APPLICATION FOR RENEWAL
OF
BYPRODUCT MATERIAL
LICENSE NO. 20-01010-04

10 JUNE 1983

ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

XA

84 pp

FORM NRC-313 I (1-79) 10 CFR 30 — U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

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

a. NEW LICENSE

b. AMENDMENT TO LICENSE NUMBER

c. RENEWAL OF LICENSE NUMBER — X — 20-01010-04

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.

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

Army Material & Mechanics Research Center

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
(617) 923-5225

3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION

William A. Lorenzen

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
(617) 923-5225

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

AMMRC
ATTN: DRXMR-H (Safety Office)
Arsenal St.
Watertown, MA 02172

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

SAME

(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.	Byproduct Material shall be used by, or under the supervision of individuals approved	
b.	by the Center's Radiation Control Committee. Training and experience of users will be evaluated by the AMMRC Radiation Control Committee in accordance with procedures	
c.	set fourth in Appendix A. Experience of Radiation Control Committe members is documented in Supplement A.	

7. RADIATION PROTECTION OFFICER Mr. W. A. Lorenzen
Mr. Charles E. Dady (Alternate)
Mr. John F. Vining III (Alternate)
(See Supplement A)

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

8. LICENSED MATERIAL

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

	E DESCRIBE USE OF LICENSED MATERIAL
(1)	Materials covered in Item 8 will be used in Research and Development as defined
(2)	in section 30.4(q), Title 10, Code of Federal Regulations, Part 30, "Rules of
(3)	General Applicability to Domestic Licensing of Byproduct Material".
(4)	See Supplements D, E and F

FORM NRC-313 I (1-79)

25711

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)			
(2)	See Supplement G		
(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)						
(2)			See Supplement H			
(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.

See Supplement I

12. PERSONNEL MONITORING DEVICES

TYPE (Check and/or complete as appropriate.) A	SUPPLIER (Service Company) B	EXCHANGE FREQUENCY C
☒ (1) FILM BADGE	See Supplement J	☒ MONTHLY
☒ (2) THERMOLUMINESCENCE DOSIMETER (TLD)		☐ QUARTERLY
☐ (3) OTHER (Specify) _____		☐ 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 See Supplement G

☒ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC N/A

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 Supplement K

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)* N/A	b. CERTIFYING OFFICIAL *(Signature)* Edward S. Wright
	c. NAME *(Type or print)* Edward S. Wright
(1) LICENSE FEE CATEGORY:	d. TITLE Director
(2) LICENSE FEE ENCLOSED: $	e. DATE 10 June 1983

FORM NRC 313 ( ) (1 79)

ARMY MATERIALS AND MECHANICS RESEARCH CENTER

Application
for
Renewal of Byproduct Material License 20-01010-04

INDEX

INDEX Continued

SUPPLEMENT A

to

Application for Renewal of Byproduct Material License Number 20-01010-04

Army Materials and Mechanics Research Center
Watertown, Mass. 02172

SUBJECT: Resume of Training and Experience of Radiation Control Committee Members.

Reference: Form NRC-313 (I), Items 7 and 8

MEMBERSHIP OF AMMRC RADIATION CONTROL COMMITTEE[1]

Dr. Gordon A. Bruggeman, Chairman
Mr. William A. Lorenzen, Radiation Protection Officer, Secretary
Mr. Charles E. Dady, Chemist, Alternate Radiation Protection Officer
Mr. John F. Vining, Chief, Safety Office, Alternate Radiation Protection Officer
Cpt. Louis J. Farese, Nuclear Radiation Specialist
Mr. Russell G. Hardy, Metallurgist
Mr. Albert Coates, X-ray Technician
Mrs. Louise M. Miller, Occupational Health Nurse

1. Occasionally, certain individuals on the Radiation Control Committee will be replaced. An effort will be made to replace members with individuals having comparable backgrounds. If either the Radiation Protection Officer or his alternate are replaced, the NRC will be notified within thirty days, however, if other members of the committee are replaced, notification will be made to the NRC the next time the license is amended or renewed.

Supplement A (Cont)

Dr. Gordon Bruggeman

1981 to present	Chief, Prototype Development Division, AMMRC
1968 to 1981	Supervisory Metallurgist in charge of physical metallurgy within the Metals Division of AMMRC. Appointed Chairman of Radiation Control Committee 11 September 1969 under Special Orders No. 73.
1962 - 1968	Metallurgist with duties as principal investigator on various research projects.
1961 - 1962	2nd - 1st Lieutenant, U.S. Army stationed at Aberdeen Proving Ground and Watertown Arsenal Laboratories.
1960 - 1961	Senior Physical Metallurgist, Man Labs Inc., working as principal investigator on metalurgical research projects.
1957 - 1960	Research Assistant, Mass. Institute of Technology, Metallurgy Department.
1955 - 1957	Instructor, Metallurgy Department, M.I.T.
Education and Training	1955 B.S. Metallurgy Mass. Institute of Technology. 1960 SC.D. Metallurgy Mass. Institute of Technology.
Pertinent Experience	Research associated with SC.D. thesis involved diffusion studies using radioisotopes (1957-60). Prior to start of this work, M.I.T. Safety Office required attendace at informal interview and briefing on radiological health hazards and safety procedures. Research at AMMRC (1961-1975) continued various diffusion studies utilizing radioisotope techniques.

Supplement A (Cont)

Mr. William A. Lorenzen

1981 - Present	Health Physicist, Army Materials and Mechanics Research Center, Watertown, MA
1980 - 1981	Safety Technician, Army Materials and Mechanics Research Center, Watertown, MA
1975 - 1980 Co-op Work Program	Civil Engineering Technician, US Dept of Army, Corps of Engineers, Waltham, MA

Education and Training

1978	A.S., Civil Engineering, Wentworth Institute of Technology, Boston, MA
1980	BSET, Civil Engineering Technology, Wentworth Institute of Technology, Boston, MA
1981	Radiological Safety Course, 7K-F3, US Army Chemical School, Fort McClellan, Alabama
1982	Radiation Safety Specialist Course, Oklahoma State University, Tulsa, Oklahoma
1983	Radiation Safety Instrumentation and Compliance Course, Oklahoma State University, Oklahoma City, Oklahoma
Pertinent Experience	As Health Physicist, responsible for: Organizing and Administrating the AMMRC Radiological Safety Program; Providing technical advice and assistance to AMMRC pertaining to the development and implementation of policies for minimizing or eliminating radiation hazards; Developing standing operating procedures for the handling and use of isotopes; conducting operational radiological safety surveys and determining degree of exposure, adequacy of protective measures, controls, and conformance with pertinent regulations; Developing and conducting a radiological safety training program, for both classroom and on-the-job.

Supplement A (Cont)

Mr. Charles E. Dady

1970 - present	Chemist, Army Materials and Mechanics Research Center, Watertown, MA
1962 - 1970	Chief, Radiological Safety Office, Army Materials Research Agency, Watertown, MA
1959 - 1962	Chief, Radiological Safety Office, Ordanance Materials Research Office (OMRO, Watertown, MA)
1957 - 1959	Physical Chemist, Atomic Energy Division, OMRO; on detached duty at Oak Ridge National Laboratory.
1954 - 1957	Analytical Chemist, Analytical Chemistry Branch, Watertown, Arsenal Laboratories.
1952 - 1954	Employed as a chemist in industry.

Education

1952	B.A., Chemistry, Boston University.
1954 - 1957	Graduate courses in Chemistry, Boston College.
1957 - 1958	Vanderbilt University, Graduate School, USAEC courses in radiological physics.
1958 - 1959	Attended Oak Ridge School of Reactor Technology (ORSORT). All prescribed courses, except engineering, were taken.

Pertinent Experience

1958 (Summer)	Field work in Health Physics Division, Oak Ridge National Laboratory (ORNL).
1958 - 1959	Assigned to Health Physics Division, ORNL.
1959 (Summer)	ORNL Reactor Division for reactor operations training.
1969	Certified as a Health Physicist
1970 - 1978	Alternate Radiological Protection Officer

Supplement A (Cont)

Cpt Louis J. Farese

1982 - Present	Member, X-ray and Neutron Analysis Group, Materials Characterization Division, Army Materials and Mechanics Research Center, Watertown, MA
1981 - 1982	Chief, Radiological Division, Professional Training Department, Directorate of Training and Doctrine, U.S. Army Chemical School, Ft. McClellan, AL
1978 - 1981	Instructor, Radiological Division, U.S. Army Ordnance and Chemical Center and School, Aberdeen Proving Ground, MD.

Education and Training

1975	B.S., Biology, Providence College
1978	Radiological Safety Course, U.S. Army Ordnance and Chemical Center, and School, Aberdeen Proving Ground, MD
1979	Laser-Microwave Hazards Course, U.S. Army Environmental Hygiene Agency Edgewood Arsenal, MD
Pertinent Experience	Was responsible for operation of the Radiological Training Laboratory at the U.S. Army Chemical School, providing instruction in the areas of radiological safety and radiological laboratory procedures, and certifying personnel as Radiological Protection Officers (RPO).

Supplement A (Cont)

Mr. John F. Vining III

1981 - Present	Safety Engineer, and Chief, Safety Office, Army Materials and Mechanics Research Center, Watertwon, Mass.
1980 - 1981	Personal service contractor for research and drafting of hazardous waste regulations, Commonwealth of Mass., Dept of Environmental Quality Engineering.
1973 - 1980	Engineer Director (Captain), US Public Health Service, NIOSH, Morgantown, W.VA
1970 - 1973	Senior Engineer (Commander), US Public Health Service, (NIOSH), Cincinatti, OH
1957 - 1968	US Army Sanitary Engineer (Lt and Captain), several tours with the Army Environmental Hygiene Agency, Edgewood Arsenal, MD. CBR Officer on Okinawa for Medical Center.
1955 - 1957	Army enlisted
1954 - 1955	Chemical supervisor, Dupont, NJ

Education

1949 - 1954	B.S., Chemical Engineering, Northeastern University, Boston, MA
1959 - 1960	M.S., University Pittsburgh School of Public Health.
1968 - 1969	Harvard School of Public (Radiological Health).
	Several short courses in Health Physics by Public Health Services and Army.

Supplement A (Cont)

Mr. Russell G. Hardy

1982 - Present	Find reasons for rejections in production of depleted uranium alloy armor piercing projectiles. Recommend methods for reducing rejection rates.
1974 - 1982	Supervisor in charge of uranium melting facility at AMMRC. Principle activity is casting uranium and uranium alloys from depleted uranium.
1960	Chief Metallurgist at Oregon Metallurgy Corporation, melting and casting enriched uranium.
1953	Argonne National Laboratories, LeMont, Illinois. Built and developed uranium melting and casting facility. Produced first shaped uranium castings and ingots for subsequent re-rolling from natural uranium and uranium alloys. Operated foundry for two years.

Education

1943	B.S. in Metallurgical Engineering, Carnegie-Mellon University, Pittsburgh, PA

Supplement A (Cont)

Mr. Albert J. Coates

1981 to present	Non-destructive Test Technician. Responsible for the operation of the AMMRC X-ray Facility, which includes 3 NDT disciplines.
1959 to 1981	NDT Technician at three X-ray facilities at Watertown Arsenal. This included X-ray equipment in the range of 5 KV to 2.5 Mev. and radio-isotopes such as Cobalt-60, Iridium-192 and Radium.

Education and Training

1976	Radio-isotope course, Technical Operations - Burlington, MA.
1964	Radiographic Film Interpretation Course, Watertown Arsenal Training Branch.
1956-1959	Served a 3 year apprenticeship in non-destructive testing at the Watertown Arsenal Laboratory. This included theory and practice in x-ray and gamma radiography, magnetic particle testing and penetrant testing.
Pertinent Experience	Developed NDT procedures and techniques for developmental investigations and failure analysis programs at AMMRC.
	NDT responsibility for 28 helicopter and fixed wing aircraft at Fort Devens, Mass.
	Performed NDT investigations for outside agencies such as... MIT, Fogg Museum, Harvard Univ. Museum of Fine Arts, Mass. State Police, Natick Labs, Dept of Transportation, National Park Service, US Bureau of Alcohol, Tobacco and Firearms, Woods Hole Oceanographic Institute, US Postal Service and Corp of Engineers.
	Has served as a technical expert witness in non-destructive testing.

Supplement A (Cont)

Mrs. Louise Miller, RN

1973 - Present	Occupational Health Nurse, U.S. Army Medical Activity Health Clinic, Army Materials and Mechanics Research Center
1979	Certified as an Occupational Health Nurse.
1979	Industrial Toxicology II course, Southeastern, Massachusetts University
1979	Industrial Health and Hygiene course, Mass. Safety Council, Boston, MA.

SUPPLEMENT B

SUBJECT: Radiation Protection Program at AMMRC

1. This Center will comply with the provisions of:

a. Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation".

b. Army Materials and Mechanics Reseach Center Memorandum Number 15-2, "Boards, Commissions, and Committees-Radiation Control Committee" (Appendix A).

c. Army Materials and Mechanics Research Center Regulation Number 385-4, "Safety-Radiation Protection-Policy and Program" (Appendix B).

d. Army Materials and Mechanics Research Center Safety Procedure Number 385-1, "Standing Operating Procedure, Kaman 14 Mev Neutron Generators" (Appendix C).

e. Army Material and Mechanics Research Center Safety Procedure Number 385-2, "Standing Operating Procedure, Californium-252 Facility" (Appendix D).

f. Army Materials and Mechanics Research Center Safety Procedure Number 385-40, "Standing Operating Procedure, Americium-241" (Appendix E).

g. Army Materials and Mechanics Research Center Safety Procedure Number 385-3, "Standing Operating Procedure, Calibration Lab, Building 97" (Appendix F).

h. Army Materials and Mechanics Research Center Safety Procedure Number 385-26, "Standing Operating Procedure, Calibration Procedure Eberline Portable Neutron Rem Counter Model PNR-4" (Appendix G).

2. Leak tests of sealed sources will be performed by the Radiation Protection Officer and will conform with the following conditions:

a. Each sealed source acquired from another person and containing by-product material with a half-life greater than thirty (30) days and in any form other than gas, shall be tested for contamination and/or leakage prior to use. In the absence of a certificate from a transfer indicating that a test has been made within six (6) months prior to the transfer, the sealed source shall not be put into use until tested.

b. Each sealed source containing byproduct material with a half-life greater than thirty (30) days and in any form other than gas, shall be tested for leakage and/or contamination at intervals not to exceed six (6) months.

c. Leak tests shall be capable of detecting the presence of 0.005 micro-curies of removable contamination on the test sample. The test sample shall

be taken from the sealed source or from appropriate accessible surfaces of the device in which the sealed source is permanently or semi-permanently mounted or stored. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the U.S. Nuclear Regulatory Commission.

d. If the test required in para 2.e reveals the presence of 0.005 microcuries or more of removable contamination, this Agency shall immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with Commission regulations. A report shall be filed within five days of the test with the Director, Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C., 20555, describing the equipment involed, the test results and the corrective action taken. A copy of such report shall be sent to the Director of the appropriate NRC's Inspection and Enforcement Regional Office listed in Appendix D of Title 10, Code of Federal Regulations, Part 20.

3. There is nothing of any environmental significance with the licensed by-product material or it's prescribed uses. There are no controversial environmental issues and there will be no significant impact on the enivronment.

