40-2253

DEPARTMENT OF THE ARMY
HEADQUARTERS US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND
5001 EISENHOWER AVENUE, ALEXANDRIA, VA. 22333

13351

REPLY TO ATTENTION OF DRCSF-P/78-0045

Regulatory Docket File

29 June 1979

Director
Nuclear Material Safety and Safeguards
ATTN: Radioisotopes Licensing Branch,
Mr. Paul Guinn
US Nuclear Regulatory Commission
Washington, DC 20555

Reference Mail Control Number 09286

RECEIVED JUL 3 PM 2 21 U.S. NUCLEAR REG. COMMISSION NMSS MAIL SECTION

Dear Mr. Guinn:

Forwarded is US Army Material and Mechanics Research Center's reply to your letter of inquiry concerning application for renewal of Source Material License Number SUB-238.

This headquarters has requested US Army Material and Mechanics Research Center to send detailed drawings of depleted uranium indoor firing ranges for incorporation into license. Upon receipt of requested drawings, this headquarters will submit same to your office.

Please acknowledge receipt of correspondence on inclosed DA Form 209 Reply Card.

Sincerely,

DARWIN N. TARAS
Chief, Health Physics
Safety Office

2 Incl
1. Reply to ltr (2cys)
2. DA Form 209
   Reply Card

FEE EXEMPT

CF:
HQDA (DASG-PSP-E) WASH DC 20310 w/incl 1 (2 cys)
Dir, DARCOM FSA, Charlestown, IN 47111 w/incl 1
Cdr, US Army Materiel and Mechanics Research Center, ATTN: DRXMR-AR, Watertown, MA 02172 w/o incl

A/78

7908140675 60pp

ADDITIONAL INFORMATION IN SUPPORT OF
APPLICATION FOR RENEWAL OF SOURCE MATERIAL LICENSE NUMBER SUB-238,
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
WATERTOWN, MASSACHUSETTS 02172

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1. The Radiation Control Committee (RCC), comprised of the following individuals, is responsible for designation of individual users under License No. SUB-238. Users are defined as supervisors at the Branch, Division, and Office level. The supervisor will be responsible for insuring that his/her employees are aware of and understand the potential hazards of source material and comply with the safety procedures associated with the use of source material. Resumes of RCC members are furnished by Appendix A.

RADIATION CONTROL COMMITTEE MEMBERS

Dr. Gordon A. Bruggeman - Chairman
Mr. Sidney Levin - Secretary, RPO
Mr. Donald J. Stevens - Alternate RPO
Dr. Thomas A. Egan - Member
Mr. Satrak DerBoghosian - Member
Dr. Clyde R. Desper - Member
Mr. Russell G. Hardy - Member

2. Before a supervisor is designated as an individual user, he/she will complete an XMR Form 16 and 16-1 "Application for Authorization to Use Radioisotopes - Part A and B" (Appendix B). The completed application is reviewed by the RCC and approved if the applicant has demonstrated sufficient educational background and experience to safely and properly use and supervise the use of source material. DARCOM Reg 385-25 is furnished by Appendix C.

3. Training is recorded on DA Form 750, Record of Training, (Appendix D), which is maintained in the individual's personnel folder located at the Civilian Personnel Office.

4. Additional information concerning the incineration of wastes:

a. Item II.a - The average quantity of depleted uranium (DU) (U-238) incinerated per week is approximately 100 lbs (16.2 mCi). This average is based on the previous six (6) month period. Previously, as much as 1,500 lbs of DU has been incinerated during a one week period and 400 lbs of DU in one day.

b. Item II.b - The incinerator is equipped with an exhaust/scrubber system utilizing an American Air Filter (AAF) Type W Rotoclone, and AFF Size 8, Type W, Arrangement A, filters with an efficiency of 99.95% for 0.3 micron size particulate by DOP method. The stack height is 53 feet and located approximately 110 from nearest inhabited building outside this installation. The maximum height of buildings in the immediate vicinity is 40 feet. Rated air flow of the exhaust system is 2,120 ft^3/min.

c. Item II.c - Refer to Appendix E for method of measurement of the average concentration of radioactive material in the effluent at the point it leaves the stack.

d. Item II.d - DU is incinerated in a 30 gallon 17H container submerged in water to within an inch of the top of the container. After incineration, the container is weighed, sealed, and decontaminated. The container weight is subtracted from the gross weight including the ash residue which is in the form of uranium oxide (black oxide - U_3O_8). The weight of the oxygen component is then subtracted from the uranium oxide compound by the following method:

$$\frac{\text{Molecular Weight of Uranium } (U_3)}{\text{Total Molecular Weight of Uranium Oxide } (U_3O_8)} \times \text{weight in lbs of Uranium oxide } (U_3O_8) =$$

Weight in lbs of Uranium (U) in drum

e.g. Assume 300 lbs of Uranium oxide in drum

$$\frac{3(238)}{3(238)+8(16)} \times 300 \text{ lbs } (U_3O_8) = 255 \text{ lbs } (U)$$

e. Item II.e - Uranium machine turning procedure is furnished by Appendix F.

f. Item II.f - The sealed container is shipped to a licensed disposal facility for burial. Radioactive waste is presently being shipped to:

Chem-Nuclear Systems, Inc.
Barnwell, South Carolina
S.C. License No. 097
DOE License No. 46-13536-01

5. As previously described, stack sampling is conducted to insure individuals are not subjected to concentrations of radioactive materials in excess of the limits specified in 10 CFR Part 20, Appendix B, Table II, when averaged over a period of one month. No credit is taken for dilution factors when the effluent leaves the stack although this is an additional consideration in mitigating airborne release to unrestricted areas. In addition, water sampling is conducted to ensure releases to the sanitary sewer system do not exceed the limits specified in 10 CFR Part 20, Appendix B, Table II. Approximately a 1,000 ml water sample is taken, homogenized, and then a 40 ml portion is evaporated in a 2 inch planchet. The planchet is counted on a gas flow proportional counter to determine the concentration of radioactivity in water released to the sanitary sewer system.

6. Evaluation of Potential Inhalation and/or Ingestion of DU

a. Uranium Incineration Area; Bldg. 43 - The ventilation system, filter, scrubber, stack air sampling and incineration procedures are described in Item 4. Additionally, general room, process, and/or breathing zone air samples are taken at least monthly during time of incineration. Analysis of these air samples is identical to that described in Appendix E.

b. Uranium Machine Shop; Bldg. 312 - The ventilation system is high velocity-low volume consisting of a Hoffman Primary Cyclone component, a Hoffman Secondary 52 Bag Filter component, and a Hoffman absolute filter component with 99.97% efficiency for 0.3 micron particle size. Air flow is assured by use of static pressure devices located stategically throughout the system. Stack sampling is conducted at least monthly and is performed and evaluated according to procedures contained in Appendix E. General room, process, and breathing zone samples are taken and evaluated according to the procedure contained in Appendix E.

c. Uranium Melt Facility; Bldg. 43 - The ventilation system in the Uranium Melt Facility contains both a prefilter component and an absolute filter component with a 99.97% efficiency for 0.3 micron particle size. Stack sampling is conducted monthly and performed and evaluated according to procedures in Appendix E. Process and breathing zone samples are also taken. Analysis of these samples is performed according to the procedure in Appendix E.

7. External exposure to radiation is controlled through written procedures, radiation work permits, rotation of personnel, survey of areas prior to initiating radiological operations, maintenance of area work logs, and at least monthly surveys of work areas. All radiation work personnel are required to wear film badges which are evaluated and exchanged on a monthly basis. Film badges indicating beta or gamma doses of 1.0 Rem or greater require investigative action. The investigative report details the nature of the exposure and corrective action to be taken to keep exposures in line with the NRC ALARA philosophy. Extremity monitoring is accomplished by Thermoluminescent Dosimetry (TLD) using Lithium Flouride (LiF) hot pressed chips. The TLD system is performance tested and documented according to a proposed ANSI standard on "TLD Standards for Performance." TLD chips are sealed in plastic and worn on the finger for dose determination. The TLD badges are exchanged and evaluated on approximately a two week interval. Doses higher than 1.0 Rem require investigation and corrective action as necessary.

