University of Notre Dame
Notre Dame, Indiana 46556

Assistant Vice President
for Business Affairs

Telephone (219) 239-6646

May 24, 1985

U. S. Nuclear Regulatory Commission
Region III
Materials Licensing Section
799 Roosevelt Road
Glen Ellyn, IL 60137

Gentlemen:

In accordance with Title 10, Code of Federal Regulations, Part 70 and Regulatory Guide 10.3, the University of Notre Dame requests that Special Nuclear Material License SNM-198 be renewed for an appropriate period of time.

Enclosed for your review and action are three copies of the University's application for renewal of License SNM-198.

As provided in Section 170.114 (4), we believe the University is exempt from payment of a license fee.

Please let us know if we can further clarify any statement in this document, or if we can be of assistance to you in any way.

Sincerely,

James J. Lyphout
Asst. Vice President
for Business Affairs

RECEIVED
MAY 28 1985
REGION III

RECEIVED BY LFMB
Date 6/3/85
Log June 1
By CJ
Orig. To RIII
Action Code CJ

Enclosures

170.11(a)(4)
FEE EXEMPT

MAY 28 1985

8508020261 850719
REG3 LIC70
SNM-0198
PDR

CONTROL NO. 79047

Application for Renewal of License Number SNM-198

1 IDENTIFICATION OF APPLICANT

University of Notre Dame du Lac
Notre Dame, Indiana
Incorporated in State of Indiana

Principal Officers:

Rev. Theodore M. Hesburgh, C.S.C.
President of the University
U. S. Citizenship

Rev. Edmund P. Joyce, C.S.C.
Executive Vice President of the University
U. S. Citizenship

Dr. Timothy O'Meara
Provost
U. S. Citizenship

Rev. David T. Tyson, C.S.C.
Vice President for Student Affairs
U. S. Citizenship

Mr. Thomas J. Mason
Vice President for Business Affairs
U. S. Citizenship

Dr. Robert E. Gordon
Vice President for Advanced Studies
U. S. Citizenship

CONTROL NO. 79047

2. SPECIFICATION OF ACTIVITIES TO BE PERFORMED

The special nuclear material is requested for educational purposes. A natural uranium graphite exponential subcritical assembly will be activated by means of five one-curie Plutonium/Beryllium sources. The assembly will be used to conduct experiments pertaining to reactor studies and neutron behavior. The graphite subcritical reactor configuration is depicted in Figure 1.

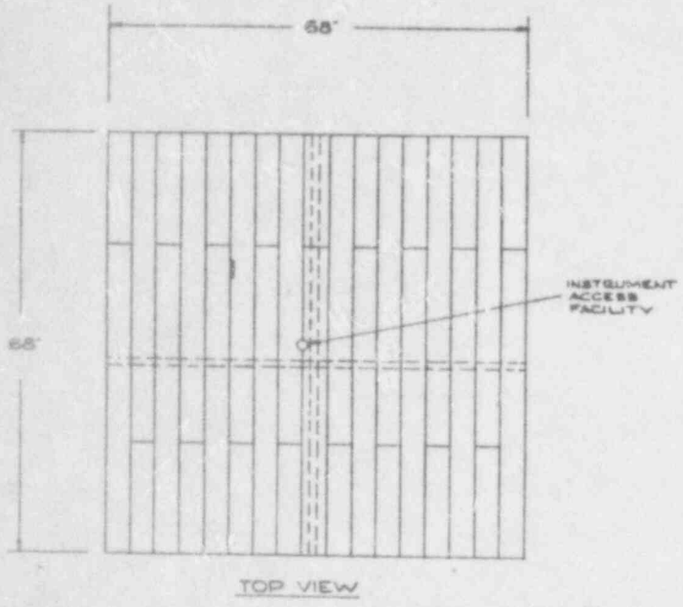
Experiments to be conducted include diffusion length and fermi age of graphite, and flux measurement and buckling determination using Indium foils. The neutron sources will also be used to irradiate foils for use in half-life determination experiments. These five sources will be used and stored in the Nuclear Engineering Laboratory in the Mechanical Engineering Laboratory Building #66 located off Old Juniper Road.

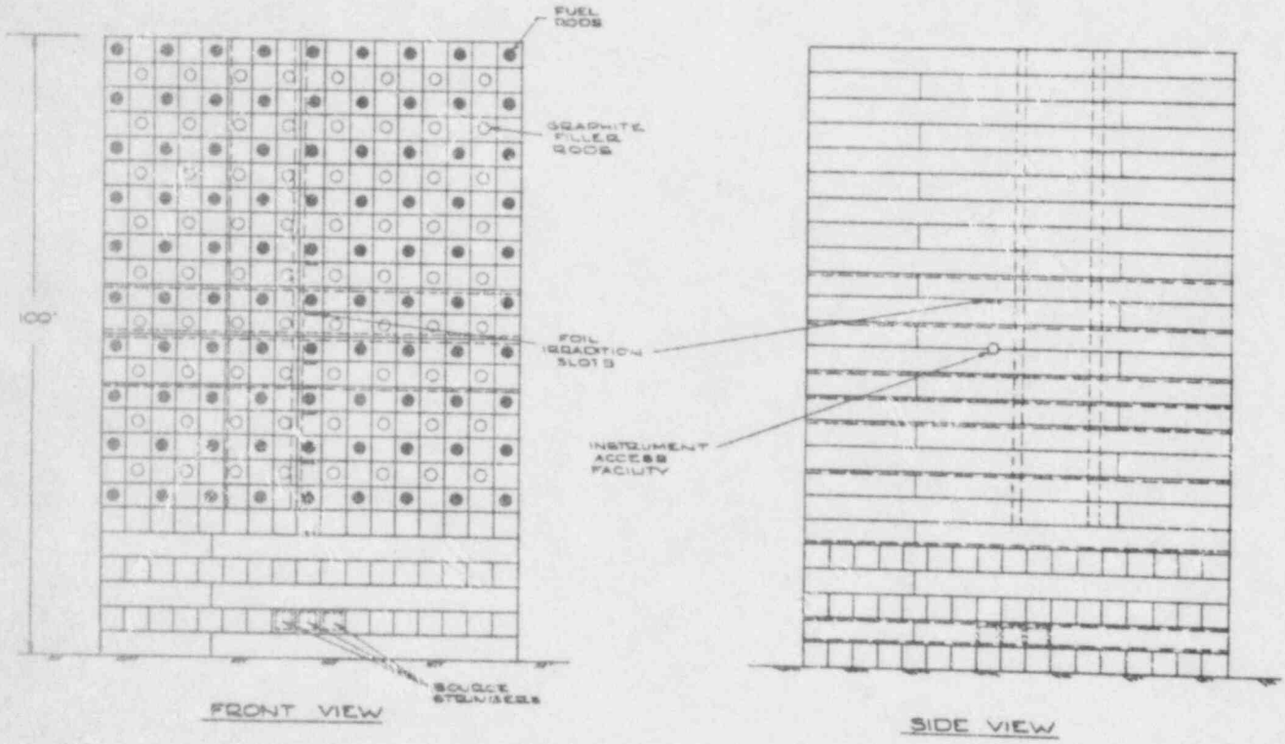
A one Curie Pu-Be neutron source is used in the Physics Department to calibrate neutron monitors in the nuclear structure laboratory, to check the performance of neutron detectors used in nuclear physics experiments, and in the advanced undergraduate and graduate laboratories in experiments such as neutron activation of isotopes. The source is contained in a large paraffin drum located in the nuclear structure laboratory in the Physics Department section of Nieuwland Science Hall, Building #52. The drum is in a roped-off area marked with radiation signs so that personnel do not normally come within a distance of about two meters from the center of the drum. The radiation level at the surface of the drum is less than 0.5 mr/hr and 2 meters away from the center of the drum the level is less than 0.3 mr/hr.

