FORM NRC-313 I
(1-79)
10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

	a. NEW LICENSE
	b. AMENDMENT TO: LICENSE NUMBER
X	c. RENEWAL OF: LICENSE NUMBER 34-6535-04

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

Ohio Wesleyan University

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
614-369-4431

3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION

L. Thomas Dillman

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
614-369-4431 ext. 900

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

Delaware, Ohio 43015

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

South Sandusky St.
Delaware, Ohio 43015

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	Dr. Lowell Thomas Dillman	Professor of Physics
b.	Dr. Leonard N. Russell	Professor of Physics
c.		

7. RADIATION PROTECTION OFFICER

none

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.

8. LICENSED MATERIAL

LINE NO.	ELEMENT AND MASS NUMBER A	CHEMICAL AND/OR PHYSICAL FORM B	NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)* C	MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME D
(1)	see attached sheet			
(2)				
(3)				
(4)				

	DESCRIBE USE OF LICENSED MATERIAL E
(1)	see attached sheet
(2)	
(3)	
(4)	

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26 pp.

9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)	see page 3 of attached document entitled		
(2)	DETAILED INFORMATION IN SUPPORT OF REQUEST TO AMEND LICENSE TO INCLUDE UP TO 20 mg of Cf-252		
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED *(alpha, beta, gamma, neutron)* E	SENSITIVITY RANGE *(milliroentgens/hour or counts/minute)* F
(1)		see attached sheet				
(2)						
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY NAME, ADDRESS, AND FREQUENCY	☐ b. CALIBRATED BY APPLICANT *Attach a separate sheet describing method, frequency and standards used for calibrating instruments.*

12. PERSONNEL MONITORING DEVICES

TYPE *(Check and/or complete as appropriate.)* A	SUPPLIER *(Service Company)* B	EXCHANGE FREQUENCY C
☐ (1) FILM BADGE ☐ (2) THERMOLUMINESCENCE DOSIMETER *(TLD)* ☒ (3) OTHER *(Specify)*: pocket dosimeters	see attached sheet	☐ MONTHLY ☐ QUARTERLY ☐ OTHER *(Specify)*:

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

☐ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS *(Include filtration, if any)*, ETC.
☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING *(fixed and/or temporary)*, ETC.
☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.
☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC.

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

see attached sheet

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

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

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.–18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)*	b. CERTIFYING OFFICIAL *(Signature)* Lauren R. Wilson
	c. NAME *(Type or print)* Dr. Lauren R. Wilson
(1) LICENSE FEE CATEGORY: 3L	d. TITLE Dean of Academic Affairs
(2) LICENSE FEE ENCLOSED: $ 110.00	e. DATE December 6, 1979

8A Element and Mass Number	8B Chemical and/ or Physical Form	8D Maximum number of millicuries	8C Name of Manufacturer and Model Number (if sealed sources)
(1) Cobalt 60	any	10 millicuries	
(2) Cesium 137	any	10 millicuries	
(3) Sodium 22	any	10 millicuries	
(4) Tin 113	any	10 millicuries	
(5) Mercury 203	any	10 millicuries	
(6) Phosphorus 32	any	10 millicuries	
(7) Phosphorus 33	any	10 millicuries	
(8) Thallium 204	any	10 millicuries	
(9) Promethium 147	any	10 millicuries	
(10) Strontium-ytterium 90	any	10 millicuries	
(11) Americium 241	electroplated on metal disc	1 microcurie	
(12) Protactinium 231	electroplated on metal disc	1 microcurie	
(13) Polonium 210	electroplated on metal disc	1 microcurie	
(14) Thorium 228	electroplated on metal disc	1 microcurie	
(15) Radium 226	electroplated on metal disc	0.01 microcurie	
(16) Californium 252	Sealed sources	10.4 millicuries (20 micrograms)	Savannah River Operations Office Model ALC
(17) Hydrogen 3	Tritiated titanium foil	1 in^2 per target & approx. 1/2 to 1-1/2 curies per target. No more than three (3) undepleted targets will be possessed at any one time.	Radiation Research Corp. model number T-1

02147

8E DESCRIBE USE OF LICENSED MATERIAL

The items (1) through (10) will be used as sources for a thin-lens beta-ray spectrometer. This spectrometer is used in advanced undergraduate physics instruction in nuclear physics. The spectrometer is always used under the direct supervision of Dr. Leonard Russell.

The alpha sources (items (11) through (15) in 8A) will be used for advanced undergraduate laboratory experiments in alpha detection, coincidence studies, etc. All students using these sources will be cautioned concerning the hazards in their use. Dr. Leonard Russell or Dr. L. Thomas Dillman will be in constant and direct supervision during their use for this purpose.

The californium-252 source will be used as specified in amendment number 02 of our license 34-06535-04. See the statements, representations and procedures contained in letters dated February 12, 1974 and March 25, 1974, signed by L. Thomas Dillman. Copies of these two documents are attached.

The tritiated titanium foils will only be stored until such time as our license is amended for a neutron generator. See amendment number 01 to our license number 34-06535-04.

02147

First sent to NRC on February 12, 1974

DETAILED INFORMATION IN SUPPORT OF REQUEST TO AMEND LICENSE TO INCLUDE UP TO 20 μg of Cf-252

1. Specification of the Sealed ^{252}Cf Source

We request approval for up to 20 μg of Cf-252 in one or more sources with either SRCF-100 series or university type encapsulation. At present LSU has earmarked source ULS-67 for us. As of February 15, 1974 it contained 7.04 μg of Cf-252, but another source or sources of similar encapsulation may be substituted. A sheet describing the ULS-67 source is attached along with an additional sheet describing the university type encapsulation.