SUPPLEMENT C

SUBJECT: Information and Data Pertaining to Licensed Material

8A* Element & Mass Number	8B* Chemical and/or Physical Form	8C* Name of Manufacturer and Model Number (If sealed source)	8D* Maximum Number of Millicuries and/or Sealed Sources and Maximum Activity per Source which will be Possessed at One Time.
1. Any byproduct material with atomic numbers 3-83, inclusive	Any	N/A	Total not to exceed 100 Curies (Ci)/3.7x10^{12} Becquerel(Bq) Except: I-129 = 0.1 Ci/3.7x10^{9} Bq Sr-90 = 1.0 Ci/3.7x10^{10} Bq I-125 = None I-131 = None P- 32 = None Cs-134 = None
Co-60	Sealed sources	various	Not to exceed 1.0 Ci/3.7x10^{10} Bq
Cs-137	Sealed sources	Various	Not to exceed 5.0 Ci/1.85x10^{11} Bq
Po-210	Sealed Sources	Nuclear Products	Not to exceed 1.0 Ci/3.7X10^{10} Bq
2. H-3	Any	N/A	Total not to exceed 100 Ci/3.7x10^{12} Bq
3. Am-241	Sealed source	New England Nuclear Corp. Model NER-476A	Total not to exceed 5.0 Ci/1.85x10^{11} Bq
4. Cf-252	Sealed sources	Savannah River Operations Office Models SR-CF-100 thru SR-CF-999	Total not to exceed 6.0 Ci/2.22x10^{11} Bq

*NRC Form 313 I Reference Number

SUPPLEMENT D

SUBJECT: Information and Data Pertaining to the use of Tritium in the Neutron Generators

Neutron Generator Facilities

The present systems in use at AMMRC are Kaman Model A-711 generators consisting of a miniature sealed tube accelerator which produces 14.3 Mev neutrons from the ionization of a mixed beam of deuterium and tritium. The accelerating tube is permanently sealed and the ionizing gases within it are repeatedly recycled.

Since all tritium is completely sealed within the tube, the health hazard normally associated with target changing is effectively eliminated. The tube is supplied factory-encased in a pressurized metal dome with tube already mounted inside. Complex facilities previously required for handling tritium are no longer necessary.

Each system is made up of four separate units; a light-weight portable ion accelerator; a refrigerator-type cooling unit; a pressurized tank containing the high voltage power supplies and a small, table-top control console.

The accelerator head consists of a sealed neutron generating tube enclosed within, and insulated from, a stainless steel dome. The tube is a vacuum-tight, miniature ion accelerator which contains a Penning ion source, gas occlusion elements, titanium tritide target, and focusing and accelerating electrodes. In operation, a mixed beam of tritium and deuterium is accelerated into the target. Ions displaced from the target are subsequently absorbed by the gas occlusion elements and accelerated back into the target.

The cooling system is such that all coolants recirculate through the systems, no drain or primary water source is required, and there is no problem of radioactive waste such as would exist with direct water cooling.

High voltage power supplies, of the conventional full-wave voltage doubler type, are contained in a cylindrical tank which is also pressurized with SF_6.

The control unit is a small portable console which contains all instrumentation necessary for completely remote operation of the equipment.

The following specifications apply to the Kaman Model A-711 units:

Type	Positive Ion
Source	Penning ion gage
Voltage	175-190 KV
Target Current	3.0-3.5 ma.
Beam Focus	Fixed, 5/8" dia.

Supplement D (Cont)

Target Type	Mixed deuterium and tritium
Target Strength	Less than 10 curies.
Target Diameter	1 1/4 inch O.D.
Target Location	Less than 1/8 inch from accelerator surface
Neutron Output	Greater than 10^{11} neutrons/second (14.3Mev)
Neutron Flux	Greater than 10^{10} $n/cm^2/sec$ for a 1 cm dia. sample placed on surface of target cooling cap.
Lifetime	Neutron yield greater than 50% of initial yield after 100 hours operation.

Fast neutrons from the $H^3(d,n)He^4$ reaction are being used to perform radiographic examinations of materials and equipment which is of interest to the Army, and also to carry out fast neutron activation analyses on a variety of materials which are being studied to determine their acceptability as construction material for the Army.

SUPPLEMENT E

SUBJECT: Information Pertaining to the use of Americium-241

Americium-241

The Americium source is a double encapsulated sealed source and will be used for x-ray fluorescense within an LEA 68 capsule modified to increase source strength (see Figure V, New England Nuclear Corp. Drawing No. 313-371). The source will be mounted in a New England Nuclear x-ray fluorescence holder, when in use, which will then in turn be mounted on a Kevex Lithium Drifted Silicon Crystal (see Figure V, Am-241,Experimental Set-up). The system will be used to chemically characterize various samples of materials. Due to the low energy of radiation from the Am-241 (Approximately 60 Kev x-rays) the source does not present a significant radiation hazard. All practical measures will be taken to reduce exposures.

SUPPLEMENT F

SUBJECT: Information and Data Pertaining to the Use of Californium-252

Californium-252

The Army Materials and Mechanics Research Center (AMMRC) entered into a contract with the Atomic Energy Commission (AEC) on 1 March 1971 to evaluate the application of a 5 milligram californium-252 source for neutron radiography and other nondestructive testing techniqes. AMMRC received one 5 milligram (2.6 curies) californium-252 source in June 1971. This source was exchanged in September 1976 for a 5.1 milligram (2.69 curies) californium-252 source. A second californium-252 source of .058 milligrams (.031 curies) was received in May 1976.

The Materials Characterization Division, (MCD), the division within AMMRC which is responsible for the use and evaluation of the californium-252, shall evaluate its application in the following program:

1. Develop a system utilizing a low temperature moderator for CF-252 neutrons to produce subthermal neutrons.

2. Perform neutron radiographic examinations utilizing the subthermal neutron system of certain composite materials which are currently under development. Composites of graphite fibers in an aluminum matrix are some of the materials planned for study.

3. Utilize the Cf-252 source for thermal neutron activation analysis of various materials of construction being considered by the army. Such materials include silicon nitride and ceramic compounds.

4. Learn more about the detection system of fast neutron imaging and futher improve its efficiency.

5. Perform thermal neutron radiography of composite and ceramic materials.

SUPPLEMENT G

SUBJECT: Facilities, Equipment, Containers and Special Shielding available at AMMRC

1. Reactor Containment Shell

a. The Reactor Facility - The reactor facility was shut down in 1970 and remains in a standby status under the control of AMMRC Reactor Safeguards Committee. (Reference NRC Facility #R-65)

b. The Californium-252 Facility - The 5.5 curie/2.03x11" Becquerel Californium-252 source is stored and used in the reactor containment shell (See Figure IV). The shipping container, which is now used also for storage of the source, was fabricated from two pressure vessel heads, 54 inches in diameter, separated by a short cylindrical section. (See Figure III.) Borated paraffin, polyethylene, lead and iron were used for shielding. An aluminum tube, 4 feet in length, is used in conveying the source from the storage container to a 5.5 foot diameter water-filled cylindrical tank.

Also sharing the californium-252 source is a commercially-built thermal neutron radiography system designated CFNR-10. This system consists primarily of a biological shield containing water-extended polyester (WEP), a collimator with variable apetures, a shutter and convenient tracks for positioning of items to be radiographed. This system is best suited to routine radiography purposes. Research in radiography is carried out primarily in the other californium-252 systems described.

The source can be positioned between the storage container and the tank for fast neutron irradiation or moved to the center of the water tank for thermal neutron irradiation, or to the CFNR-10, by means of a flexible cable.

The fast neutron area is shielded with "Benelex" sheets and concrete blocks. A mazed walk-in area permits the convenient set-up of fast neutron radiography experiments.

The 5.5 foot diameter water tank has three ports. A boral collimator is inserted into one of the ports for thermal neutron radiography.

A 31.71 millicurie source is also stored and used in the Reactor Containment Shell. The storage container is constructed of lead, Boron and Lithium filled polyethylene blocks, and an outer layer of concrete blocks. The source may be positioned in the storage container so that a 1/2 inch beam port can be used for experimentation.

When the source is positioned such that the beam port is employed, a highly collimated beam is used to detect the presence of hydrogenous materials in mechanical assemblies. The beam port is angled upwards to preclude the possibility of striking an individual standing immediately next to the experimental apparatus. In addition, the beam and experiment is enclosed in

Lithiated paraffin blocks which are contiguous to the storage container. Scatter radiation intensities are not significantly greater than the general background radiation level.

Neutron and beta-gamma survey meters are available to monitor the position of the sources and associated radiation levels. The area also has a continuously operating audible beta-gamma area monitor.

c. The Mobile Neutron Generator Facility - This facility consists of a Kaman Model A-711 neutron generator (14.3 MeV) and moderator assembly configured for neutron radiography situated within a shielded enclosure on the containment shell operating floor. The shielding incorporates a portion of the reactor shield, the 1st balcony floor and the containment shell wall. Additional shielding which encloses this area and forms a maze entrance is provided by solid concrete block walls (See Figure IV).

Since this radiographic system is moveable, an extensive system of interlocks and alarms has been provided for personnel safety. The control console for the radiography system is located outside the shielded area described above and contains a lighted panel which indicates the status of the various radiation monitors and interlocks. The entrance doors to the containment shell and the barrier at the maze entrance are interlocked with the power-on switch for the accelerator. Continuous neutron and x/gamma-ray monitoring is provided by detectors at the location of the control console. A separate x/gamma-ray detector monitors the radiation within the radiography exposure room to provide independent evidence that radiation is being produced. Lighted signs within the exposure area warn of the power being turned on at the accelerator (before radiation is produced) and a scram button is located within that area for defeat of the power turn-on should personnel be there mistakenly.

A system of ultrasonic intrusion alarms is employed to detect motion should personnel be in the exposure area just prior to the high voltage power-on which results in the production of radiation. The high voltage power-on results in the ringing of an alarm bell and activation of a flashing red light within the exposure area, as well as indication at the control console.

Provision is made for continous monitoring of tritium in the air of the exposure room. This monitoring is provided particularly for operations which may involve the disassembly of the accelerator itself.

2. Building 97 - This building is joined to the reactor containment shell by an airlock and is connected to Building 292 by a passageway. Building 97 contains a Neutron Generator Facility, an Americium-241 Facility, Chemistry Laboratories, and a Calibration Facility (See Figure I).

a. Neutron Generator Facility - One AMMRC neutron generator, Kaman Model A-711 is located in Room 145 in Building 97. The walls of this room are poured concrete (6 inches) and shielding around the generator was

fabricated using iron slabs and solid concrete blocks. (See Figure II). The air in the room is discharged directly to the outside via four exhaust ducts. Additionally the air is maintained at a negative pressure with respect to the adjacent cooridor.

A plastic scintillation system is used to monitor neutrons (above 0.5 Mev) during operation of the neutron generator. The system consists of an anthracene scintillation detector, located near the target and a scaler located outside the shielded area.

Portable survey meters capable of monitoring fast and thermal neutrons are available to the experimenter. In the event of a tritium release, swipes taken to evaluate the extent of contamination will be sent to the Natick Army Research and Development Command, Natick, MA, for analysis by scintillation techniques.

b. Americium-241 Facility - The double encapsulated Am-241 source, NEN x-ray florescence holder, and Kevex Lithium drifted silicon crystal assembly is located in Room 143 in Building 97. The walls of this room are poured concrete (6 inches). The room is used for sample analysis and contains various types of counting equipment including several multichannel analyzers.

The room is equipped with a fume hood which contains the Am-241 lead storage pig and a lead shield. This area is used for the loading and unloading of the Am-241 from the NEN x-ray florescence holder to the Am-241 storage pig.

Portable survey meters and audible output monitors are available to the experimenter as well as remote handling devices.

c. Chemistry Laboratories - There are two laboratories in Building 97 (Rms. 144 and 146) which are used for chemistry.

d. Calibration Facility - The calibration facility is a 20 foot by 30 foot building attached to the north end of building 97. This facility, although physically attached to building 97, was constructed with a separate air conditioning system in order to prevent the spread of airborne activity into building 97, in case of a source leak.

The facility is divided into three sections, the high-level calibration area, the low-level calibration area and the utility area.

The high-level area measures six by eighteen feet and is shielded on three sides by poured concrete walls which are 18 inches thick. The source well consists of a steel pipe, twenty-four inches in diameter and twenty-one feet deep. A Cobalt-60 source, used to calibrate high range survey meters, is moved up and down in this well by a remote control device.

The low-level area contains millicurie level cobalt 60 sources for calibrating beta-gamma survey meters up to the range of 200 mr/hr. A plutonium-

IEM11

beryllium neutron source is also used in this area to calibrate fast and thermal neutron meters. This area contains an area for the storage of radioactive material and includes 4 one-foot diameter below-ground-level storage cylinders.

The utility area is used to maintain records as well as repair and maintain the radiation detection instrumentation used in the Health Physics program.

3. Health Physics Laboratory - The Health Physics Laboratory is located on the second floor in building 37. This air-conditioned, 20 foot by 30 foot room, contains a stainless steel, Kewaunee-type exhaust hood and a variety of radiation counting instrumentation. Included in the counting equipment a re-two gas flow proportional counting system with automatic sample changer which are used to evaluate swipes, air samples, and liquid wastes. Other equipment includes film badges, TLD system, personnel dosimeters, beta-gamma and neutron survey meters, radiation sources and calibrated standards. In addition the Health physics laboratory is equipped to provide AMMRC personnel with such items as remote handling tools, storage containers for radioactive material, shielding materials, protective clothing and respirators.

SUPPLEMENT H

TYPE OF INSTRUMENTS

Survey Instruments:	No. Avail	Radiation Detected	Sensitivity Range
G. M. Survey Meter, Nuclear Chicago, Model 2650	3	Beta-Gamma	0-.1,3,1,3,10,30 100 mr/hr
Low Energy Survey Meter, Victoreen, Model 440	4	Alpha and Beta-Gamma	0-3,10,30,100,300 mr/hr
Low Energy Survey meter, Victoreen, Model 440 B	1	Alpha and Beta-Gamma	0-.3,1,3,10,30 mr/hr
G. M. Survey Meter, Eberline Model E-500-B	1	Beta-Gamma	0-.2,2,20,200,2,000 mr/hr
Ionization Chamber Victoreen, Model 592 B	1	Beta-Gamma	0-10,100,1,000 mr/hr
Neutron Detector, Model PNR-4, Eberline	2	Neutrons	0-50,50-5K mrem/hr
Ionization Chamber Victoreen, Model 471	1	Beta-Gamma	0-1,3,10 mr/hr
Ionization Chamber Victoreen, Model 470 A	1	Beta-Gamma	0-30,100,300 mr/hr
BF_3 Neutron Survey Meter, Nuclear Chicago, Model 2671	2	Neutrons	0-75,250,750,2.5K, 7.5K,25K $n/cm^2/sec$
Victoreen Condensor R-meter	1	Gamma	0-250 R
G. M. Neutron Ratemeter Ludlum, Model 15	1 (5 probes)	Alph-Beta Gamma- Neutrons	0-500,0-5,000 0-50,000, 0-500,000 cpm
Digi/Master, Ratemeter Reactor Experiments	1	Beta-Gamma	0-100 mr/hr 0-100 r/hr
Ionization Chamber Eberline, Model RO-2	1	Beta-Gamma	0-5,0-50,0-500 0-5,000 mr/hr

Supplement H (Cont)

Laboratory Moniters:	No. Avail	Radiation Detected	Sensitivity Range
Tracerlab Ratemeters	3	Alpha and Beta-Gamma	0-100,200,500,1K,2K 5K,10K,20K cpm
Technical Associates Radiation Monitor Model SML-2	4	Alpha and Beta-Gamma	0-500,0-5,000 0-50,000,0-500,000 cpm
Area Monitor Dosimeter Corp. Model 3000	1	Beta-Gamma	0-100 mr (Audible)
Area Alarm Meter Ludlum, Model 300	1 (2 Probes)	Gamma	0-1,000 mr/hr
Area Alarm Meter Ludlum, Model 3005	1	Fast Neurton	0-1,000 Mrem/hr
Tritium Sniffer Johnson Assoc., E S-E-1036-17	1	Tritium	> 1 $\mu Ci/M^3$
Personnel Audable Units:			
Radiation Detector Solar Electronics	1	Beta-Gamma	0-.2,1-2,10-20 (variable alarm)
Digital Exprosure Meter Xetex, Model 409A	1	Beta-Gamma	0-1,000 mr (variable alarm)
Radiation Alert Solar Electronics, "Mini" Model	2	Beta-Gamma	0.1-0.3,1-3,10-30
Counting Systems:			
Tracerlab Proportional Counter with Automatic Sample Changer	1	Alpha, Beta	Variable
Searle Analytic Proportional Counter, Model 1152B, with Automatic Sample Changer	1	Alpha, Beta	Variable
Nuclear Data 4410 Multi Channel Gamma Spectrometer	2	Gamma	Variable
TMC 256 Channel Spectrometer	1	Gamma	Variable

Supplement H (Cont)

Laboratory Moniters:	No. Avail	Radiation Detected	Sensitivity Range
Counting Systems:			
Canberra 8603A Muti Channel Analyzer	1	N/A	Variable
Film Badges:			
Dupont Film*			
Whole Body	255	Beta-Gamma	10 mrem-500 rem
	20	Neutron	
Wrist	20	Beta-Gamma	10 mrem-500 rem
Thermoluminescent Dosimetry (TLD):			
Victoreen TLD Model 2800	1	Beta-Gamma	10 mrem-500 rem
Air Samplers:			
Staplex Unico Model #30	2	N/A	35 L/min
Staplex Unico Hurricane	1	N/A	20 cfm
Staplex Hi-V	1	N/A	50 cfm
Fisher Scientific	3	N/A	80 L/min
MSA, Model 5	2	N/A	10 L/min

*The beta-gamma film packet contains two Dupont films in a single envelope. One film covers the lower ranges and the other covers the upper ranges. The films are processed at the Lexington-BlueGrass Army Depot, Lexington, Kentucky, at four or five week intervals.