Only trained personnel under the direct supervision of a Responsible Investigator will handle a Pu-Be sealed source. Presently, Dr. John Lucey, Associate Professor, Aerospace and Mechanical Engineering Department, and Chairman of the Radiation Control Committee, is a Responsible Investigator and is responsible for the safe use of the five Pu-Be sources located in the Nuclear Engineering Laboratory.

Figure 1

GRAPHITE SUBCRITICAL
REACTOR CONFIGURATION





GRAPHITE SUBCRITICAL REACTOR CONFIGURATION

FIG. 1

Several researchers in the Physics Department are Responsible Investigators and are approved to use the Department's Pu-Be source. Dr. Sperry Darden, Professor, Physics Department, is a Responsible Investigator and has been designated "custodian" of the Physics' source, which requires that he maintain the physical inventory and location of the source.

3. NATURE OF SPECIAL NUCLEAR MATERIALS

This request is made for six (6) Pu-Be sealed sources, each containing 16 grams of Plutonium-239.

A. Physical Description

1. Sources (supplied by Mound Laboratory)

Six sources containing 16 grams of plutonium and approximately 1 curie strength, yielding approximately 1.4×10^6 n/sec each.

All sources have been supplied by the Monsanto Mound Laboratory.

Serial Number	Pu Content (gms)	Size (inches)	Location
452	15.82	1.04 x 1.36	Nuclear Engineering Lab.
453	15.97	1.03 x 1.37	" " "
454	16.00	1.06 x 1.37	" " "
455	15.99	1.04 x 1.36	" " "
456	15.99	1.06 x 1.36	" " "
913	15.97	1.02 x 1.45	Physics Lab.

4. TECHNICAL QUALIFICATIONS OF PERSONNEL

Regulating the use of radioactive material and radiation-producing devices is the ultimate responsibility of the University of Notre Dame's Radiation Control Committee. Members of the Committee are appointed for two-year terms by the President of the University. Administration

of certain responsibilities of this Committee shall be delegated to the Radiation Safety Officer, who shall be qualified by training and experience in radiation safety. University Faculty Members wishing designation as Responsible Investigator and permission to use the subcritical assembly or a Pu-Be source must complete the appropricte application (EH&S Form 1) and submit it to the Radiation Control Committee. The Radiation Control Committee will rule on the qualifications of the individual to handle Special Nuclear material in a safe manner on the basis of experience and training.

Listed below are the members of the Radiation Control Committee and brief resumés of their technical qualifications including training and experience.

Dr. John Lucey, Committee Chairman
Associate Professoor
Aerospace & Mechanical Engineering

B.S.-Univ. of Notre Dame 1957
S.M.-Massachusetts Institute of Technology, 1963
Ph.D.-Massachusetts Institute of Technology, 1965

Training Types -

(a) Principles and Practices of Radiation Protection
(b) Radioactivity Measurements, Standardization, and Monitoring Techniques and Instruments
(c) Mathematics and Calculations Basic to the Use and Measurement of Radioactivity
(d) Biological Effects of Radiation

Type	Where Trained	Duration	On the Job	Formal Course
a.	Massachusetts Institute of Technology	1 year	Yes	Yes
b.	M.I.T.	1 year	Yes	Yes
c.	M.I.T.	1 year	Yes	Yes
d.	M.I.T.	1 year	Yes	Yes

Experience With Radiation -

Isotope	Maximum Amount	Where Experience	Duration	Type of Use
^{137}Cs	15 mCi (Sealed)	Notre Dame	20 years	Educational
(Source Mat.)	(4200 lbs Uran)	Notre Dame	20 years	Educational
Special Nuclear Material	(80 grams Pu)	Notre Dame	20 years	Educational

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Dr. Roger Bretthauer
Professor
Chemistry Department

B.S.-Univ. of Illinois, 1956
M.S.-Univ. of Illinois, 1959
Ph.D.-Michigan St. Univ., 1961

Training -

Type	Where Trained	Duration	On the Job	Formal Course
a.	Michigan State Univ.	4 years	Yes	No
b.	Michigan State Univ.	4 years	Yes	No
c.	Michigan State Univ.	4 years	Yes	No
d.	Michigan State Univ.	4 years	Yes	No

Experience With Radiation -

Isotope	Maximum Amount	Where Experience	Duration	Type of Use
^{3}H	500 mCi	Notre Dame	17 yrs.	Tracers for
^{14}C	2 mCi	Mich. State	Total	<u>in vitro</u> &
^{32}P	22 mCi	Univ. of		<u>in vivo</u>
^{33}P	20 mCi	Wisconsin		metabolic
^{35}S	2 mCi			studies

Dr. Emerson Funk
Professor
Physics Department

B.A.-Wayne State Univ., 1953
M.A.-Univ. of Michigan, 1955
Ph.D.-Univ. of Michigan, 1958

Training -

Type	Where Trained	Duration	On the Job	Formal Course
a.	Univ. of Michigan	4 years	Yes	No
b.	Univ. of Michigan	4 years	Yes	Yes
c.	Wayne St. University Univ. of Michigan	10 years	Yes	Yes
d.	Univ. of Michigan	4 years	Yes	No

Experience With Radiation -

Isotope	Maximum Amount	Where Experience	Duration	Type of Use
^{76}As	10 mCi	Univ. of Michigan	29 years	Nuclear
^{110m}Ag	10 mCi		Total	Spectroscopy
^{197}Hg	10 mCi			
Many	10 mCi	Notre Dame		

Dr. Howard Saz
Professor
Biology Department

B.S.-City College of New York
Ph.D.-Western Reserve Univ.,
1952

Training -

Type	Where Trained	Duration	On the Job	Formal Course
a.	Western Reserve Univ.	4 years	Yes	Yes
b.	Western Reserve Univ.	4 years	Yes	Yes
c.	Western Reserve Univ.	4 years	Yes	Yes
d.	Western Reserve Univ.	4 years	Yes	Yes

Experience With Radiation -

Isotope	Maximum Amount	Where Experience	Duration	Type of Use
^{3}H	25 mCi	Louisiana State Univ.	30 yrs	Biochemical
^{14}C	20 mCi	Western Res. Univ.	Total	Studies of
^{32}P	15 mCi	Sheffield U. England		Metabolism
		John Hopkins Univ.		& Organic
		Notre Dame		Synthesis
				of Various
				Compounds

Mr. Edward Ulicny
Staff Professional Specialist
Radiation Research Laboratory

B.S.-St. Vincent College, 1953
M.B.A.-Duquesne Univ., 1963

Training - Included on-the-job training in radiation protection, principles and practices, and radioactivity measurements and monitoring at Carnegie-Mellon University and University of Notre Dame.

