UNIVERSITY OF VIRGINIA
NUCLEAR REACTOR FACILITY

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February 9, 2000

Mr. Alexander Adams, Jr., Senior Project Manager
Non-power Reactors and Decommissioning Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission M.S. 0-11-D-19
Rockville, MD 20852-2738

Subject: Request for Approval of the University of Virginia Reactor Decommissioning Plan and Issuance of a Decommissioning Order (Docket No. 50-62, License R-66).

Dear Mr. Adams:

The University of Virginia respectfully requests the United States Nuclear Regulatory Commission to review and approve the enclosed Decommissioning Plan for the University of Virginia Reactor (UVAR), approved by the University of Virginia Reactor Decommissioning Committee on February 4, 2000, and thereupon issue a corresponding Decommissioning Order for the UVAR.

As the NRC is aware, South Carolina intends to join the Northeast Compact and form the Atlantic Compact for LLW disposal. Virginia is presently in the Southeast Compact. Chem-Nuclear in Barnwell, SC, informed the University of Virginia of a likely gradual restriction of access to Barnwell for all non-Atlantic Compact Members beginning in this July. For this reason, we urge the NRC to expedite its review and approval process.

Currently, the University of Virginia Reactor is in a safe, de-fueled and shutdown condition, in full compliance with its Technical Specifications. Please contact me at (804) 982-5440 if you have any questions regarding this request.

Sincerely,

Robert U. Mulder
Director, University of Virginia Reactor Facility &
Associate Professor of Nuclear Engineering

City/County of Albemarle
Commonwealth of Virginia
I hereby certify that the attached document is a true and exact copy of a letter (type of document) presented before me this 9th day of February, 19 2000.
by Robert Mulder (name of person seeking acknowledgement)
Notary Public
My commission expires 2/28, 19 2002.

enc: UVAR Decommissioning Plan, February 9, 2000
Notification from Chem-Nuclear, Barnwell, SC

cc: Mr. Craig Basset, NRC Region II, Atlanta, Ga.
Document Control Desk, NRC, Washington

A020

CNS, LLC, forwarded the following letter to all customers.
>>>

January 7, 2000

Dear Customer:

As we begin the new millenium, Chem-Nuclear would like to take this opportunity to thank you for your continued support of the Barnwell Low-Level Nuclear Waste Management Facility (Barnwell) in 1999.

Chem-Nuclear wants to assure you that Barnwell will be available to meet your disposal needs through June 30, 2000. As a result of the recommendation of the South Carolina Governor's Task Force to join the Northeast Compact, and thereby form the Atlantic Compact, there is a degree of uncertainty concerning the future availability of Barnwell for all of our customers. We have been and are continuing to work with all the stakeholders to ensure that the Barnwell disposal option is available to all of our customers July 2000 and beyond.

Even if legislation is passed that forms the Atlantic Compact, we believe that an agreement will be included which will allow for a gradual restriction of access to Barnwell for all non-Atlantic Compact members.

To ensure the continuity of access to Barnwell for all of our customers, Chem-Nuclear is developing contracts to provide for disposal effective July 1, 2000.

We look forward to your continued support. If you have any questions and/or comments, please call George Antonucci (803-758-1807) or me (860-677-0457).

Sincerely,CHEM-NUCLEAR SYSTEMS, L.L.C.
Joseph E. Amico, Vice President
Sales and Marketing
END of CSN LLC Letter

UNIVERSITY OF VIRGINIA
REACTOR DECOMMISSIONING PLAN

Prepared For
University of Virginia

Prepared By
GTS Duratek
Radiological Engineering and Field Services
628 Gallaher road
Kingston, TN 37763

