

APPLICATION FOR MATERIAL LICENSE

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

FEDERAL AGENCIES FILE APPLICATIONS WITH:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF FUEL CYCLE AND MATERIAL SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS, IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIAL SECTION B
631 PARK AVENUE
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
MATERIAL RADIATION PROTECTION SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
MATERIAL RADIATION PROTECTION SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR (Check appropriate item)

- ☐ A. NEW LICENSE
☐ B. AMENDMENT TO LICENSE NUMBER _____
☒ C. RENEWAL OF LICENSE NUMBER SUD-197

2. NAME AND MAILING ADDRESS OF APPLICANT (Include Zip Code)

University of Notre Dame du Lac
Environmental Health & Safety Department
119 Student Health Center
Notre Dame, IN 46556

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

Nuclear Engineering Laboratory, Mechanical Engineering Laboratory Building #66,
Old Juniper Road, University of Notre Dame, Notre Dame, IN 46556

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Robert M. Zerr

TELEPHONE NUMBER

219-239-5037

SUBMIT ITEMS 5 THROUGH 11 ON 8 1/2 x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL

a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE.

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.

9. FACILITIES AND EQUIPMENT.

10. RADIATION SAFETY PROGRAM.

11. WASTE MANAGEMENT.

12. LICENSEE FEES (See 10 CFR 170 and Section 170.31)

FEE CATEGORY AMOUNT
ENCLOSED \$

13. CERTIFICATION. (Must be completed by applicant) THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN, IS TRUE AND CORRECT TO THE BEST OF THEIR 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.

SIGNATURE—CERTIFYING OFFICER

TYPED/PRINTED NAME

TITLE

DATE

James J. Lyphout

Asst. Vice President
for Business Affairs

3/25/85

14. VOLUNTARY ECONOMIC DATA

a. ANNUAL RECEIPTS

<\$250K
\$250K-500K
\$500K-750K
\$750K-1M

\$1M-3.5M
\$3.5M-7M
\$7M-10M
>\$10M

b. NUMBER OF EMPLOYEES (Total for entire facility excluding outside contractors)

c. NUMBER OF BEDS

d. WOULD YOU BE WILLING TO FURNISH COST INFORMATION (Dollar and/or staff hours) ON THE ECONOMIC IMPACT OF CURRENT NRC REGULATIONS OR ANY FUTURE PROPOSED NRC REGULATIONS THAT MAY AFFECT YOU? (NRC regulations permit it to protect confidential commercial or financial—proprietary—information furnished to the agency in confidence)

☐ YES

☐ NO

FOR NRC USE ONLY

TYPE OF FEE

FEE LOG

FEE CATEGORY

COMMENTS

APPROVED BY

AMOUNT RECEIVED

CHECK NUMBER

DATE

8506110069 850524
REG3 LIC40
SUD-0197

PDR

CONTROL NO. 78603

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e)(3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on NRC Form 313. This information is maintained in a system of records designated as NRC-3 and described at 40 Federal Register 45334 (October 1, 1975).

1. **AUTHORITY:** Sections 81 and 161(b) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2111 and 2201(b)).
2. **PRINCIPAL PURPOSE(S):** The information is evaluated by the NRC staff pursuant to the criteria set forth in 10 CFR Parts 30, 32, 33, 34, 35 and 40 to determine whether the application meets the requirements of the Atomic Energy Act of 1954, as amended, and the Commission's regulations, for the issuance of a radioactive material license or amendment thereof.
3. **ROUTINE USES:** The information may be (a) provided to State health departments for their information and use; and (b) provided to Federal, State, and local health officials and other persons in the event of incident or exposure, for their information, investigation, and protection of the public health and safety. The information may also be disclosed to appropriate Federal, State, and local agencies in the event that the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding. In addition, this information may be transferred to an appropriate Federal, State, or local agency to the extent relevant and necessary for an NRC decision or to an appropriate Federal agency to the extent relevant and necessary for that agency's decision about you.
4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION:** Disclosure of the requested information is voluntary. If the requested information is not furnished, however, the application for radioactive material license, or amendment thereof, will not be processed. A request that information be held from public inspection must be in accordance with the provisions of 10 CFR 2.790. Withholding from public inspection shall not affect the right, if any, of persons properly and directly concerned need to inspect the document.
5. **SYSTEM MANAGER(S) AND ADDRESS:** U.S. Nuclear Regulatory Commission
Director, Division of Fuel Cycle and Material Safety
Office of Nuclear Material Safety and Safeguards
Washington, D.C. 20555