Experience - Radioactive material activities have involved operation of multicurie Cobalt-60 sources and Van de Graaff accelerators since 1959.

Dr. Bernard Wostmann
Professor
Microbiology Department

B.S.-Univ. of Amsterdam, Netherlands, 1940
M.S.-Univ. of Amsterdam, Netherlands, 1945
D.S.C.-Univ. of Amsterdam, Netherlands, 1948

Training -

Type	Where Trained	Duration	On the Job	Formal Course
a.	Univ. of Amsterdam, Netherlands	5 years	Yes	No
	California Institute of Technology	2 years	Yes	No
b.	Same as a.	Same as a.	"	"
c.	Same as a.	Same as a.	"	"
d.	Same as a.	Same as a.	"	"

Experience With Radiation -

Isotope	Maximum Amount	Where Experience	Duration	Type of Use
^{3}H	10 mCi each	Univ. of Amsterdam	40 yrs.	Labeling of
^{14}C		Cal. Tech., Univ. of	Total	Metabolites
^{22}Na		Kentucky Med.		
^{32}P		School, Notre Dame		
^{35}S				
^{45}Ca				
^{125}I				
^{131}I				

Mr. Robert Zerr
Radiation Safety Officer
Director of Environmental Health
& Safety Department
Ex-Officio Member

B.A.-Franklin College, 1975
M.S.-Purdue University, 1977

Training -

Type	Where Trained	Duration	On the Job	Formal Course
a.	Purdue	2 years	Yes	Yes
	Brookhaven	3 months	Yes	No
b.	Purdue	2 years	Yes	Yes
	Brookhaven	3 months	Yes	No.
c.	Purdue	2 years	Yes	Yes
	Brookhaven	3 months	Yes	No
d.	Purdue	2 years	Yes	Yes

Experience With Radiation -

Isotope	Maximum Amount	Where Experience	Duration	Type of Use
^{3}H	1 mCi	Franklin	1 month	Rat Tracer Study
^{32}P	1 mCi	Purdue	3 months	Lab Training Course
51Cr	10 mCi	Purdue	6 months	Rat Tracer Study
^{109}Cd	5 mCi	Purdue	1 month	"
^{131}I	10 mCi	Franklin	3 months	"
^{137}Cs	5 mCi	Purdue	1 month	"
Many	2 Ci	Notre Dame	8 years	Rad. Safety Program

Mr. James Lyphout
Assistant Vice President for Business Affairs
Ex-Officio Member

Experience -

Member of Radiation Control Committee since July 1984.

Dr. Francis Kobayashi
Professor
Aerospace & Mechanical Engineering
and Assistant Vice President
for Advanced Studies
Ex-Officio Member

Experience -

Member of Radiation Control Committee since the Committee's inception in 1970.

Mr. Michael McCauslin — B.S.-Ferris State College, 1978
Environmental/Safety Specialist
Environmental Health & Safety Dept.
Ex-Officio Member

Experience -

Member of Radiation Control Committee since February 1983 and use of several radionuclides while working in University Radioactive Waste Program.

Training -

Type	Where Trained	Duration	On the Job	Formal Course
a.	Ferris State College	1 year	Yes	Yes
	Berrien Co. Health Dept.	1 year	Yes	No
b.	Ferris State College	1 year	Yes	Yes
	Berrien Co. Health Dept.	1 year	Yes	No
c.	Ferris State College	1 year	Yes	Yes
	Berrien Co. Health Dept.	1 year	Yes	No
d.	Ferris State College	1 year	Yes	Yes
	Berrien Co. Health Dept.	1 year	Yes	No

Dr. Sperry E. Darden
Custodian of Physics Department Source

Experience -

Research Assistant at Los Alamos Scientific Laboratory - Fast Reactor Group, 1952-1953.
Principal Research Activity was in study of fast neutron reactions and scattering, 1953-1969.

Training -

B.S., Iowa State University	1950
M.S., University of Wisconsin	1951
Ph.D., Univ.of Wisconsin-Experimental Nuclear Physics	1955
Research Associate, Univ. of Basel (Switzerland)	1955-1956
Research Associate and Instructor, Univ. of Wisconsin	1956-1957
Assistant Professor, University of Notre Dame	1957-1962
Visiting Assistant Professor, Univ. of Wisconsin	1961
Associate Professor, University of Notre Dame	1962-1964
Professor, University of Notre Dame	1965-Present

APPLICATION FOR APPROVAL AS A RESPONSIBLE INVESTIGATOR
IN THE USE OF RADIOACTIVE MATERIALS AND RADIATION SOURCES

1. Name: _____ Department: _____

Office: _____ Lab: _____ Phone: _____

2. Type of training:

Type	Where Trained	Duration of Training	Formal	On the Job
(a) Principles and Practices of Radiation Protection			Yes No	Yes No
(b) Radioactive measurement, 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

3. Formal Courses: (list all courses pertaining to radioisotopes, atomic and nuclear structure, radiochemistry, radiobiology, etc.)

Title of Course	Where Trained	Duration
(a)		
(b)		
(c)		
(d)		

4. Experience: (Actual use of radionuclides or radiation producing machines)

Radionuclide	Maximum amount (mCi)	Where experience gained	Duration

Type of use: _____

_____

_____

5. Statement of intended application(s) of Radioactive Material or Radiation Sources

Isotope(s)	Maximum Quantities on hand at one time	Location of Use Building & Room

Intended use of each isotope. Give full explanation of use(s). (Use reverse if necessary)

6. STATEMENT OF AGREEMENT:

The below named individual signifies that he/she has read and is willing to abide by the University of Notre Dame regulations governing the use of radioisotopes and other sources of ionizing radiation. The undersigned agrees to comply strictly with all such rules and regulations and hereby waives any right or recourse against the University of Notre Dame for any damage whatsoever resulting from any failure to conform with said regulations. He further assumes responsibility for ascertaining that employees, students, and associates working under his direction shall comply with the regulations of the University of Notre Dame governing the use of radioactive materials and radiation sources.

DATE: _____ SIGNED: _____

Approval shall be for a period of no more than one year. The expiration date shall be October 1.

Approximately 30 days prior to expiration, current Responsible Investigators shall be notified by the Radiation Safety Officer.

- -

DO NOT WRITE IN THIS SPACE

Date

Received _____

Temporary Approval _____

Request for Additional Information _____

Approved: Radiation Control Committee _____

Authorization Number _____

5. DESCRIPTION OF EQUIPMENT, FACILITIES AND INSTRUMENTATION

5.1 Remote Handling Devices

Handling devices which provide a separation of at least five feet from the handler will be used in moving the sources. Wipe tests (see Section 6) will be performed at arm's length behind a lead brick shield.

5.2 Storage Containers

The five Engineering sources, when not in use, are stored in their original paraffin-lined shipping containers. These containers are kept in a secured storage area within the Nuclear Engineering Laboratory. The general description or layout of the Nuclear Engineering Laboratory is described in Diagram 5-1. There are only three keys to the room and storage area: one is held by the Responsible Investigator in charge of the subcritical assembly, one by the Professor in charge of the Mechanical Engineering Laboratory Building, and one by the Radiation Safety Officer. When not in use, the Nuclear Engineering Lab and the storage room are locked.