SUPPLEMENT I

SUBJECT: Method, Frequency and Standards Used in Calibrating Instruments Listed in Supplement G

Instrument	Method	Frequency	Standards
Beta-Gamma Survey Meters	External Sources	Quarterly	Co-60 (4mCi-Apr 78) Ra-266 (500 mg) Co-60 (157mCi-Apr 78)
Neutron Survey Meters	External Sources	Quarterly	Plutonium-Beryllium 5 Curie
Alpha Survey Meters	External Sources	Quarterly	Plutonium and Uranium Oxide Standard Sources
Victoreen "R" Meter	Sent to Blue Grass Army Depot, Lexington, Kentucky	Annually	Co-60, Cs-137, X-rays
Gas-Flow Proportional Counters	External Sources	Before Use	Various Calibration Standards
Multichannel Analyzers	External Sources	Before Use	Various Calibration Standards
TLD System	External Sources	Before Use	Various Calibration Standards

SUPPLEMENT J

SUBJECT: Film Badges, Dosimeters, and Bio-Assay Procedures at AMMRC.

1. Film Badges - The beta-gamma film packet contains two Dupont Films in a single envelope. One film covers the lower ranges and the other covers the upper ranges. The beta-gamma radiation dose range extends from 10 mrem to 500 rem, while the range for x-rays (20 KV-300KV) is 2 mrem to 100 rem.

The neutron film packet contains a Kodak type "B" film. The packet is designed to be energy independent and has a useful range from 36 mrem to 20 rem.

The films are processed at the Lexington Blue Grass Army Depot, Lexington, Kentucky. The films are processed at four or five week intervals.

All personnel assigned to either the Neurton Generator Facility or the Californium-252 Facility are required to wear both beta-gamma and neutron film badges. Personnel assigned to work in other areas where byproduct materials are used will wear badges in accordance with the instructions prescribed in AMMRC Regulation No. 385-4.

2. Dosimeters - Direct reading pencil dosimeters will be worn when required by regulation (See AMMRC Regulation No. 385-4) or when requested by the Radiation Protection Officer or the supervisor of the area.

Number	Range	Detects	Calibration
15	0-200 mr	gamma	6 months
2	0- 5 r	gamma	6 months
10	0-600 r	gamma	6 months

NOTE: 0-600r dosimeters are not routinely used but are available on an "as needed" basis.

3. Bio-Assays - Bio-Assay samples are no longer being collected or processed routinely for AMMRC personnel. Previous license agreements included the requirement of routine bio-assay samples for the determination of tritium for all personnel assigned to the Neutron Generator Facility. This practice was terminated when the new neutron generator system, Kaman Model A-711, was installed. The tritium in the new system is permanently sealed in the accelerator tube. Depleted targets are changed by replacing the complete accelerator tube. The tritium is thus never open to the atmosphere.

Arrangements have been made with the following to perform bio-assay for AMMRC personnel on an "as needed" basis:

a. Murray M. Bolton Jr., Consulting Radiochemist, Room 20B-238, 77 Massachusetts Avenue, Cambridge, MA 02139.

b. U. S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD 21005.

Provided a bio-assay can yield data pertinent to the internal exposure, bio-assay will be required whenever:

a. The individual receives a single exposure to airborne radioactive material in concentrations which if averaged over a period of 24 hours would exceed 10 times the limits specified for such material in 10 CFR 20, Appendix B, Table 1.

b. The individual is routinely engaged in work where there is a likelihood that he will be exposed to airborne concentrations of byproduct material which is 25% of the limits specified for such materials in 10 CFR 20, Appendix B, Table 1.

c. Upon request by the Radiation Control Committee or the Radiation Protection Officer.

SUPPLEMENT K

SUBJECT: Waste Disposal at AMMRC

1. Radioactive wastes will be disposed of in accordance with paragraph 15 of AMMRC Regulation Number 385-4. (See Appendix B)

a. Wastes from Neutron Generator Facility - Tritium is the only byproduct material used at this facility. The depleted tritium tritide targets contained in a sealed generator tube, will be returned to Kaman Nuclear, 1700 Garden of the Gods Road, Colorado Springs, Colorado 80907 for ultimate disposal.

b. Waste from the Californium-252 Facility - The Californium-252 will be returned as a sealed source to the USNRC, Savannah River Operations Office at the termination of the loan agreement.

c. Other Wastes - Any other radioactive wastes will be disposed of in a accordance with instructions from:

Commander
U.S. Army Armament Material Readiness Command (ARRCOM)
ATTN: DRXAR-MAD-CG
Rock Island, Illinois 61201

2. ARRCOM disposes of radioactive wastes in accordance with AR 385-11 for Army Installations. Presently, ARRCOM has a contract with:

Chem-Nuclear System, Inc.
Highway #64
Snelling, S.C. 29812

3. AMMRC will package all radioactive solid wastes and ship them to the current commercial waste disposal service being utilized by ARRCOM.

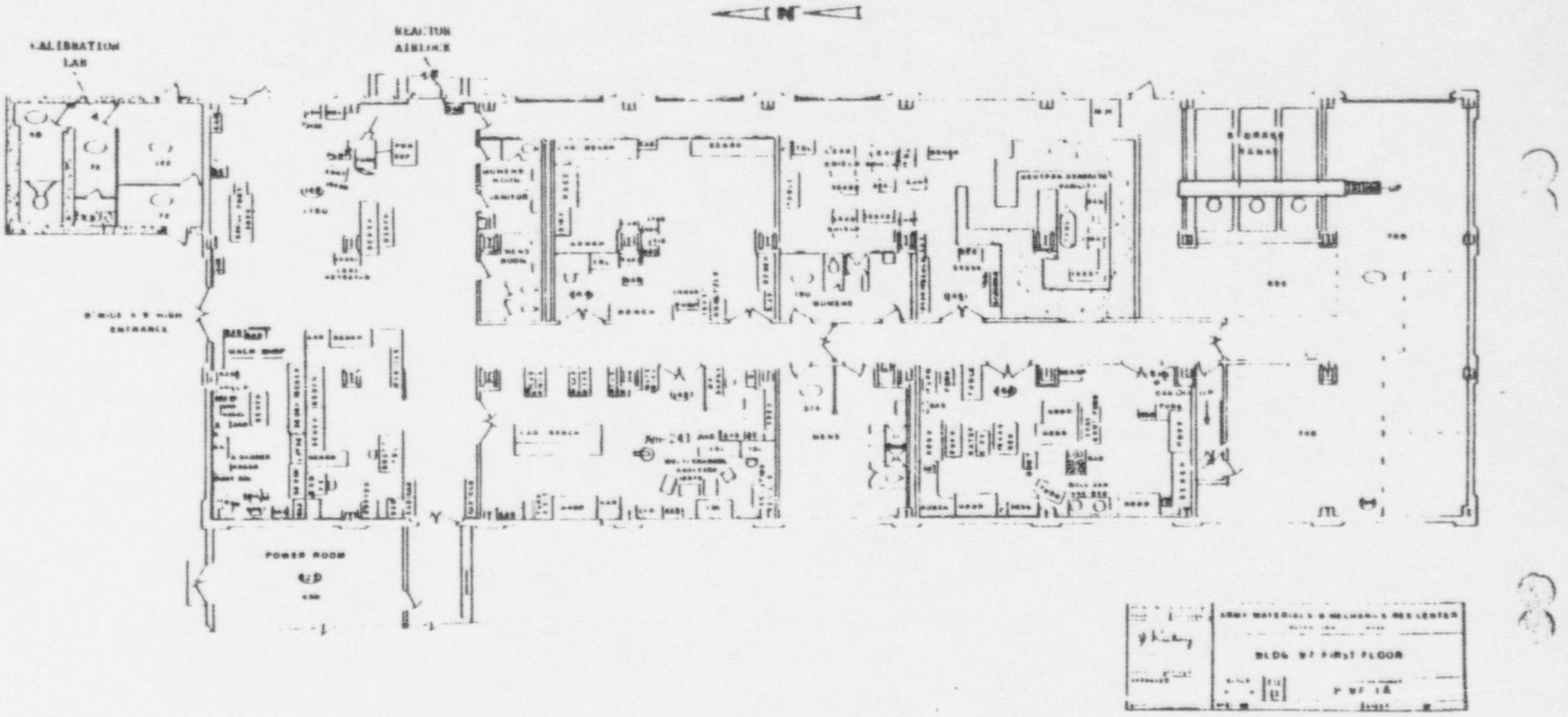


FIGURE I

FIGURE I

ARMY MATERIALS AND MECHANICS RESEARCH CENTER

REQUEST FOR CHANGE TO OCCUPATIONAL HEALTH ROSTER

(Prepare in Quintuplicate)

To: Safety Director From: _____ PART I

Supervisor

It is requested that the following actions be taken: Add to Roster ☐ Remove from Roster ☐ Other ☐

Name _____ Date of Birth _____ Payroll No. _____

Extension _____ Social Security No. _____ Job Title and Grade _____

Organization _____ Branch _____ Bldg. _____ Room _____

Education: Grammar School ☐ High School ☐ College ☐

Previous radiation exposure record; include industrial exposure and medical X-rays other than routine. (Check area of concern)

Ionizing Radiation: Depleted Uranium ☐ Machine-Produced Radiation ☐ Other Radioisotopes ☐

Heavy Metals ☐ Beryllium ☐ Laser ☐ Noise ☐ Other ☐

Brief description of duties involving item(s) checked: _____

_____

_____

_____

Signature _____ Date _____

To: Medical Officer From: Safety Director PART II

Perform physical examination for areas checked in Part I.

Beta-Gamma Badge No. _____ Neutron Badge No. _____

Remarks: _____

_____

_____

_____

Signature _____ Date _____

To: Safety Director From: Medical Officer PART III

Acceptable, no restrictions ☐ Acceptable, with restrictions ☐ _____ _____

Rejected (state reasons) _____

_____

_____

_____

Remarks: _____

_____

_____

Signature _____ Date _____

To: _____ From: Safety Director PART IV

Supervisor

Forwarded for your information and retention.

Signature _____ Date _____

XMR FORM 245
9 FEB 73 Revised

Code: White - R&OSB; Yellow - Employee's Supervisor; Green - Medical Officer; Blue - Suspense (R&OSB); Pink - Suspense (Employee's Supervisor).

FIGURE II

ARMY MATERIALS AND MECHANICS RESEARCH CENTER

REQUEST FOR FILM BADGE MONITORING FOR PERSONNEL NOT REQUIRED TO BE ON THE OCCUPATIONAL HEALTH ROSTER

(Prepare in Quintuplicate)

To: _____ From: Radiation Protection Officer (RPO), R&OSB **PART I**
Supervisor

_____ is not required to be placed on the Occupational Health Roster (OHR) for ionizing radiation (See AMMRC Memorandum No. 385-4 for OHR requirements). In the interest of monitoring low level exposures to ionizing radiation, recommend that subject employee be issued a film badge. Part II should be completed and returned to this office in order that a film badge can be issued.

_____ _____
Signature Date

To: RPO, R&OSB From: _____ **PART II**
Supervisor

Employee's Name _____ Payroll No. _____ Ext. _____

Date of Birth _____ Social Security No. _____

Job Title and Grade _____ Lab/Div _____

Branch _____ Building _____ Room _____

Previous radiation exposure record (include industrial exposure and medical X-rays other than routine). _____

_____

_____

_____

Briefly describe duties which involve possible low level radiation exposure. _____

_____

_____

_____ _____
Signature Date

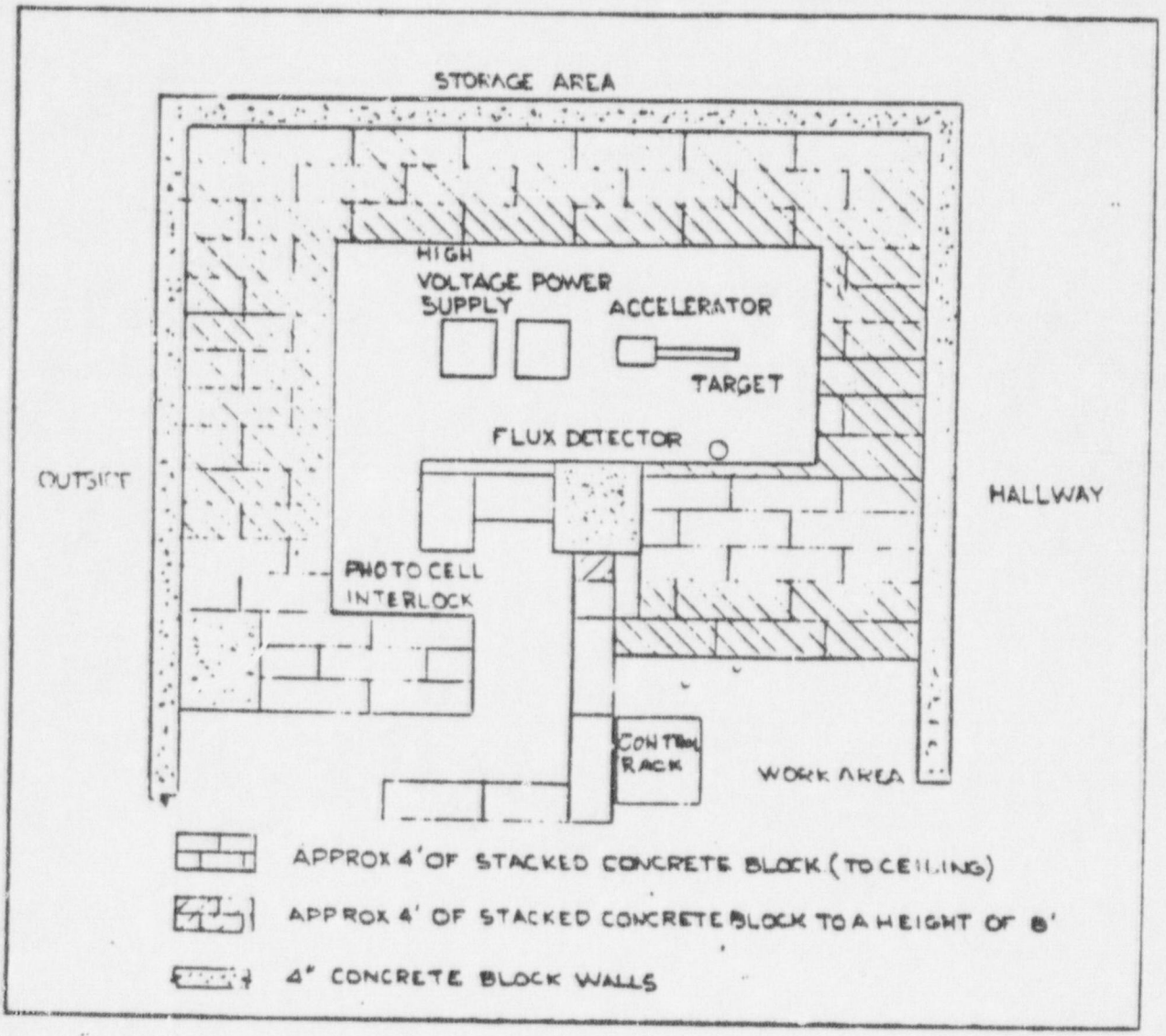
To: _____ From: RPO, R&OSB **PART III**
Supervisor