March 25, 1985

University of Notre Dame
Renewal Application of License No. SUD-197

5. The type of source material is natural uranium. The uranium is contained in rods measuring one inch in diameter, eight inches long, weighing approximately 1.97 Kg each, clad in aluminum 0.04 inches thick (see Figure 5-1). Eight of these rods will be assembled in an aluminum tube to form one "fuel element". Altogether, there will be 120 fuel elements in the graphite subcritical assembly. The maximum amount of natural uranium possessed at any one time is 1990 kilograms.
6. The Natural uranium in the form of cylindrical slugs canned in aluminum will be used in a graphite-moderated subcritical system. The assembly is activated by means of five one-curie PuBe sources (License SNM-198). The natural uranium will be stored in the graphite assembly or secured storage area at all times. The graphite subcritical reactor configuration is depicted in Figure 6-1. A few spare elements will be kept in the secured storage area in containers properly labeled to describe contents. This assembly will be used for educational purposes to conduct experiments pertaining to reactor studies and neutron behavior. Experiments to be conducted include diffusion length and fermi age of graphite, and flux measurement and buckling determination using Indium foils.

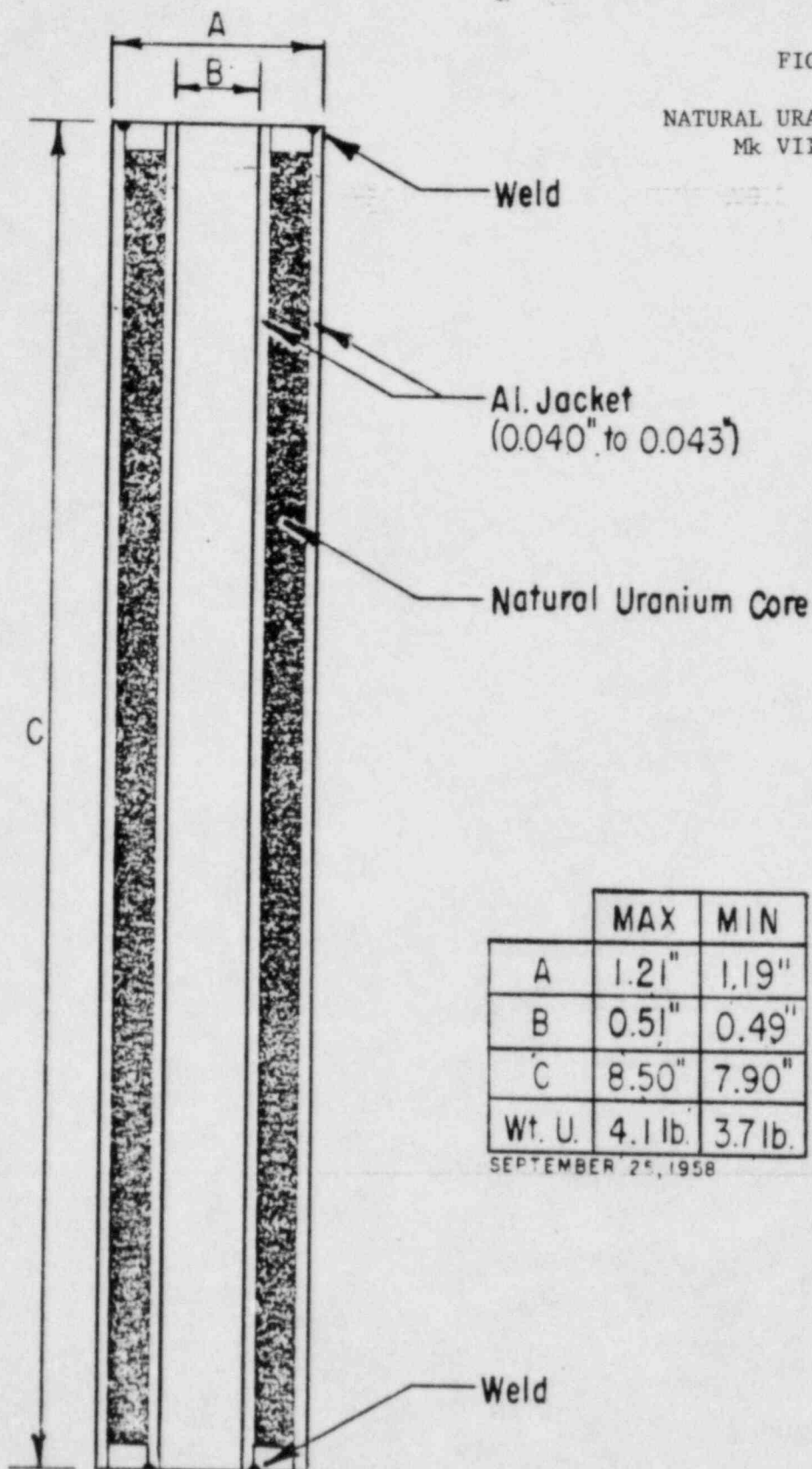
The fuel elements will be removed only to change loading configurations. They will be handled while in the aluminum tubes. The persons handling the tubes will wear protective gloves and lab coats as a precaution against contamination of their hands and clothes and possible ingestion of the material. Only trained personnel under the direct supervision of a Responsible Investigator will handle the tubes. Under no circumstances will the aluminum cladding on the uranium bar be removed or opened. With the uranium sealed in the tubes and personal protective precautions taken, the potential hazard from the chemical toxicity of the uranium is reduced.