Incl

Appendix A - Radiation Control Committee Resumes
Appendix B - XMR Form 16 and 16-1
Appendix C - DARCOM Regulation 385-25, Radiation Protection
Appendix D - DA Form 750, Record of Training
Appendix E - Isokinetic Stack Sampling Procedure and Air Sampling Analysis Procedure
Appendix F - Procedure for Incineration of Uranium Machine Turning and Swarf

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APPENDIX A

RADIATION CONTROL COMMITTEE MEMBER RESUMES

Dr. C. Richard Desper

1968 - present	Research Chemist, Polymer Research Division, Army Materials and Mechanics Research Center, Watertown, MA
1966 - 1968	Research Chemist, Clothing and Organic Materials Division, US Army Natick Laboratories, Natick, MA
1962 - 1966	Graduate Student, Department of Chemistry, University of Massachusetts, Amherst, MA
1960 - 1962	Research Assistant, Fabric Research Laboratories, Inc., Dedham, MA

EDUCATION

1959	B. S. Chemical Engineering, M.I.T.
1960	M.S., Chemical Engineering, M.I.T.
1966	Ph.D, Chemistry, University of Massachusetts

PERTINENT EXPERIENCE

1962 - 1966	Experimental thesis work in x-ray diffraction studies of polymers at University of Massachusetts.
1966 - 1968	Continuing work in x-ray diffraction at Natick Laboratories.
1968 - present	Continuing x-ray diffraction work at AMMRC, in charge of x-ray diffraction laboratory of the Polymer Research Division.

RESUME OF TRAINING AND EXPERIENCE

RUSSELL G. HARDY

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Jul 74 - Present	Responsible for setting up operations for a complete prototype melting laboratory facility which contains equipment used to perform melting, powder processing heat treating, and machining of mold and crucible materials. Coordinates and schedules workload, determines priorities and coordinate schedules with other organizations. Insures compliance with safety and health physics requirements. Determines equipment needs and has some modified or recommends the purchase of new equipment. This facility is staffed by members of other organizations who are performing specific phases of the work as assigned by their supervisors.
EXPERIENCE	April 1970 to June 1974 full time Metallurgical Consultant. Determine cause of defective titanium bar and forgings; advise titanium bar, forgings, sheets, and formed metal part producers on sales approach to customers; assist in preparation of eningeering reports, design of titanium castings for economical production, with optimized strength-weight ratio, statistical analysis of data, material specification writing, process specification writing, advise producers on usage of titanium by final user, study inclusions in titanium ingots and wrought products, advise on cost effect of specification changes. 1965-1970 (Part-time) Metallurgical Consultant. Consulted on: Design of titanium casting furnace, methods of casting titanium, gating, risering, and molding; design of titanium valves to meet ASME Unfired Pressure Vessel Code. Advise on marketing titanium valves and miscellaneous and sales brochures; give deposition as expert witness in Federal Court on cracked steam turbine--work involved determining how old was the crack when it was discovered. Review drawings for correct materials.

1960-1970 - The Boeing Company, Seattle, Washington, Senior Engineer, Structures Technology, Materials.

Evaluate refractory metal alloys for use of Dynasoar Space Glider. Write columbian and molybdenum alloy material specifications. Monitor subcontractor work on government funded R & D programs. Prepare proposals to solicit government funded R & D programs and prepare engineering reports. Prepare and coordinate material specifications for titanium castings, forgings, extrusions and tubing. Investigate causes of and methods of prevention of service failures of metallic parts in commercial airplanes. Advise aircraft design engineers on use of castings, forgings, and 747 airplanes. Advise design engineers of titanium castings, forgings, extrusions, and tubing to be used on SST airplanes.

1957-1960 - Chief Metallurgist at Oregon Metallurgical Corporation, Albany, Oregon - a leading producer of titanium zirconium, hafnium, tantalum, columbium, molybdenum and tungsten. Worked on metallurgical problems involved in vacuum melting and casting of reactive metals. Advise customers on problems involved in applications of these metals. Assist in preparation of advertising, sales brochures, and publicity releases. Prepare proposals to solicit government funded or private industry funded R & D programs. Prepare R & D Engineering Reports. Developed process for making cast tungsten rocket nozzles. In charge of government sponsored $400,000 R & D program that was successful in developing the process of making titanium castings from a laboratory process to a commercial product.

1950-1957 - Metallurgist at Edward Valves, Inc., East Chicago, Indiana, a subsideary of Rockwell Manufacturing Company, manufacturers of steel valves for petroleum, chemical, and steam power generating plants. Evaluation and selection of wrough and cast alloy and stainless steels and treatments for use in high temperature valves and supervise research to enable the most intelligent selections. Assist customers on problems in applications of valves. Lectures to sales groups and individual training of salesmen on metallurgy of high temperature steel valves. Review drawings for proper material usage. In charge of mechanical testing, metallographic, and creep and stress rupture laboratory. Advise sales department on the suitability of valves for particular environments. Make failure investigations in the field and in the laboratory. Write technical articles for house organ. Advise on technical correctness of advertising copy. Assist purchasing department in negotiation with suppliers.

1948-1950 - American Steel Foundries, Indiana Harbor, Indiana. One year in railroad and miscellaneous steel casting foundry working on methods of improving quality of stell castings by improvements of gating or other pattern revisions. One year as molding foreman at their cast armor plant while that plant was producing large steel castings for army tanks.

1946-1948 - Metallurgist at Argonne National Laboratories, Lemont, Illinois. Developed a process for making shaped uranium castings, and was then in charge of the foundry making uranium castings for nuclear reactors.

1945 - Metallurgist at Ohio Brass Company, Mansfield, Ohio. Work on methods of improving quality of brass castings.

1943-1945 - US Naval Research Laboratories, Anacostia Station, Washington, D.C. One year as Metallurgist, one year as Chief Petty Officer. Worked on methods to improve quality of non-ferrous castings. Developed method of using Reynold's number to design gating to prevent turbulent flow. Patented means of creating pressure in risers to improve feeding.

TECHNICAL COMMITTEES

ASTM Committee E07.02 Reference Radiographics for Titanium Castings.

AIA MSC Project 340-7 Updating MIL specifications for Titanium

TECHNICAL COMMITTEES (Cont'd)

American Foundrymen's Society, Chairman Reactive Metals Committee

PUBLICATIONS AND LECTURES

"Mechanical Property Distribution in Sand Cast Bronzes." Trans AFA, Vol. 54, pp 641-647. 1946

"Conditions of Flow in Bronze Castings." Trans AFA, Vol. 54, pp 732-739. 1946

"Vacuum Casting of Titanium." National Conference on Vacuum Metallurgy. June 1-6. 1960.

"Melting and Casting of Tungsten Alloys." Southwest Joint ASM-ASME Regional Meeting, Las Vegas, April 24-25, 1961.

"Centrifugal Casting of Tungsten." Metals Progress, August, 1962.

"Design Properties of Cast Titanium Alloys." Joint ASM-ASME Chapter Meeting, Richland, Washington. December 2, 1959.

PATENTS

US Patent 2,476,296 - 1949. "Metal Casting Apparatus" (Method for producing an internal pressure in risers to improve feeding).

RESUME OF TRAINING AND EXPERIENCE

DR. GORDON BRUGGEMAN

1972 - Present	Research Metallurgist in the Materials Sciences Division with duties as principal investigator on various research projects. Continued as Chairman of Radiation Control Committee.
1968 - 1972	Supervisory Metallurgist in charge of physical metallurgy group 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, US Army stationed at Aberdeen Proving Ground and Watertown Arsenal Laboratories.
1960 - 1961	Senior Physical Metallurgist, Man Labs, Inc. working as principal investigator on metallurgical 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 M.I.T. 1960 SC.D. Metallurgy M.I.T.
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 attendance at informal interview and briefing on radiological health hazards and safety procedures. Research at AMMRC (1961-1972) continued various diffusion studies utilizing radioisotope techniques.