Beta-gamma film badge has been assigned to above named employee of your organization. Film badge can be picked up at R&OSB, Bldg. 37, and when not in use will be stored in the film badge rack located at Building _____, Room _____

_____ _____
Signature Date

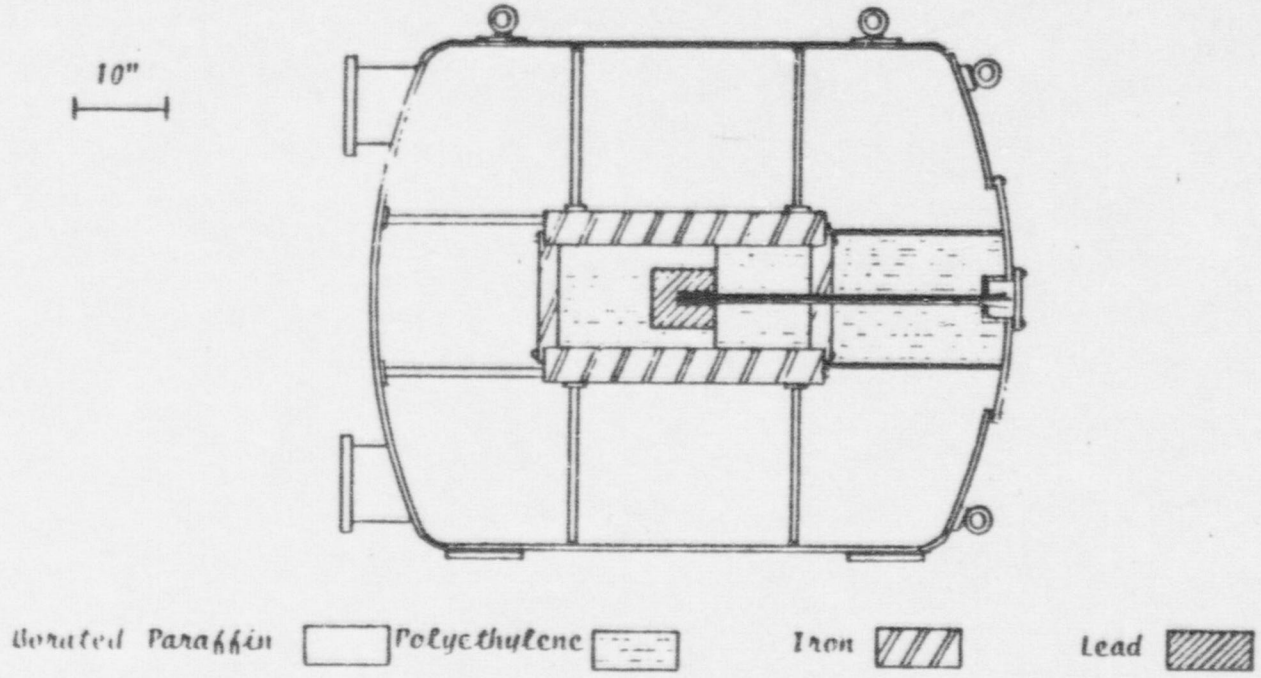
XMR FORM 406
9 FEB 73

Code: White - R&OSB; Yellow - Employee's Supervisor; Green - Employee; Blue - Suspense (R&OSB); Pink - Suspense (Supervisor)



NEUTRON GENERATOR SHIELDING DESIGN
ROOM 145, BLDG 97

FIGURE II



AMMRC CALIFORNIUM-252 SHIPPING CONTAINER

FIGURE III

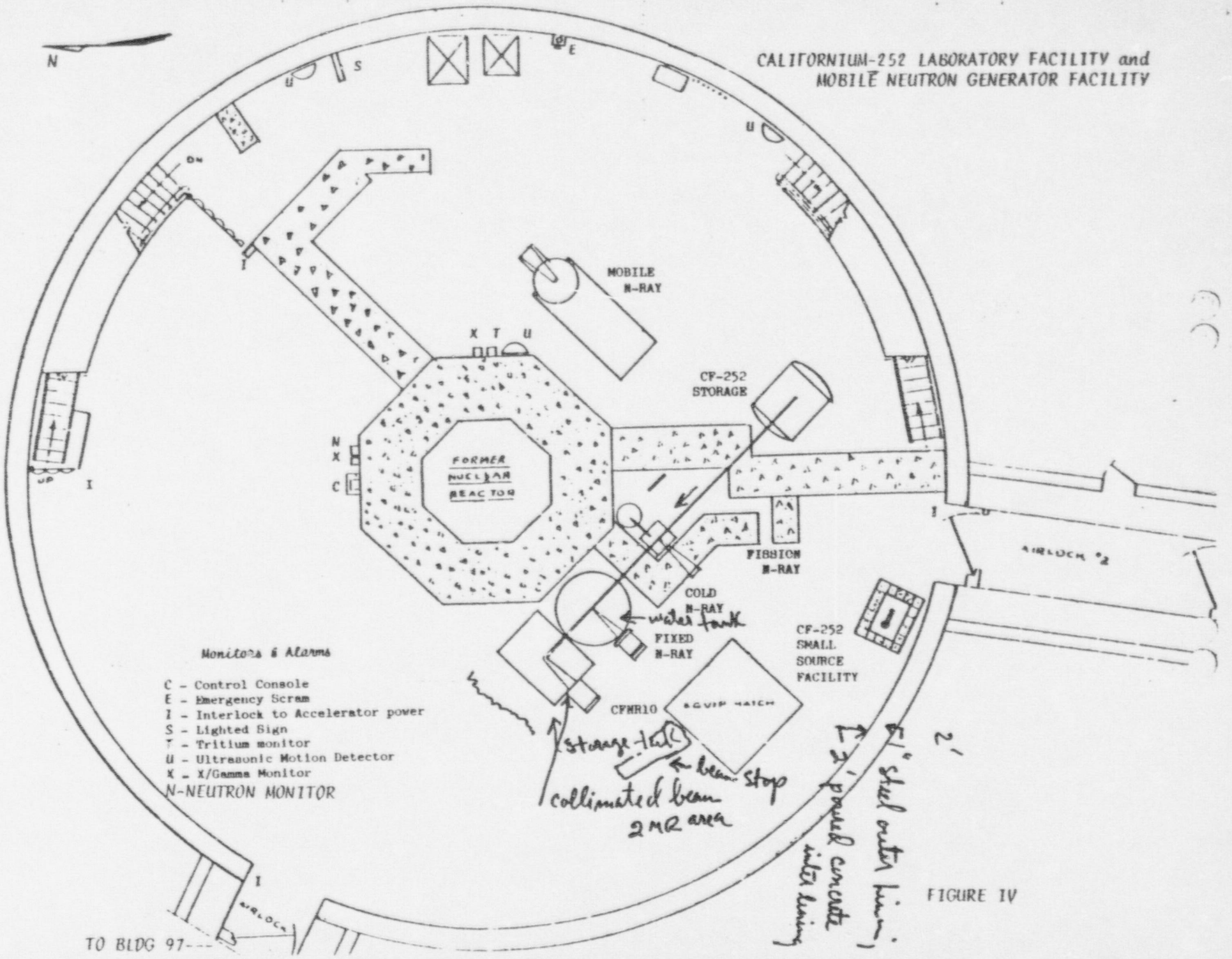
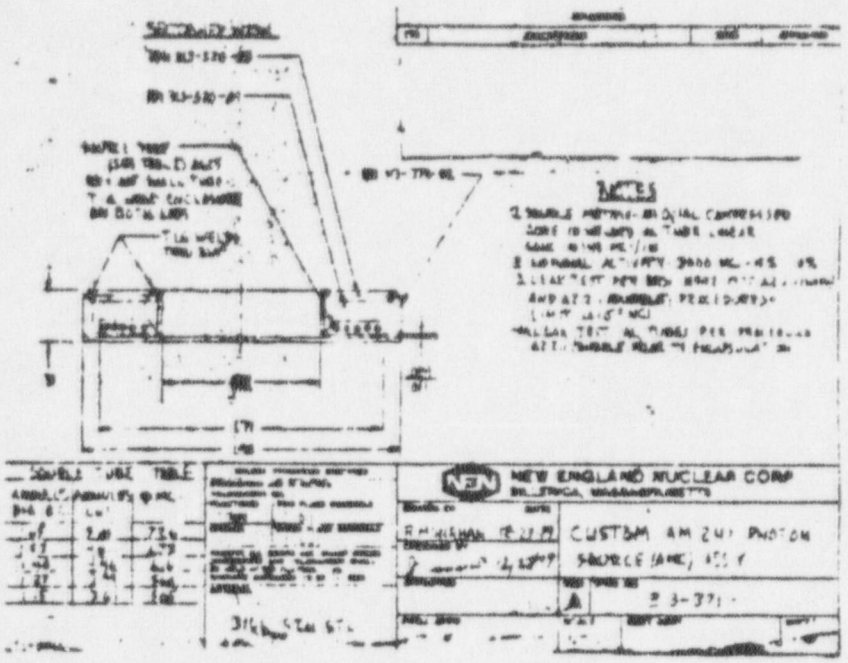
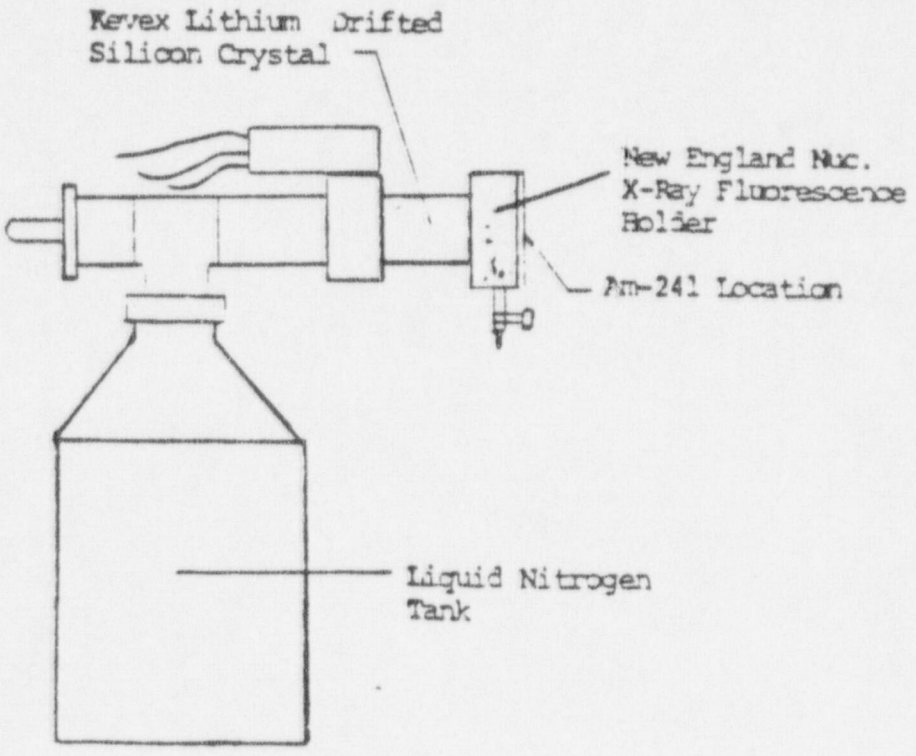

CALIFORNIUM-252 LABORATORY FACILITY and
MOBILE NEUTRON GENERATOR FACILITY
N
S
E
U
DN
I
MOBILE
N-RAY
X T U
CF-252
STORAGE
N
X
C
FORMER
NUCLEAR
REACTOR
FISSION
N-RAY
AIRLOCK #2
COLD
N-RAY
water tank
FIXED
N-RAY
CF-252
SMALL
SOURCE
FACILITY
CFNR10
EQUIP HATCH
storage tank
beam stop
collimated beam
2 MR area
Monitors & Alarms
C - Control Console
E - Emergency Scram
I - Interlock to Accelerator power
S - Lighted Sign
T - Tritium monitor
U - Ultrasonic Motion Detector
X - X/Gamma Monitor
N-NEUTRON MONITOR
TO BLDG 97---
AIRLOCK
2'
steel outer lining
2' poured concrete
inner lining

FIGURE IV

FIGUPE V



NEN MODEL NER-476A in a 1"A68 CAPSULE



(not to scale)

Am-241 EXPERIMENTAL ARRANGEMENT

APPENDIX A

DEPARTMENT OF THE ARMY
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

AMMRC MEMORANDUM
NUMBER 15-2

1 July 1980

Boards, Commissions, and Committees
Radiation Control Committee

1. PURPOSE. To prescribe the responsibilities and procedures of the Radiation Control Committee (RCC).

2. SCOPE. The RCC advises the Director on policy and actions necessary to insure the safe use of material and equipment which produces ionizing radiation, except as they pertain to the nuclear reactor.

3. RESPONSIBILITIES. The Committee will perform the following functions:

a. Recommend to the Director policies on safe use, handling, storage, transport, receipt, shipment, and disposal of sources of ionizing radiation.

b. Review the radiation safety aspects of proposals for the procurement and use of sources of ionizing radiation, the modification of existing radiological operations and operating procedures, and provide recommendations to the Director for appropriate action.

c. Review applications for Nuclear Regulatory Commission (NRC) licenses or Department of the Army authorizations.

d. Review and approve the qualifications of users of materials and equipment which produce ionizing radiation.

e. Review reports of radiation accidents and incidents to determine the cause and recommend appropriate action to the Director.

*This Memorandum supersedes AMMRC Memorandum 15-2, dated 17 April 1980.

4. COMPOSITION OF THE COMMITTEE. a. The Committee is responsible to the Director.

b. The Committee will be appointed on special orders by the Director and will be comprised of the following:

(1) Director's designated representative who will serve as the Chairman

(2) Chief, Occupational Safety and Health Office (OS&HO)

(3) Medical Officer or Occupational Health Nurse

(4) Two senior scientific staff members of AMMRC experienced in safe use of ionizing radiation.

(5) Representative from AFGE Locals 3176 and 3404

c. The Chief, OS&HO, will serve as the Alternate Chairman.

d. The Committee membership will be kept up-to-date. Training and experience resumes for each member of the Committee will be kept on file by the OS&HO. In those cases where the Committtee membership list and resumes are on file at the NRC, the NRC will be advised of membership changes by letter forwarded through the Commander, DARCOM, ATTN: DRCSF-P.

e. In the event of a vacancy on the Committee, the Chairman will nominate a qualified replacement, with the advice of the Committee, for approval by the Director. The appointment will be announced by special orders.

f. Alternates who may represent members of the Committee will be nominated in the same way as members and will be appointed by special orders. Alternates will serve only when the regular member cannot be present.

g. Each member of the Committee, or his appointed alternate, will have voting privileges. Each will have adequate technical background for this assignment.

h. Any member of the Committee may call upon technical experts for advice on proposals under review. Such experts may attend meetings of the Committee but they will withdraw from the meeting when the Committee sits in executive session.

i. A quorum will consist of four members or alternates, as follows: the Chairman; the Chief, OS&HO, and any two other members.

5. MEETINGS. Meetings will be scheduled at least quarterly by the Chairman, but more often if proposals are to be reviewed or other matters have been presented to him for discussion. Subjects discussed and the attendance will be documented. A copy of the minutes will be forwarded to the Commander, DARCOM, ATTN: DRCSF-P.

a. The Chief, OS&HO, will schedule meetings with the concurrence of the Chairman. All matters to be reviewed by the Committee will be submitted to the Chairman.

b. Normally, meetings will be open. The Chairman may call the Committee into executive session to discuss questions of policy.

c. Committee actions on matters involving radiation safety shall receive unanimous approval of members present. Any proposal that has not received unanimous approval shall not be reconsidered at a meeting from which the non-approving member(s) is absent.

d. The Chairman may carry out Committee business without calling the Committee into formal session, provided no action is taken without written concurrence of all Committee members or alternate members who are on site at the time. The members so concurring; however, must constitute a quorum.

e. Any member may rescind a previous approval by writing a memorandum to the Chairman, after which the matter will again be submitted to the Committee for consideration.

f. The Chief, OS&HO, will distribute copies of the minutes to the Director, DD/Cdr, Associate Director and all Committee members and their alternates.