In addition, the external radiation hazards are minimal since handling and actual experimental use of the source material is very limited.

CONTROL NO. 78003

FIGURE 5-1

NATURAL URANIUM FUEL ROD
Mk VIIa REJECTS



	MAX	MIN
A	1.21"	1.19"
B	0.51"	0.49"
C	8.50"	7.90"
Wt. U.	4.1 lb.	3.7 lb.

SEPTEMBER 25, 1958

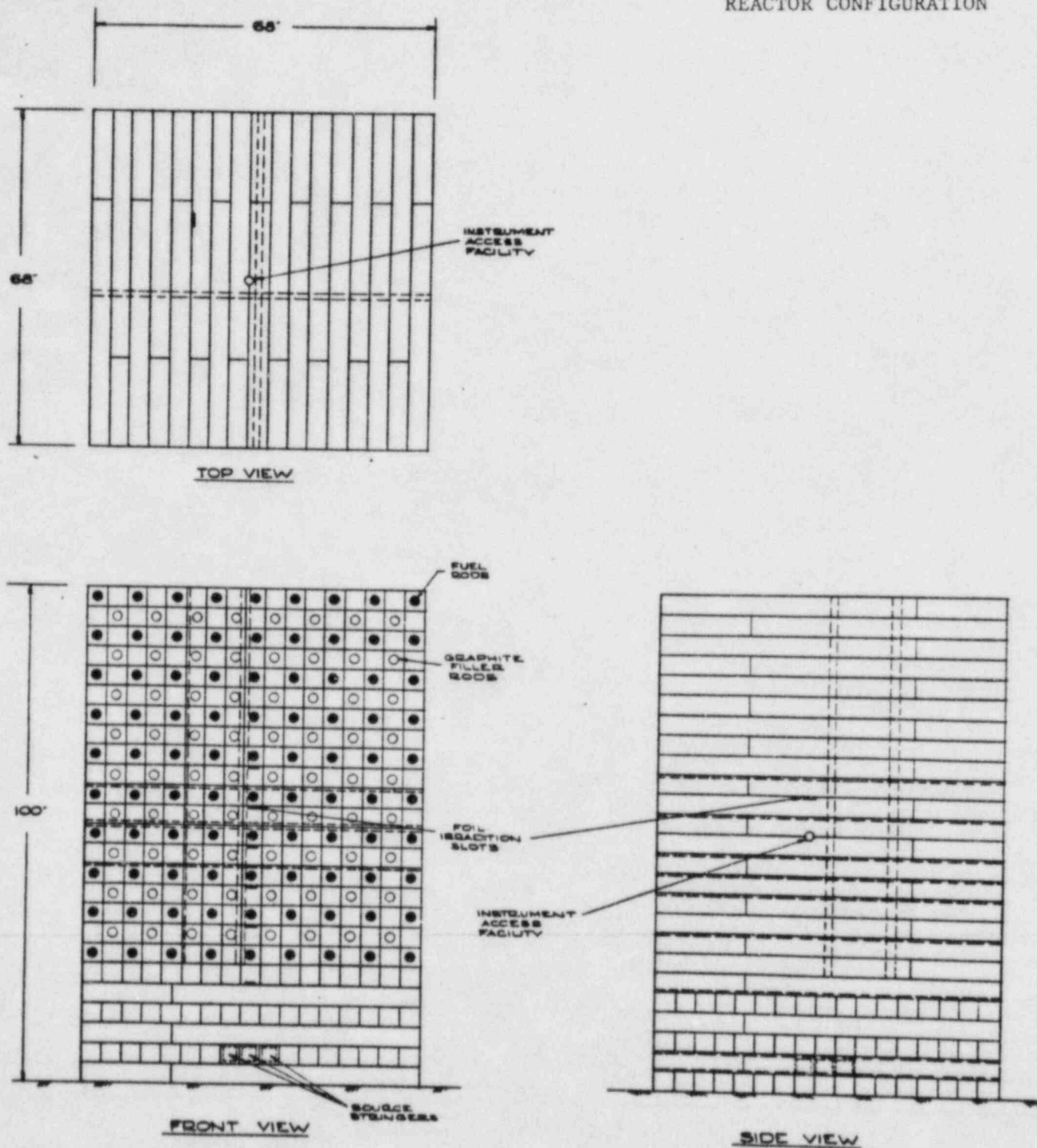
CROSS - SECTION
HOLLOW SLUG
(Not to Scale)