February 2000

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ACRONYMS and ABBREVIATIONS

ACGIH	American Conference of Government Industrial Hygienists
ALARA	As Low As Is Reasonably Achievable
ALI	ANNUAL Limit on Intake (see 10 CFR 20)
ANSI	American National Standards Institute
AP	Activation Products
ARA	Airborne Radioactivity Area (see 10 CFR 20)
ARWT	Advanced Radiation Worker Training
ASME	American Society of Mechanical Engineers
BRWT	Basic Radiation Worker Training
CAM	Continuous Air Monitor
CAVALIER	Cooperatively Assembled Virginia Low Intensity Educational Reactor
CDE	Committed Dose Equivalent
CFR	Code of Federal Regulations
cm	centimeter
cpm	counts per minute
D&D	Decontamination and Decommissioning
DAC	Derived Air Concentration (see 10 CFR 20)
DCGL	Derived Concentration Guideline Levels
$DCGL_W$	Weighted DCGL
$DCGL_{EMC}$	Elevated Measurement Comparison DCGL
DDE	Deep Dose Equivalent (see 10 CFR 20)
DECON	Decontamination Decommissioning Option
DOC	Decommissioning Operations Contractor
DP	Decommissioning Plan
dpm	disintegrations per minute
EDE	Eye Dose Equivalent (see 10 CFR 20)
EH&S	UVA Environmental Health and Safety Group
ENTOMB	Entombment Decommissioning Option
EPA	U.S. Environmental Protection Agency
g	gram, a unit of mass
GET	General Employee Training
GM	Geiger-Mueller
GTCC	Greater Than Class C
HEPA	High Efficiency Particulate Air (Filter)
HEU	High Enriched Uranium
HP	UVA Health Physics Department
HPGe	High Purity Germanium Detector
IH	Industrial Hygiene
LLRW	Low-Level Radioactive Waste
LSA	Low Specific Activity (see 49 CFR)
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*, NUREG-1575

micro-R	micro-Roentgen, 10^{-6} Roentgen
mR	milli-Roentgen, 10^{-3} Roentgen
mrad	milli-rad, 10^{-3} rad
mrem	millirem, 10^{-3} rem
MSDS	Material Safety Data Sheet
MSHA	U.S. Mine Safety and Health Administration
mSv	milli-Sievert (unit of dose equivalence, see 10 CFR 20), 10^{-3} Sievert
MW	Megawatt
NCRP	National Council on Radiation Protection and Measurements
NEC	National Electric Code
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NIST	U.S. National Institute of Standards and Technology
NQA	Nuclear Quality Assurance
NTS	Nevada Test Site
NRC	Nuclear Regulatory Commission
OSHA	Federal Occupational Safety and Health Acts
pCi	pico-curie, a unit of radioactivity (2.22 disintegrations per minute) 10^{-12} curie
PCM	Personnel Contamination Monitor
POL	Possession Only License
PQM	Project Quality Manager
QA	UVA Quality Assurance Organization
QC	Quality Control
R	Roentgen
rad	unit of absorbed radiation dose
RCA	Radiological Control Area
RCRA	Resource Conservation and Recovery Act
RDS	UVA Reactor Decommissioning Scope
rem	Roentgen Equivalent man (unit of dose equivalence, see 10 CFR 20)
RESRAD	USDOE Computer Code for Residual Radioactivity Calculations
RO	Reactor Operator
RP	Radiation Protection
RPM	Radiation Protection Manager
RPP	Radiation Protection Program
RSC	Radiation Safety Committee
RSHM	Radiation, Safety and Health Manager
RSO	Radiation Safety Officer
RWP	Radiation Work Permit
SAFSTOR	Safe Storage Decommissioning Option
SDE	Shallow Dose Equivalent (see 10 CFR 20)
SNM	Special Nuclear Material
SP	Safety Program
SS	Stainless Steel

Sv	Sievert (unit of dose equivalence, see 10 CFR 20)
TEDE	Total Effective Dose Equivalent (see 10 CFR 20)
TLD	Thermoluminescent dosimeter
USAEC	U.S. Atomic Energy Commission
USDOE	U.S. Department of Energy
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USNRC	U.S. Nuclear Regulatory Commission
UVA	University of Virginia
UVAR	University of Virginia Reactor

1.0 SUMMARY OF PLAN

1.1 INTRODUCTION

1.1.1 Overview

The UVAR has been variously used since 1960 to provide training for Nuclear Engineering students, and research by all Departments of Engineering and the Departments of Physics, Chemistry, Biology, and Medicine. A profile of this reactor is presented in Table 1-1. In July, 1998, the University of Virginia (UVA) ceased reactor operations at the UVA Reactor (UVAR) located in Charlottesville, Virginia. The objective of this Decommissioning Plan is to conduct decontamination (DECON) of the UVAR and removal of radiologically-contaminated and/or radioactive materials, equipment, components, and soil, to obtain release to unrestricted use by the U.S. Nuclear Regulatory Commission (USNRC). The term "unrestricted use" means that there will be no future restrictions on the use of the site.