The Physics Department source is stored in a paraffin-lined storage container in the Department's Nuclear Structure Laboratory. The general description or layout of this Laboratory is described in Diagram 5-2. When the source is not in use, the source container is locked with the one key to the container maintained by Dr. Sperry Darden.

5.3 Physical Plant

The Nuclear Engineering Laboratory and the Nuclear Structure Laboratory are described in Diagrams 5-1 and 5-2. There are no chemical or physical processing operations involving the Plutonium.

5.4 Radiation Detection Instruments Used

The instrument used for leak test measurements is a windowless, gas flow proportional counter composed of the following equipment:

- Packard Instrument Proportional Gas Chamber
- Wm. B. Johnson Scaler - Model LS-4

The instrument will be calibrated prior to each leak test measurement by the Radiation Safety Officer. A Thorium-230 source manufactured by Eberline Instrument Corporation will be used to calibrate the counting system. See Report of Calibration (Page 21) for additional source information.

The equipment used for surveying beta-gamma radiation and neutron radiation in the Nuclear Engineering Laboratory will be:

Wm. B. Johnson GSM-10 - Survey Meter with a
- Wm. B. Johnson GP-200 - end-window geiger probe
- Wm. B. Johnson FNSP - 2A Fast neutron probe

The range of the meter is 0 to 20 mR/hr.

In the Physics Department Nuclear Structure Laboratory, the instrument used for surveying neutron radiation will be: Texas Nuclear - Model 9146. The range of the instrument is 0 to 1000 mR/hr.

Calibration Procedures - The survey meter with the G.M. Probe will be calibrated annually by the Environmental Health and Safety Department using a J. L. Shepherd & Associates Series 28 Calibrator. The calibrator is a model number 28-5, serial number 10014, which contains 100 millicuries of Cesium 137. The source activity is traceable within 5% accuracy to the U. S. Bureau of Standards Calibrations.

The calibration certificate of radiation levels at specific distances provided by the manufacturer will be used to determine exposure rates for specific calibration points. The calibration will include two points on each scale with the two points separated by at least 50% of the scale.

If the exposure rate measured by the instrument differs by greater than 10% from the true exposure rate, then the survey meter will be adjusted. If the instrument cannot be adjusted and the reading falls within $\pm$ 20% of the true exposure rate, then a correction factor calibration chart or graph will be attached to the instrument.

The survey meters with neutron probes will be calibrated annually by the Environmental Health and Safety Department using the Physics Department's Plutonium/Beryllium source. The approximate reading of the source is 2.0 mR/hr at one meter. If the exposure rate measured by the instrument differes by greater than 10% from the true exposure rate, then the meter will be adjusted. If the instrument cannot be adjusted and the reading falls within $\pm$ 20% of the true exposure rate, then a correction factor calibration chart or graph will be attached to the instrument.

All survey meters will be calibrated following repair of the instrument.

DIAGRAM 5-1

NUCLEAR ENGINEERING LABORATORY

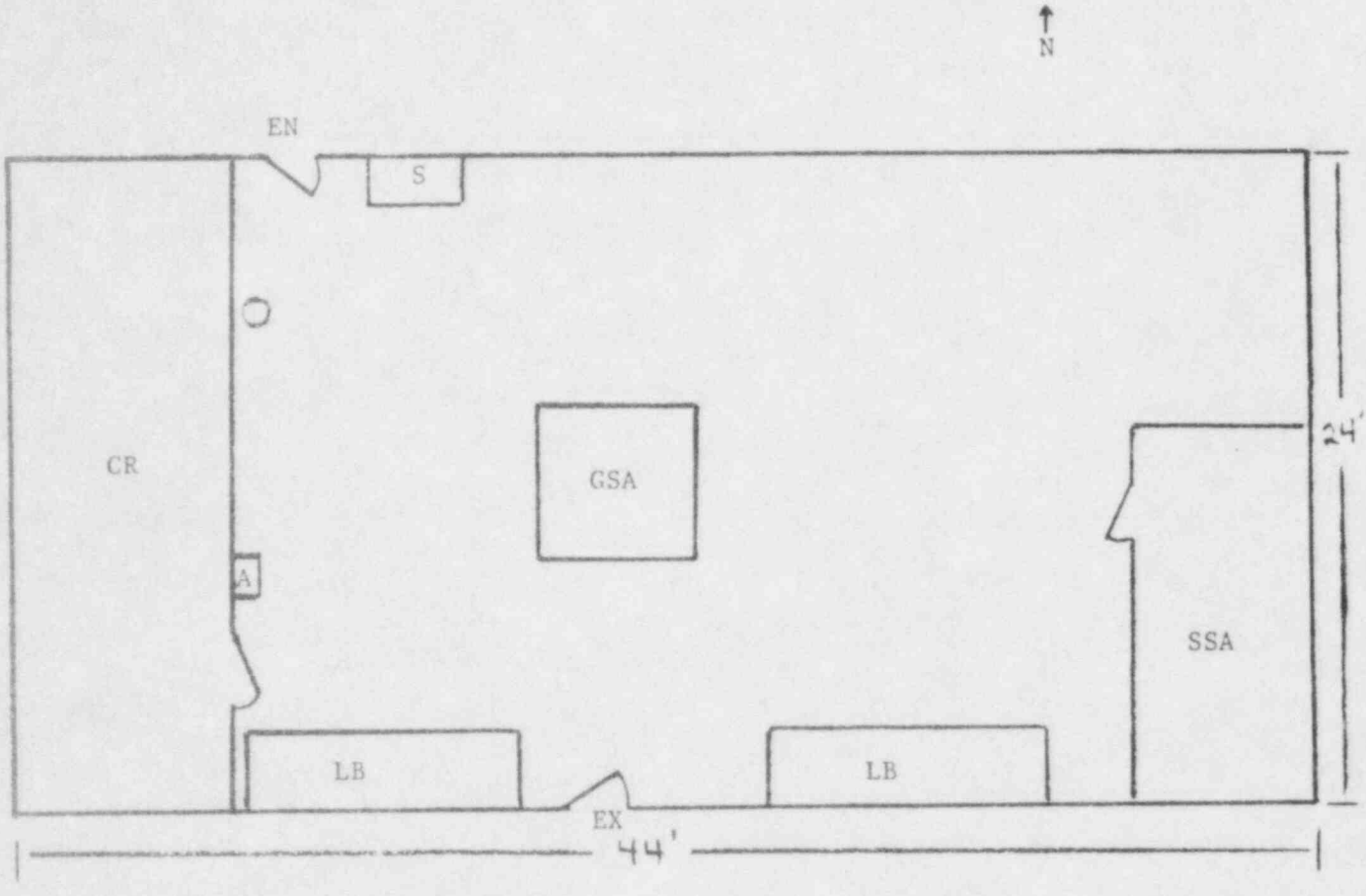
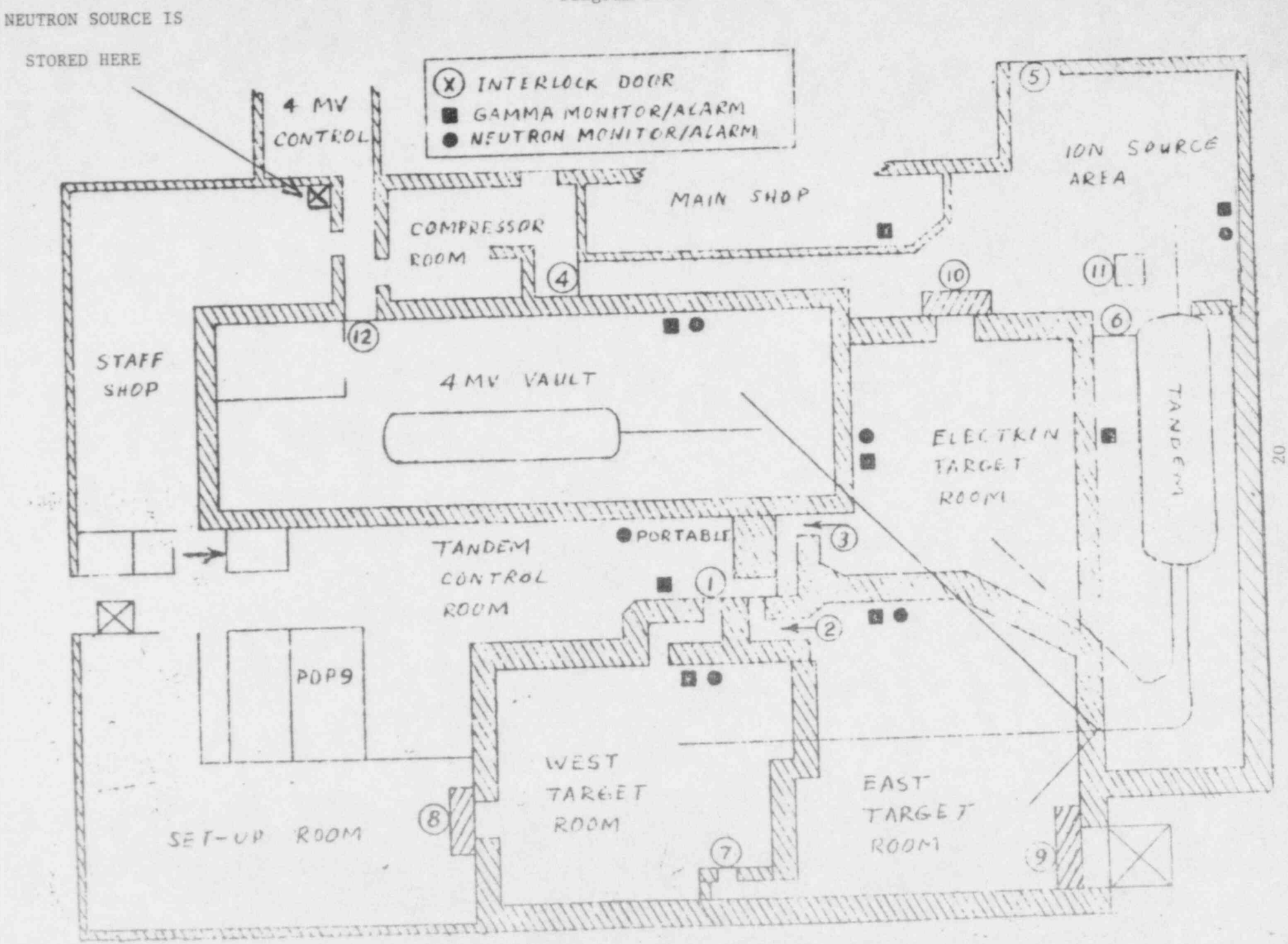