Mk VII a Rejects

CONTROL NO. 78603

Figure 6-1

GRAPHITE SUBCRITICAL
REACTOR CONFIGURATION



GRAPHITE
SUBCRITICAL REACTOR
CONFIGURATION

FIG. 6.1

7. 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 must complete the appropriate 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 the source material and operate the assembly in a safe manner on the basis of experience and training.

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

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

B.S.-Univ. of Notre Dame 1957
M.S.-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 -

<u>Isotope</u>	<u>Maximum Amount</u>	<u>Where Experience</u>	<u>Duration</u>	<u>Type of Use</u>
^{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

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 -

<u>Type</u>	<u>Where Trained</u>	<u>Duration</u>	<u>On the Job</u>	<u>Formal Course</u>
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 -

<u>Isotope</u>	<u>Maximum Amount</u>	<u>Where Experience</u>	<u>Duration</u>	<u>Type of Use</u>
^3H	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	10 years	Yes	Yes
	Univ. of Michigan			
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
$^{110\text{m}}\text{Ag}$	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 -

<u>Isotope</u>	<u>Maximum Amount</u>	<u>Where Experience</u>	<u>Duration</u>	<u>Type of Use</u>
^3H	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
^3H	10 mCi each	Univ. of Amsterdam	40 yrs.	Labeling of Metabolites
^{14}C		Cal. Tech., Univ. of	Total	
^{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
^3H	1 mCi	Franklin	1 month	Rat Tracer Study
^{32}P	1 mCi	Purdue	3 months	Lab Training Course
^{51}Cr	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

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 radio-isotopes 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 _____

CONTROL NO. 3603

8. Training

Newly approved Responsible Investigators and laboratory teaching assistants or supervisors 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 Laboratory. 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.
- e. Principles and practices of protection against the chemical toxicity of source materials.

This training will be performed by the Radiation Safety Officer and the Responsible Investigator presently in charge of the Laboratory, Dr. John Lucey.