6. PROCESSING OF APPLICATIONS. a. Proposals to utilize sources of ionizing radiation under the jurisdiction of the Committee will be submitted to the Committee on approved forms, [XMR Form 16 and XMR Form 16-1 (Parts A & B)]. The applicant shall submit to the Committee, in writing, his proposed experiment including details of proposed radiation safety precautions. The Committee will review the submitted material and determine whether the proposed experiment can be carried out in such a manner as not to endanger the health and safety of Center personnel, property, or the general public.

b. An AMMRC Memorandum or Safety Procedure will be prepared for approval by the Committee to cover the operation of the particular piece of equipment or facility.

(1) If the requester has submitted previous applications and is currently designated a qualified user by the Committee, requester may omit the completion of XMR Form 16-1, Part B.

(2) Two signed copies of the application will be submitted through channels with approval of the organizational chief to the Chairman, RCC.

(3) The Chairman will provide and forward reproduced copies of each application to all Committee members and announce the date of the meeting at which it will be considered (usually after an interval of one week).

(4) When an application has been approved by the Committee, the Chairman will assign a serial number to the authorization and will sign the two copies of the proposal. The original signed copy will be retained by the OS&HO. The second signed copy will be returned to the applicant, through channels, and will serve as his authorization to proceed with his proposed use of radiation sources.

c. Qualifications of Applicant. (1) In order to determine the adequacy of the qualifications of an individual who desires to use sources of ionizing radiation, the experience and training of the applicant in the following areas will be reviewed:

(a) Radiation Protection

(b) Radioactivity measurements, standardization, and monitoring techniques and instruments; detection and measurement of ionizing radiations.

(c) Mathematics and calculations, basic to the use and measurement of ionizing radiations.

(d) Biological effects of ionizing radiation.

(2) In addition, the amount of training and experience in allied fields and the amount and type of formal education of the applicant are taken into account. His ability to make mature judgments and to use common sense are also considered as well as his attitude toward adherence to rules and regulations.

(3) Applicants must be familiar with pertinent AMMRC, DARCOM, DA, and USNRC regulations.

(4) The information required is provided to the Committee by the filing of XMR Form 16-1.

d. Renewals. Authorizations will be granted for periods not to exceed three years. Renewals will be initiated on newly-prepared (XMR Form 16) prior to the date of expiration.

7. PROCUREMENT OF RADIOACTIVE BYPRODUCT MATERIALS. a. All applications for US NRC licenses, covered under 10 CFR 30, 40, or 70 or DA Authorizations will be prepared by the Chief, OS&HO, and reviewed by the Committee and approved in writing.

b. All requests for procurement of radioactive material will require approval by the Chief, OS&HO. Prior to giving approval, the Chief, OS&HO, will ascertain that the request has been authorized by the Committee, and that the possession limits of the pertinent license are not exceeded.

8. INVENTORIES. a. The OS&HO will maintain inventories of all radioactive material, to insure that possession limits are not exceeded.

b. Users of radioactive material authorized by the Committee and Material Balance Area Accountability Officers will maintain log books and/or inventories of radioactive material in their possession.

9. RECORDS. Minutes of meetings, approved applications, and other pertinent records of the Committee's proceedings will be maintained in a permanent file in the OS&HO.

10. REFERENCES. a. AMMRC-R 385-4, Radiation Protection Policy and Program

b. AMC-R 385-25, Radiation Protection

c. DARCOM Suppl 1 to AR 385-10, The Army Safety Program

d. AMMRC-R 385-1, AMMRC Safety Program

(DRXMR-AR)

FOR THE DIRECTOR:

GEORGE W. SIBERT
Colonel, Infantry
Deputy Director/Commander

OFFICIAL:

PETER H. EGGIMANN
DAC
Actg, Ch, Admin Off

DISTRIBUTION:
B
OS&HO (50 cys)
Publications Control Officer (25 cys)

AMMRC-M 15-2

ARMY MATERIALS AND MECHANICS RESEARCH CENTER

APPLICATION FOR AUTHORIZATION TO USE IONIZING RADIATION SOURCES - PART A

INSTRUCTIONS: Complete all pertinent items, in accordance with AMMRC Regulation 15-2. If authorized as a user within three years, omit Part B. Forward to Chairman, Radiation Control Committee.

1. _____ _____

Name of Applicant Laboratory Branch Location Ext.

2. _____

Areas where sources of ionizing radiation will be used.

3. _____

Previous authorization serial number(s). (If this application is for a renewal, refer to previous serial number).

4. _____

Ionizing radiation sources for which authorization is requested. (Attach a supplementary sheet, if more space is needed).

a. Radioisotope

Element -Symbol	Mass Number	Total amount -mCi	Half-life	Chemical and/or Physical Form. If a sealed source, state name of manufacturer, model number & amount

b. Equipment

Description	Energy	Expected Radiation Levels

5. CERTIFICATION: All information contained in this application is true and correct to the best of my knowledge. I have read and understood AMMRC Regulation 385-4, Radiological Safety Policy and Program, and NRC Regulation No. 10 CFR 20.

DATE _____ _____

(Type name and signature of applicant)

6. APPROVAL of Radiation Control Committee, subject to any condition cited on reverse, under Remarks.

DATE _____ _____

(Type name and signature, Chairman, Radiation Control Committee)

XMR Form 16
17 Apr 80 (Revised)

AUTHORIZATION NO. _____

(complete reverse side)

AMMRC-M 15-2

ARMY MATERIALS AND MECHANICS RESEARCH CENTER

APPLICATION FOR AUTHORIZATION TO USE IONIZING RADIATION SOURCES - PART B

Record your experience and training pertinent to ionizing radiation in detail, listing each training period separately. State where training was obtained, its duration, and whether it was formal or on-the-job; give inclusive dates. If Part B has been updated within three years, it may be omitted, unless pertinent new information is available.

1. TRAINING

   a. Principles and practices of protection:

   b. Radioactivity measurements and monitoring techniques; instrumentation:

   c. Mathematics and calculations, basic to the measurement of radioactivities:

   d. Biological effects of radiation:

   e. Pertinent other training, including college and university courses, degree obtained, with dates and subjects:

2. EXPERIENCE

   List each type of experience separately. Append a second sheet if more space is needed. List sources of ionizing radiation separately or in logical groups, showing maximum amounts or equipment used, installation where experience was gained, duration of experience, and type of use:

DATE _____ _____

(Type name and signature of applicant)

XMR Form 16-1
17 Apr 80 (Revised)

7. Describe the purpose for which each type source of ionizing radiation will be used, in sufficient detail to permit evaluation of potential hazards.

8. Describe laboratory facilities, remote handling equipment, storage containers, shielding, fume hoods, etc. (If already described in a previous authorization, omit details, but cite serial number of permit).

9. Describe radiation protection procedures, including control measures. Cite pertinent sections of AMMRC regulations that permit use of radioactive materials in area. If application covers sources, submit leak testing procedures and arrangements for performing initial radiation survey, servicing, maintaining, and repairing source. Describe waste disposal procedures. Use an extra sheet if more space is needed.

10. Remarks.

FIGURE III

ARMY MATERIALS AND MECHANICS RESEARCH CENTER

PERIODIC PHYSICAL EXAMINATION OCCUPATIONAL HEALTH ROSTER

(Prepare in Triplicate)

Part 1

GENERAL INFORMATION

Date _____

Name: _____ Payroll No. _____ Extension _____

Date of Birth _____ Social Security No. _____

Job Title and Grade _____

Organization _____ Branch _____ Bldg. _____ Room _____

Date of Last Physical Examination _____

Part 2

To: Safety Director
From: Medical Officer

(Check area of concern)

Ionizing Radiation: Depleted Uranium ☐ Machine-Produced Radiation ☐ Other Radioisotopes ☐
Heavy Metals ☐ Beryllium ☐ Laser ☐ Noise ☐ Chemical ☐
Other ☐ (Specify) _____

_____

☐ Acceptable, no restrictions _____

☐ Acceptable, with restrictions _____

☐ Rejected (state reasons) _____

Remarks: _____

_____

_____ _____
Medical Officer Date

Part 3

To: _____
Supervisor

From: Safety Director

☐ Forwarded for your information and retention.

☐ Employee is no longer physically qualified to work with ionizing radiation and should return his film badge to the R&OSB immediately.

☐ Employee is no longer physically qualified to work with _____

_____ _____
Signature Date

CODE: White - R&OSB
Green - Medical Officer
Yellow - Employee's Supervisor

XMR FORM 265
1 MAY 75 (Rev)

APPENDIX

DEFINITIONS

AREA DEFINITIONS:

a. Unrestricted Area. Any are in AMMRC, entry into which is not controlled.

b. Restricted Area. Any area to which access is controlled for the purpose of protection of individuals from exposure to radiation and radioactive materials.

c. Controlled Area. Any area, accessible to personnel in which there exists radiation such that special controls or conditions have been established for the protection of individuals.

d. Uncontrolled Area. Any are in which no special radiation controls or conditions have been established for protection of individuals.

e. Radiation Area. Any area, accessible to personnel, in which there exits radiation at such levels that a major portion of the body could receive in any hour a dose in excess of 2.0 millirem, or in 5 consecutive days a dose in excess of 100 millirem.

f. High Radiation Area. Any area, accessible to personnel, in which there exists radiation at such level that a major portion of the body could receive in any one hour a dose in excess of 100 mrem.

g. Airborne Radioactivity Area. (1) Any room enclosure, or operating area in which airborne radioactive material exist in concentrations in excess of the amounts specified in 10 CFR 20, Appendix B, Table I, Column I; or (2) Any room enclosure, or operating area in which airborne radioactive material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25% of the amount specified in CFR 20, Appendix B, Table I, Column I.

AUTHORIZED USER. An individual whose qualifications to use radioisotopes and/or equipment which produces ionizing radiation has been reviewed and approved by the AMMRC Radiation Control Committee (see AMMRCM 15-2).

BACKGROUND RADIATION. Radiation arising from radioactive material other than the one directly under consideration. Background radiation due to cosmic rays and natural radioactivity is always present. There may also be background radiation due to the presence of radioactive substances in other parts of the building in the building itself, etc.

CONTAMINATION (RADIOACTIVE). Deposition of radioactive material in any place where it is not desired, and particularly in any place where its presence can be harmful, to an experiment or a procedure, or is actually being a source of danger to persons.

CURIE. A unit of activity defined as the quantity of any radioactive nuclide in which the number of disintegrations per second is 3×10^{10}.

a. Millicurie - One-thousandth of a curie (3×10^7 disintegrations per second).

b. Microcurie - One-millionth of a curie (3×10^4 disintegrations per second).

DOSE:

a. Absorbed Dose. When ionizing radiation passes through matter, some of its energy is imparted to the matter. The amount absorbed per unit mass of irradiated material at the place of interest is called the absorbed dose and is measured in rads, where one rad = 100 erg/gm = 1/100 joule/kg. The rad unit is applicable to any type of ionizing radiation, but in reporting dose, the type as well as irradiated material (for instance, tissue), and the place of interest must be specified. Without the above three factors, a statement of absorbed dose received is incomplete and probably useless, since the same dose of different kinds of radiation even delivered to the same place, can produce entirely different effects.

b. Exposure Dose. See EXPOSURE.

c. Biological Dose. The radiation dose absorbed in biological material. It is measured in rems.

DOSE EQUIVALENT. The term "RBE" dose has been used in the past in both radiobiology and radiation safety. It is now recommended that the term RBE be used in radiobiology only and that another term be used for purpose of radiation safety. The linear-energy-transfer factor is multiplied by the absorbed dose, D_a to obtain a quantity that expresses on a common scale the irradiation received by persons exposed to all ionizing radiations. The name recommended for the linear-energy-transfer dependent factor is quality factor QF. Other factors must also be considered for the purposes of radiation safety. A distribution factor, DF, is used to express the modification of the biological effect of radiation due to a nonuniform distribution of isotopes in the body. The distribution factor, like the quality factor, also effects the absorbed dose when radiation safety is being considered. It is recommended by the International Commission on Radiological Units and Measurements that the final calculated dose received by an individual after the absorbed dose is modified by the above-mentioned factor, plus any other factors that may effect the incoming radiation, be called the dose equivalent, DE. If the only apparent modifying factors are QF and DF then:

$$DE = D_a(QF)\ (DF)$$

If other factors must be considered and are defined, then:

$$DE = D_a(QF)\ (DF).....$$

where the dose takes into account the product of these other factors. The unit of dose equivalent, DE is the rem. The unit of absorbed dose, D_a is the rad. (Compare definitions of rad and rem). Although the above definition of dose equivalent does not cover a number of theoretical aspects (in

particular the physical dimensions of some of the quantities) it fulfills the immediate requirement for an unequivocal specification of a scale that may be used for numerical expression in radiation safety.

EXPOSURE. The term "Exposure Dose" is obsolete. Exposure is a term adopted by the International Commission on Radiological Units and Measurements in 1962 to replace the term "exposure dose" introduced in their 1956 report. The quantity is used for X- and gamma radiation. Exposure is the measure at a certain place of radiation which has the ability to produce ionization. The unit of exposure is the roentgen, R, where 1R equals 2.58×10^{-4} coulombs/kilogram. The definition thus corresponds to the terms roentgens dose and air dose.

EXPOSURE OCCUPATIONAL. Exposure to ionizing radiation that is incurred as a result of an individual's employment or duties which are in support of facilities which use materials or machinery capable of producing ionizing radiation. Exposure of an individual to ionizing radiation for medical or dental diagnosis or therapy shall not be deemed as occupational exposure.

FAIL-SAFE. A design characteristic of the hardware, component or system which, in the event of a malfunction, will not result in a degradation of safety.

FILM BADGE. A pack of appropriate photographic film and filters used to determine radiation exposure.

HAZARD, RADIATION. See RADIATION HAZARD.

INTERLOCK. A device, usually electrical and/or mechanical in nature, to prevent activation of a control until a preliminary condition has been met or to prevent hazardous operations. Its purpose usually is safety of personnel or equipment. For example, it may be used to warn responsible personnel of an unsafe condition or unauthorized entry of personnel.

IONIZING RADIATION. See RADIATION.

LEAK TEST. A determination of the integrity of sealed source encapsulation by detection of leakage or escape of radioactive contamination.

NUCLEAR REACTOR SYSTEM. Any equipment or device, except a nuclear weapon capable of neutron multiplication through fission of special nuclear material. This definition includes nuclear reactors and subcritical assemblies of special nuclear material and the supporting equipment or device (if any) associated with them.

RAD. The rad is defined as the unit of absorbed dose of any nuclear (or ionizing) radiation which is accompanied by the liberation of 100 ergs of energy per gram of absorbing material. Or, one rad is approximately equal to absorbed dose delivered when soft tissue is exposed to one roentgen of medium voltage X-radiation. The rad is to be used solely with absorbed dose.

1 rad = 100 erg/gram = 1/100 joule/kg

RADIATION. Energy propagated through space. As used in this regulation, the term refers to two kinds of ionizing radiation:

a. Electromagnetic waves (X-rays and gamma rays), and

b. Corpuscular emissions from radioactive substances or other sources (alpha and beta particles, etc.). Ionizing radiation is any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter.

RADIATION CONTROL COMMITTEE. A group of persons appointed by the Director to advise him on policy and actions necessary to ensure safety of personnel and property from hazards of radiation. Synonymous with "Isotope Committee," "Radiological Health and Safety Committee," "Radiation Protection Committee," and other similar titles of committees with the same purpose.

RADIATION HAZARD. A condition under which persons might receive radiation in excess of the applicable maximum permissible dose, or where radiation damage might be caused to materials or personnel.

RADIATION SOURCES. Materials, equipment or devices which generate or are capable of generating ionizing radiation, including: (1) naturally occurring radioactive material, (2) by-product materials, (3) source materials, (4) Special nuclear materials, (5) fission products, (6) materials containing induced or deposited radioactivity, (7) nuclear reactors, (8) radiographic and fluoroscopic equipment, (9) particle generators and accelerators, and (10) radio frequency generators such as klystrons and magnetrons which produce X-rays.

RADIATION WORKER. Any person occupationally exposed to ionizing radiation and/or radioactive materials. (Job descriptions of radiation workers should reflect that the individual is potentially exposed to ionizing radiation.)