RESUME OF TRAINING AND EXPERIENCE

MR. SATRAK DERBOGHOSIAN

1964 - Present	Materials Engineer in the field of Nondestructive Testing at AMMRC. Supervisor of Radiographic Lab.
1962 - 1964	Technologist, Nondestructive Testing Branch, Watertown Arsenal Laboratories.
1959 - 1962	Inspection Specialist - Nondestructive Testing Branch, Watertown Arsenal Laboratories.
1945 - 1959	Physical Science Technician - Metallurgical Lab and Nondestructive Testing Branch, Watertown Arsenal Laboratories

EDUCATION

1950 - 1956	Northeastern University - BBA Engineering Management.
1950 - 1973	Numerous courses in the field of Nondestructive Testing.
	Currently registered as a Professional Engineer in the State of Massachusetts.

PERTINENT EXPERIENCE

1951 - 1956	Occasional radiographic work and other forms of Nondestructive Testing.
1957 - 1965	Interpretation of radiographic and reference criteria preparation.
1966 - Present	Supervisor of Radiographic Laboratory

RESUME OF TRAINING A[illegible] EXPERIENCE - THOMAS A. EGAN, [illegible]

February 1974 to Present	Chief, Medical Health Dispensary (MEDDAC) AMMRC, Watertown, Mass.
1963 to 1974	Civilian Medical Officer Medical Department, US Naval Shipyard Boston, Mass.
1946 to 1963	Private Practice of Medicine (Anesthesiology) Staff Anesthesiology at: 1. St. Joseph's Hospital, Providence, R.I. 2. R.J. Medical Center, Cranston, R.I. (1947-1963) 3. Charles V. Chopin Hospital, Providence, R.I. (1948-196[illegible] 4. Our Lady of Fatima Hospital, N. Providence, R.I. (1954-1963)
1943 to 1946	US Army Medical Corps, European Theatre of Operations Captain, Major: 1. Company Commander, 324th Medical Battalion 2. Anesthesiologist, Surgical Team, 3rd Auxiliary Surgical Group
1935 to 1943	Private Practice of Medicine (Anesthesiology) Providence, R.I.
1933 to 1935	Residency in Pediatrics, St. John's Hospital, New York, New York
1932 to 1933	Rotating Internship, St. Joseph's Hospital, Providence, R.I.
1928 to 1932	Georgetown University School of Medicine M.D. 6 June 1932
1926 to 1928	Providence College, Providence, R.I. Pre Medical Certificate

POST GRADUATE TRAINING

1959	US Naval Medical Center, Bethesda, Maryland, Chemical, Biological and Radiological School
1961	Refresher Course, CBR, Hq 1st Army, Governors Island, New York
1963	Medical Field Service School (Army) Ft. Sam Houston, Texas (Refresher School for Field Grade Officers CBR)

RESUME - (continued)

1968	National Guard Bureau (1st Army Area) Conference on CBR Techniques, Charleston, West Virginia.
1969	Retired as LTC, MC, USAR, 1 October 1969

RESUME OF TRAINING AND EXPERIENCE

MR. SIDNEY LEVIN (RPO)

Sept 67 to Present	Chief, Occupational Safety and Health Office, (formerly Radiation and Occupational Safety Branch), Army Materials and Mechanics Research Center, Watertown, Mass. Responsible for planning, directing, and administering a comprehensive occupational safety and health program for AMMRC.
Jan 66 - Sept 67	Acting Chief, Industrial Health Safety Branch, AMMRC. Same as above.
Aug 63 - Jan 66	Health Physicist, Watertown Arsenal (WA) and Army Materials Research Agency, Watertown, Mass. Responsible for planning directing, and administering the WA radiological safety program.
Nove 62 - Aug 63	Nuclear Power Engineer, Portsmouth Naval Shipyard, Portsmouth, New Hampshire. Concerned with reactor shielding and safeguards, radiation surveys, and radiation detection instrumentation.
Jan 53 - Jan 60	Quality Control Representative (Electronics), Inspector of Naval Material, Boston, Mass.
Jul 52 - Jan 53	Aircraft Electronics Equipment Installer and Repairer, Air Force Cambridge Research Labs.

EDUCATION AND TRAINING

1952	B.S. Physics (Magna Cum Laude) Suffolk University
1963	Basic Radiological Health Course, U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Radiological Health, Northeastern Radiological Health Laboratory, Winchester, Mass.

EDUCATION AND TRAINING (Cont'd)

1965	Radionuclide Analysis by Gamma Spectroscopy Course, U.S. Public Health Service, Winchester, Mass.
1968	Operational Aspects of Radiation Surveillance Course, U.S. Public Health Service, Winchester, Mass.
	Graduated courses at Boston University, Northeastern University and Harvard University School of Public Health.
	Is presently a member of the New England Chapter, Health Physics Society, New England Section American Industrial Hygiene Association, and Boston Federal Field Safety and Health Council.

PERTIENT EXPERIENCE

1963 - 1971 1972 - Present	Served as Radiological Protection Officer and/or Alternate Radiological Protection Officer for AMMRC and WA.

RESUME OF TRAINING AND EXPERIENCE

MR. DONALD J. STEVENS (ALTERNATE RPO)

Jan 78 - Present	Health Physicist, Army Materials and Mechanics Research Center, Watertown, Mass. Responsible for planning, directing, and administering the radiological safety program at AMMRC.
Jun 74 - Dec 77	Assistant Radiation Safety Officer, Stone & Webster Engineering Corporation, Boston, Mass. Responsible for assisting the Radiological Safety Officer in the development and implementation of the corporate radiological safety program.
Jun 73 - Sept 73	Assistant to the Radiation Safety Officer, Joint center for Radiation Safety Therapy, New England Deaconess Hospital, Boston, Mass. Responsibilities included radiation surveys, packaging, and shipping of radioactive waste, instrument calibration, and leak testing of small sealed sources.

EDUCATION AND TRAINING

1974	B.S., Health Physics (Cum Laude), Lowell Technological Institute, Lowell, Mass.
1971	Attended an eight week course in specific radiological health physics problems.
	Currently a member of the National Health Physics Society, and the New England Chapter of the Health Physics Society.

PERTINENT EXPERIENCE

1974 - Present	Developed a computerized radiation exposure monitoring system. Developed and taught a radiographic radiological safety training course and a basic radiation safety training course. Developed, performance tested and implemented a TLD gamma radiation monitoring program. Designed a shielded installation for a 300 KvP, 10ma industrial x-ray unit.

PERTINENT
EXPERIENCE (Cont'd)

Developed operating, emergency, and instrument calibration procedures for an industrial radiography program, and all other employee exposures to radiation and radioactive materials.

APPENDIX B

XMR FORM 16 AND 16-1,
APPLICATION FOR AUTHORIZATION TO USE RADIOISOTOPES

U. S. ARMY MATERIALS RESEARCH AGENCY

APPLICATION FOR AUTHORIZATION TO USE RADIOISOTOPES - PART A

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

1. ____

Name of Applicant Laboratory Branch Location Ext

2. ____

Areas where radioactive materials will be used

3. ____

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

4. Radioisotopes for which authorization is requested. (Attach a supplementary sheet, if more space is needed.)

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

5. CERTIFICATION: All information contained in this application is true and correct to the best of my knowledge. I have read and understood AMRA Regulation 386-1, "Radiological Safety Policy and Program", and AEC Reg. No. 10 CFR 20.

Date ____________ ______________________________

(Typed name and signature of applicant)

6. APPROVAL of Radioisotopes Committee, subject to any conditions cited on reverse, under Remarks.

Date ____________ ______________________________

(Typed name and signature, Chairman, Radioisotopes Committee)

AUTHORIZATION NO. ____________________

XMR Form 16
24 May 67 Previous edition is obsolete.