The regional location of the UVAR facility (USNRC License R-66) is shown in Figure 1-1; Figure 1-2 depicts the UVA Reactor facility site and adjacent UVA structures; the UVAR site is depicted on Figure 1-3. Figures 1-4 through 1-6 presents plan views of the three floors of the UVAR. This Decommissioning Plan has been prepared using the guidance and format of NUREG -1537 Rev. 0, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors* (Ref. 1.1).

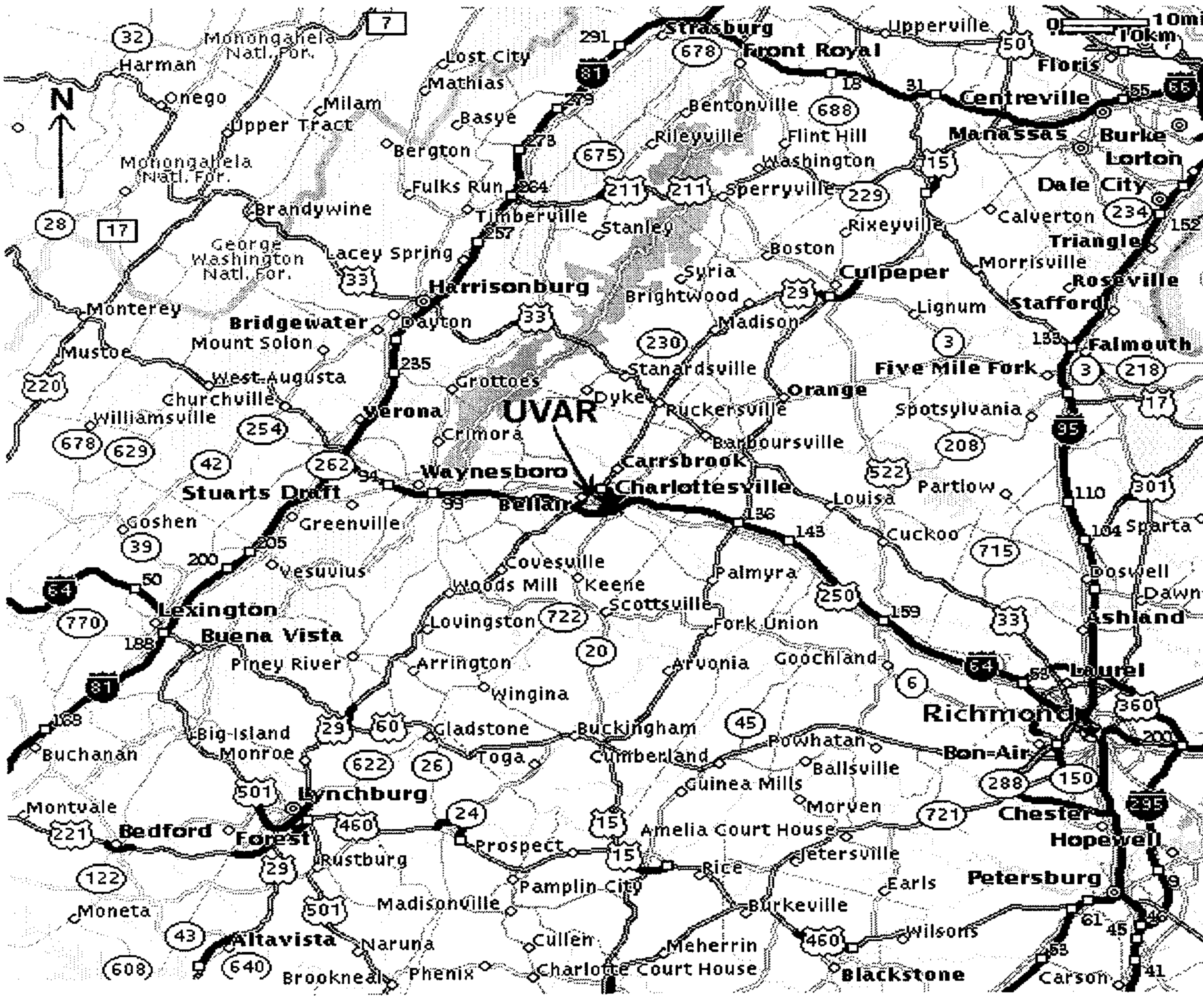


Figure 1-1 Map of Area Surrounding the UVAR Site