RADIOACTIVE MATERIAL. Any substance which undergoes spontaneous disintegration in which energy is liberated, generally resulting in the formation of new nuclides (a species of atom characterized by the constitution of its nucleus). The process is accompanied by the emission of one or more types of ionizing radiation. Included are materials possessing artificial induced and natural radioactivity.

a. By-product materials. Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to radiation incident to the process of producing or utilizing special nuclear material.

b. Source material. Uranium or thorium or a combination thereof in any physical or chemical form or ores which contain by weight, one-twentieth of one percent (0.05 percent) or more of uranium, thorium or any combination thereof. Source material does not include special nuclear material.

c. Special nuclear material. Plutonium, uranium 233, uranium enriched in the isotope 235 or any other material which the U.S. Atomic Energy Commission pursuant to the provisions of Section 51 of the Atomic Energy Act of 1954, 42 USC Section 2071, determies to be special nuclear materials, but does not include source material: or anv material artificiallv enriched by any of the foregoing but does not include source material.

d. Naturally occurring radioactive material. Substances which are radioactive in the natural state, such as radium and thorium and their decay products, except those defined as source and special nuclear material.

RADIOLOGICAL PROTECTION OFFICER. An individual designated by the Commander to provide consultation on the degree of hazards associated with ionizing radiation and the effectiveness of measures to control these hazards. This individual shall be technically qualified by virtue of education, military training, and/or professional experience to assure a capability commensurate with the assignment. The term "Radiological Protection Officer" is a functional title and is not intended to denote a commissioned status or job classification within the Armed Forces.

RBE. (Relative Biological Effectiveness.) The RBE of a given radiation is defined as the ratio of the absorbed dose in rads of gamma radiation (of a specific energy) to the absorbed dose in rads of the given radiation having same biological effect. (See DOSE EQUIVALENT)

REM. (Roentgen Equivalent Mammal.) One rem is the quantity of ionizing radiation of any type which, when absorbed by man or other mammal produces a physiological effect equivalent to that produced by the absorption of one roentgen of X-ray or gamma radiation. Dose in rems equal RBE times dose in rads. The rem provides an indication of the extent of biological injury (of a given type) that would result from the absorption of nuclear radiation. Thus, the rem is a dose unit of biological effect, whereas the rad is a unit of absorbed energy dose, and the roentgen (for X-ray and gamma rays only) is one of exposure. The rem can also be defined as the unit of dose equivalent. The dose equivalent is numerically equal to the dose in rads, multiplied by the appropriate modifying factors.

ROENTGEN. The quantity of gamma or X-radiation which will give rise to the formation of 2.08×10^9 ion pairs per cubic centimeter of dry air, STP ($0^{\circ}C$, 1 atm). This is equivalent to the release of 87.7 ergs of energy when one gram of dry air under STP conditions is exposed to one roentgen of radiation. The roentgen is to be used solely as the unit for exposure.

$$1\ R = 2.85 \times 10^{-4} \text{ coulombs/kg}$$

SEALED SOURCE. Radioactive material that is encased in and is to be used in a container in a manner to prevent leakage or escape of the radioactive material.

APPENDIX B

DEPARTMENT OF THE ARMY
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

AMMRC REGULATION
No. 385-4*

12 May 1983

Safety
RADIATION PROTECTION - POLICY & PROGRAM

1. PURPOSE. This regulation prescribes the Army Materials and Mechanics Research Center (AMMRC) policy and programpetaining to the protection of personnel and property from unwarranted radiation exposure.

2. SCOPE. A. This regulation pertains to the requirements for procuring, receiving, storing, shipping, using, transporting, maintaining, or disposing of material and/or equipment which produces ionizing radiation.

*This Regulation supersedes AMMRC Regulation 385-4, dtd 22 March 1978.

b. The provisions of this regulation apply to all organizations and employees of AMMRC, guest scientists and personnel on detail to AMMRC from other organizations.

3. POLICY. All operations involving ionizing radiation-producing material and equipment will be conducted in such a manner as to maintain radiation exposures to personnel as low as reasonable achievable (ALARA). Operations involving ionizing radiation shall be planned so that the limits established by NRC, DA, DARCOM, OSHA, and AMMRC regulations are not exceeded.

4. RESPONSIBILITIES. a. The Chief, Safety Office, is responsible for all aspects of the AMMRC Occupational Safety and Health (OSH) Program.

b. The Radiation Protection Officer (RPO), as a staff member of the Safety Office, will perform, as an integral part of the overall AMMRC Safety Program, the actions required to establish and maintain preventive measures to safegaurd personnel and equipment from harmful effects of ionizing radiation. Responsiblities of the RPO are delineated in DARCOM-R 385-25.

c. Radiation Control Committee (RCC) advises the Director on policy and actions necessary to insure the safe use of material and equipment which produces ionizing radiation. Responsiblities of the RCC are outlined in AMMRC Memorandum 15-2.

d. Reactor Safeguards Committee (RSC) reviews, evaluates, and approves all aspects of maintenance and radiological safety for the former nuclear reactor which is in standby status. Responsibilities of the RSC are outlined in AMMRC Memorandum 15-1.

e. The MEDDAC Health Clinic at AMMRC is responsible for providing medical examinations in support of the Safety Program as required by higher authority within the provisions of this regulation.

f. Chiefs of operating organizations utilizing radioactive materials or equipment which produces ionizing radiation are responsible to the Commander for establishing and implementing the radiological safety program in their respective organizations. The program will be consistent with the guidelines established in this regulation. The responsibilities of an organizational chief include:

(1) Complying with and enforcing the radiological safety requirements prescribed in this regulation, and radiation safety requirements applicable to all the operations for which he/she is responsible.

(2) Assuring that his personnel are properly instructed and trained in the requirements for working with any radioactive materials or radiation producing equipment which is under his jurisdiction.

(3) Assuring that all equipment and facilities are operated in accordance with established procedures to minimize radiation hazards to personnel and contamination of equipment.

(4) Assuring that prior to the start of any operation involving radioactive material or possible exposure to radiation not covered by a procedure or RCC authorization, a Radiation Work Permit (RWP) is properly completed for review and approval by the RPO.

(5) Assuring that an AMMRC Procedure is prepared covering work which is performed at a frequency which makes the completion of RWP's impractical. Such procedures will be submitted to the Safety Office for review and approval by the Radiation Control Committee.

(6) Providing necessary space and facilities for the Safety Office to carry out prescribed monitoring programs in his/her area.

g. Supervisors of radiation workers or radiological projects are responsible for:

(1) Being familiar with the radiological safety requirements prescribed in this regulation and radiation safety requirements applicable to all the operations for which he is responsible.

(2) Requesting placement on the Occupational Health Roster (OHR), XMR Form 245, Figure 1, of all personnel under his/her control who are likely to receive an accumulated dose of radiation in excess of 5 percent of the applicable quarterly limit.

(3) Assuring that his personnel are instructed in requirements for working with radioactive materials or radiation equipment and compliance with applicable rules and regulations governing radiological safety.

(4) Assuring that required monitoring devices, protective clothing and equipment, and contamination control methods are used.

(5) Assuring that all equipment and facilities are operated in accordance with established procedure to minimize radiation exposure to personnel and contamination of equipment.

(6) Notifying the Safety Office in advance of any scheduled maintenance or repair work which may involve radiation exposure or the release of radioactive materials not covered by an approved standing operating procedure (SOP).

(7) Obtaining recommendations of the Safety Officein nonroutine operations where radiation exposure or contamination is involved.

(8) Preparing SOP's covering the use, handling, operations and storage of ionizing radiation producing material and equipment.

(9) Posting NRC Form 3 in the immediate work area and posting the following documents or the location where they may be found:

(a) NRC Form 3

(b) NRC license applicable to the area

(c) 10 CFR Part 19

(d) 10 CFR Part 20

(e) 10 CFR Part 21

(f) 10 CFR Part 30 (By-Product Material Only)

(g) 10 CFR Part 40 (Source Material Only)

(h) 10 CFR Part 50 (Nuclear Reactor Only)

(i) 10 CFR Part 70 (Special Nuclear Material Only)

(j) Section 206 of the Energy Reorganization Act of 1974

(k) Copy of the regulation

(l) Copy of AMMRC procedures pertinent to operations in the area pertaining to radiation

(m) DA authorization applicable to the area

(n) AMMRC Memorandum 385-15

(10) Limiting working times so as to control the total radiation exposures of personnel within prescribed limits.

(11) Keeping informed on the radiation exposure status of personnel under his control.

(12) Maintaining control of visitors.

(13) Reporting to the chief of the operational organization any violation of these regulations or failure to follow prescribed procedures by any individual in his area.

(14) Ensuring that radiological safety surveys are conducted at least weekly reporting any abnormal results to the RPO, and maintaining permanent records of these surveys.

(15) Inform the Safety Office by telephone (ext. 5225 or 5605) as soon as he/she knows that an individual on the Occupational Health Roster is to separate from employment, complete XMR Form 245, and forward it to the

Safety Office for processing.

h. The individual is responsible for:

(1) Completing Form NRC-4 and/or DD Form 1952 upon request by the Safety Office. Form NRC-4 and DD Form 1152 are furnished by the Safety Office.

(2) Keeping his daily exposures to radiation as low as practicable.

(3) Wearing prescribed monitoring devices.

(4) Wearing prescribed protective clothing whenever contamination is possible and removing clothing before entering "clean" areas.

(5) Using respiratory protective devices when prescribed.

(6) Using prescribed techniques and facilities in operations involving radioactive materials, in accordance with organizational SOP's or RWP's.

(7) Complying with restrictions on drinking, eating and smoking.

(8) Reporting wounds, ingestion accidents, and other incidents involving radioactive material promptly to his supervisor, Safety Office, and MEDDAC Health Clinic.

(9) Being familiar with the radiological safety requirements prescribed in this regulation and SOP covering his operation.

(10) Roping off working areas, posting warning signs, properly labeling waste containers, and otherwise controlling special radiation hazards for which he is responsible.

(11) Limiting the volume of radioactive wastes.

(12) Cleaning up any contamination he generates following prescribed procedures.

(13) Properly storing and handling radioactive materials.

(14) Recording data in accordance with organizational SOP's.

(15) Complying with all sections of this regulation and with posted pertinent NRC, DA, DARCOM, OSHA, and AMMRC regulations or posting their location.

5. CONTROL OF RADIOACTIVE MATERIAL IN AMMRC. a. Procurement of radioactive material. All requests for procurement of radioactive materials will receive the concurrence of the Safety Office before being forwarded to the Procurement Office.

b. Receiving and Shipping. All radioactive material being shipped to or from AMMRC will be cleared by the RPO in accordance with AR 385-11.

c. Internal Transfer of Radioactive Materials. Internal transfer of radioactive material will be made only between authorized users. Each such user will maintain an inventory of all radioactive material under his control and will notify the RPO prior to transferring the control of any radioactive material to other authorized users.

d. Disposal of Radioactive Material. The RPO will be responsible for insuring that radioactive materials are disposed of in accordance with AR 385-11. The RPO will be consulted prior to the disposal of any radioactive materials. Disposal of radioactive effluents (liquids or gases) into unrestricted areas will be carried out in accordance with 10 CFR Part 20 and under the direction of the RPO.

6. PERSONNEL DOSIMETER. a. Personnel who are likely to receive an accumulated dose of radiation in excess of 5 percent of that tabulated in paragraph 7.a will be placed on the OHR for ionizing radiation. Personnel on the OHR will be issued film badges and/or thermoluminescent dosimeters (TLD), and will be subject to periodic medical examinations in accordance with paragraph 9.

b. Personnel who either because of the limited time they are required in radiation areas and/or because their exposures are expected to be less than that permitted for the population at large, i.e., 500 mrem per year, may be issued film badges (XMR Form 406), Figure 2, without being placed on the OHR. These badges will be used to obtain data on low radiation exposures which, in accordance with AR 40-14, do not require official monitoring or maintenance of radiation exposure records on DD Form 1141. Personnel in this category will not require periodic medical examinations nor maintenance of a DD Form 1141.

c. Personnel on the OHR who receive medical exposure (other than routine chest and dental x-rays) or who receive industrial exposures under circumstances that the exposure is not recorded on their film badges are responsible for notifying the RPO. The RPO will forward applicable exposure information to the Medical Officer for inclusion in their DD-1141 Form.

d. AMMRC personnel who may be occupationally exposed to ionizing radiation outside of AMMRC will wear film badges issued by the Safety Office.

e. Personnel on the OHR may request a copy of their radiation exposure to date from the MEDDAC Health Clinic at AMMRC.

7. PERSONNEL EXPOSURE LIMITS. The radiation exposure standards contained in this paragraph are applicable to all personnel. Exposures incurred during examination or treatment for medical or dental purposes are not to be included in calculations for compliance with this paragraph.

a. In order to be permitted to receive the maximum exposures listed in the following table, the individual must (1) be at least 18 years of age; (2) be occupationally exposed; (3) have on file with the MEDDAC Health Clinic

a complete NRC-4 Form, DD Form 1952 or equivalent and (4) meet the restrictions of Section b of this paragraph.

TYPE OF EXPOSURE	PERIOD OF EXPOSURE	DOSE (REM)
Whole body, hand and trunk, active blood-forming organs, gonads or lens of eye.	accumulated calendar qtr	*5 (N-18) 3
Hand and forearms, feet and ankles	calendar qtr calendar year	18 3/4 75
Skin of whole body or thyroid	calendar qtr calendar year	7 1/2 30

*N = age of individual
Note: Beta radiation should be counted as skin dose.

b. An individual who has not completed Form NRC-4, or equivalent, an individual employed at age 18 or an individual beyond age 18 who has received the maximum allowable dose shall not be exposed during ensuing year to whole body doses exceeding:

(1) 1.25 rem for first calendar quarter.

(2) 2.5 rem total for first two quarters.

(3) 3.75 rem total for first three quarters.

(4) 5 rem for the year.

c. Members of the general public, personnel not occupationally exposed and persons who are less than 18 years of age will not be exposed in excess of .500 rem in any calendar year.

d. An individual exposed to external and internal radiation must have his total dose considered and recorded.

e. When an individual has received an exposure in excess of the quarterly limit, he shall be removed from duties involving radiation exposures until subsequent exposure limits are established through consultation with the medical officer. When an individual exceeds a yearly limit, he will be removed from duties involving radiation exposure until his records are reviewed by Headquarters, DARCOM, and subsequent limits established. When an individual exceed the 5(N-18) dose, he will be removed from duties involving radiation exposures until his records are reviewed by the DA, Surgeon General, and subsequent limits established.

8. EXPOSURES ASSOCIATED WITH ACCIDENTS OR EMERGENCIES. It is recognized that there may be accidents or emergencies in which an overexposure should be accepted in order to prevent serious body injury or property damage.

a. In "planned emergency" action, i.e. action which is taken following some preparation, twenty-five (25) rem should be considered the maximum allowable dose.

b. To prevent serious body injury or death of an individual, the maximum considered dose should not exceed 100 rem.

9. MEDICAL EXAMINATIONS. a. Radiation workers on the OHR will be given a pre-employment examination. Personnel who are to be occupationally exposed to neutrons will be given a slit-lamp test prior to assignment to duty.

b. Visitors and personnel on temporary duty for less than 30 days do not require a medical examination provided they will not be exposed to radiation in excess of 1.25 rem per quarter or to airborne radioactivity in excess of the limits established in 10 CFR 20, Appendix B, Table II.

c. All personnel on the OHR will be given medical examinations at least yearly. XMR Form 245 will be used for initial and termination examinations. XMR Form 265, Figure 3, will be used for periodic examinations.

d. Upon termination of employment or removal from the OHR the individual will be given a medical examination.

10. TRAINING OF PERSONNEL. Personnel, including guest scientists, who will be exposed to radiation and/or radioactive materials will be given training in accordance with the instruction prescribed in DARCOM Reg 385-25. A record of training will be recorded and placed in each employee's official personnel folder. The Safety Office will arrange for required training in conjunction with the Training Officer.

11. GENERAL PROCEDURES FOR RADIATION CONTROLLED AREAS. These rules constitute the basic techniques and procedures to be followed in restricted area:

a. Smoking, drinking and eating are prohibited in airborne radioactivity areas and contamination areas.

b. Refrigerators will not be used to store food or beverage in airborne radioactivity areas or contamination areas.

c. Location of radiation sources will be clearly indicated.

d. Properly labeled and suitable containers will be available for radioactive waste.

e. Protective clothing and monitoring devices will be worn when required.

f. No one shall work with radioactive material with open or uncovered

wounds. Appropriate gloves, bandages, or coverings are allowed if approved by the RPO.

g. Custodial personnel will only wet-mop and vacuum-clean areas where radioactive contamination may be present. Dusting and sweeping will not be allowed. Vacuum cleaners used in radiation areas will be approved by the RPO.