DIAGRAM CODES

GSA - Graphite Sub-critical Assembly
SSA - Secured Storage Area
LB - Laboratory Benches
S - Laboratory Sink
CR - Counting Room
A - Area Monitor
O - Fire Extinguisher
EN - Entrance
EX - Emergency Exit

NUCLEAR STRUCTURE LABORATORY
Diagram 5-2



REPORT OF CALIBRATION

Electroplated Alpha Source

Serial No. 11083

Description of Source:

Principal radionuclide Thorium - 230

Electroplated on polished Stainless steel (type of metal) disc, approximately 0.79 mm thick.

Diameter, 1.91 cm active, 2.23 cm total.

Radioactive material permanently fixed to the disc by heat treatment, without any covering over the active surface.

Calibration Date: May 30, 1979

Measurement Method:

The 2π alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operating voltage. Traceability to NBS has been demonstrated, the most recent intercomparison with NBS being June and July 1974 when the EIC–NBS agreement was within 0.2%.

Measurement Result:

The total number of alpha particles emitted from the surface of the disc per minute on the above date was

4,500 ± 90

The total disintegration rate, assuming 1.5% backscatter of alpha particles from the surface of the disc, was

8,870 ± 180 (0.0039 uCi)

The uncertainty of the measurement is 2%, which is the sum of random counting error at the 99% confidence level and the estimated upper limit of conceivable systematic error in this measurement.

Information on isotopic composition or radioactive impurities:

Calibrated by: J. Donald Rodriguez
(please print or type)

J. Donald Rodriguez
(signature)

eberline
Eberline Instrument Corporation
P.O. Box 3874
Albuquerque, New Mexico 87110

6. PROCEDURES TO PROTECT HEALTH AND MINIMIZE DANGER

6.1 Specifications of Radiation Safety Responsibilities and Duties

The respective roles of the University Radiation Control Committee, the Radiation Safety Officer, Responsible Investigator, and User of radiation sources are documented in the University's Radiation Safety Manual as follows:

A. The Radiation Control Committee. This Committee shall be appointed by the President of the University. It shall consist of at least 8 members, to include representatives from the administration, the Office of Environmental Health and Safety, and from each of the major areas employing radioactive materials or radiation devices.The Radiation Safety Officer, the Environmental/ Safety Specialist, and the representatives from the office of Business Affairs and the office of Research and Sponsored Programs shall be ex-officio members of the Radiation Control Committee.

The duties of the Radiation Control Committee are:

1. To establish regulations pertaining to the use of radioactive materials and radiation producing devices at the University of Notre Dame.

2. To receive the reports of the Radiation Safety Officer, and to consider additional regulations in accordance with his recommendations.

3. To review and act on applications of individuals who wish to become Responsible Investigators.

4. To define the conditions and the requirements for safe use of radioactive materials and radiation producing devices and rule on the suitability of existing and proposed facilities.

5. To assure the maintenance of adequate records concerning exposure of personnel and the acquisition and disposition of radioactive materials.

6. To review reports of noncompliance with these regulations and to take such action as may be necessary to assure the provisions of these regulations are being met.

7. To review proposals for field uses (off campus sites) of radioactive isotopes and to rule on the suitability of such proposals prior to submitting a request for an amendment to the University Byproducts Materials License.

8. To serve as the University's sole liaison with the Nuclear Regulatory Commission and the Indiana State Board of Health in matters of registration, licensing, and radiological control.

