7. DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED.

I. Formal courses
   a. Radiobiology course
   b. Physics laboratory course

II. Research involving the following:

   a. Nutritional studies with potato plants
   b. Phosphate retention by soils
   c. Enzyme studies in animal science
   d. Physiological studies in zoology
   e. Plankton productivity and laboratory studies on lake sediment
   f. Biochemical studies with chickens
   g. Tracer studies to be performed in vitro or in lower animals.
   h. Soft x-ray for analysis of light elements
   i. Rate of uptake and metabolism of carbohydrates and sulfur amino acids in aquatic invertebrates undergoing osmotic stress
   j. Study protein synthesis in virus-infected cell cultures
   k. Studies of bacterial lipids in membrane biosynthesis and enzymology
   l. Label protozoan cells in various studies of their physiology

III. Measuring
   a. To be used (Krypton 85) in industrial nucleonics model 0-3 source unit to measure basis weight of paper
   b. To be used (Cesium 137) in Nuclear Chicago Model P20 density meter gauge for measuring density of materials
   c. To be used (Americum 241) in Troxler Electronics Laboratories Inc., Model No. 105A depth moisture gauge and Model No. 217-105A surface moisture gauge
   d. B & C to be used at various temporary job site locations throughout the State of Maine

8. TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4

Type of Training	Where Trained	Duration Training	Job	Formal
Alan R. Langille				
a. Principles	Penn. State	3-weeks	No	Yes
	ORINS, Oakridge, Tenn.	8-weeks	No	Yes
b. Measurement	Univ. of Vt.	16-weeks	No	Yes
	ORINS, Oakridge, Tenn.	8-weeks	No	Yes
c. Mathematics	Univ. of Vt.	16-weeks	No	Yes
	ORINS, Oakridge, Tenn.	8-weeks	No	Yes
d. Biological effects	Penn. State	3-weeks	No	Yes
	ORINS, Oakridge, Tenn.	8-weeks	No	Yes
Charles T. Hess				
a. Principles	Neutron Lab, Ohio	1-semester	No	Yes
b. Measurement	Argonne Nat. Lab, Argonne, Ill.	1-summer	Yes	No
	X-ray Research Wabash College	1-year	Yes	No
	X-ray Research, Ohio Univ.	2-years	Yes	No
c. Mathematics	Ph.D. in Nuclear Theory, Ohio Univ.	3-years	Yes	Yes
	Post Doctoral in Nuclear Physics, Florida State U.	1-year	Yes	Yes
d. Biological effects	as "c" above			
Charles W. Major				
a. Principles			No	No
b. Measurement			No	No
c. Mathematics			No	No
d. Biological effects	ORNL Lectures and Seminars, Univ. of Tenn.Course	3-months	No	Yes
Gordon E. Ramsdell (Radiation Protection Officer)				
a. Principles	ORINS, Oakridge, Tenn.	4-weeks	No	Yes
b. Measurement	" " "	"	No	Yes
c. Mathematics	" " "	"	No	Yes
d. Biological effects	" " "	"	No	Yes
Bruce R. Poulton (Administrative Member)				
a. Principles			No	No
b. Measurement			No	No
c. Mathematics			No	No
d. Biological effects			No	No

10. RADIATION DETECTION INSTRUMENTS

Type	Number	Radiation	Sensitivity	Thickness	Use
Scaler G.M. Tube	8	Beta		1.4 mg/cm^2	Measuring
Scaler Proportional	3	Beta			Measuring
Spectrometer	1	Gamma			Measuring
Dosimeters	12		10 mr		Monitoring
Survey Meter	2	Beta Gamma	10 mr	35 mg/cm^2	Monitoring
Tracer Lab SU-3C	2	Beta Gamma		1.5 mg/cm^2	Monitoring
Tracer Lab SC-71 Scaler & FD1 Flow Counter	1	Beta Gamma		125 mg/cm^2	Measuring
Tracerlab SC5 Autoscaler & Tgc^{14} Flow Counter	1	Beta Gamma		9 mg/cm^2	Measuring
Packard Model 210 Flow Window Counter	1	Beta Gamma			Measuring
Tracer Lab 4T Scanner	1			Windowless	Monitoring
Tracer Lab Monitor SU-3D	1	Beta Gamma	20,000 CPM	2.0	Monitoring
Tracer Lab CS-73	1	Beta Gamma			Measuring
Packard Model 3310 Tricarb Liquid Scintillation Spectrometer	1	Beta			Measuring
Nuclear Chicago Gas Flow Open Faced Counter Model D47(D447)	1	Alpha Beta	100 picocuries	None	