2. Description of Intended Research and Student Use

The source will be used primarily in routine undergraduate physics experiments in the nuclear sciences. It will be used in our beginning college physics sequence for producing short half-life radionuclides for routine use with Geiger counters in determining half-lifes. It will also be used in the beginning physics sequence to provide neutron activated sources for use with single channel scintillation detectors. The source will be used extensively in our advanced undergraduate nuclear physics course. The uses would include experiments on the "growth" or saturation factor of a radionuclide under neutron bombardment, studies of fast and thermal neutron cross-sections and reactions, measurement of thermal and fast neutron, and various other experiments described in the AEC report (ORAU-102) by Geoffrey I. Gleason and entitled Isotopic Neutron Source Experiments. Experiments using an isotopic neutron source and which have been published in the American Journal of Physics (such as "Undergraduate Experiment to Find Nuclear Sizes by Measuring Total Cross Sections for Fast Neutrons", Amer. J. Phys. 37, 649-654 (1969) or "Mass of the Neutron: A Student Exercise", Amer. J. Phys. 35, 739-742 (1967) will also be among the options for experiments we will choose from. Experiments taken from AEC report TID-25752 and entitled "Program to Evaluate Educational Uses of a CF-252 Source in a Nuclear Science and Engineering Program" will also be used. The equipment used in the advanced undergraduate physics experiments will be scintillation detectors, a multi-channel analyzer and various arrangements of associated electronic gear such as coincidence units, etc.

The ^{252}Cf source will be used in one of two possible configurations. For experiments with thermal neutrons the source will be suspended at the center of a 55 gallon drum filled with water. The source will also be stored in this configuration when not in use. Ports will be provided for lowering a small sample to be irradiated to various distances from the ^{252}Cf source. The samples to be irradiated will be encapsulated in plastic if in liquid or powder form and lowered into position by means of dropping them into hollow plastic tubes and then inserting the plastic tube in the desired port. This will permit easy, rapid and safe insertion and removal of samples to be irradiated.

For experiments with fast neutrons Professor L. Thomas Dillman or Professor Leonard N. Russell will directly supervise the handling of the exposed ^{252}Cf source, stressing to students the care which must be taken, since the potential for significant exposure to neutron and gamma radiation is much greater. The source will always be handled with tongs so that distance from source to nearest body surface of person handling the source is at least 12 inches. For fast neutron experiments the source and sample to be irradiated or neutron detector head will be placed in a room separate

from the room containing the multichannel analyzer and other electronic instrumentation. The students will only enter the room containing the source for short periods of time to change source-detector geometry or retrieve the sample being irradiated.

3. Personnel Exposure Evaluation Provisions

The necessary personnel exposure evaluation provisions are implicit in AEC report SRO-153 which is entitled "Guide for Fabricating and Handling ^{252}Cf sources," dated January 1971. That guide indicates that sealed ^{252}Cf sources containing 0.5 milligrams or less can be considered small and can be handled safely with simple tools such as long-handled forceps or tongs. Since the maximum source size permitted by this license is 20 micrograms, much smaller than the maximum size which AEC report SRO-153 considers to be small, simple tongs will be used to handle the source. The only time possibly significant exposure of personnel will occur is when the source is removed from its normal storage position inside the 55 gallon drum of water to its point of use in fast neutron experiments. The calculational techniques described on pages 8, 9 and 15 of AEC report SRO-153 will be used to estimate personnel exposure during such transfers. Since the dose rate in air at 30 inches (arm's length with tongs) for a 20 microgram ^{252}Cf source is 83 mrem/hour and transfer times will be quite small compared to one hour, the dose to any personnel for any forseeable use of the source will be quite small compared to the total weekly allowance based on continuous exposure. The exposure rate at the surface of the 55 gallon drum of water in which the source will be stored will be clearly marked on a radiation hazard warning sign. (The dose-equivalent rate at the surface of a 55 gallon drum of water for a 20 μg source of Cf-252 is about 62 mrem/hr. About half of this is gamma and about half is neutron produced.)

4. Instructions and Training Provided Students

All students in the beginning physics sequence will use the source only in its normal storage position inside the 55 gallon drum of water. The source will be locked in such a way that beginning students cannot inadvertently remove the source. Therefore, since activities of more than a few microcuries cannot be made with a source of this size and the personnel exposure is expected to be very low, no special instructions above and beyond the usual instructions we give all students in the safe handling techniques for license exempt quantities of radionuclides is anticipated. All students will be introduced to the basic ways the various types of radiation interact with matter and associated health physics principles.

Advanced undergraduate physics students who use the source for fast neutron experiments where significant neutron exposure is possible will have studied in depth the interaction of gamma rays, beta and alpha particles and neutrons with matter. Prior to use of the source they will have instruction in health physics principles including the concept of the rem and maximum permissible doses.

Since the maximum thermal neutron flux will be of the order of 4.7×10^5 n/cm^{2}-sec for the maximum size source permitted by this license (20 μg), we will not have any significant induced radiation hazard. However, students will be warned and precautions will be taken to prevent ingestion or inhalation of any activated substances.

5. Neutron Instrument Calibration Procedures

Ohio Wesleyan possesses 3 neutron sensitive probes which can be used with scalers. One of these is sensitive to both fast and slow neutrons (Nuclear-Chicago model DN-3 neutron probe) and was calibrated at Oak Ridge National Laboratory in the Health Physics Division using a Po^{210} Be neutron source of known strength. This calibration indicated that 0.711 counts/sec is equivalent to 1 mrem/hr for the DN3 probe for the neutron spectrum of Po^{210} Be. The calibration measurements indicated a sensitivity of approximately one count per second for a flux of 10 fast neutrons per square centimeter per second from the Po^{210} Be source. The sensitivity for thermal neutrons (without wax moderator and cadmium shield) is approximately 3 counts per second in a flux of 10 thermal neutrons per square centimeter per second. The other two neutron probes are sensitive to thermal neutrons and will be calibrated relative to the third probe. Until we receive the ^{252}Cf source we have no method of periodically rechecking the calibration of our neutron probes. Upon initial receipt of the ^{252}Cf source of known source strength we will recheck the calibration of our neutron probe against the previous calibration made at ORNL. If a discrepancy appears, we will have the calibration rechecked at ORNL. We will recheck the calibration of the probe at least once every six months thereafter using the ^{252}Cf source as a reference for a known neutron flux. Comparison of thermal neutron detector count rates and activation foil data will be used to recheck the absolute calibration of the detectors. The methods and graphs included in NCRP Report No. 38 on Protection Against Neutron Radiation will be used to convert neutron flux to rem dose.