9. To review the radiation protection program at least annually to determine that all activities are being conducted safely and in accordance with the NRC regulations and conditions of the license.

10. To review and approve or disapprove applications from Responsible Investigators for new radionuclides, for additional quantities of radionuclides, and annually for continued use of radionuclides. Authorizations issued to Responsible Investigators for the use of specific radionuclides are granted for periods of one year.

11. To maintain written records of all Committee meetings, actions, recommendations, and decisions.

The Chairman of the Radiation Control Committee and the Radiation Safety Officer, or their duly authorized representatives, are authorized to act (under policies established by the Committee) for the Committee between meetings. Actions taken will be reported to the Committee for review at appropriate intervals.

B. Radiation Safety Officer. The Radiation Safety Officer shall be approved by the Radiation Control Committee and shall be a person who has training in Radiological Health. The responsibilities of the Radiation Safety Officer and his authorized representatives are:

1. To maintain radiation exposures at the lowest feasible level by the supervision or operation of an effective and appropriate radiation protection program.

2. To provide an annual training course in Radiological Safety to new radiation personnel and to provide training semi-annually to generators of radioactive waste on the proper transfer, packaging, and transport of low-level radioactive material.

3. To assure that personnel monitoring devices are used where indicated and that records are kept of the results of such monitoring.

4. To advise all personnel working with radioactive material and radiation producing devices of their annual radiation exposures.

5. To conduct periodic radiation surveys and keep records of such surveys, including descriptions of corrective measures.

6. To investigate each case of excessive or abnormal exposure to determine the cause and take steps to prevent its recurrence.

7. To supervise disposal of radioactive materials and maintain disposal records.

8. To provide consulting services in all aspects of radiation protection.

9. To report interim activities at each meeting of the Radiation Control Committee.

10. To submit to the Radiation Control Committee for their approval or recommendations all proposals from Responsible Investigators for new uses or changes in the use of radioactive isotopes.

11. To maintain a complete inventory of all radioactive isotopes on campus and at off-campus sites to assure that the University will remain within the possession limits.

12. To receive, approve, validate, and record all requisitions submitted by Responsible Investigators prior to being sent to the University Purchasing Department.

13. To suspend operations in any facility where it is evident that health hazards exist to the extent of endangering life or property or to the extent that continued operation would result in violation of existing federal, state, or University regulations. Actions of this nature shall, so far as possible, be a joint decision with the Area Radiation Safety Officer. The Radiation Control Committee shall be advised of any suspension of operations at the earliest possible time.

14. To examine certain incoming packages in accordance with 10 CFR 20.205 and to examine all packages of radioactive material leaving the institution.

15. To perform leak tests on all sealed sources and maintain records of such tests.

C. Responsible Investigators. Faculty members of the University of Notre Dame who make application to the Radiation Control Committee and provide evidence of training, experience, and facilities which enable them to work safely with radioactive materials and radiation producing devices shall be designated Responsible Investigators.

The responsibilities of Responsible Investigators are:

1. To comply with all applicable regulations for the safe use of radiation and radioactive materials.

2. To ensure that all users of radiation devices and radioactive materials working under their supervision comply with all applicable regulations.

3. To instruct users of radiation devices and radioactive materials, working under their supervision, in the use of safety devices and procedures.

4. To provide facilities and accept responsibility for the safe use of radioactive materials and radiation devices by individuals under their supervision.

5. To limit use of radiation devices and radioactive materials, covered in his/her approval as a Responsible Investigator, to persons over whom he has supervision.

6. To provide adequate planning of experiments or procedures to assure that required safety precautions are taken.

7. To keep the Radiation Safety Officer informed of new techniques, changes in operational procedures, or in the physical plant which might lead to increased personnel exposure or contamination levels.

8. To initiate orders for needed radioactive isotopes and keep records of the disposal of such materials.

9. To obtain and review records of exposure of themselves and of personnel under their supervision.

10. To prepare an inventory of radioactive material on hand at least annually and at other times when requested by the Radiation Safety Officer.

11. To notify the Area Safety Officer of his/her leave plans and also of the arrangements made for the handling of radioactive material during his/her absence whenever

he/she plans to take sabbatical leave, an extended vacation, or for any reason will be unable to maintain personal supervision or fulfill his/her responsibilities as contained in these regulations. These arrangements shall be made well in advance of his/her departure.

The Responsible Investigator shall also notify the Environmental Health and Safety Office prior to his/her leaving the campus.

12. To advise all female radiation workers of childbearing age orally and in written form of the increased risk of prenatal radiation exposure. New female employees shall be so advised before beginning work. Forms may be obtained from the Environmental Health and Safety Office.

D. Responsibilities of the Individual USER of Radiation Devices and Radioactive Materials. No person shall use radioactive material or radiation devices on the Notre Dame campus who has not been appropriately idoctrinated in the safe use of these sources of radiation.

Each person at Notre Dame who uses sources of radiation has a responsibility to:

1. Wear the recommended personnel monitoring devices, film badges, or pocket ionization chambers.

2. Keep his/her exposure at the lowest feasible value and below the maximum permissible exposure as stated in 10 CFR 20.101.

3. Maintain good housekeeping practices in laboratories.

4. Be aware of and work in accordance with Government and University regulations concerning the safe use of radiation sources.

5. Monitor himself or herself (hands, feet, clothing) for contamination each and every time he/she has run a risk of contamination.

6. Use all recommended protective measures.

7. Prohibit smoking, eating, drinking, or applying cosmetics in areas where radioactive materials are used.

8. Check working area for contamination after procedures with radioisotopes.

9. Label contaminated equipment and segregate radioactive waste and equipment to avoid cross-contamination.

10. Report immediately to the Radiation Safety Officer the details of spills or accidents involving radioactivity.

11. Conduct decontamination procedures in accordance with emergency procedures outlined in these regulations.

12. Be familiar with and abide by information concerning the increased risks of prenatal radiation exposures.

6.2 Personnel Monitoring

Film badge service obtained from the:

R. S. Landauer Jr. & Co.
Glenwood Science Park
Glenwood, IL 60425

Film badges used:
Type E1 - Fast Neutron (Neutrak) Whole Body
Type G1- X, Gamma, and Beta Whole Body

Monthly frequency evaluation to determine radiation exposures. Radiation exposure reports maintained by the Radiation Safety Officer.

Badges will be worn by Responsible Investigators and users whenever sources are used. Students enrolled in the Nuclear Section of ME 462 are not considered users as they will not handle or manipulate any source. It should be noted that there have been no significant exposures to individuals using the subcritical assembly in the past and, considering the present uses of the sources, it is unlikely that any will occur in the future.

6.3 Radiation Survey Program

The laboratories are surveyed semi-annually by the University's Radiation Safety Office in conjunction with the wipe testing of the Pu-Be sources. Surveys will include measurements of gamma and neutron radiation levels for storage and use configurations. Supplemental surveys will be performed following any changes in operation, shielding, use, or location of device. Survey results of the labs will be maintained by the Radiation Safety Officer.

6.4 Waste Disposal

No radioactive waste is generated by the normal use of the Pu-Be sources.