Type	Number	Radiation	Sensitivity	Thickness	Use
Tracer Lab Monitor Model SU-3DTW	1	Beta Gamma	200 picocuries	1.25 mgm/cm^2	Monitoring
ORTEC Ge(Li) Detector For Gamma Rays, Model 8102-0521 XL 2Ke V Resolution	1	Gamma	20 picocuries	0.5 mm	Measuring
EON Portable Survey Meter PSM 700	1	Beta Gamma	20 CPM 0.1 mr/hr	2 mil	Monitoring
Nuclear Chicago Scintillation Detectors DS5-3,DS5-6	2	Beta Gamma	200 picocuries	0.5 mm	Measuring
End Window G.M. Tube With Scaler D501	1	Beta		1 mg/cm^2	
Tracer Lab Monitor	2	Beta		1 mg/cm^2	
TMC 2122 Scintillation Detector	1	Beta Gamma			
Tracer Lab SU-3D	1	Beta Gamma		2.7 mg/cm^2	Monitoring
TMC-DS1A Scintillation Detector	1	Beta Gamma			Measuring
Nuclear Industries D-501 Low Background Flow Counter	1	Alpha Beta		1 mg/cm^2 & 100 ug/cm^2	Measuring
TMC Model SG2A Scaler	3	Beta Gamma	0-400	30-40	Measuring
Nuclear Chicago 1620LS Ratemeter	1	Beta Gamma	0.1-667 (F.S.)	30-40	Measuring
Tracer Lab Model SU-3D	1	Beta Gamma	.13-13 (F.S.)	30-40	Measuring
Nuclear Chicago 2650 Survey Meter	1	Alpha Beta Gamma	.1-100	1.5-2	Monitor
Baird Atomic Abacus 123 Scaler	2	Beta Gamma	0-50	30-40	Measuring

Type	Number	Radiation	Sensitivity	Thickness	Use
Nuclear Chicago Model D--47 with 181B Decade Scaler	1	Alpha Beta		150 ug/cm^2	Measuring
End Window Geiger Tube with Scaler REAC D501	1	Beta			
TMC 2122, Scintillation Well Detector	1	Beta Gamma			
Baird Atomic GM Scaler Model 123A	4	Beta	100,000 CPM		
Baird Atomic Rate Meter, Model 432A	1	Beta			
Atomic Acessories Strip Scanner	1				

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED IN PARAGRAPH 10

METHODS: Mainly calibration is performed using standard sealed sources. Some units are returned to factory for calibration.

FREQUENCY: Use of equipment will determine frequency of calibration. Equipment for courses teaching use and principles of ionizing radiation is calibrated a number of times during semester. In some research projects calibration of instruments is performed prior to experiment and if of any duration will be performed weekly. Instruments are calibrated prior to making surveys or wipe tests.

STANDARDS: Commercial ^{3}H, ^{14}C, and ^{60}Co standards are used.

12. FILM BADGES, DOSIMETERS, AND BIO-ASSAY PROCEDURES USED

Film badge service is provided on a monthly basis by R. S. Landauer, Jr. & Co., Glenwood, Illinois. Additionally dosimeters are used by students taking the radiobiology courses and nuclear physics laboratory training. Individuals involved in operations which utilize ^{3}H, in a form other than sealed or metallic foil, in amounts equal to or greater than 100 millicuries per week shall have bio-assays performed within one week following a single operation and at weekly intervals for continuing operations.

13. FACILITIES AND EQUIPMENT

Fume hoods are available in all laboratories. Brick shielding and remote handling tongs are available in laboratories handling levels of radiation requiring this protection. Lead storage containers are available where levels of radiation necessitate this protection. Gloves will be worn whenever radioactive material is handled.

Rats are housed in an air conditioned animal room (many experiments are done with rat tissue in a laboratory in which case the radioactive material is added to the tissue in the in the laboratory). When radioactive material is fed or injected, the rat is kept in a closed system (Delmar) and the CO_2 collected in sodium hydroxide. Waste materials, the rat carcasses, and glass cage wastings are handled by the researcher. The caretaker does not participate in any phase of the radioactive work.

In other use of animals with radioisotopes used for tracers the chicken intestine segments are placed in a tissue incubation chamber. The tracer is not used on the whole bird.

14. RADIATION PROTECTION PROGRAM

Student training:

1. Working rules and laboratory regulations
2. Survey meter and use discussed and other counting equipment studied
3. Proper handling and dilution techniques
4. Proper bench use such as blotters, etc.
5. Proper clean-up and disposal of waste and potentially contaminated waste
6. Proper storage of materials - glassware marking, etc.