12. RADIATION SURVEYS. The Safety Office is responsible for performing radiation surveys and ensuring that radiation surveys are performed by others in accordance with the following:

a. Initial Surveys. An initial survey will be made by the RPO of sites and areas where sources of radiation will be used and/or stored, before an operation involving radiation is initiated or changes approved, or upon installation of a device which produces ionizing radiation.

b. Routine Surveys by the Safety Office. Surveys of each area in which sources of radiation are used and/or stored shall be performed by the Safety Office at least once each month. Areas of static storage shall be surveyed at least once every three months. The radiation hazards incident to the production, use, release, disposal, or presence of evaluation includes a physical survey of the location of materials and equipment, measurements of levels of radiation and/or concentrations of radioactive material in and around the site. Locations of the monitoring points with the results, statement of the hazard, and any recommendations as to decontamination, shielding, procedural changes, etc., will be recorded.

c. Operational Surveys. Operating organizations will survey their areas at least weekly to insure that their operations are within the limits prescribed by this regulation.

d. Special Surveys. The RPO is responsible for performing the following special surveys:

(1) Non-routine operations involving radioactive materials or radiation producing equipment where there is a resonable probability of any individual being exposed in excess of 2 mrem in one hour.

(2) Receipt or shipment of radioactive materials. Packages of radioactive materials for shipment will be checked for external radiation level, leakage probability, contamination, and proper labeling. Packages of radioactive materials received at AMMRC will be surveyed by the RPO prior to their delivery to the individual who is reponsible for their use.

(3) Termination of a project involving radioactive materials. A survey will be performed to determine that no contamination exists and that sources of radiation are properly stored or have been disposed of properly.

(4) Unplanned Events. Loss of control, spill, overexposure, or any unplanned event which could adversely or did adversely affect the safety of the operation will be investigated by the RPO.

(5) Hazardous operations. Particularly hazardous operations will be continuously monitored.

(6) Leak Tests. Leak tests of sealed sources will be performed at least once every 6 months except for alpha sealed sources that are not in storage which will be performed at least every 3 months.

13. CALIBRATION OF METERS. The Safety Office is responsible for the calibration of all portable radiation survey meters.

a. All portable radiation survey meters, unless labeled CBU, will be calibrated at least every 3 months and after each maintenance or battery charge. Instruments will be calibrated at a minimum of 2 points on each scale.

b. Pencil dosimeters assigned to individuals will be calibrated at 6 month intervals. Others will be CBU.

14. PURCHASE OF METERS. The Safety Office should be consulted prior to the purchase of survey meters or other meters to be used for radiation protection in order that the type and variety of meters at AMMRC can be kept to a minimum This procedure is adopted to minimize spare parts requirements as well as to facilitate the maintenance and calibration of meters.

15. WASTE DISPOSAL. a. The Safety Office is responsible for insuring that unwanted radioactive materials are disposed of in accordance with AR 385-11.

b. Radioactive waste may be released to the environment or unrestricted areas provided that the maximum permissible average concentration for the particular isotope or combination of isotopes given in 10 CFR 20, Appendix B, Table II, is not exceeded at the point of release unless otherwise authorized by the U.S. Nuclear Regulatory Commission.

c. The concentration of liquid waste released to the environment shall conform to 10 CFR 20.

d. Storage areas and containers for radioactive materials will be approved by the Safety Office.

16. NRC LICENSES AND DEPARTMENT OF THE ARMY AUTHORIZATIONS. AMMRC will be guided by the procedures in AR 385-11 when applying for NRC Licenses and Department of the Army Authorizations.

17. AMMRC AUTHORIZATION TO USE RADIOACTIVE MATERIALS. Personnel wishing to use radioactive materials at AMMRC must apply to the AMMRC Radiation Control Committee before purchasing or using radioactive material. See AMMRC Regulations 15-2 for details.

18. PURCHASE REQUESTS INVOLVING RADIOACTIVE MATERIALS OR EQUIPMENT PRODUCING IONIZING RADIATION. All requests for purchase of or services involving radioactive materials or equipment producing ionizing radiation shall be submitted to the RPO for approval.

19. KEY EMERGENCY PERSONNEL. Key emergency personnel will be kept currently informed of the receipt, storage, use, disposal, or transfer of radiation sources and will be sufficiently trained and equipped to cope with radiological emergencies independent of the presence of the RPO. The Intelligence and Security Office will maintain a current listing of personnel to be called in on emergencies.

20. ON-POST TRANSPORTATION OF RADIOACTIVE MATERIALS. Within an installation, it is usually not convenient to package and transport radioactive materials in the manner required for off-post shipment. However, the following precautions will be observed:

In loading the vehicles:

a. Keep within the weight limitations.

b. Limit or arrange cargo to keep radiation levels to which personnel (including the driver) will be exposed during transportation as low as practical. Maximum permissible dose rate in occupied areas of the vehicle will depend upon the time required to transport the material. The driver will wear film badge, if specified by the RPO, and will not be exposed to ionizing radiation in excess of the limits indicated in paragraph 7.

c. Keep the containers away from the cab of the vehicle.

TABLE I

Contaminated Items and Indications for Actions	Fixed Removeable	Contamination Level				Method Measurement
		Alpha		Beta-gamma		
		dpm per 100 cm2	dpm per 100 cm2	mrad/hr @ 1 In.	dpm per 100 cm2.	
1. Clothing, including shoes:						
a. Personal. Should be replaced, decontaminated or stored for decay if above.	F[1]	200		.05		Probe
	R[1]		None		None	Smear
b. Anticontamination.						
(1) General. Should be replaced and/or decontaminated if above.	F	1000		0.2		Probe
	R		200		1000	Smear
(2) Resirators. Should be decontaminated or replaced after use if above.	F	200		1.0[2]		Probe
	R		None		None	Smear
2. Containers. Before nonradioactive use, should be decontaminated if above.	F	200		0.2		Probe
	R		None		100	Smear
3. Work areas and Equipment.[3]						
a. Uncontrolled. Requires decontamination if above.	F	1000		0.05		Probe
	R		100		100	Smear
b. Controlled:						
(1) Areas.	F	1000		0.02		Probe
	R		200		400	Smear
(2) Hoods.	F	1000		2.0		Probe
	R		200		2000	Smear
(3) Glove Boxes.	F	5000		2.5		Probe
	R		1000		5000	Smear
(4) Workbench Surface.	F	1000		2.00		Probe
	R		2000		400	Smear
(5) Other Equipment Items	F	1000		2.00		Probe
	R		200		2000	Smear
4. Skin:						
a. Body. Continue decontamination if above.	F	200		0.06		Probe
	R		None		None	Smear
b. Hands. Continue decontamination if above.	F	400		0.06		Probe
	R		None		None	Smear

1. F Fixed
   R Removable
2. In contact with any surface of the mask.
3. For natural uranium, U-depleted, and U-238; levels for alpha contamination should be increased by a factor of 5 as determined by the RPO.

TABLE II

RELATIVE BIOLOGICAL EFFECTIVENESS VALUES OF VARIOUS TYPES OF RADIATION FOR TOTAL BODY CHRONIC EXPOSURE

Type of Radiation	RBE
Alpha	10
Beta	1
X or Gamma	1
Protons	10
*Thermal Neutrons	2.5
*Fast Neutrons	10

TABLE III**

NEUTRON FLUX DOSE EQUIVALENTS

Neutron energy (Mev)	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm^2)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm^2 per sec.)
Thermal	970×10^6	670
0.0001	720×10^6	500
0.005	820×10^6	570
0.02	400×10^6	280
0.1	120×10^6	80
0.5	43×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	26×10^6	18
7.5	24×10^6	17
10	24×10^6	17
10 to 30	14×10^6	10

*If neutron energy is known, the value in Table III may be used.
**10 CFR 20.4(c)

TABLE IV

CAUTION SIGN AND SIGNAL DEVICE REQUIREMENTS

	Categories	Caution Symbol	Cautioning Words	Small Devices
a.	Radiation Area	Yes	Caution Radiation Area	None
b.	Contamination Area	Yes	Contaminated Area	Barriers
c.	High Radiation Area	Yes	Caution High Radiation Area	Alarms as required by 10 CFR 20
d.	Airborne Radioactivity Area	Yes	Caution Airborne Radioactivity Area	None
e.	Entrance to area or rooms in which radioactive material is used or stored in an amount exceeding 10 times the amount of radioactive material exempted by Table I - 10 CFR 20	Yes	Caution Radioactive Material(s) (and, where practical, describe the quantities and kinds of radioactive materials involved)	None
f.	Radiation Containers	Yes	Caution Radioactive Material in accordance with 10 CFR 20	None
g.	Radiation (Accelerators, X-ray machines, etc.)	Yes	Caution - Radiation This equipment produces ionizing radiation (or X-rays) when energized	A sign will be placed on the control panel near the switch which energizes the tube and also at entrance to area

UNSEALED SOURCE. A discrete amount of radioactive material that is not encapsulated in a container to prevent leakage or escape of the radioactive material.

(DRXMR-H)

FOR THE DIRECTOR:

OFFICIAL:

GEORGE W. SIBERT
Colonel, Infantry
Deputy Director/Commander

LEROY BERRYMAN
Chief, Administrative Office

DISTRIBUTION:
B
Safety (200 cys)
MEDDAC Health Clinic (2 cy)

APPENDIX C

DEPARTMENT OF THE ARMY
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

AMMRC SAFETY PROCEDURE NO. 385-1* 5 May 1983

STANDING OPERATING PROCEDURE
KAMAN 14 MEV NEUTRON GENERATORS

1. PURPOSE. To prescribe specific rules and procedures pertaining to the use of the Kaman 14 MEV Neutron Generator to insure minimum radiation exposure to operating personnel and to others in adjacent areas.

2. SCOPE. The provisions of this procedure outline minimum safety measures to be adhered to by all personnel involved in the use of the Neutron Generators.

3. RESPONSIBILITIES. Operating personnel are responsible for insuring compliance with the following:

a. All accessible areas in which an individual, if he was continuously present in the area, could receive a dose in any one hour of 2.0 mrem, but less than 100 mrem must be posted with "RADIATION AREA" signs.

b. All accessible areas in which an individual, if he was continuously present in the area, could receive a dose in any one hour of 100 mrem or greater, must be posted with "HIGH RADIATION AREA" signs. Access to all high radiation areas shall be strictly controlled.

c. All personnel working in or in near proximity to the Neutron Generator are required to wear whole body beta-gamma and neutron film badges.

d. The Safety Office, shall be notified of any abnormal condition involving the Neutron Generators.

e. All other safety requirements as deemed necessary by the Radiation Protection Officer.

*This Safety Procedure supersedes AMMRC Safety Procedure No. 385-1, dtd 19 April 1978

4. GENERAL. a. The procedure will be conspicuously posted in the Neutron Generator Facility and Mobile Neutron Generator Facility.

b. The following procedural steps must be adhered to while operating either Neutron Generator:

(1) Prior to turning on the accelerator cooling system, a visual check of mechanical systems and gas tanks must be made to insure normal conditions.

(2) Gas pressure in the accelerator dome and the high voltage power supply must also be checked. The accelerator cannot be activated if pressures are not correct.

(3) After all visual checks have been made, the accelerator is ready to be turned on. When the freon coolant reaches the present temperature the "READY TO OPERATE" light will appear on the console. At this point, the accelerator can be made to produce neutrons by pushing the reset button at the maze entrance and then activating the high voltage power supply at the console.

(4) The accelerator is turned off by use of a key at the console. The key is kept in a secure location when not in use.

(5) When entering the accelerator cave, a radiation survey meter will be used to monitor activity levels. If the activity at the face exceeds 100 mr/hr more time must be allowed to elapse before working in the cave. Operators should minimize the amount of exposure time to themselves restricting their activities in the cave.

c. The following safety precautions and devices have been implemented into the Neutron Generator Facilities to insure that inadvertent accidents do not occur:

(1) A photo-electric eye/motion detectors are activated when the accelerator is made operational. If tripped by someone walking into the accelerator cave the accelerator high voltage is automatically cut-off making neutron production impossible.

(2) Micro-switches performing the same function as in the above paragraph are in the door leading to the loft and the cage door leading to the Mobil Unit. Switches are tripped if the doors are opened at any time and can only be reset by a key located in the loft, and in the Mobile Facility Cave. Therefore, even if someone goes into either area when the accelerator is not in use, the operator must still reset it and determine if anyone is in the area.

5. EMERGENCY PLAN. In case of an emergency requiring the evacuation of either Neutron Generator Facility, the operator using the generator will shut down the generator and notify the Safety Office immediately.

APPROVED BY:

Chief, Materials Characterization Division

John F. Vining III
Chief, Safety Office

APPENDIX D

DEPARTMENT OF THE ARMY
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

AMMRC SAFETY PROCEDURE
No. 385-2*

5 May 1983

STANDING OPERATING PROCEDURE
CALIFORNIUM-252 FACILITY

1. PURPOSE. To prescribe specific rules and procedures pertaining to the use of the Californium-252 (Cf-252) neutron source to insure minimum radiation exposure to personnel.

2. SCOPE. The provisions of this procedure outline minimum safety measures to be adhered to by all personnel involved in the nandling or use of the Cf-252 sources.

3. RESONSIBILITIES. Personnel working with the source shall be responsible for insuring compliance with the following:

a. All accessible areas in which an individual, if he was continuously present in the area could receive a dose in any one hour of 2.0 mrem, but less than 100 mrem, must be posted with "RADIATION AREA" signs.

b. All accessible areas in which an individual, if he was continuously present in the area could receive a dose in any one hour of 100 mrem or more, must be posted with "HIGH RADIATION AREA" signs. Access to all high radiation areas shall be in accordance with 10 CFR 20.203.

c. All personnel working in the Cf-252 facility are required to wear whole body beta-gamma and neutron film badges and self-reading pocket dosimeters.

d. The Safety Office shall be notified of any changes involving the Californium Facility, such as new Cf-252 source or changes in approved procedures or shielding.

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*This Safety Procedure supersedes AMMRC Safety Procedure No. 385-2, dtd 19 April 1978

4. GENERAL. a. This procedure, NRC Form 3, and the NRC By-product Material License 20-01010-04 will be conspicuously posted in the Californium Facility.

b. The Californium Facility will be considered a restricted area. The entrances to the facility must remain locked when the room is not in active use.

c. The radiation levels outside the facility will not be allowed to exceed 2.0 mrem in any one hour, or 100 mrem in any 5 consecutive days unless appropriate steps are taken to have such areas designated "Radiation Areas" with restrictions initiated for controlling entry into those areas.

d. A log book will be maintained for all visitors and personnel entering the facility while the Cf-252 is outside the storage container.

5. RADIATION SURVEYS. a. Radiation surveys will be conducted by users of the Cf-252 source prior to entry into the Fast Neurtron set-up area. The purpose of such surveys is to insure proper storage of the source within the storage container.

b. An area monitor with an audible output and at least one portable survey meter shall be available to the experimenter.

6. IRRADIATION OF MATERIALS. a. Materials to be activated with thermal neutrons for activation analysis will be irradiated with the source located at the center of the working shield. Individuals receiving activated material must be authorized by the Radiation Control Committee to receive said material.

b. The movement of the Cf-252 source to the fast neutron position or the thermal neutron position shall be continually monitored, using an audible output area monitor or a portable survey meter.

c. When the irradiation is completed, the source will be returned to the storage container by returning the cable to a fully seated position.

7. NEUTRON BEAM EXPERIMENTS. a. A beam stop will always be provided whereever a beam might enter the room beyond the experimental apparatus at that beam tube.

b. The source will not be withdrawn from the storage container without prior reference to the area monitor reading.

c. Following the set-up of a beam experiment, the radiation levels in the room will be determined and Radiation Areas delineated with ropes where required and marked with a "Radiation Area" sign.