6. Complete Storage Information

As previously indicated the ^{252}Cf source will be stored in the middle of a 55 gallon drum of water. The port for insertion and removal of the source will be padlocked shut so as to prevent unauthorized removal of the source from its storage position. The drum itself will be stored in a room of inside dimensions approximately 6' by 10' with eight inch thick poured concrete walls. This room was designed for a 200 kev x-ray unit and as a consequence is shielded with 1/4" thick lead on all walls and the door in addition to the poured concrete of the walls. The room will be locked at all times when the neutron source is not in use. The x-ray unit stored in this room is not in use at the present time and we do not intend to use it on a regular basis in the future. Even if it is used, personnel using the x-ray unit are in the room only for short periods of time to set up the experimental arrangement. The x-ray unit is operated from a separate control room.

7. Survey and Monitoring Procedures

We do not anticipate the need for continuous monitoring of the source in its storage configuration. The neutron flux is not expected to be detectable at any point in any unrestricted area. When the source is in use for fast neutron experiments (i.e. removed from the 55 gallon drum of water) the neutron flux near the experimental configuration will be monitored at all times.

8. Leak Test Procedures

The source will be tested for leaks at time of receipt of the source and at least once every six months thereafter. A survey of the surface will be made by means of a smear test on filter paper and then counting the smear with a personnel monitoring probe sensitive to beta and gamma radiations. If more than 0.005 microcuries of ^{252}Cf can be removed from the surface, the source will be considered contaminated and will be sent to Savannah River Laboratory or an authorized disposal ground.

First sent to NRC on March 5, 1974

SUPPLEMENTAL DETAILED INFORMATION IN SUPPORT OF REQUEST TO AMEND LICENSE TO INCLUDE UP TO 20 μg of Cf-252

1. Complete description of the ast neutron experiments.
At the present time we have only two experiments which will be performed with fast neutrons using the surce in an exposed position. One of these is an "Undergraduate Experiment to Find Nuclear Sizes by Measuring Total Cross Sections for Fast Neutrons" by T. C. Minor et. al, Amer. J. Phys. 37, 649 (1969). The source will be mounted inside a hollow plastic tube which has been closed off at one end. The plastic will be thick enough to provide mechanical stability but thin enough so as not to moderate the neutrons significantly. The plastic tube in turn will be held in position by an aluminum ring stand. Due to the low neutron intensity of the source and the nearest distance of 12 inches of any part of the ring stand from the source we do not expect significant radioactivity to be induced in the aluminum. Initial alignment of the plastic source holder, the neutron absorber and/or "shadow bar" and the neutron detector will be made without the neutron source itself being in position. Thus the only time sugnificant exposure is possible is during transfer of the source from its normal storage location to the exposed position used in this experiment.

The second type of fast neutron experiment will be simply to place small samples of material to be irradiated immediately adjacent to the plastic source holder in order to obtain induced radioactivity in the material from fast neutrons, while minimizing the possible interfering effects of slow neutrons. For this type of experiment the source to be irradiated will be secured in place without the neutron source itself being in position. It will be attached to the source holder in such a way that it can be removed quickly and without the need of approaching closer than 12 inches from the source. The normal way this will be accomplished is to type a second hollow plastic tube to the source holder and lower the substance to be irradiated into this tube with a string.

The fast neutron experiments will be carried out in our neutron generator room. In our building we have a room which was explicitly designed for a small accelerator type neutron generator. The shielding was designed for a neutron production of up to 10^{12} neutrons per second. There is a deep pit in this room for such an accelerator type neutron source. However, exclusive of the pit which we not plan to use for the Cf-252 source there is considerable shielding in the walls of this generator room, including an L-type entrance to protect against a direct line of flight of neutrons through the door. A viewing port filled with a mixture of alcohol and water is also provided between the control room and the neutron generator room. Several architectural drawings some of which show the thicknesses of the poured concrete walls of the neutron generator room are attached. In these drawings the neutron generator room is marked in red with the letter N. The three-X-ray rooms, the control room, and toilet which complete the complex of rooms adjacent to the neutron generator room are marked in red with the letters X-1, X-2, X-3, C and T, respectively. The normal storage location of the neutron source is X-1 (see paragraph 4 below).

We expect that the <u>absolute</u> neutron radiation level and any <u>increase</u> in the background gamma radiation level due to the source will be undetectable in the control room and in all adjacent unrestricted areas. After initial checks to verify that this is the case in rooms X-1, X-2, X-3, C and T we do not plan to continuously monitor adjacent unrestricted areas. If the increase in the background radiation due to the presence of the Cf-252 source is detectable in any of these rooms, future use of fast neutron experiments will be scrubbed and only experiments with slow neutrons will be performed or the experiments will be performed in the pit provided for the neutron generator.

As the accompanying diagrams show there is only one access to the neutron generator room. This door will be locked at all times when a fast neutron experiment is in progress with the exposed neutron source in place except for the short intervals of time needed to transfer the source to and from its exposed position or to retrieve an irradiated sample. Supervision of the key to the door lock will be the direst responsibility of Professor L. Thomas Dillman or Professor Leonard N. Russell.

2. Clarification concerning records and restrictions for exposure during fast neutron experiments.
The normal storage location for the Cf-252 neutron source is the room marked X-1 in red on the enclosed drawings. The time required to transfer the source from its storage location to the exposed position in the neutron generator room is estimated to be one-half minute at a maximum. Since the dose rate in air at 30 inches (arm's length with tongs) for a 20 microgram ^{252}Cf source is 83 mrem/hour the expected dose in each transfer will only be of the order of 1 mrem even if we have the largest possible source permitted. However, we will maintain a record book of the exposure of every person involved in a source transfer to or from the exposed position and a record of the exposure to any person who enters the room to retreive irradiated samples. For each such person the record will indicate the name of the individual, the date, the length of time of the exposure, the estimated amount of exposure in mrem, and the nature of the activity which necessitated
the the exposure.

The only sense within which time restrictions will be imposed will be that any given individual will be requested to spend a total maximum of less than five minutes handling the source in any given week. This is comparable to the exposure limit for the population at large suggested by the ICRP of 3 mrem per week since it would correspond to approximately ~~10-15~~ 5-7 mrem. It is unlikely that any individual will approach this upper limit.