(complete reverse side)

7. Describe the purpose for which each radioactive material 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 AMRA 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.

U. S. ARMY MATERIALS RESEARCH AGENCY

APPLICATION FOR AUTHORIZATION TO USE RADIOISOTOPES - PART B

Record your experience and training 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 filed within three years, it may be omitted, unless pertinent new information is available. On three year renewals, list only new training and experience since the previous filing. Forward to Chairman, Radioisotopes Committee.

1. TYPE OF 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, degrees obtained, with dates and subjects:

2. TYPES OF EXPERIENCE

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

Date ________________ ____

Type name and signature of Applicant

XMR Form 16-1
24 May 67 Previous edition is obsolete.

APPENDIX C

DARCOM REG 385-25, RADIATION PROTECTION

APPENDIX D

DA FORM 750, RECORD OF TRAINING

RECORD OF TRAINING (CPPM-1)	1. DATE	2. INSTALLATION AND ORGANIZATION		
3. LAST NAME - FIRST NAME - MIDDLE INITIAL		4. TITLE OF COURSE		
		5. DATE COURSE COMPLETED	6. TOTAL COURSE HOURS	7. RATING OR GRADE
8. COURSE DATA [1]		9. REQUIREMENTS FOR SATISFACTORY COMPLETION OF COURSE [1]		
10. REMARKS ON TRAINEE PERFORMANCE [1]				
11. SIGNATURE OF TRAINING OFFICER		12. THE CONTENTS HEREOF HAVE BEEN REVIEWED HEAD OF ORGANIZATIONAL ELEMENT (*Signature*)		

13. POSTED TO DA FORM 80 OR 80A	INITIALS	DATE	*FORWARD TO TRAINEE AFTER COMPLETION OF ITEMS 12 AND 13* [1] *USE REVERSE IF NECESSARY IDENTIFYING BY ITEM NUMBER*

DA FORM 2 SEP 54 750 REPLACES DA FORM 750, 1 JUL 53, WHICH IS OBSOLETE

c83-16-77646-1 : GPO

APPENDIX E

ISOKINETIC STACK SAMPLING PROCEDURE

AND

AIR SAMPLING ANALYSIS PROCEDURE

AIR SAMPLING ANALYSIS PROCEDURE

1. Air Sampling Procedure. Usually the sampling of DU particulates in the atmosphere, the standard method of evaluating potential inhalation hazards, is accomplished by drawing air through a filter at a measured rate. The amount of U^{238}, UX_1, and UX_2 collected on the filter from a known volume of air is determined by measurement of the alpha and beta radioactivity. The procedure for determining airborne activity is as follows:

a. Air samples are collected by filtering air through a filter, Whatman #41 or equivalent, at a known rate of flow and for a predetermined time. Routine control samples are collected by running the air sampler for at least 60 minutes at a flow rate greater than 25 liters per minute.

b. The filter paper is normally not counted for 48 hours to allow for the decay of naturally occuring Radon daughter products.

c. Counting technique utilizes a 2" planchet for holding the sample to be counted. The filter paper is placed in the planchet and counted for 30 minutes in a gas proportional counter for alpha and beta.

d. The total count obtained is divided by the counting time to determine the counting rate in counts per minute.

e. The background count rate of the detector is subtracted from the counts per minute to obtain the corrected counts per minute.

f. The corrected counts per minute is divided by the efficiency of the detector to determine the disintegrations per minute (dpm).

g. The airborne activity is then computed as follows:

$$\text{airborne activity} = \frac{\text{dpm}}{(2.22 \times 10^6 \text{ dpm}/\mu\text{Ci})\ (\text{volume of air sampled})}$$

h. The calculated activity is then compared with limits specified in 10 CFR 20.

2. Determine the air sampler flow rate to sample isokinetically.

a. Calculate the area of the isokinetic probe to be used in the stack. Area, $A = \pi r^2$ where $\pi = 3.1416$ and r = radius of the probe in feet.

b. The required air sampler flow rate is equal to the corrected air velocity (V_c) times the area of the probe (A).

Air Sampler Flow Rate = (V_c) (A) in ft^3/min.

c. Adjust air sampler flow rate to the value determined in 2.b. If your air sample meter is in liters/min, the conversion factor is ft^3 = 28.3 liters.

3. Set the probe directly in the center of the stack with the probe opening opposing the flow of air. NOTE: The probe should be installed in the center of a straight section of the stack which is at least 3 stack diameters from the nearest bend. This will insure laminar air flow. The filter holder should be located directly behind the isokinetic probe to minimize error in air sample due to adsorption.

4. Sampling time should cover a period that is representative of the activity being monitored.

1. Determine the air velocity at the center of the stack (A Dwyer Model 400 air velocity ? is a typical instrument).

a. Measure stack temperature ($^{\circ}F$) at center of stack.

b. Obtain the barometric pressure (inches of mercury).

If you do not have a barometer, call the nearest weather station for this information.

(1) Convert this reading from ft/min to inches of water.

$$P_v = \left[\frac{V}{4005}\right]^2$$

where: P_v = face velocity pressure (inches of water)

V = face velocity (ft/min)

NOTE: For the Dwyer 400 P_v for any V can be read directly off the meter.

(2) The corrected air velocity (for temperature and pressure).

$$V_c \text{ (ft/min)} = 1096.2 \left[\frac{P_v}{\frac{1.32\ P_b}{T + 460}}\right]^{1/2}$$

where: V_c = corrected air velocity (ft/min)

P_v = Face velocity pressure (inches of water)

P_b = Barometric pressure (inches of Hg)

T = Stack temperature $^{\circ}F$

APPENDIX F

PROCEDURE FOR INCINERATION OF DU

URANIUM MACHINE TURNING AND SWARF INCINERATION PROCEDURE

Emergency Equipment

1. Respirator
2. Metal-X powder
3. Garden type hose

Safety Equipment

1. Full face shield
2. Laboratory shopcoat
3. Gloves
4. Safety shoes
5. Safety glasses

Operation

1. Turn exhaust scrubber system on
2. Turn water to scrubber on - adjust to 40 lbs. pressure
3. Lock barrel in place and check for pressure leaks
4. Adjust water flow under the barrel used for incineration so that water drains out of tank slightly faster than into tank
5. To maintain water level at approximately 1 inch from top of barrel, occassionally open another valve and let water level rise. DO NOT LET WATER FLOW INTO THE BARREL! Water serves as a catalyst and increases the intensity of the fire.
6. To start, drain water from poly bag of chips by puncturing a small hole in the corner of the bag. If bag is sealed, puncture vent holes in the top. This will prevent the bag from popping.

7. Place 2 bags of chips in bottom of barrel (no more than 50-60 lbs). Maintain a record of weight of chips added to each barrel.

8. Start the incineration process by placing a burning towel into the barrel on top of the poly bag.

9. When the flame has subsided to a point where the chips are glowing, continue to place drained and vented bags into the barrel one at a time until barrel is two thirds full. (DO NOT ADD A BAG OF CHIPS WHILE FLAMES OR HEAVY SMOKE IS PRESENT).

10. When a barrel is full, allow to cool for two days. Cooling water should be maintained for at least 16 hours after incineration.

11. Maintain the exhaust system for at least two hours after the last bag of chips has been incinerated. NOTE: This is required whether barrel is filled or just partially full.

12. To remove full barrel raise hold down frame, place in plastic bag to minimize the spread of contamination and then lift over the side of tank.

13. Place cover and ring on barrel and lift out with overhead crane.

14. Paint burned areas of the barrel to prevent rusting during outside storage.

15. Weigh the barrel substracting the weight of the barrel to obtain the net DU content.

16. Mark barrel with permanent ink with the following information

GROSS WEIGHT
NET DU WEIGHT
DU OXIDE
DATE

ADDITIONAL INFORMATION IN SUPPORT OF
APPLICATION FOR RENEWAL OF SOURCE MATERIAL LICENSE NUMBER SUB-238,
ARMY MATERIALS AND MECHANICS RESEARCH CENTER
WATERTOWN, MASSACHUSETTS 02172

1. The Radiation Control Committee (RCC), comprised of the following individuals, is responsible for designation of individual users under License No. SUB-238. Users are defined as supervisors at the Branch, Division, and Office level. The supervisor will be responsible for insuring that his/her employees are aware of and understand the potential hazards of source material and comply with the safety procedures associated with the use of source material. Resumes of RCC members are furnished by Appendix A.