8. EMERGENCY PLAN. a. In case of an emergency requiring evacuation of the Californium Facility, the person using the Cf-252 source should attempt to return the source to the center of the storage container should the source be in some other position at that time.

b. Should the source be removed completely from the storage container accidentally in such a way that it cannot be returned immediately, the person using the source will immediately secure the area and notify other personnel to remove themselves from the area. He/she should then consult with the area supervisor and the Safety Office to plan proper actions for retrieval of the source and its return to the storage container with a minimum exposure to personnel.

APPROVED BY:

Chief, Materials Characterization Division

John F. Vining III
Chief, Safety Office

APPENDIX E

DEPARTMENT OF THE ARMY
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

AMMRC SAFETY PROCEDURE
NO. 385-40

22 May 1983

STANDING OPERATING PROCEDURE
AMERICIUM-241 SOURCE

1. PURPOSE. To prescribe specific rules and procedures pertaining to the use of the Am-241 source to insure minimum radiation exposure to operating personnel and to others in adjacent areas.

2. SCOPE. The provisions of this procedure outline minimum safety measures to be adhered to by all personnel involved in the use of the Am-241 source.

3. RESPONSIBILITIES. Operating personnel are responsible for insuring compliance with the following:

a. All accessible areas in which an individual, if he was continuously present in the area, could receive a dose in any one hour of 2.0 mrem, but less than 100 mrem must be posted with "RADIATION AREA" signs.

b. All accessible areas in which an individual, if he was continuously present in the area, could receive a dose in any one hour of 100 mrem or greater, must be posted with "HIGH RADIATION AREA" signs. Access to all high radiation areas shall be strictly controlled.

c. All personnel in or in near proximity to the Am-241 source are required to wear whole body beta-gamma film badges.

d. The Safety Office, shall be notified of any abnormal condition involving the Am-241 source.

e. All other safety requirements as deemed necessary by the Radiation Protection Officer.

4. GENERAL. a. The procedure and NRC Form 3 will be conspicuously posted where the Am-241 source is being used or stored.

b. The Am-241 Facility will in general be considered to be a "Radiation Area" and applicable signs will be posted on each entrance.

c. When Am-241 source is not in use, it will be stored in the appropriate, labeled, storage container.

d. Loading and unloading of the Am-241 source from the NEN x-ray fluorescence holder will be done with the use of remote handling devices, behind the protective lead shield and shall be continually monitored, using an audible output monitor or a portable survey meter.

e. A monitor with an audible output and at least one portable survey meter shall be available to the experimenter.

f. Following the set-up of an experiment, the radiation levels in the room will be determined and Radiation Areas delineated with ropes where required and marked with a "Radiation Area" sign.

5. EMERGENCY PLAN. In case of an emergency arising with the Am-241 source, the operator using the (Am-241 source generator) will notify the Safety Office immediately.

Chief, Materials Characterization Division

John F. Vining III
Chief, Safety Office

APPENDIX F

DEPARTMENT OF THE ARMY
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown. Massachusetts 02172

AMMRC SAFETY PROCEDURE
NO. 385-3*

11 May 1983

STANDING OPERATING PROCEDURE
CALIBRATION LAB, BUILDING 97

1. PURPOSE. To prescribe operating rules pertaining to use of the Calibration Lab, Building 97.

2. SCOPE. The provisions of this procedure apply to all personnel whose assigned duties require their presence in the Calibration Lab.

3. GENERAL. Personnel who are required to enter the Calibration Lab as a part of their assigned duties will adhere to the following general requirements:

a. The Safety Office, Ext. 5225, will be notified prior to entrance into Lab. Access will be restricted only to personnel authorized by the Radiation Protection Officer (RPO).

b. Personnel entering the Calibration Lab must be accompanied by a member of the Safety Office.

c. Personnel using the Calibration Lab are required to wear whole body film badges and/or self-reading pocket dosimeters.

d. During operations such as calibration of survey instruments, calibrations of radiation sources, leak testing of sealed sources, physical inventory of sources, and other similar functions which require radioactive sources to be exposed, all persons present will wear whole body film badges and self-reading pocket dosimeters. Wrist badges will be worn when exposure to the hands is expected to be significantly greater than to the whole body.

4. GAMMA SOURCE FACILITY-OPERATING INSTRUCTIONS. a. Before entering the source elevator room, an operating beta-gamma survey meter should be obtained. Area should be surveyed to insure that source has not been moved or left in a raised position. In addition to the regular film badge and dosimeter, a wrist film badge or a dosimeter attached to the wrist may be worn.

*This Safety Procedure supersedes AMMRC Procedure No. 385-3, dtd 19 April 1978.

b. Two survey meters should be used while operating the facility. One survey meter should be placed near the well to show radiation field in this area and one survey instrument should be available at console in order to measure radiation filed at this point.

c. Turn on main switch, power and clutch switch.

d. Check that powerstat reads 80 and that the motor controller rheostat is at 7.5 or lower. A setting of 7.5 is equivalent to 20 feet per minute if the travel switch, upper right on console, is in the high mode. In the low mode, the travel is halved to 10 feet per minute for the same rheostat setting of 7.5.

e. The usual position for the source is at the bottom of the well. The clutch must be reversed before movement can be made. Place the maunal switch to re-set position, this will place source travel in proper direction. Return to manual position and the facility is now ready for use.

f. Press up or down button and source will move, but only when button is held down. CAUTION - press one button at a time. Depressing the up and down button at the same time will blow the fuse located on the front face of the console.

g. If top or low travel switch is tripped by the source holder mechanism the manual switch has to be placed in the re-set mode and then back to the manual position before source movement can be made.

h. For hand operation, the clutch switch should be off. This will allow the hand wheel to turn more easily. CAUTION - In manual operation upper limit switch does not function. Do not raise source higher than 6.00 inches on the digital counter or damage to the microswitch may occur.

i. When leaving the facility, the source should be driven to the bottom of well, and clutch switch, power switch and main switch turned off.

j. If an extended measurement is made while no one is present, the console should be left on so that the red lights on the console will indicate that the source is in use. The door to the source room should be locked and signs posted at both entrances to the Calibration Lab stating that the source is in the raised position and entrance into the lab is strictly forbidden.

5. RADIATION WARNING SIGNS. The Calibration Lab will be conspicuously posted with radiation warning signs in compliance with all applicable regulations. In addition, when a radioactive source must be left unattended in an exposed position, signs stating, "RADIOACTIVE SOURCE EXPOSED - NO NOT ENTER", will be posted on the outside of each entrance.

6. EMERGENCY PLAN. a. In the event of fire, personnel in the Calibration Lab will attempt to control local fires with extinguishers unless radioactive sources are involved. Where sources are involved, personnel will immediately leave the Calibration Lab and notify the Safety Office.

b. Personnel shall immediately notify Security (Ext. 5157) and the RPO (Ext. 5225).

APPROVED BY:

John F. Vining III
Chief, Safety Office

APPENDIX G

DEPARTMENT OF THE ARMY
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

AMMRC SAFETY PROCEDURE NO. 385-26* 18 May 1983

STANDING OPERATING PROCEDURES
CALIBRATION PROCEDURE
EBERLINE PORTABLE NEUTRON REM COUNTER
MODEL PNR-4

1. PURPOSE. This procedure describes the calibration procedure to be followed when calibrating the Eberline Portable Neutron REM Counter Model PNR-4.

2. PROCEDURE.

a. The Curie Pu-Be neutron source will be used to calibrate the neutron survey meter.

b. Calibration values, i.e., distance vs. neutron flux vs. dose rate data, are listed in Appendix A.

c. The graduated 2" x 4" calibration board, located in the calibration room, Building 97, is used for positioning the neutron survey meter from the Pu-Be source.

d. All calibration will be performed outside the building and away from reflecting surfaces.

e. The Pu-Be source is placed in the holder at the end of the calibration board using a remote handling device prior to start of calibration.

f. The instrument detector is positioned with the center of the detector at the desired calibration point.

g. Prior to calibration determine the sensitivity to gamma radiation by placing the instrument in a gamma field of 200 mr/hr. There should be no response to gamma radiation. If the meter responds to gamma radiation, adjust the high voltage as described in paragraph 2.i (3), of the instrument manual.

h. Instruments readings within plus or minus 20% are considered to be within acceptable limits.

i. Calibration: Three separate steps are required to calibrate the instrument. These are:

Sensitivity Adjustment
Calibration Adjustment
High Voltage Adjustment

* This Safety Procedure supersede AMMRC Safety Procedure No. 385-26, dtd 31 Dec '80.

(1) SENSITIVITY ADJUSTMENT (see manual for location). This adjustment is not critical since the high voltage will compensate for a wide range of settings. However, if set too sensitive the instrument is susceptible to noise, and if set too insensitive, linearity of the detector operation is affected. Optimum setting is about 2 millivolts, which can be approximated by two 360° counterclockwise turns from extreme clockwise rotation.

(2) CALIBRATION ADJUSTMENT. The PNR-4 may be calibrated directly to a neutron field if a calibrated neutron range is available. Before calibrating, the high voltage is adjusted as outlined in paragraph 2.i (3).

(a) To calibrate, the following procedure is used:

1. Turn R3 and R5 maximum clockwise.

2. Place instrument in 4 mREM/hr field and adjust R2 for 4 mREM/hr reading.

3. Place instrument in 40 mREM/hr field adjust R3 for 40 mREM/hr reading.

4. Place instrument in 400 mREM/hr field and adjust R4 for 90 mREM/hr reading. This normally should be a 400 mREM/hr reading but the Pu-Be source is not of sufficient strength where reliable readings greater than 90 mREM/hr can be obtained.

5. Place instrument in 4K mREM/hr field and adjust R5 for 4K mREM/hr reading. This is not applicable when using a 5 Curie Pu-Be source.

(b) If a calibrated neutron range is not available, calibration may be accomplished by using a pulse generator. The pulse generator must have a negative pulse at least 3 millivolts amplitude with a rise time faster than 1 microsecond with frequency variable from below 200 PPM to 200K PPM.

1. Remove the instrument from its case and the high voltage supply from the instrument. Connect the pulse generator to the spring connector (junction of R8 and C2).

2. Follow the same procedure as above except adjust pulse generator frequency to correspond to the count rate from each field. 200 pulses per minutes is equal to 4 MREM/hr, and multiples thereof.

(3) HIGH VOLTAGE ADJUSTMENT (see manual for location). The operational threshold high voltage is located on the flat portion of the plateau, below the gamma threshold. One method of arriving at this setting is to turn up the voltage slowly with the detector in a gamma field, until counting is observed. This will be gamma threshold. Turn the voltage down until counting stops.

NOTE: The high voltage comes down, slowly, so be certain to wait until it is stabilized.

(a) A preferable method is to calculate a plateau with the detector in a neutron field, and a second plateau with the detector in a gamma field equal to the intensity of gamma it is desired to reject. From the two curves, select the optimum setting for the high voltage. Refer to manual for a typical plateau.

(b) A longer cable between the detector and counter will cause the plateau to shift to higher voltages because of capacitive loading effect. Therefore, the instrument should be set up with the cable with which it is to be used.

APPROVED

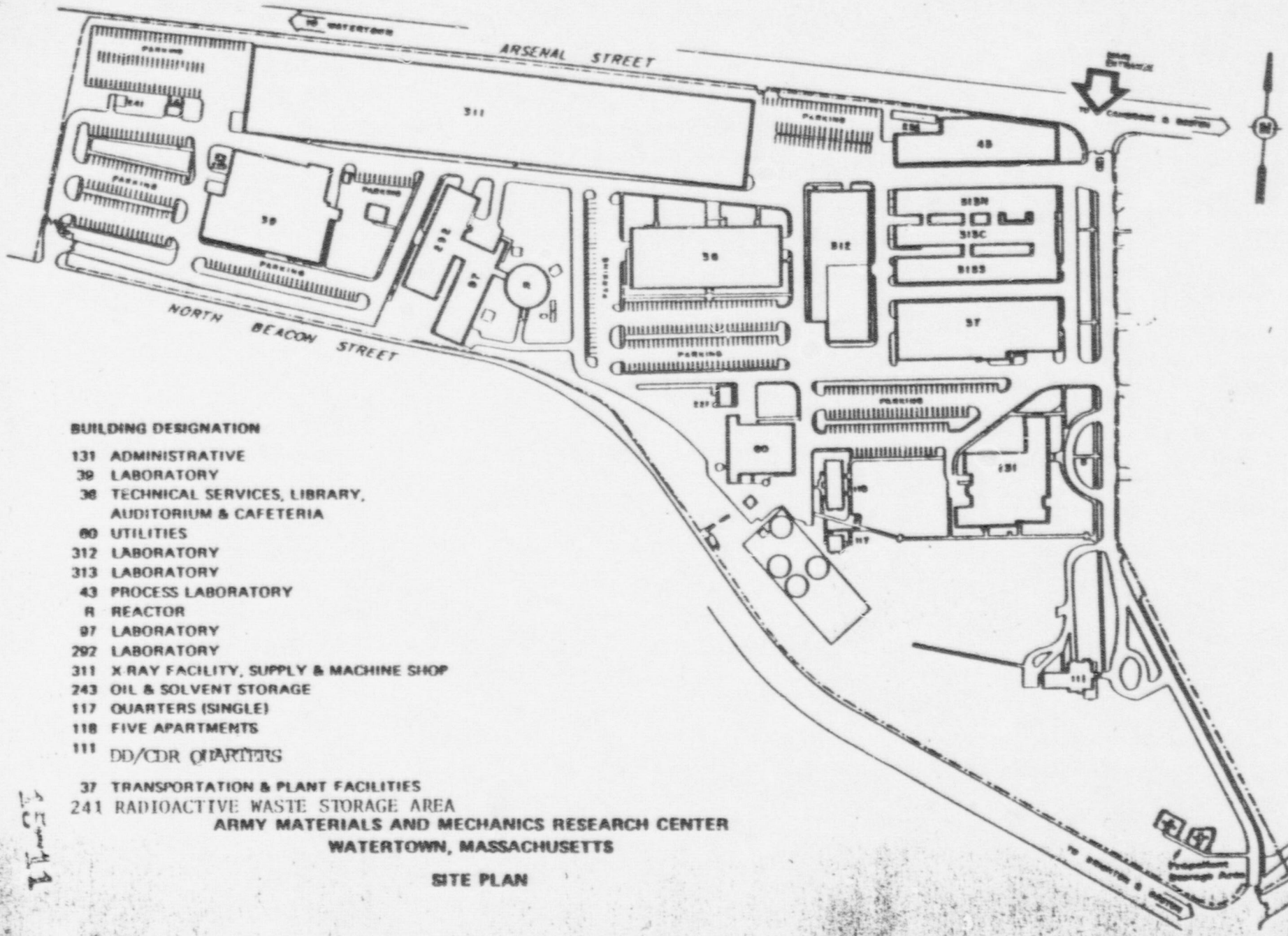
JOHN F. VINING III
Chief, Safety Office

APPENDIX A

5 Ci Pu-Be Neutron Source Calibration Data

Distance (Cm)	Neutron Flux (n • Cm^{-2} • sec^{-1})	mREM/hr.
30	652	90.6
40	377	52.4
50	234	32.5
60	163	22.6
70	119.5	16.6
80	91.7	12.7
90	72.4	10.1
100	58.7	8.2
110	48.5	6.7
120	40.7	5.7
130	34.7	4.8
140	29.9	4.2
150	26.1	3.6
160	23.9	3.3
170	20.3	2.8
180	18.1	2.5

8/24/8



BUILDING DESIGNATION

131	ADMINISTRATIVE
39	LABORATORY
38	TECHNICAL SERVICES, LIBRARY, AUDITORIUM & CAFETERIA
60	UTILITIES
312	LABORATORY
313	LABORATORY
43	PROCESS LABORATORY
R	REACTOR
97	LABORATORY
292	LABORATORY
311	X RAY FACILITY, SUPPLY & MACHINE SHOP
243	OIL & SOLVENT STORAGE
117	QUARTERS (SINGLE)
118	FIVE APARTMENTS
111	DD/CDR QUARTERS
37	TRANSPORTATION & PLANT FACILITIES
241	RADIOACTIVE WASTE STORAGE AREA

ARMY MATERIALS AND MECHANICS RESEARCH CENTER
WATERTOWN, MASSACHUSETTS

SITE PLAN