9. The Nuclear Engineering Laboratory is located in the Southwest corner of the basement floor of the Mechanical Engineering Laboratory Building. The general description or layout of the Nuclear Engineering Laboratory is described in Diagram 9-1. The diagram depicts the subcritical assembly, storage area, counting room, area monitor, and fire extinguisher. 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.
- 9a. All visitors and students entering the nuclear lab will be required to wear pocket dosimeters. Students or visitors will not be allowed to enter or remain in the laboratory unless an Instructor or Teaching Assistant is in the laboratory. The Course Instructor, a Responsible Investigator, and his/her Teaching Assistant will wear a film badge whenever using the lab. This will provide a documented record of

DIAGRAM 9-1

NUCLEAR ENGINEERING LABORATORY

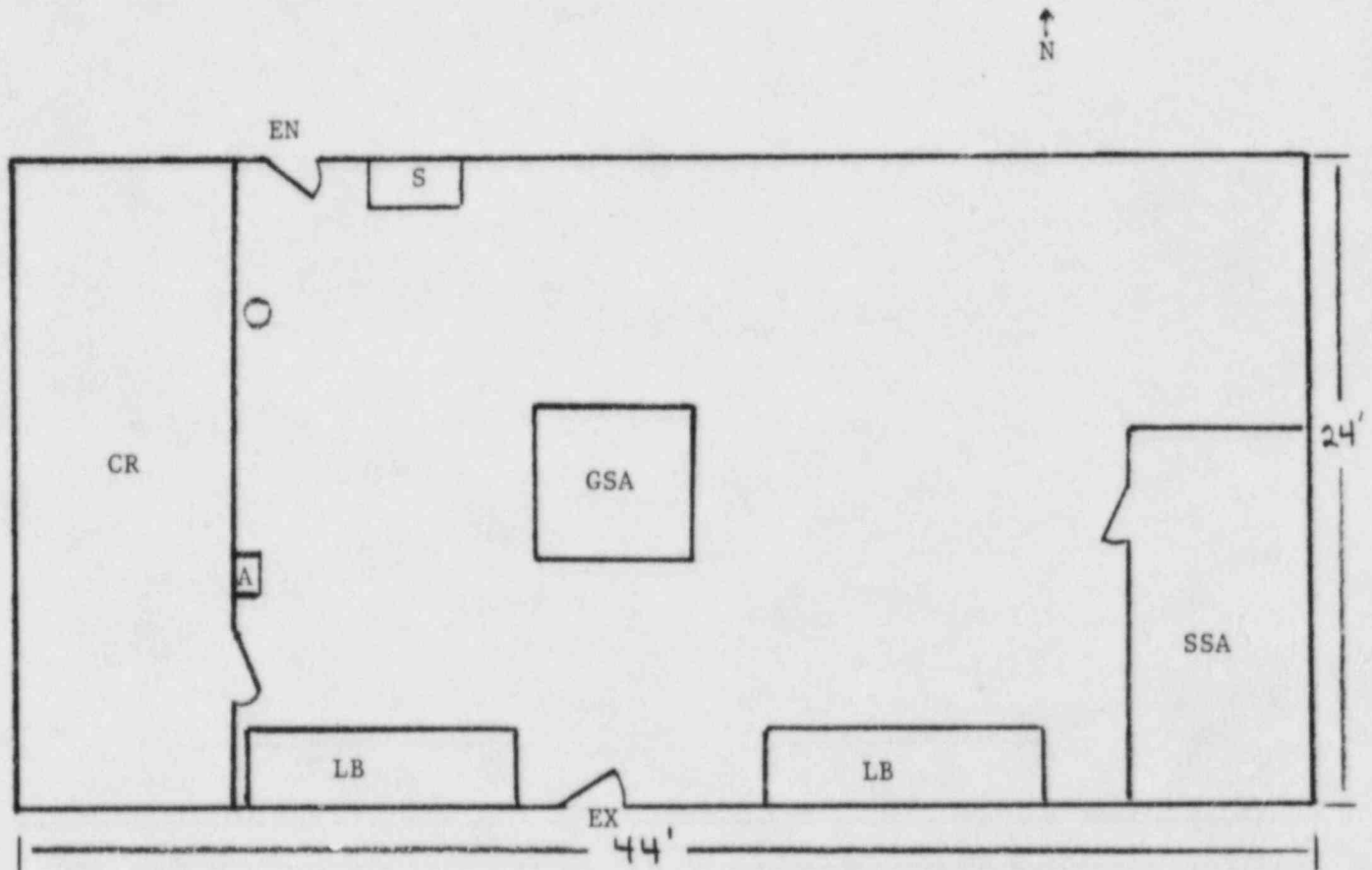


DIAGRAM CODES

- 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

CONTROL NO. 78603

possible exposure. It should be noted that there have been no significant exposures to people using the Nuclear Engineering Laboratory in the past and, considering the sources present in the laboratory, it is unlikely that any will occur in the future.

