. Advance the HIGH VOLTAGE ADJUST knob for a setting of about 35. No high voltage meter indication should be obtained at this time.

5. Depress the HIGH VOLTAGE ON switch. The light above it should illuminate, and the OFF light should go out.

CAUTION. - Step 6, depressing NEUTRONS MANUAL switch initiates production of neutrons. If necessary to stop production of neutrons, flip switch off.

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6. Depress the NEUTRONS MANUAL switch. The following should occur:

   a. The light above NEUTRONS MANUAL switch should illuminate.

   b. The HIGH VOLTAGE meter reading should rise toward approximately 100 kV.

   c. The beam current should start from a value of approximately 0.2 milliamperes, rise slowly to full scale or slightly above, and then rapidly recover to approximately 0.8 milliamperes.

NOTE. - If a condition should occur which trips the source and/or high voltage circuit breakers, refer to section 4.3 of the Instruction Manual for specific adjustments.

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7. Advance the HIGH VOLTAGE ADJUST knob clockwise to obtain an indication of not more than 140 kV on the high-voltage meter.

8. Depress the NEUTRONS MANUAL switch to its OFF position. The amber light should go out and neutron production will cease. Do not change any other switch.

C. IRRADIATION PROCEDURE

With the HIGH VOLTAGE and MAIN POWER switches still ON, neutron production can be controlled by any one of the following three methods:

1. Manual Control

   a. By means of pneumatic transfer system, place sample in irradiation position.

   b. To initiate generation of neutrons, place NEUTRONS MANUAL switch in its ON position. The amber light should illuminate.

   c. After the desired irradiation time, stop production of neutrons by depressing the NEUTRONS MANUAL switch to its OFF position. Light should go out.

   d. Retrieve sample by means of pneumatic transfer system.

2. Automatic Control

a. By means of pneumatic transfer system, place sample in irradiation position.

b. Set the timer on the control console, using the knob on its face, for the desired irradiation time.

c. Depress the NEUTRONS AUTOMATIC switch to its ON position. This initiates the generation of neutrons and simultaneously activates the timer. When the pointer on the timer reaches zero, the timer will reset and neutron production will cease.

CAUTION. - If it should become necessary to interrupt the timed cycle of neutron production, turn off the MAIN POWER switch. The cycle cannot be interrupted by means of the NEUTRONS AUTOMATIC switch. If the MAIN POWER switch is used, it is necessary to go back to step B. - 2.

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d. Retrieve the sample by means of the pneumatic transfer system.

3. Remote Control

a. Place capsule containing sample in loader.

b. Set the timer on the Flexo-Rabbit control for the desired irradiation time.

c. Depress the AUTOMATIC switch. The capsule will be transferred to the irradiation position and neutron generation will be initiated. When timer reaches zero, neutron generation will cease and capsule will return.

D. PROCEDURE TO DE-ENERGIZE

1. Rotate the HIGH VOLTAGE ADJUST knob to approximately 30, then depress the HIGH VOLTAGE OFF switch. The light above this switch should illuminate, and simultaneously the one above the ON switch should go out, as well as the warning light above the door to the irradiation vault.

2. Wait 30 seconds, then turn key in the MAIN POWER switch counter clockwise to its "off" position. The MAIN POWER light should go out.

3. Turn valve of cooling water "off."

E. FINAL SAFETY CHECK

1. Remove sign "CAUTION - NEUTRON GENERATOR ON" from door of irradiation vault.

2. Prior to working in irradiation vault, monitor radiation level by means of a Hanford-type ion chamber to determine if safe.

3. Lock door to irradiation vault at conclusion of work with mechanical lock.

GDC:rm