RADIATION CONTROL COMMITTEE MEMBERS

Dr. Gordon A. Bruggeman - Chairman
Mr. Sidney Levin - Secretary, RPO
Mr. Donald J. Stevens - Alternate RPO
Dr. Thomas A. Egan - Member
Mr. Satrak DerBoghosian - Member
Dr. Clyde R. Desper - Member
Mr. Russell G. Hardy - Member

2. Before a supervisor is designated as an individual user, he/she will complete an XMR Form 16 and 16-1 "Application for Authorization to Use Radioisotopes - Part A and B" (Appendix B). The completed application is reviewed by the RCC and approved if the applicant has demonstrated sufficient educational background and experience to safely and properly use and supervise the use of source material. DARCOM Reg 385-25 is furnished by Appendix C.

3. Training is recorded on DA Form 750, Record of Training, (Appendix D), which is maintained in the individual's personnel folder located at the Civilian Personnel Office.

4. Additional information concerning the incineration of wastes:

a. Item II.a - The average quantity of depleted uranium (DU) (U-238) incinerated per week is approximately 100 lbs (16.2 mCi). This average is based on the previous six (6) month period. Previously, as much as 1,500 lbs of DU has been incinerated during a one week period and 400 lbs of DU in one day.

b. Item II.b - The incinerator is equipped with an exhaust/scrubber system utilizing an American Air Filter (AAF) Type W Rotoclone, and AFF Size 8, Type W, Arrangement A, filters with an efficiency of 99.95% for 0.3 micron size particulate by DOP method. The stack height is 53 feet and located approximately 110 from nearest inhabited building outside this installation. The maximum height of buildings in the immediate vicinity is 40 feet. Rated air flow of the exhaust system is 2,120 ft^3/min.

6. Evaluation of Potential Inhalation and/or Ingestion of DU

a. Uranium Incineration Area; Bldg. 43 - The ventilation system, filter, scrubber, stack air sampling and incineration procedures are described in Item 4. Additionally, general room, process, and/or breathing zone air samples are taken at least monthly during time of incineration. Analysis of these air samples is identical to that described in Appendix E.

b. Uranium Machine Shop; Bldg. 312 - The ventilation system is high velocity-low volume consisting of a Hoffman Primary Cyclone component, a Hoffman Secondary 52 Bag Filter component, and a Hoffman absolute filter component with 99.97% efficiency for 0.3 micron particle size. Air flow is assured by use of static pressure devices located stategically throughout the system. Stack sampling is conducted at least monthly and is performed and evaluated according to procedures contained in Appendix E. General room, process, and breathing zone samples are taken and evaluated according to the procedure contained in Appendix E.

c. Uranium Melt Facility; Bldg. 43 - The ventilation system in the Uranium Melt Facility contains both a prefilter component and an absolute filter component with a 99.97% efficiency for 0.3 micron particle size. Stack sampling is conducted monthly and performed and evaluated according to procedures in Appendix E. Process and breathing zone samples are also taken. Analysis of these samples is performed according to the procedure in Appendix E.

7. External exposure to radiation is controlled through written procedures, radiation work permits, rotation of personnel, survey of areas prior to initiating radiological operations, maintenance of area work logs, and at least monthly surveys of work areas. All radiation work personnel are required to wear film badges which are evaluated and exchanged on a monthly basis. Film badges indicating beta or gamma doses of 1.0 Rem or greater require investigative action. The investigative report details the nature of the exposure and corrective action to be taken to keep exposures in line with the NRC ALARA philosophy. Extremity monitoring is accomplished by Thermoluminescent Dosimetry (TLD) using Lithium Flouride (LiF) hot pressed chips. The TLD system is performance tested and documented according to a proposed ANSI standard on "TLD Standards for Performance." TLD chips are sealed in plastic and worn on the finger for dose determination. The TLD badges are exchanged and evaluated on approximately a two week interval. Doses higher than 1.0 Rem require investigation and corrective action as necessary.

Incl

Appendix A - Radiation Control Committee Resumes
Appendix B - XMR Form 16 and 16-1
Appendix C - DARCOM Regulation 385-25, Radiation Protection
Appendix D - DA Form 750, Record of Training
Appendix E - Isokinetic Stack Sampling Procedure and Air Sampling Analysis Procedure
Appendix F - Procedure for Incineration of Uranium Machine Turning and Swarf

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Table 2. Airborne contamination levels.

Required respiratory protection	Alpha Concentration	Beta Concentration
[1]Half face mask with filter or canister respirator.	1 MPC	1 MPC
Supplied air or self-contained air supply with full face mask.	5 MPC	10 MPC

[1]For operations under the control of an AEC license, specific approval of the AEC must be obtained before making any allowance for use of respiratory equipment.

Table 3. Maximum permissible personnel contamination.

Area and action	Alpha or Beta-Gamma
1. Skin. Contact medical officer if contaminated on face or over major area of the body. Continue decontamination, if above:	Any detectable level above background.
2. Hands. Continue decontamination, if above:	Any detectable level above background.

23. Personnel decontamination. a. Thorough washing with non-abrasive soap and lukewarm water is the best general method of decontamination of the hands and other parts of the body regardless of the contaminant. If the contaminant is localized, it is often more practical to mask off the affected area and cleanse with swabs, rather than risk the danger of spreading the contaminant by general washing. Organic solvents must be avoided as decontamination agents because they may increase the probability of the radioactive materials entering the body through skin absorption. Special attention must be given to the areas between the fingers and around the nails. The outer edges of the hands are readily contaminated and often neglected in the washing.

b. After repeated washings, the skin may tend to chap. To avoid this, apply lanolin or hand cream and then continue to wash. If repeated washing with soap and water is unsuccessful in decontamination, the individual should be referred to the local medical officer for application of the more drastic chemical decontamination procedures listed in the National Bureau of Standards Handbook No. 48.

c. If it is suspected that any person, by inhalation, ingestion, or by any other manner, has introduced radioactive materials into his body, the local medical officer will be notified immediately so that medical procedures can be initiated to facilitate the elimination of such material. Contamination over a large area of his body or his face will be the basis for suspecting that the person is internally contaminated.

d. In the event an individual is contaminated on a large portion of his body, the following decontamination procedure is recommended:

(1) Place the individual under a lukewarm shower.

(2) Using a mild toilet soap, individual will cover his entire body with lather.

(3) While still covered with lather, the individual will step out of the shower. An assistant will then cover the individual with a heavy coat of mild soap flakes. (The purpose of the lather is to cause the soap flakes to adhere to the person.)

(4) Using his hands, the contaminated individual will rub the soap flakes on his body into a paste.

(5) Individual will then return to shower and attempt to rinse off the soap by starting at the top and working his way down. (Note. It will be necessary for the individual to rub body surfaces with his hands while rinsing, in order to remove soap paste.) Soap paste will remain in

those areas that have not been thoroughly rinsed. Although a soft cloth may be used, a brush may not. Particular attention should be given the hairy portions of the body.

(6) When the individual has rinsed himself to the point that he no longer feels slimy and while still under the shower, he will be examined by an assistant for traces of soap. The presence of soap will indicate which areas of the body have not been decontaminated.

(7) After removing all traces of soap, the individual will leave the shower and dry himself.

(8) After drying off, the individual will be monitored. If the individual is still contaminated, procedures outlined above will be repeated.

d. In all cases of personnel contamination, the radiological protection officer will be consulted.

e. All water used in the washing and rinsing described above will be contaminated and its disposal should be conditioned by this fact.