3. Amended leak test procedures.
The Cf-252 source will be leak tested at three-month intervals rather than the six months interval originally proposed.

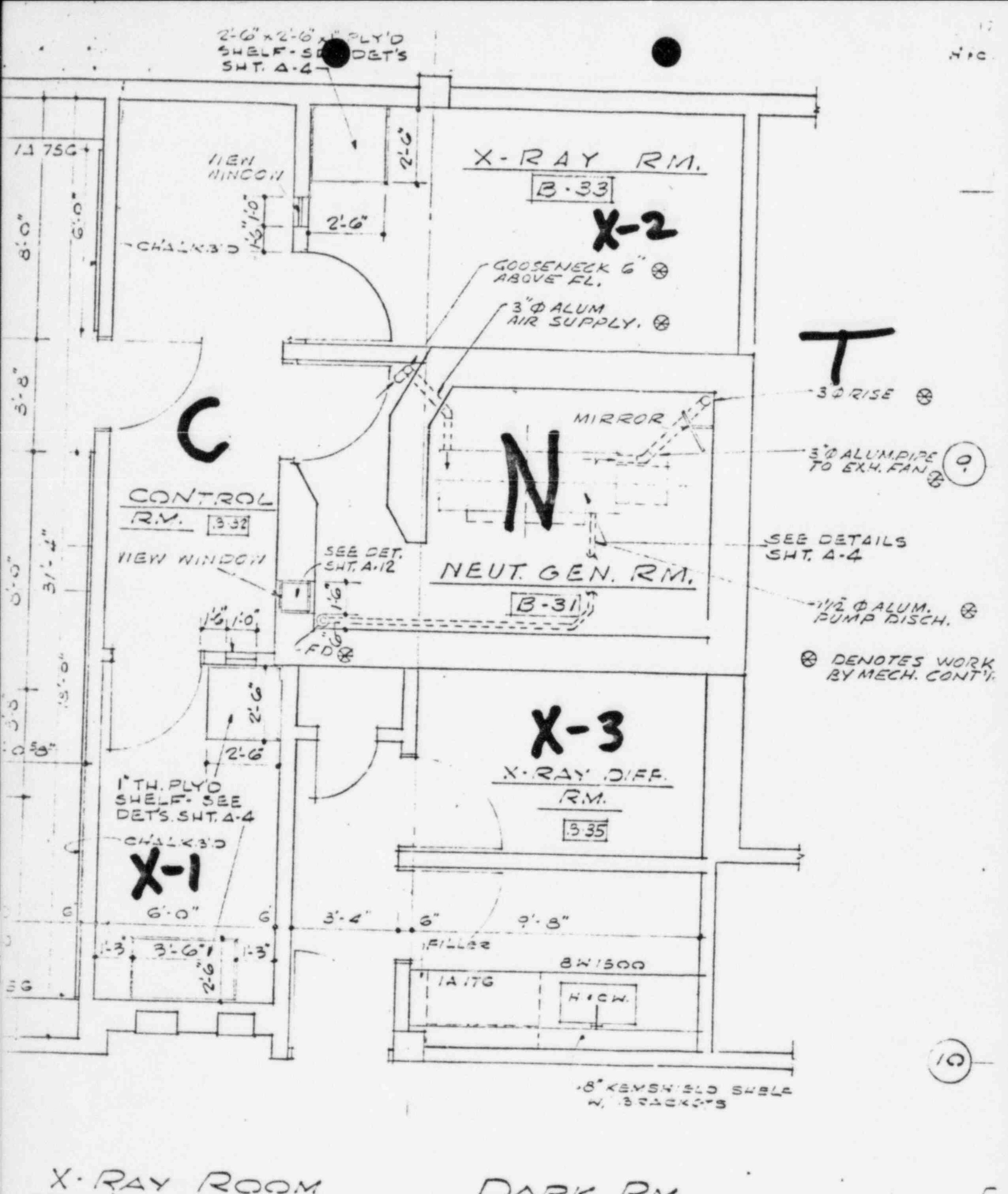
Ohio Wesleyan University has low level sources of Cs-137, Co-60, Na-22 and Cs-134 which are calibrated in absolute intensity (i.e., disintegrations per second) with an accuracy of approximately 5%. These will be used as references to determine the absolute wipe activity levels. For example, the

fission yield of Cs-137 in the spontaneous decay of Cf-252 is known to be 4.4 percent (AEC Conference report CONF-681032, 1969) entitled The Nuclear and Physical Properties of Cf-252). Thus a measurement of the Cs-137 in a wipe with a NaI detector and in a known geometry can allow one to determine the absolute activity of the wipe. This is done by comparison of the activity with that of the standard Cs-137 source in the same geometry.

The above procedure is possible only if the fission products as opposed to the Cf-252 itself leak. If the Cf-252 itself leaks then the characteristic Cs-137 spectrum will be covered up by other prompt gamma ray emissions, from Cf-252. However, the total gamma ray abundance (prompt + equilibrium fission product gammas) in photons/second per gram of Cf-252 and as a function of gamma ray energy is known (AEC Conference report CONF-681032). Thus by measuring the total gamma counting rate of the wipe in a specified energy band and in a specified geometry and by using the calibrated sources (such as Co^{60} if an energy band around 1.2 Mev is used) as references and in the same geometry, one can estimate the absolute activity of the wipe.