The pocket dosimeters were manufactured by the Victoreen Company. They are Model Number 541/A Dosimeters with an exposure range of 0-200 milliroentgen.

The film badge service is provided by R. S. Landauer Jr. & Co., Glenwood, Illinois. Film badges are changed monthly and exposure reports are maintained by the Radiation Safety Officer and the Responsible Investigator in charge of the laboratory. The film badges used are:

R. S. Landauer Jr. & Co. Type G1 - X, Gamma, Beta - Whole Body
E1 - Fast Neutron (Neutrak 1) - Whole Body

Radiation Survey Meters:

- Beta-Gamma Survey Meter

A Ludlum Model 3 survey meter with a Geiger Mueller end-window probe will be used to assess Beta-gamma radiation levels in the laboratory. The range of the meter is 0 to 200 mR/hr.

- Neutron Survey Meter

A Texas Nuclear Model 9146 survey meter will be used to assess neutron radiation levels in the laboratory. The range of the instrument is 0 to 1000 mRem/hr.

Area Monitor: A beta-gamma area monitor is located on the West wall of the subcritical assembly room. This monitor is located approximately 10 feet from the assembly and is located on the wall between the assembly room and counting room.

Area Monitor Manufacturer: Eberline

Model & Serial No: RM-2, 187

Range: 0-20 mR/hr

Alarm Set: 2.5 mR/hr

- 9b. The pocket dosimeters and the Beta-Gamma Survey Meter 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, Calibrator Serial Number 10014, which contains 100 millicuries of Cesium 137. The source activity is traceable within 5% accuracy to the U. S. National Bureau of Standards Calibrations.

Calibration Procedures:

1. The calibration certificate of radiation levels at specific distances provided by the manufacturer, the inverse square law and the gamma constant will be used to determine exposure rates for specific calibration points.
2. Survey meter: 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.
3. For the pocket dosimeters: If the exposure measured by the dosimeter differs by greater than 10% from the true exposure; then a correction factor chart or graph will accompany the dosimeter. If the exposure reading differs by greater than 20% from the true exposure, then the dosimeter will be removed from use.
4. The neutron survey meter will be checked annually for proper operation by the Environmental Health and Safety Department. A one curie Plutonium Beryllium Source, approximate reading at one meter - 2.0 mR/hr, will be used to check the meter. If the exposure rate measured by the instrument differs 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.

5. The area monitor will be checked annually for proper operation by the Environmental Health and Safety Department. A five mCi Cesium 137 source will be used to check the monitor at two points on the scale. If the reading differs by more than $\pm 20\%$ and cannot be adjusted, a correction factor calibration chart or graph will be attached to the instrument.

9c. Use of the source material will not generate dust, fumes, mists or gases that will require ventilation equipment.

10a. Present uses of the subcritical assembly do not require the use or laboratory storage of flammable liquids, corrosives, reactives or explosive material. If for some reason a hazardous compound must be used in the laboratory, it will be brought in just prior to the experiment and will be removed immediately following the experiment. A fire extinguisher is available in the event of a fire.

10b. Emergency Procedures

In the event of an accident involving source material, the Radiation Safety Officer and the Responsible Investigator shall be notified immediately without such action as to cause excessive spread of contamination. Table 10-1 lists telephone numbers and additional emergency information. Emergency procedures and numbers will be posted in the laboratory.

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.

The following procedures shall be followed according to type and degree of accident.

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.

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.

- 10c. Surveys to evaluate radiation hazards incident to the use of the source material will be conducted every six months by Environmental Health and Safety Department personnel. The survey will assess radiation levels around the subcritical assembly and storage area using a beta-gamma survey meter and a neutron survey meter. Results of the surveys will be maintained by the Radiation Safety Officer. Radiation levels determined in a previous survey are recorded on Diagrams 10-2 and 10-3.

The duties and responsibilities of the Radiation Control Committee members, the Radiation Safety Officer, the Responsible Investigator, and the user are described below.

- 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 recommendation.
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 indoctrinated 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.
-
11. No wastes will be produced as a result of operations involving the source material.
 12. As provided in 10 CFR 170.114(4), we believe the University is exempt from payment of a license fee.