24. Equipment and area decontamination. a. General methods.

(1) Care must be taken during the decontamination process to avoid further spread of the contaminant which can be accomplished by:

(a) Always taking precautions to contain the contamination by the use of monitoring, protective clothing, and shoe covers.

(b) Always working from the areas of least contamination toward the area(s) of the heaviest contamination.

(c) Using a minimum amount of decontamination liquids and being aware that the runoff solutions, mops, rags, and brushes will all be contaminated.

(2) The methods listed below should be tried in the following sequence:

(a) Damp mopping. The area is wiped with a damp rag. The wiping surface of the rag is changed repeatedly to minimize spreading of the contaminant.

(b) Water and detergent. The area is wetted with a minimum amount of detergent solution. The area is then wiped dry with absorbent gauze or cloth.

(c) Steam cleaning.

(d) Cleaning with solvents other than water.

(e) Surface removal by use of chemicals, abrasives, sand blasting, grinding, etc.

(3) Vacuum cleaners. Only vacuum cleaners which are equipped with absolute filters and which have been tested for filtration efficiency may be used. The filtration efficiency will be tested after each replacement of the filter and each time contents are emptied.

b. Specific methods. If the above methods (a above) do not work, the following specific methods may be tried:

(1) Metals.

(a) Remove any oil from the surface with organic solvents.

(b) Soak in a solution of citric acid prepared by addition of one pound of citric acid to one gallon of water.

(c) Soak in a solution of diluted hydrochloric acid prepared by carefully adding one part of commercial grade concentrated hydrochloric acid to four parts of water. Hydrochloric acid should not be used on stainless steel because of the etching which will take place and destroy the smooth surface of the metal.

(d) Use metal polish.

(2) Plastics. Clean with ammonium citrate, dilute acids, or organic solvents (of a type not injurious to the plastics).

(3) Glass and porcelain. Clean with detergent solution. If this method fails, soak in concentrated nitric acid or chromic acid cleaning solution.

(4) Painted surfaces. Use paint remover, or, in cases where surfaces were coated with a strippable paint, peel the paint from surface.

(5) Rubber, including respirators and gas masks. Wash with detergent and water or with a warm 20 per cent (by weight) water solution of sodium citrate.

c. Decontamination of clothing.

(1) Determine extent of contamination using an AN/PDR-27, or equivalent, with the beta shield removed, and with the AN/PDR-60, or equivalent.

(2) Wash in special laundry facility (home type or other washer and dryer kept in the facility for washing "hot" clothing only). Use the following steps:

(a) Soak overnight in water solution of laundry detergent.

(b) Drain.

(c) Wash for full cycle with hot water and laundry detergent.

(d) Rinse, dry and remonitor.

(3) Water utilized for washing, rinsing or soaking contaminated clothing will be contaminated as a result of such usage and its disposal should be conditioned by this fact. Laundry equipment may become contaminated also.

d. Monitoring technique. Check crevices and inside corners of areas, tools, and equipment. Special attention should be given to oily and greasy surfaces such as those on automotive equipment.

25. Storage of radioactive materials. a. Areas will be set aside for the secure storage of radioactive materials. These areas will be used to store only radioactive materials. The storage area will be free from the danger of flooding and outside the danger radius of flammables or explosives. Physical security standards for storing radioactive materials are contained in appendix A, AMCR 190-3.

b. Each storage and shipping container will be marked as required by AR 55-55 and AR 385-30, whether or not the radioactive material is under the license control of the AEC. Laboratory containers such as flasks and test tubes need not be marked as long as the user is continuously present.

c. Radioisotopes will not be stored in glass containers unless secondary containment is provided.

d. Radioisotopes should not be transferred from one storage container to another within the storage area. A system will be provided to control and record the "check in" and "check out" and monitoring of radioactive materials.

e. Storage areas will be adequately ventilated as determined by the RPO if gaseous sources are being stored.

f. All sources and containers will be labeled. The areas will be monitored periodically to assure adequate shielding and to detect any contamination.

g. Dose rates of a shipping container should not exceed 200 mrem/hr at the surface nor 10 mrem/hr at 3 feet from any surface of the container.

h. Operating officials will keep a current record of all stored radioactive material, and a copy of this record will be forwarded to the RPO. The RPO will conduct a physical inventory every 6 months.

26. 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 shipments. However, the following precautions will be observed:

a. In loading the vehicles:

(1) Keep within the weight limitations.

(2) Limit or arrange cargo to keep radiation levels, to which personnel (including the driver) will be exposed during transportation, as low as possible. Maximum permissible dose rate in occupied areas of the vehicle will depend upon the time required to transport the material. The driver will wear a film badge and will not be exposed to ionizing radiation in excess of the limits indicated in paragraph 12a.

(3) Keep the containers away from the cab of the vehicle.

b. Do not haul loose radioactive materials. Tail gates should be closed to minimize the chance of cargo loss.

c. Containers should be sturdily constructed, sealed air-tight, and be free of removable contamination. Each container must have a completed DA Label 15 (Caution: Radioactive Materials) unless specifically exempt by military specification M-19590C.

d. The route used should be planned to avoid areas in which explosives are stored or handled and in which there is heavy traffic or personnel activity. The fire department, guard force, and safety director should be informed of the exact route and time of movement in sufficient time to allow implementation of any special protective measures required.

e. A suitable vehicle should be used. Vehicles that are difficult to decontaminate, and privately-owned automobiles should not be used.

f. Unless emergency personnel (guard force and fire department) have demonstrated a capability to cope with a radiological emergency, a technically trained person should accompany the movement to be able to advise in the event of an emergency.

27. Off-post transportation of radioactive materials. a. Radioactive material will be transported in accordance with AR 55-55 and applicable Federal and State regulations.

b. Radioactive material should not be forwarded through the U.S. mail channels except in an emergency. Should transmission by mail be necessary, shipment will comply with Part 125.24, U.S. Postal Manual, and will be registered.

c. Containers should be secured by blocking or tie down, when appropriate.

d. Materials shipped will be properly addressed to insure delivery to the proper installation and section within the installation.

e. Personnel who will transport and/or escort radioactive shipments will be briefed as to potential hazards, methods to minimize hazards and emergency procedures. In addition to the briefing, personnel engaged to transport the radioactive material will be given a completed DD Form 836 (Special Instructions for Motor Vehicle Drivers) supplemented with written emergency procedures. Written information will be provided as to the means for obtaining assistance of radiological emergency teams off-post.

f. Consignees will be notified in advance of impending shipments in order that consignees may assure that they have the capability to receive and handle the materials being shipped.

28. On-site command of emergency during transportation. The ranking person accompanying the shipment will take immediate steps to clear the area and request assistance. He retains command at the accident site pending the arrival of the commander of the nearest military installation or his representative. The designated Army area representative assumes responsibility upon his arrival.

29. Radiac instrumentation. a. Sufficient radiac instruments will be available to properly support the use of radiation sources. The instruments will be capable of detecting the types and levels of radiation involved and any possible resulting contamination.

b. Personnel monitoring devices will be immediately available in areas in which radioactive materials are handled.

c. All instruments used for radiation protection will be calibrated at least every 3 months, and after each maintenance or battery change. More frequent calibration will be necessary for instruments which receive heavy use. Dosimeters need to be calibrated only at 6-month intervals. Dose rate instruments used to determine time of stay and exposure estimates should be calibrated at a minimum of two points on each instrument scale. The instruments will be labeled with DA Label 80 (U.S. Army Calibration System) to show the date of the last calibration, source or method used for calibration, and the initials of the calibrator.

d. Faulty instruments will be tagged with DA Form 2417 (Unserviceable Test Instrument or Standard) to prevent their being used before having been repaired.

e. Each instrument used for radiation protection should be provided with a check source or test sample.

f. Pocket dosimeters should be calibrated every 6 months. At the time of calibration, the correction factor for the dosimeter should be determined. Dosimeters which leak more than 5 percent of full scale after 24 hours in a radiation free area or which have an error of more than 10 percent should be repaired. Dosimeters should be calibrated by exposing them to known sources of an energy level comparable to that which the dosimeter will be exposed during use. Each dosimeter will bear a label showing the correction factor and the date of calibration. The correction factor is determined by dividing the actual level of radiation by the indicated level.

g. Dosimeters are used to give the wearer an estimate of his exposure while receiving the dose, in order that he may limit himself to permissible levels. Disagreement between dosimeter and film badge measurements is to be expected. The film badge reading will be used as the official dose for record purposes unless the badge is proven to have recorded an incorrect exposure.

h. Instrumentation must be selected based on the type and level of radioactive material and/or radiation to be encountered. In high radiation areas, it is desirable to have a high-range survey meter in addition to a low-range meter, in order to cover the range of dose rates likely to be encountered.

i. If funds permit, duplicate radiation protection instruments should be available. The duplicate instruments will avoid the necessity of shutting down a radiological operation until an instrument can be repaired or replaced.