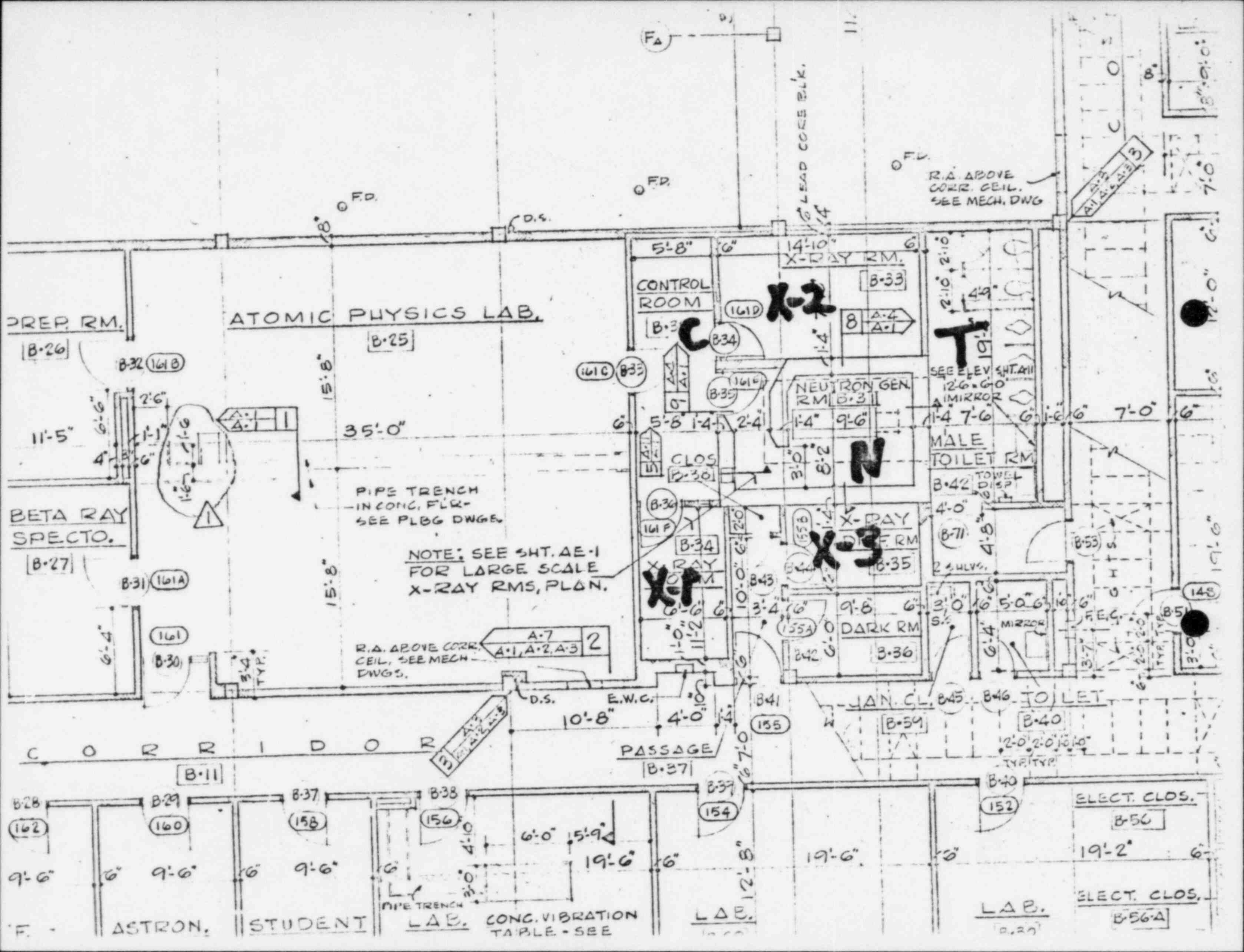
4. Clarification of Storage Information.
Item 6 of the original detailed information in support of request to amend our license to include at Cf-252 source dealt with storage information. The storage room referred to in that item is the room marked in red as X-1 on the attached drawings. One of the attached drawings shows the proposed location within that room of the 55 gallon storage drum for the neutron source. I previously stated that this room had eight inch think poured concrete walls. In reviewing the attached architectural drawings I have dis discovered that the walls are six inche thick lead covered concrete blocks (as previously stated this room was originally designed for a 200 keV X-ray unit).

I do not anticipate that this somewhat less shielding will change any of the other statements previously made. However, if upon receipt of the source we discover that the neutron flux or an increase in the intensity of the background gamma ray spectrum is measurable in any unrestricted area surrounding the storage room, X-1, then the source and 55 gallon storage drum will be transferred permanently to the neutron generator room marked N on the accompanying drawings. We prefer not to do this unless necessary since space in the neutron generator room is at a premimum and we wish to keep it available for other uses.



GENERAL NOTES:

- ALL COUNTERS ... (PHYSICS) TO HAVE



ATOMIC PHYSICS LAB.
B-25
PREP. RM.
B-26
BETA RAY SPECTO.
B-27
CONTROL ROOM
X-RAY RM.
B-33
NEUTRON GEN. RM
CLOS
B-30
X-RAY DIFF RM
B-35
DARK RM
B-36
MALE TOILET RM
B-42
TOWEL DISP
SEE ELEV SHT. A11
MIRROR
2 SHLVS.
F.E.C.
X-2
C
T
N
X-3
X-1
LEAD CORE BLK.
R.A. ABOVE CORR. CEIL. SEE MECH. DWG
PIPE TRENCH IN CONC. FLR - SEE PLBG DWGE.
NOTE: SEE SHT. AE-1 FOR LARGE SCALE X-RAY RMS, PLAN.
R.A. ABOVE CORR. CEIL, SEE MECH DWGS.
35'-0"
15'-8"
14'-10"
5'-8"
11'-5"
D.S.
F.D.
E.W.C.
10'-8"
4'-0"
PASSAGE
B-37
JAN. CL.
B-59
TOILET
B-40
C O R R I D O R
B-11
ELECT. CLOS.
B-56
ELECT. CLOS.
B-56-A
19'-2"
19'-6"
9'-6"
PIPE TRENCH
ASTRON.
STUDENT
LAB.
CONC. VIBRATION TABLE - SEE
LAB.
LAB.