6.5 Record Management

Records of surveys, leak tests, inventories, personnel exposures as measured by film badges, and receipt, use and disposal of materials are maintained by the Radiation Safety Officer in the Environmental Health and Safety Department Office, 119 Student Health Center.

6.6 Material Control Provisions

It is not anticipated that any additional material will be received.

6.7 Sealed-Source Leak-Testing Provisions

The sealed Pu-Be neutron sources are tested for leakage and contamination at intervals not exceeding 6 months. If leak tests are not performed within the appropriate interval, the sources will not be used until leak tested. The test samples are taken from the sealed source and records of the leak test results are maintained in the office of the Radiation Safety Officer. Any source found to be leaking will be withdrawn from use and the appropriate action; decontamination, repair, and/or disposal, will be determined by the Radiation Safety Officer and Dr. John Lucey or Dr. Sperry Darden.

The Radiation Safety Officer will perform the leak testing. The sealed sources will be removed from their shielded containers with the use of a remote handling tool and placed behind lead bricks. The sources will be wipe tested with Whatman #1 filter paper and then immediately returned to their storage containers. The filter papers will then be counted for leakage in the gas-flow proportional counter described in Section 5.4 of this application.

6.8 General Safety Instruction

Only Responsible Investigators or trained personnel under the direct supervision of a Responsible Investigator will handle

the sources. Each Responsible Investigator must abide by and enforce the regulations as established in this application under Sections 6.1.C and 6.1.D.

6.9 Emergency and Decontamination Procedures

The following pages are from the University's Radiation Safety Manual and are posted and/or available in the laboratories.

Radiation Emergency Procedures

A. Definition and purpose.

An emergency is any incident resulting from the use of radioactive substances that presents or threatens to present an internal or external radiation hazard to personnel. The fundamental purposes of a radiation safety program are:

1. To prevent internal contamination which can result from ingestion, absorption, entry through wounds, or inhalation of radioactive material.

2. To reduce personnel exposure to external radiation as low as reasonably achievable.

3. To guard against damage to property or injury to personnel from the use of radioactive materials.

In an emergency the primary concern must always be the protection of human life and health. The secondary concern is the confinement of contamination to the local area of the accident, if possible, and the protection of personnel from radiation hazards.

B. Procedures.

In the event of an emergency or suspected emergency, e.g., major spill, overexposure, etc., the Radiation Safety Officer and the Responsible Investigator shall be notified immediately without such action as to cause excessive spread of contamination. See Table 10-1 for telephone numbers and additional emergency information.

The user and Responsible Investigator shall be responsible for the decontamination procedures necessary and shall carry out these procedures under the direction of the Radiation Safety Officer or persons designated by him.

1. Minor Spills-involving no significant radiation hazard to personnel:
   a. Notify all other persons in the area at once.

   b. Permit only the minimum number of persons necessary to deal with the spill into the area.

   c. Confine the spill immediately.

      1. Liquid spills -- Don protective gloves.
         -- Drop absorbent paper on spill.
      2. Dry spills -- Don protective gloves
         -- Gently dampen area thoroughly and cover it with absorbent paper taking care not to spread the contamination.

d. Notify the Radiation Safety Officer and Responsible Investigator as soon as possible, giving all details of the spill.

2. Major Spills - involving radiation hazard to personnel:

a. Notify all persons not involved in the spill to vacate the room at once.

b. Make no immediate attempt to clean up the spill.

1. If the spill is liquid and the hands are protected, right the overturned container.

2. If the spill is on the skin, flush thoroughly with water. Do not scrub or use strong detergents.

3. If spill is on clothing discard outer or protective clothing at once.

c. Switch off all fans and air conditioners.

d. Vacate the room and prohibit unauthorized entrance to contaminated area.

e. Notify the Radiation Safety Officer and Responsible Investigator at once and give all details of the accident.

f. The spread of radioactive contamination can be diminished by restricting the movements of potentially contaminated persons to a local zone just outside of the spill area until the extent of shoe and clothing contamination is ascertained.

g. Anyone who might have been contaminated should be monitored for radioactivity and, if contaminated, should discard that clothing and be decontaminated. If no means are available for monitoring it should be assumed that the person is contaminated.

h. Immediately take the necessary steps to decontaminate personnel involved. Under no circumstances should an untrained person attempt to examine or clean up the radioactive material.

i. Decontaminate the area under the supervision of the Radiation Safety Officer or his designate.

j. Monitor all persons involved in the spill and cleaning to determine the effectiveness of decontamination.

k. Permit no person to resume work in the area until a survey is made and approval of the Environmental Health and Safety Office is secured.

3. Accidents involving radioactive dusts, mists, fumes, organic vapors and gases.

   a. Notify all other persons to vacate the room immediately.

   b. Hold breath and close escape valves. Switch off air circulating devices if possible and if time permits.

   c. Vacate the room.

   d. Notify the Radiation Safety Officer and Responsible Investigator at once giving all details of the accident.

   e. Ascertain that all doors giving access to the room are closed and sealed by the use of wide masking tape or adhesive tape and heavy paper. Post conspicuous warning signs or guards to prevent accidental opening of doors.

   f. Report at once all known or suspected inhalations of radioactive materials.

   g. Decontaminate the area under the supervision of the Radiation Safety Officer or designate.

   h. Monitor all persons suspected of contamination.

4. Injuries to personnel involving radiation hazards.

   a. Wash minor wounds immediately under running water while spreading the edges of the wound.

   b. Report all radiation accidents (wounds, overexposures, ingestion, inhalation, etc.) to the Radiation Safety Officer as soon as possible (5037).

   c. Permit no person involved in a radiation injury to return to work without the approval of the Radiation Safety Officer and the attending physician.

   d. Have appropriate bioassays performed as specified by the Radiation Safety Officer.

5. Fires involving radioactive material.

   a. Notify all persons in the room and building at once.

   b. Notify the fire department and Radiation Safety Officer of the emergency involving radioactive material.

   c. Attempt to put out minor fires if radiation hazard is not immediately present.

d. Following the emergency, monitor the area and determine the protective devices necessary for safe decontamination.

e. Decontaminate under the supervision of the Radiation Safety Officer or his designate.

f. Monitor all persons involved in combatting the emergency.

g. Permit no person to resume work without approval of the Radiation Safety Officer.

Decontamination Procedures

A. Personnel Contamination - External

External contamination of personnel can be hazardous in three ways:

— It may cause injury from local exposure of the skin.

— It may penetrate the intact skin (especially in the presence of certain organic solvents).

— It may eventually be transferred into the body by ingestion or inhalation.

The danger of the loose activity being eventually carried into the body is by far the most critical hazard, so decontamination procedures are primarily concerned with loose contamination.

If the contamination is localized, it is often more practical to mask off the affected area and cleanse with swabs before risking the danger of spreading the contaminant by general washing.

The skin may become sensitive following repeated application of detergents to the same area; therefore, care should be taken to avoid this practice. In any case, one must avoid the use of organic solvents that may increase the probability of the radioactive materials penetrating through the pores of the skin.

After each decontamination operation the treated area should be dried with a fresh, non-contaminated towel or swab and monitored. All materials used in the decontamination process should be treated as contaminated material.