TABLE 10-1

EMERGENCY INFORMATION

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

2. 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

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

4. Notre Dame Fire Department - - - - - 6200

5. 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.

6. Student Health Center - - - - - 7497 or 7567

DIAGRAM 10-2

NUCLEAR ENGINEERING LABORATORY

BETA-GAMMA RADIATION LEVELS
(mR/hr)

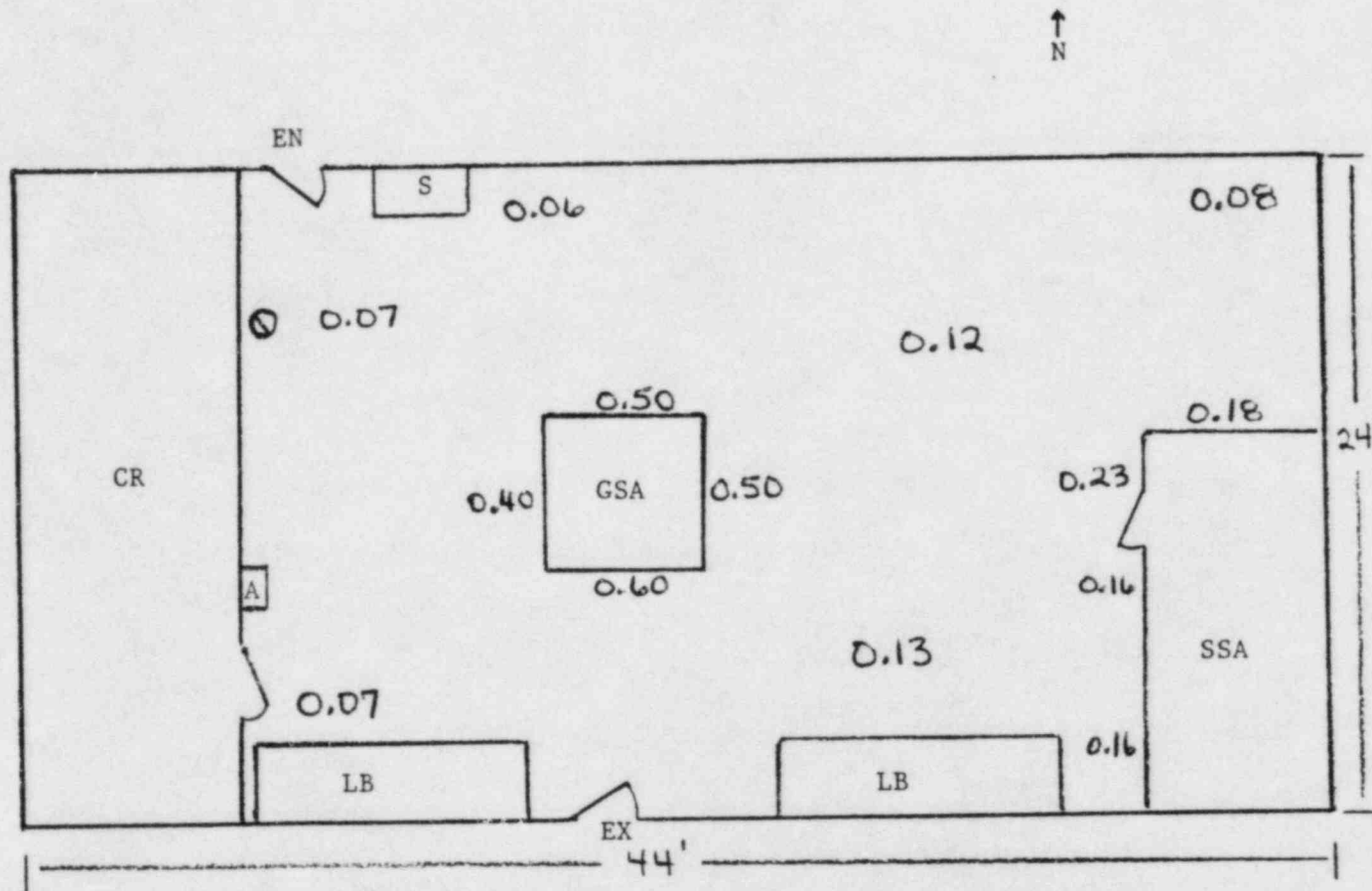


DIAGRAM CODES

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

DIAGRAM 10-3

NUCLEAR ENGINEERING LABORATORY

NEUTRON RADIATION LEVELS
(Counts/Minute)