10. Description of Radiation Detection Instruments.

Type of Instruments	Number Available	Radiation detected	Sensitivity Range	Window Thickness	Use
1. Radicon II, Model 555 Integrating Ratemeter Victoreen Instrument Co.	1	X	0-3 mR/min to 0-10 R/min in 8 ranges		calibration monitor survey
2. Roentgen meter, Model 70 Victoreen Instrument Co.	2	X and γ	250 mr/hr or 25 mr/hr full scale		calibration survey
3. Geiger Muller counter, Model DS 57 El Tronics	1	X and γ	speaker circuit		room monitor
4. Model 1613A Geiger Counter and retemeter nuclear Instrument & Chemical Corp.	1	X and γ	0-500 mr/hr 0-5 r/hr 0-50 r/hr		room monitor
5. Pulse Height Analyzer (scintillation) Model 10-2 detector Model 33-1 analyzer Model 49-10 scalar	1	X and γ			measuring
6. Thin lens beta ray spectrometer made at Mound Laboratory, Miamisburg, Ohio	1	β			measuring

7 (continued)

7.	Pulse Height Analyzer Model 40-8C High Voltage supply Model 30-23 double delay line amplifier Model 33-10B single channel Analyzer Model 49-30 Scalar Timer Radiation Instrument Development Laboratory. (for α and β detection we have a RIDL model 49-14 detector bias supply and an Ortex model 805 Vacuum Chamber with a solid state detector which is used in conjunction with this equipment)	2	α, β, γ and			measuring
8.	Technical Measurement Corporation Model 102 100 channel analyzer	1	α, β, γ and X			measuring
9.	Radiation Instrument Development Lab. Model 32-3 Coincidence Unit	1	β and γ			measuring
10.	Radiation Instrument Development Lab. Model 49-50 Scalar and proportional counter power supply with a model RSG 30-A Reuter-Stokes proportional counter tube	2	X and γ	5 mil beryllium		measuring
11.	REAC model E-115 scalar and Geiger counter	1	β and γ		5 mg/cm^2	measuring and survey

7 (continued)

12.	Nuclear-Chicago model 151 A scalars and geiger counters	7	α, β and γ	1.5 mg/cm^2	measuring
13.	Baird Atomic model 135 Scalar timer	2	β	1.4 mg/cm^2	measuring
14.	Victoreen model 740 F cutie pie survey meter	1	α, β, X and γ	0.00025 inches Mylar	survey
15.	Nuclear Chicago Model DN-3 neutron probe	1	fast and slow neutrons		survey, measuring, monitoring
16.	Nuclear Chicago Model 1062 neutron probe, with model NC-000213 detector tubes	2	fast neutrons		survey, measuring, monitoring
17.	Foils for foil activation (Al, Cu, Ni, Au, In)	1 set	neutrons		measuring
18.	Model ST800 M 800 channel multichannel analyzer, The Victoreen Instrument Co., with scintillation and solid state detecting probes	1	α and β (with solid state detectors) X and γ (with scintillation detectors)		measuring

11. Calibration of Radiation Detection Equipment

All gamma detection survey instruments and pocket dosimeters are calibrated once every three months by measuring the dosage rate at specified distances from a 5 millicurie radium-beryllium needle owned by the physics department.

An intercomparison of the dose rate calibration determined by the above method is made with the dose rate measured by the Radicon II, Model 555 Integration Ratemeter. This is a fairly new instrument (purchased in 1974) with an ionization thimble calibrated by the Victoreen Instrument Co., who manufactures the Radicon II.

The model DN-3 neutron probe was calibrated at Oak Ridge National Laboratory. This calibration will be re-checked periodically by comparison with the results of foil activation.

Item 12

All personnel will wear two pocket dosimeters at all times when handling non-licence exempt quantities of byproduct materials and will be required to keep a permanent record of dosage readings. These dosimeters will be calibrated by comparison with the Victoreen r-meter. It is not anticipated that Bio-Assay techniques will be necessary since virtually all isotopes (when used in non-licence exempt amounts) will be used in sealed containers. The preparation of the sealed containers and beta-ray spectrometer sources will be performed under a hood in a special radioactive handling room which is described in item 13.

Item 13. Facilities and Equipment

In the fall of 1968 the Physics Department moved into a new building which has a radioactive handling room, a special room for the thin lens beta ray spectrometer, two x-ray rooms shielded on all sides by high density concrete and lead for up to 250 keV x- and gamma radiation of moderate levels (our x-ray units provide radiation fields up to 200 Roentgens per minute at 200 keV) and a specially shielded room (and associated pit) for our neutron generator. The neutron generator room is designed to reduce the background level of neutrons in the control room to a negligible value for a generator intensity of 10^{11} 14 mev neutrons per second. The shielding for this room and the pit was designed by a professional radiologist under contract with the building architect. We specified to the radiologist that the maximum neutron intensity would be 10^{11} neutrons per second. The pit into which the neutron generator fits is surrounded on all sides by 5 feet of high density concrete plus approximately one foot of polyethylene for thermalization of the neutrons. The pit is 9 feet deep and approximately 2 feet wide by 6 feet long.

All licensed quantities of radio-isotopes are received, opened, tested for leaks, stored and used in room 175 of the new science building, the radioactive handling room. The room is 8' x 20' and contains a work bench, wall cabinets and a fume hood with a special filter mounted on top in the air exhaust system to trap any airborne radioactivity. The air pressure in the room is maintained at a lower level than outside the room so that any radioactive contamination will be contained within the room. The exhaust duct for this fume hood is separate from all other exhausts in the building. All handling of unsealed sources is performed in this fume hood.

In addition to the above built-in equipment, the room contains an old iron safe (6" thick walls) which is used for the storage of radioisotopes. Many of the

sources listed in item 8 are pure alpha or beta or low energy γ emitters and the thick walls of the safe will be quite sufficient to reduce the radiation level to a negligible value. The higher energy gamma emitters will be surrounded by enough lead while stored in the safe to reduce the radiation level outside the safe to a negligible value.

Room 161-E which houses the Californium-252 neutron source has been described in detail in the attached document entitled SUPPLEMENTAL DETAILED INFORMATION IN SUPPORT OF REQUEST TO AMEND LICENSE TO INCLUDE UP TO 20 mg of Cf-252.

14. Waste Disposal Procedures

Relatively small amounts of unsealed radioisotopes are called for in this license request. It is anticipated that the amount of radioactive waste materials to be disposed of will be minimal. Any water soluble radioactive wastes will be disposed of by dilution through the sanitary sewer system in concentrations far below the dilution standards as prescribed in appropriate N.R.C. regulations. It is unlikely that there will be need to dispose of solid radioactive waste materials. However, if it becomes necessary to dispose of small quantities of solid radioactive materials, this will be done by contracting with one of the commercial firms licensed for the purpose. If large quantities of radioactive wastes must be disposed of, the regulatory agency will be requested to provide instructions on how we should proceed. The Cf-252 sealed sources will be returned to the manufacturer.