1. The recommended procedures for general washing of contaminated areas, especially hands, are as follows:

a. Wash for not less than two minutes, nor more than three minutes by the clock with a mild, pure soap in tepid water with a good lather, covering the entire affected area thoroughly. Give special attention to areas between the fingers and around the fingernails. The outer edges of the hands are readily

contaminated and often neglected in the washing. Do not use highly alkaline soaps or abrasives. Rinse thoroughly and repeat, as monitoring indicates, until the desired degree of decontamination is achieved, but not to exceed three or four times.

b. If the above procedure is not sufficient to remove the contamination, scrub the hands with a soft brush using a heavy lather and tepid water. This scrubbing is primarily to agitate the cleansing agent, hence prolonged scrubbing without change of reagent is of questionable value. For this reason at least three washes, including rinses, should be made within eight minutes of which at least six minutes should be applied to the brush--not sufficient to bend the bristles out of shape or to scratch or erode the skin. Rinse thoroughly and monitor.

c. Apply lanolin or hand cream to prevent chapping. In more serious cases of hand contamination the following steps may be taken. This procedure should be used only if thorough soap and water scrubbing fails to remove the contamination, and then only under the supervision of the Radiation Safety Officer.

1. Wash hands lightly in about 5 per cent solution of sodium hypochlorite.

2. Rinse thoroughly in tepid water.

3. Rinse hands lightly with a small amount of 3N hydrochloric acid.

4. Rinse hands thoroughly with tepid water.

5. Apply hand lotion to prevent dryness and cracking of skin.

Further attempts to remove contamination should be made only under medical supervision.

B. Personnel Contamination - Wounds

When the skin is lacerated by glassware, hypodermic needles, or other instruments containing radioactive materials the wounded area must be washed immediately under a stream of cold water. If the radioactive material is unusually toxic a tourniquet should be applied to the injured extremity tightly enough to occlude the veins without stopping the arterial pulse. After first aid measures have been taken whoever is in charge shall notify the Radiation Safety Officer and otherwise follow the emergency procedures found in Section IV of these rules.

C. Personnel Contamination - Internal

Internal contamination is essentially a medical problem, similar in some ways to the absorption of chemical toxins. Special corrective procedures should, therefore, be carried out only under medical advice and supervision.

The aims of the corrective procedures are:

1. Try to eliminate as much of the internally introduced contaminant still remaining in the mouth, gastro-intestinal or respiratory tract as quickly as possible; try to prevent or reduce its uptake into the bloodstream and tissues.

2. Try to prevent the fixation of the contaminant in the body or try to increase its excretion from the body.

For the first of these aims it is sometimes necessary that the contaminated person or another nonmedical person takes immediate action; for instance, to promote the mechanical elimination of the contaminant by vomiting or expectoration.

For the second of these aims more complicated chemical or physico-chemical methods are required. Hence, treatment is a medical matter and should be undertaken as soon as possible, but only under medical supervision.

In all cases of internal contamination, the Radiation Safety Officer should be notified as soon as possible and the emergency procedures listed in Section IV followed.

D. Non-Human Contamination

The exact procedure for facility decontamination depends on the type of equipment and facility contaminated, the chemical and physical form of the specific isotope involved, and the extent of the area contaminated. Adequate decontamination requires knowledgeable personnel and adequate equipment.

The material used in the decontamination procedure should be considered contaminated and disposed of as radioactive waste.

The possibility of disposal of contaminated objects should be considered. It is sometimes more economical (in terms of time and risk to personnel) to dispose of a piece of equipment than to decontaminate it.

Each researcher should insure that his personnel are familiar with the following:

1. The technique of "concentrate and confine" shall be used to avoid the spread of the contamination.

2. Decontamination should be carried out as soon as possible.

3. The decontamination procedure should avoid large amounts of liquid. The working materials should be moist, but not so moist that they will flow.

4. If an excess of liquid contaminant is present blotting should be the first step in the decontamination procedure.

5. In proceeding with decontamination, the least caustic and least abrasive procedures should be tried first.

6. Any procedure that produces dust or other air-borne contaminants should be avoided.

7. With short half-life radioisotopes decay is an acceptable method of decontamination, provided that during decay some provision is made for preventing the spread of contamination and exposure of personnel.

8. Decontamination of movable items should be done in a hood.

9. In general, glass may be cleaned with chromic acid.

10. In general, decontamination of a rough surface will require the use of a brush (e.g., a small soft brush or toothbrush).

11. Masking tape should be used to pick up dry powder contaminants.

12. Aerosols and chemicals that would produce gases should be avoided.

13. Sometimes a non-radioactive carrier is useful.

14. Soft beta and alpha radiation emitters which cannot be removed may be sealed in by painting with approval of the Radiation Safety Officer. This technique is normally limited to areas not subject to abrasion.

After each step of the decontamination procedure the contaminated item should be dried and monitored. It should be remembered that moisture can reduce the actual level of the radiation considerably (in the case of alpha or beta emitters) and give a false impression that the contamination has been removed.

Disposable plastic gloves should be worn throughout the decontamination procedure.

TABLE 10-1

EMERGENCY INFORMATION

1. Responsible Investigator in Charge of Nuclear Laboratory, Mechanical Engineering Building
   Dr. John Lucey (8 a.m. to 5 p.m.) - - - - - - - - - - - - - - - - - 7381
   " " (after hours) - - - - - - - - - - - - - - - - - 232-4481

2. Responsible Investigator in Charge of Nuclear Structure Laboratory, Nieuwland Science Hall
   Dr. Edgar Berners (8 a.m. to 5 p.m.) - - - - - - - - - - - - - - - 7716
   " " (after hours) - - - - - - - - - - - - - - - 291-3559

3. Environmental Health and Safety Office
   8 a.m. to 5 p.m.
   Radiation Safety Officer (Bob Zerr) - - - - - - - - - - 5037
   Environmental/Safety Specialist
   (Mike McCauslin) - - - - - - - - - - 5037

   After hours:
   Bob Zerr - 259-0611
   Mike McCauslin - - - - - - - - - - - - - - - - - 616/683-2494

4. Campus Emergency Number - - - - - - - - - - - - - - - - - - - 6600
   This number is open 24 hours a day and should be called to arrange for an ambulance.

5. Notre Dame Fire Department - - - - - - - - - - - - - - - - - - - 6200

6. Memorial Hospital - 284-7458
   Memorial Hospital of South Bend is the designated treatment center for radiation ingestion or injury due to the "Poison Control Center" facilities located there and the existence of a radioisotope treatment program at the hospital.

   For injuries not involving radiation, the victim may be taken to the Student Health Center for emergency treatment.

7. Student Health Center - 7497 or 7567

6.10 Personnel Training Procedures

Newly approved Responsible Investigators and laboratory teaching assistants, supervisors, and users will receive training in the form of on-the-job instruction, written instruction, and formal classroom instruction prior to actual work in the Nuclear Engineering or Nuclear Structure Laboratories. Training will cover:

a. Principles and practices of radiation protection.

b. Radioactivity measurements and monitoring techniques.

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

d. Biological effects of radiation.

This training will be performed by the Radiation Safety Officer and the Responsible Investigators in charge of the sources.