30. Emergency procedures. a. In view of the complicating factors that may arise in an emergency, it is impossible to establish simple rules of procedure to cover all situations of a radiation emergency. However, in any emergency, the primary concern must always be the protection of personnel from radiation hazards. Confinement of the contamination to the immediate environment of the accident should be a secondary concern. Copies of the investigation report, relative to exposures received by the personnel involved, will be given to each individual involved in that emergency.

b. Emergencies will probably be of the following types:

(1) Spill of radioactive material.

(2) Explosion.

(3) Fire.

(4) Overexposure.

(5) Injury to personnel.

(6) Loss of radioactive source.

(7) Vehicular accident involving radioactive material.

c. The medical officer of each AMC element having radiation sources shall establish written medical procedures for radiation casualties.

d. Emergency procedures will be preplanned and rehearsed at least once each year. In the event of an emergency, the following action will be taken:

(1) Spills or uncontrolled spread of contamination.

(a) Notify all persons not involved with the spill to vacate the area at once.

(b) If the spill is liquid and the hands and clothing are protected, right the container and take steps to contain the spillage.

(c) If the spill is on the skin, flush thoroughly.

(d) If the spill is on the clothing, discard outer or protective clothing at once.

(e) Notify the local radiological protection officer.

(f) Decontaminate personnel.

(g) Decontaminate the area.

(h) Monitor all persons involved in the spill and cleaning operation to determine adequacy of decontamination.

(i) Permit no person to resume work in the area until an area survey is made and the area is cleared by the radiological protection officer.

(j) Prepare a complete history of the incident and decontamination operation related thereto for the facility or area records. The history will include a statement of the corrective actions taken to prevent a recurrence. Forward within 2 weeks of the accident, an information copy to the Commanding General, AMC, ATTN: AMCAD-S.

(2) Accidents involving radioactive dusts, mists, fumes, organic vapors, and gases.

(a) Notify all personnel not directly involved with the incident to vacate the area immediately.

(b) Hold breath, and switch off any air circulating devices; e.g., fans, air conditioners, blowers, etc.

(c) Vacate the area to a predesignated region, and allow no person to leave until monitored.

(d) Close and seal all entrances into the area and post conspicuous warning signs or guards to prevent doors from being opened accidentally.

(e) Notify the RPO.

(f) Immediately report all known or suspected inhalations of radioactive materials to the local RPO and the medical officer.

(g) Evaluate the hazards and the safety devices required for safe re-entry and apply the "two man rule."

(h) Determine cause of contamination and rectify the condition.

(i) Decontaminate the area.

(j) Perform an area survey (including air sampling) of the area before resuming normal operations.

(k) Monitor all persons suspected of contamination.

(l) Prepare a complete history of the accident and subsequent activity related thereto for the facility records. Forward, within 2 weeks of the incident, an information copy to the Commanding General, AMC, ATTN: AMCAD-S.

(3) Injuries to personnel involving radiation.

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

(b) Contaminated personnel who are injured. In any radiological accident involving injured personnel, the local medical officer will be notified immediately. Unless an emergency medical reason requires that the injured person be removed immediately, the injured person will not be transported until a litter or ambulance is available. If, however, other emergencies exist (e.g., fire or possible explosion), good common judgment should be used. Moving of the patient may become imperative.

(c) Personnel with minor wounds will be monitored and decontaminated, if necessary, before leaving the radiation facility. If the wounds are of a serious nature, the injured individual will be wrapped in a blanket to prevent the further spread of contamination, and immediately be removed to the nearest medical facility. Persons accompanying the individual will warn the medical personnel that there is a possibility that the injured is contaminated.

(d) Report all radiation accidents (overexposure, wounds, ingestion, inhalation) to the personnel involved, to the medical officer, and to the RPO.

(e) Permit no person involved in radiation injury to return to work without the approval of the attending physician and the RPO.

(f) Prepare a complete history of the accident and subsequent activity related thereto for the radiation facility records. The history will include a statement of the corrective actions taken to prevent a recurrence. Forward, within 2 weeks of the occurrence, an information copy to the Commanding General, AMC, ATTN: AMCAD-S.

(4) Fires and other major emergencies.

(a) Notify all persons not directly involved with the incident who are in the area.

(b) Notify the fire department and other emergency personnel.

(c) Attempt extinguishment of fires using readily available first-aid type extinguishers if a radiation hazard is not immediately present. Efforts should be made to prevent water or fire fighting chemical from coming in contact with the radiation source. Attempt to control runoff, preventing it from entering sewers or drainage systems until it has been monitored.

(d) Notify the RPO.

(e) The RPO will advise and assist the emergency personnel.

(f) Following the emergency, monitor the area and determine the protective devices necessary for safe decontamination.

(g) Decontaminate.

(h) Monitor all persons who were in the emergency area and those who were involved in combating the emergency.

(i) Monitor downwind, delineate all contaminated areas, and restrict access as necessary.

31. Additional requirements. The above reporting requirements are in addition to the requirements of AR 385-40; AMCR 385-2; AMCR 385-3; and in addition to Title 10, Code of Federal Regulations, Sections 20.401, .402 and .403, when AEC-licensed material is involved. Information copies of reports to the AEC will be forwarded (AMCR 385-9) immediately, through channels, to the Commanding General, AMC, ATTN: AMCAD-S.

32. Key emergency personnel. Key emergency personnel, such as Provost Marshal, Fire Chief, Medical Officer, and Safety Officer 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.

33. Records. Records will be maintained to document all aspects of the radiation protection effort. Included are:

a. Licenses, authorizations, and supporting applications

b. Receipts, transfers and shipment records, notification of movement, and instructions to drivers.

c. Inventory and leak test records.

d. Instrument and source calibration records and certificates.

e. Utilization logs and radiation work permits.

f. Radiation survey records which include description of each use, operation or work performed; radiation levels and personnel exposure rates encountered; airborne and smearable contamination detected; hazards and corrective action, estimated personnel exposure; and disposition of radiation sources.

g. Environmental monitoring records.

h. Waste disposal records.

i. Records of training, plans of instruction, experience and certification of radiation workers.

j. Standing operating procedures.

k. Records of special studies, investigations.

l. Copies of reports originated and received.

m. Inspection reports and related papers.

n. Radiation analysis files.

o. Minutes of committee meetings.

p. Directives and interpretation of regulations.

q. Personnel occupational exposure records. AR 40-14 requires the custodian of the medical records to prepare and maintain DD Form 1141 for each person occupationally exposed to ionizing radiation. For administrative control purposes, it is recommended that the Radiological Protection Officer maintain forms AEC-4 and AEC-5 also, where AEC licenses are involved. These forms are available at the U.S. Atomic Energy Commission, Division of Materials Licensing, Washington, D.C. 20545, and may be reproduced locally.

Appendix A

GLOSSARY OF RADIATION SAFETY TERMS

APPROVAL. Official certification of compliance with the provisions of this regulation and with instructions and directives as issued by Headquarters, AMC, or with those of other approving agencies specifically referred to in this regulation.

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 material 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. The harm may be in invalidating an experiment or a procedure, or in 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 3.700×10^{10}

- millicurie - One-thousandth of a curie (3.700×10^7 disintegrations per second).