15. Radiation Protection Program

Although our license permits the use of several radionuclides, they are not used on a routine basis except for the Californium-252 neutron source. Complete description of our survey program for the Cf-252 neutron source is included with the supplementary material attached as part of item 8E. Almost all other uses of radioactive materials involves license exempt quantities of radioisotopes. Because of the infrequent use of licensed quantities of radioactive materials, no routine survey program (except as previously noted for the Californium-252 neutron source) is expected. The area surrounding the safe in the radioactive handling room where radionuclides are stored will be surveyed after receipt of each new shipment of radionuclides. We will survey all areas in the immediate vicinity of the location where the licensed radioactive materials are used at the conclusion of each day of such use. A localized contamination below 0.005 microcuries will be considered acceptable. Records will be kept of all surveys in the log book used to maintain an inventory of licensed radionuclides. This logbook will be kept in the radioactive handling room.

Other specific points in relation to our radiation protection program are:

A. Procedure for examining incoming packages for leakage, contamination or damage, and for safely opening packages.

All incoming packages containing radioactive materials will be visually inspected for evidence of damage. If damage appears evident, smear tests will be made to determine if the external surface is contaminated. All packages containing radioactive materials, whether apparently damaged or not, will be surveyed with a detector sensitive to both beta and gamma rays in order to ascertain that the package can be safely handled. If the survey or physical appearance indicate the possibility of leakage or damage, care will be taken to contain the spread of the contamination and all parts of the packing container will be surveyed for contamination before disposal. All radioactive materials packages will be opened in the filtered hood of our radioactive handling room by a person wearing rubber gloves.

B. Procedure for Ordering Radioactive Materials, and for Receipt of Materials During Off-Duty Hours

Radioactive materials will be ordered through the University's normal procedure. That is, a purchase request will be submitted to the University Purchasing Office for transmittal to the specified supplier of nuclear materials. However, the following additional procedure will be used. The University Purchasing Office will be instructed to specify the attention of Professor L. Thomas Dillman or Professor Leonard N. Russell in the mailing address given to the supplier. The Central Receiving Office of the University will be notified of the purchase order at the time a purchase order is sent to a vendor and an estimated time of arrival of the radioactive material at Ohio Wesleyan will be given. The Central Receiving Office will be asked to notify Professor Leonard N. Russell or Professor L. Thomas Dillman immediately upon receipt of the radioactive materials so that rapid transfer to the ultimate user can be facilitated. (Central Receiving will be asked to contact Professor Russell or Professor Dillman by phone at home addresses, during off-duty hours. We have been informed by Central Receiving that Ohio Wesleyan only receives orders during normal working hours, namely 9:00 a.m. through 5:00 p.m. Monday through Friday, so the above procedure should be adequate.)

C. Type of training required for personnel who are involved in or associated with the use of radioactive materials

Most of our use of radioactive substances involves license exempt levels of radioactivity. All students, even those using license exempt levels of radioactivity are given instructions in safe handling techniques for radioactive substances. However, no extensive background is required of such students.

All uses of non license exempt levels of radioactivity such as students' projects, will be carried out under the direct supervision of Professor Leonard Russell or Professor L. Thomas Dillman. All such students will have had the equivalent of at least 5 weeks of study of the interactions of radiation with matter, radioactivity, modes of radioactive decay, radioactive decay properties and health physics principles of radiation protection. This will be in the form of formal course work in our course in nuclear physics in most cases (taught at the level of P. Arya's bock, Fundamentals of Nuclear Physics). This is a 10 week course but students will not be permitted to handle licensed levels of radioactivity until after at least 5 weeks into the course.

D. The radioactive handling room will be locked at all times when not in use to prevent entry of unauthorized personnel. As stated in a prior item, personnel will be required to wear pocket dosimeters at all times while working with non licence exempt quantities of byproduct materials.

Areas in which non license exempt amounts of byproduct materials are in use will be clearly marked with radiation hazard signs.

As stated in item 8E, the tritium impregnated titanium foil targets will be stored only! The tritium targets, when inspected, will only be handled by Dr. Dillman personally. No method for evaluating radiation exposure to Dr. Dillman from this handling will be used. The rationale behind this is that tritium is not hazardous, even in the Curie amount of the targets we possess as an external emitter. The end point energy of the tritium beta spectrum is such that the dose delivered to the production, maintenance and repair cells of even skin is quite small and zero to essential body organs. There is some bremsstrahlung radiation emitted by these tritium targets but the maximum energy of the bremsstrahlung radiation is low enough to be easily shielded by thin sheets of lead or other materials. The tritium targets will always be handled with tongs to shield (by means of distance) against the bremsstrahlung radiation and to prevent direct contamination of the fingers with tritium.

E. Leak testing procedures

All sealed sources are tested for leaks once every three months by use of wipes on their outer surfaces and on the inside of their containers. The wipes are monitored for activity with a geiger mueller tube. The leak-testing procedures for the neutron source have been adequately described elsewhere.

F. Neutron generator

There are no plans to use a tritium target with the neutron generator at this time. Its function has been supplanted by the Californium-252 neutron source. If future plans call for its use, an amendment to this licence will be requested.

G. Copy of general Safety Instructions

See attached sheet. This sheet is posted in the radioactive handling room.

H. Emergency Procedures and Instructions

During April, 1975, a meeting was arranged between Dr. Leonard N. Russell the Director of Campus Security, the Chief of the Delaware City Fire Department and representatives of the Delaware City Police Department. The above personnel were carefully briefed by Dr. Russell on the location and nature of all of the licensed quantities of radioactive materials in the possession of the physics department. Emergency procedures were discussed and agreed upon by those present. A copy of the current emergency procedures is attached to this memo. Copies of the emergency procedures are posted in the doors leading to rooms 175 and 161-E in the science building and have also been distributed to each of the emergency departments listed above.

(See attached copy of emergency procedures.)