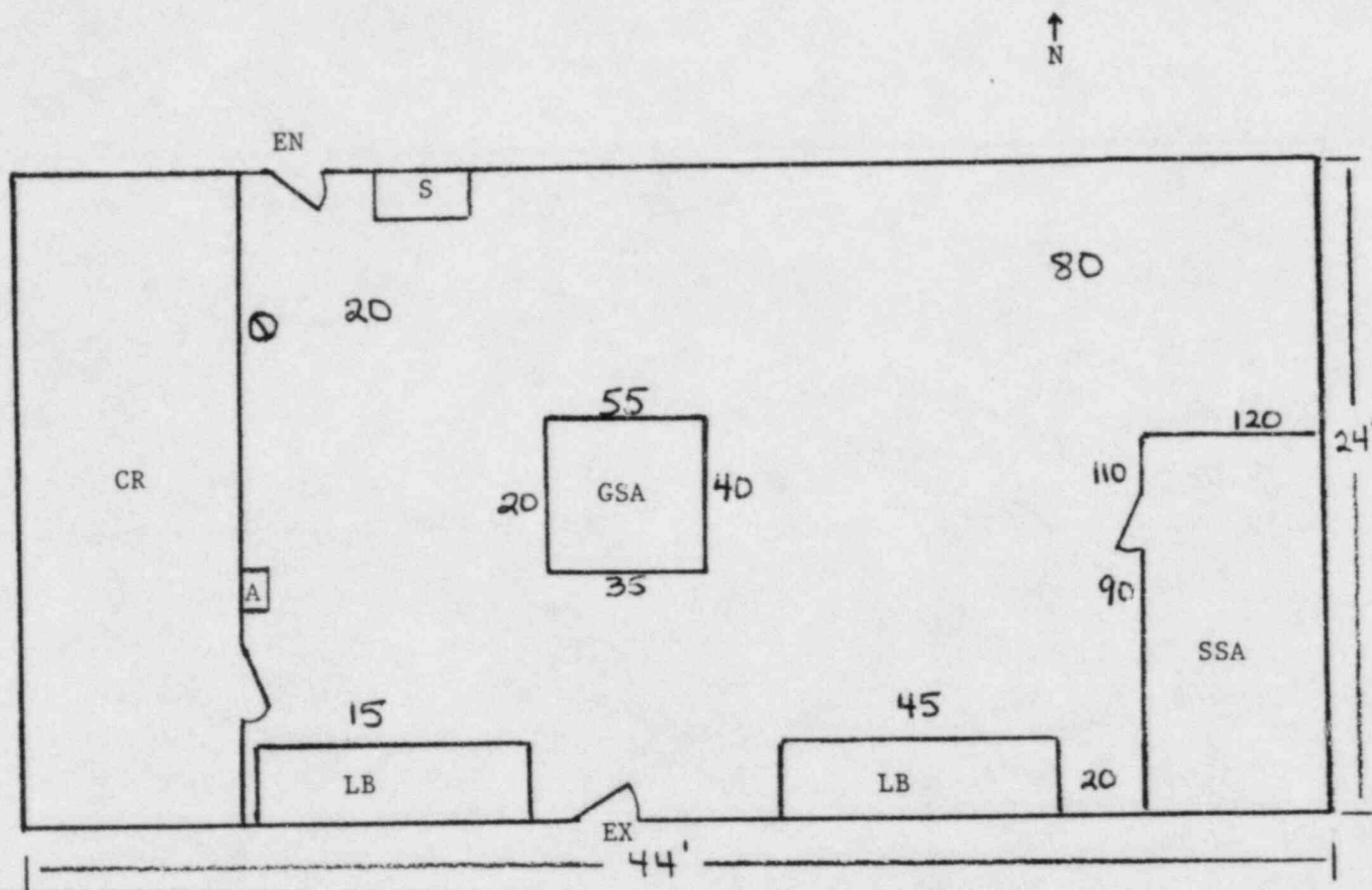


DIAGRAM CODES

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