General Laboratory Refulations for Handling Radioisotopes

1. The project leader shall be responsible for:

    a. all personnel who may be exposed to radiation, including visitors, personnel in neighboring laboratories, etc.
    b. Adequate training and supervision of all participating personnel
    c. Securing film badges and physicals where required
    d. Execution of safety measures, clean-up and decontamination procedures
    e. Routine monitoring of his own operation and maintaining records for inspection.
    f. Maintaining inventory and disposition of all isotopes he acquires
    g. Posting proper caution signs
    h. Notifying the Radiation Safety Committee of any substantial changes in working conditions from that proposed on his application
    i. Enforcing all other safety procedures as recommended herein or by the Radiation Safety Committee.

2. A caution sign must be posted on the door of any room containing more than 10 times the LOW LEVEL amount of any isotope or combination thereof. This sign must name the isotope involved, and bear the name, address, and phone number of the project leader and of the Radiation Protection Officer.

3. A monitoring instrument capable of detecting the radiations emitted must be quickly available to any laboratory containing greater than LOW LEVEL amounts of isotopes, and should be used regularly to check for contamination.

4. Containers holding more than LOW LEVEL amounts of isotopes must be labeled with type, amount, and date of measurement (for exceptions see 10CFR20).

5. A shielded storage space must be provided such that the maximum radiation intensity at any accessible place on the outside is no greater than 12mr/day (0.5mr/hr for most areas). It is advised to keep the dose-rate at any normal working area less than 1/10 this amount. The storage space must be clearly marked with radiation symbols, and should preferably be locked. If not locked, then the room must be locked when not in use.

water. The swab will be wiped over the surface of the source or from appropriate accessible surfaces of the device in which the sealed source is permenantly mounted or stored. The swab will be placed in a plastic tube for gamma ray counting.

b. The instrumentation to be used will include a Model 810B Baird Atomic Well-Scintillation Counter with a 1 3/4" Na I (tl) detector set with a descriminator to the radiation from Cobalt-60. The effeciency of the detector will be nominally 30%. The sensitivity of the detector will be nominally 100 picocuries. The scintillation counter is a Baird Atomic single channel analyzer Model 510, sealer Model 988A stable high voltage supply Model 312A.

c. The sensitivity of the test will be 0.1 nanocuries for a 5 minute count. The presence of contamination of 5 nanocuries in excess of background will be the limit of acceptable contamination. This level of contamination will result in the determination of the spectrum of gamma rays using an 8% efficiency Ge (li) detector. If the spectrum is caused by Cobalt-60 contamination, the source will be disposed of by RPO. Records of the leak test will be kept in units of microcuries and maintained for inspection, leak tests will be made at intervals of 6 months.

15. WASTE DISPOSAL

The waste disposal program is a burial operation. All waste radioactive materials and potentially contaminated materials are packaged and held for burial. Burial of radioactive wastes is on a yearly basis. Perishable waste are held in frozen storage and other small volumes are held by laboratory until burial. When required large volumes of waste will be removed from laboratory area and held in isolated storage building until burial.

The University maintains its own approved burial site on State owned land. The site is many miles from University. The site is fenced and marked as a disposal area.

Instructions for packaging wastes:

1. Dry wastes are packaged in plastic bags and boxed in containers usually less than 50 lbs, sealed and labeled.

2. Liquid waste: containers preferably polyethylene, are placed in larger nonbreakable, leakproof containers to contain liquid in case of leakage or breakage. Containers to have securely fitting covers. Care is taken that pH is not altered by addition of acid or alkali in such a manner as to generate heat or gas. Chemical action of waste is considered on container before selection of container. If any, special handling instructions are attached.

3. Animal Carcasses: radioactive carcasses are placed in waterproof polyethylene bags and held in freezer storage. Carcasses held by researcher until burial. Carcasses to be packaged in suitable container for handling and transporation on burial date.

4. A record is kept of quantity and types of radioactive wastes.

5. The total amount of radioactive material put into any one container must be controlled so that radiation level one foot from the container is less than 5 mrads/hr, and the radiation level at contact with any surface of container is less than 200 mrad/hr.

The University records of radioactive waste disposal for the three preceeding years indicates the useage of byproduct material in research at the present and should be the approximate level of useage for a considerable period:

Waste disposal (range for three preceeding years)

Isotope	Range
Carbon 14	2.6 millicuries to 11 millicuries
Hydrogen 3	3 millicuries to 300 millicuries
Phosphorus 32	0.5 millicuries to 2 millicuries
Iodine 131	500 microcuries per year
Iodine 125	160 microcuries per year
Strontium 85	500 microcuries per year
Iron 59	500 microcuries per year
Cobalt 60	500 microcuries per year