SAFETY INSTRUCTIONS FOR USERS OF RADIOACTIVE MATERIALS

1. You must wear two pocket dosimeters at all times while working directly with licensed radioactive materials. Be sure to read the dosimeters both at the beginning and the conclusion of the use of the radionuclides. Record the dosimeter readings in the log book in the radioactive handling room.

2. Wear latex or rubber gloves while handling radioactive materials.

3. Never bring food or drink into areas where radioactive materials are being used.

4. Use radioactive materials only in areas designated by Professor Russell or Professor Dillman.

5. If in any doubt ~~whether~~ whatever concerning the nature or magnitude of the radiation hazard involved contact Professor Russell or Professor Dillman before proceeding.

6. Contact Professor Russell or Professor Dillman immediately in case of accidents involving radionuclides.

7. Survey yourself for contamination at the conclusion of handling radioactive materials. As a precautionary measure always wash your hands thoroughly after handling radioactive materials.

8. Unsealed sources should only be used in the specially vented hood in the radioactive handling room.

EMERGENCY PROCEDURES FOR ROOMS HOUSING RADIOISOTOPES

1. The doors to room 175 and room 161-E are to be locked at all times except under the supervision of Dr. Dillman or Dr. Russell

2. No inflammable or explosive materials are to be stored in the vicinity of the above two rooms.

3. In the event of an emergency of any type in the vicinity of the above two rooms, the following persons should be notified:

DR. L. Thomas Dillman	(Home Phone - 369-4244)
DR. Leonard N. Russell	(Home Phone - 369-3153)
Campus Security Office	(Ext. 282)

4. In any emergency situation, do not enter the above two rooms until either Dr. Dillman or Dr. Russell is present.

5. In the event of a spill of radioactive materials, it will be the responsibility of either Dr. Dillman or Dr. Russell to determine the extent of the contamination and to take appropriate action.

6. Dr. Dillman or Dr. Russell will request the assistance of campus security in closing off the immediate vicinity of these two rooms if such action is called for.

7. If an emergency situation arises which requires that licensed quantities of radioactive material must be moved from room 175 or room 161-E, Dr. Dillman or Dr. Russell will supervise the transfer of the material to a suitably protected area.

Item 16 for Leonard N. Russell

8. Type of Training	Where Trained	Duration of Training	On the Job	Formal Courses
a. Principles and practices of radiation protection	Ohio State Univ.	3 yrs.	yes	no
	Mound Laboratory	2 yrs.	yes	no
b. Radioactivity measurement standardization and monitoring techniques and instruments	Mound Laboratory	2 yrs.	yes	no
c. Mathematics and calculations basic to the use and measurement of radioactivity	Ohio State Univ.	3yrs.	yes	yes
	Mound Laboratory	2 yrs.	yes	no

Item 16 for L. Thomas Dillman

a. Principles and practices of radiation protection	Univ. of Illinois	3 yrs.	yes	no
	Oak Ridge National Laboratory	1 yr.	yes	no
b. Radioactivity measurement standardization and monitoring techniques and instruments	Univ. of Illinois	3 yrs.	yes	no
	Los Alamos Scientific Lab.	3 mo.		
	Oak Ridge National Laboratory	3 mo.	yes	no
	University of Colorado	6 mo.	yes	no
c. Mathematics and calculations basic to the use and measurement of radioactivity	Univ. of Illinois	3 yrs.	yes	yes
	Oak Ridge National Laboratory	1 yr.	yes	no
d. Biological effects of radiation	Univ. of Illinois	3 yrs.	yes	no
	Oak Ridge National Laboratory	1 yr.	yes	no

Item 17 For Leonard N. Russell

Dr. Russell was employed from June, 1952 to August, 1954 as a reaearch physicist at Mound Laboratory, Miamisburg, Ohio. During that period of time his work included the preceding experience with radio-isotopes:

Isotope	Maximum Amount	Where Experience was Gained	Duration of Experience	Type of Use
Radium-226	5 curies (sealed Capsule)	Mound Laboratory	several months	Gamma-Ray Energy Measurements
Thorium-228	several curies (sealed capsule)	Mound Laboratory	two months	Gamma-Ray Energy Measurements
Actinium-227	about 200 milli-curies (sealed capsule)	Mound Laboratory	several months	Dosage Determination
Strontium-90	25 curies (sealed capsule)	Mound Laboratory	month	Beta-Ray Energy Determination
Cesium-137	1 millicurie	Mound Laboratory	1 year	Source for Beta-Ray Spectrometer
Cobalt-60	1 millicurie	Mound Laboratory	6 months	Source for Beta-Ray Spectrometer
Strontium-90	1 millicurie	Mound Laboratory	6 months	Source for Beta-Ray Spectrometer

Item 17 for L. Thomas Dillman

Cs 137	30 millicuries	Univ. of Ill.	2 yrs.	β-ray spectrometer
C_o 60	5 millicuries	Univ. of Ill.	3 yrs.	Scintillation spectrometer
Sn 113	30 millicucies	univ. of Ill.	2 yrs.	β-ray spectrometer
Hg 203	30 millicuries	Univ. of Ill.	2 yrs.	β-ray spectrometer
Na 22	1 microcurie	Univ. of Ill.	3 yrs.	Scintillation spectrometer
Lu 173	1 microcurie	Univ. of Ill.	2 yrs.	Scintillation spectrometer
Tb 156	1 microcurie	Univ. of Ill.	1 yr.	Scintillation spectrometer
Ra-Be	250 millicuries	Univ. of Ill.	1 mo.	neutron source

SC 44	1 millicurie	Univ. of Colorado	6 mos.	Scintillation spectrometer
Ru 96	100 millicuries	Oak Ridge National Laboratory	6 mos.	q-ray spectrometer and Lithium drifted germinium y-detector
Sc 40	10 microcuries	Univ. of Colorado	6 mos.	Scintillation spectrometer

Also experience at Oak Ridge National Laboratory with up to 50 microcurie amounts of various other gamma emitters which are routinely used for calibration of lithium drifted germanium detectors over a 6 month period. Professor Dillman has been a consultant to the Health and Safety Research Division of Oak Ridge National Laboratory since 1967. His research specialty is radiation dosimetry.