- microcurie - One-millionth of a curie (3.700×10^4 disintegrations per second).

DOSE.

1. 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

$$1 \text{ rad} = 100 \text{ erg/gm} = 1/100 \text{ joule/kg}.$$

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.

2. Exposure Dose. See EXPOSURE.

3. 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 purposes 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 affects 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 factors, 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 dots take 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 Rem and Rad.) 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 roentgen 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 a 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:

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

2. 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 CONTROLLED AREAS. Any area, whose access or occupancy is controlled for the purpose of protection of individuals from exposure to ionizing radiation and radioactive materials.

RADIATION CONTROL COMMITTEE. A group of persons appointed by the commander 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 materials, (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.

1. 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.

2. 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 per cent (0.05 per cent) or more of uranium, thorium or any combination thereof. Source material does not include special nuclear material.

3. Special nuclear material. Plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 233, 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, determines to be

special nuclear materials, but does not include source material; or any material artifically enriched by any of the foregoing but does not include source material.

4. 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 and 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 the 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 equals 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^oC, 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.

$$1 \text{ R} = 2.58 \times 10^{-4} \text{ coulombs/kg.}$$

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.

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

USER. The activity, section, division or other organizational unit which has been assigned responsibility for the use, handling, operation or storage of radiation sources.

Appendix B

RECOMMENDED DOCUMENTS FOR A REFERENCE LIBRARY

1. Army regulations. AR's 40-4, 40-5, 40-14, 40-37, 40-501, 55-55, 55-355, 385-10, 385-12, 385-30, 385-32, 385-40, 385-80, 700-25, 700-52, 700-63, 700-64, and 755-15.

2. AMC regulations. AMCR's 190-3, 385-1, 385-3, 385-7, 385-9, 385-13, and 385-15.

3. Field manual. FM 3-15.

4. Table of allowances. TA 50-914.

5. Supply bulletin. SB 11-206.

6. Technical bulletins. TB's CML 52, CML 53, CML 63, 3-6665-200-12, 3-6665-201-12, 3-6665-202-12, 3-6665-203-12, 3-6665-204-12, MED 62, MED 223, MED 232, MED 249, SIG 226-8, SIG 226-9, TC 7, and 5-6600-227-15/1.

7. Technical manuals. TM's 3-220, 3-260, 3-261, 3-6665-214-15, 11-5514, 11-5514A, 11-5543, 11-6665-204-12, 11-6665-206-12, 11-6665-208-15, 11-6665-209-15, 11-6665-216-15, 11-6665-221-15, 11-6665-224-15, 38-250, 38-750, 39-20-3, 39-20-6, 39-35-15, 39-N-11.

8. Military standards and specifications.[1]

a.	MIL-STD-129	Marking for Shipment and Storage.
b.	MIL-M-3935A	Markers, Self-Luminous.
c.	MIL-C-10436	Compasses, Lensetic, Luminous Dial.
d.	MIL-M-19590	Marking of Commodities and Containers to Indicate Radioactive Material.
e.	MIL-STD-450	Radiation Hazard Symbol Contaminated Areas.

9. Miscellaneous. a. DOD 4160.21-M, Defense Disposal Manual.

b. Title 10, Code of Federal Regulations. Atomic Energy.[2]

c. Title 14, Part 49 of Code of Federal Regulations.[2]

d. Title 46, Part 146 of Code of Federal Regulations.[2]

e. Title 49, Parts 171 through 178 of Code of Federal Regulations.[2 3]

f. U.S. Postal Manual, Chapter 1, Sections 124.24 and 125.24.[4]

[1 2 3 4] See footnotes on page 47.

g. Radiological Health Handbook, U.S. Department of Health, Education and Welfare.[4]

10. U.S. Department of Commerce, National Bureau of Standards Handbooks.

48 - Control and Removal of Radioactive Contamination in Laboratories.

49 - Recommendations for Waste Disposal of Phosphorus 32 and Iodine 131 for Medical Users.

51 - Radiological Monitoring Methods and Instruments.

53 - Recommendations for the Disposal for Carbon-14.

55 - Protection Against Betatron-Synchrotron Radiations up to 100 Million Electron Volts.

57 - Photographic Dosimetry of X- and Gamma Rays.

58 - Radioactive Waste Disposal in the Ocean.

59 - Permissible Dose for External Sources of Ionizing Radiation.

63 - Protection Against Neutron Radiation up to 30 Million Electron Volts.

65 - Safe Handling of Bodies Containing Radioactive Isotopes.

66 - Safe Design and Use of Industrial Beta-Ray Sources.

69 - Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure.

72 - Measurement of Neutron Flux and Spectra for Physical and Biological Applications.

73 - Protection Against Radiation from Sealed Gamma Sources.

75 - Measurement of Absorbed Doses of Neutrons and of Mixtures of Neutrons and Gamma Rays.

76 - Medical X-ray Protection up to 3 Million Volts.

78 - Report of International Commission on Radiological Units. and Measurements

80 - A Manual of Radioactivity Procedures.

[4]See footnotes on page 47.

84 - Radiation Quantities and Units (ICRU Report 10a).

85 - Physical Aspects of Irradiation (ICRU Report 10b).

86 - Radioactivity (ICRU Report 10c).

87 - Clinical Dosimetry (ICRU Report 10d).

88 - Radiobiological Dosimetry (ICRU Report 10e).

89 - Methods of Evaluating Radiological Equipment and Materials (ICRU Report 10f).

92 - Safe Handling of Radioactive Materials.

93 - Safety Standard for Non-Medical X-ray and Sealed Gamma Ray Sources: Part I. General.

11. Federal Radiation Council Reports[4]

No. 1 - Background Material for the Development of Radiation Protection Standards.

No. 2 - Background Material for the Development of Radiation Protection Standards.

12. International Atomic Energy Agency Regulations[5]

Safety Series No. 1 - Safe Handling of Radioisotopes.

Safety Series No. 2 - Safe Handling of Radioisotopes: Health Physics Addendum.

Safety Series No. 3 - Safe Handling of Radioisotopes: Medical Addendum.

Safety Series No. 4 - Safe Operation of Critical Assemblies and Research Reactors.

Safety Series No. 6 - Regulations for the Safe Transport of Radioactive Materials.

Safety Series No. 7 - Regulations for the Safe Transport of Radioactive Materials. Notes on Certain Aspects of the Regulations.

Safety Series No. 8 - The Use of Film Badges for Personnel Monitoring.

[4] [5] See footnotes on page 47.

Safety Series No. 9 - Basic Safety Standards for Radiation Protection.

Review Series No. 12 - The Packaging, Transport and Related Handling of Radioactive Materials.

Review Series No. 18 - Processing of Radioactive Wastes.

13. National Fire Protection Association Publications[6]

Fire Protection Handbook, 12th Edition, 1962.

National Fire Codes -
Pamphlet 801, Laboratories Handling Radioactive Material, 1955.
Pamphlet 802, Nuclear Reactors, 1960.

14. USA Standards Institute Publications[7]

ASA N6.1 - Safety Standard for Operations with Fissionable Materials Outside Reactors, 1964.

ASA N5.2 - Design Guide for a Radioisotope Laboratory (Type B), 1963.

[1]Military standards and specifications are available from the Commanding Officer, U.S. Naval Supply Depot (NSD 103), 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

[2]Copies of the Code of Federal Regulations are normally available from the Post Judge Advocate. Copies can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

[3]The Interstate Commerce Commission regulations are also published as "Agent TC George's Tariff No. 19", available from the Bureau of Explosives of the American Association of Railroads, 30 Vesey Street, New York, New York. Installation Transportation Officers usually have copies of George's Tariff No. 19.

[4]Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

[5]Available from National Agency for International Publications, Inc., 801 Third Avenue, New York, New York 10022

[6]Available from National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts 02110.

[7]Available from USA Standards Institute, 70 East 45th Street, New York, New York 10017.

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