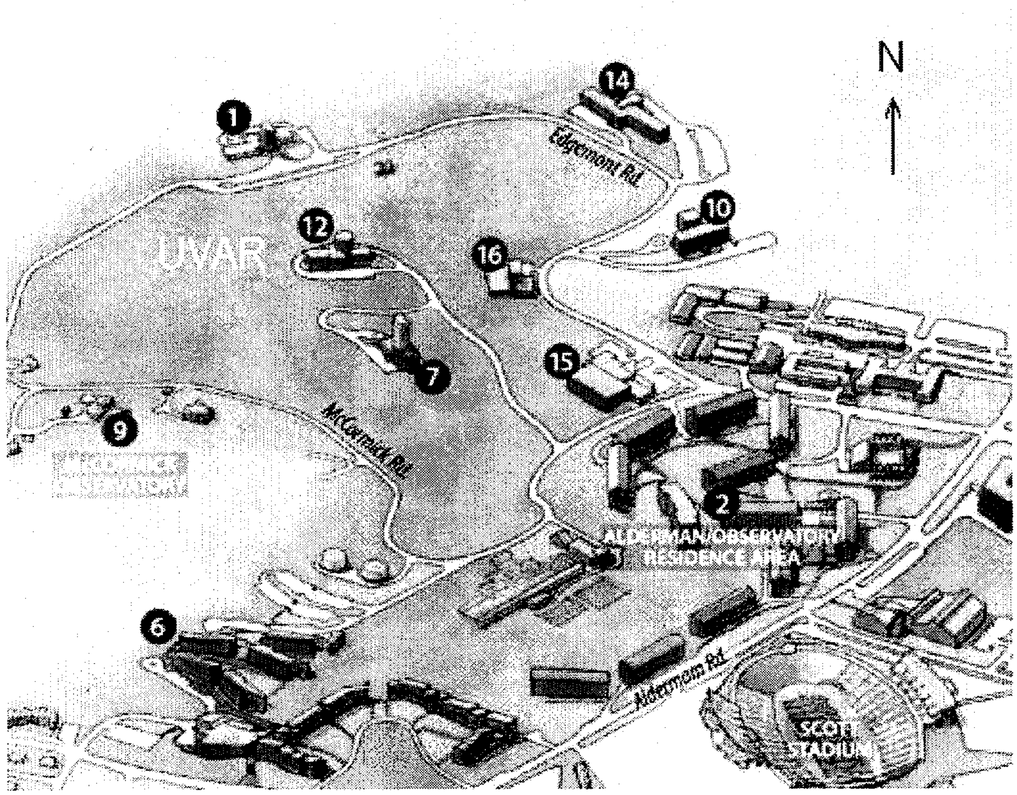


Figure 1-2 Northern University of Virginia Campus

Location 12:	Reactor Facility
Location 1:	Aerospace Research Laboratory
Location 2:	Alderman Observatory Residence Area
Location 6:	Hereford Residential College
Location 7:	High Energy Physics Laboratory
Location 9:	McCormick Observatory
Location 10:	National Radio Astronomy Observatory
Location 14:	Shelbourne Hall
Location 15:	Slaughter Recreation Facility
Location 16:	Special Materials Handling Facility

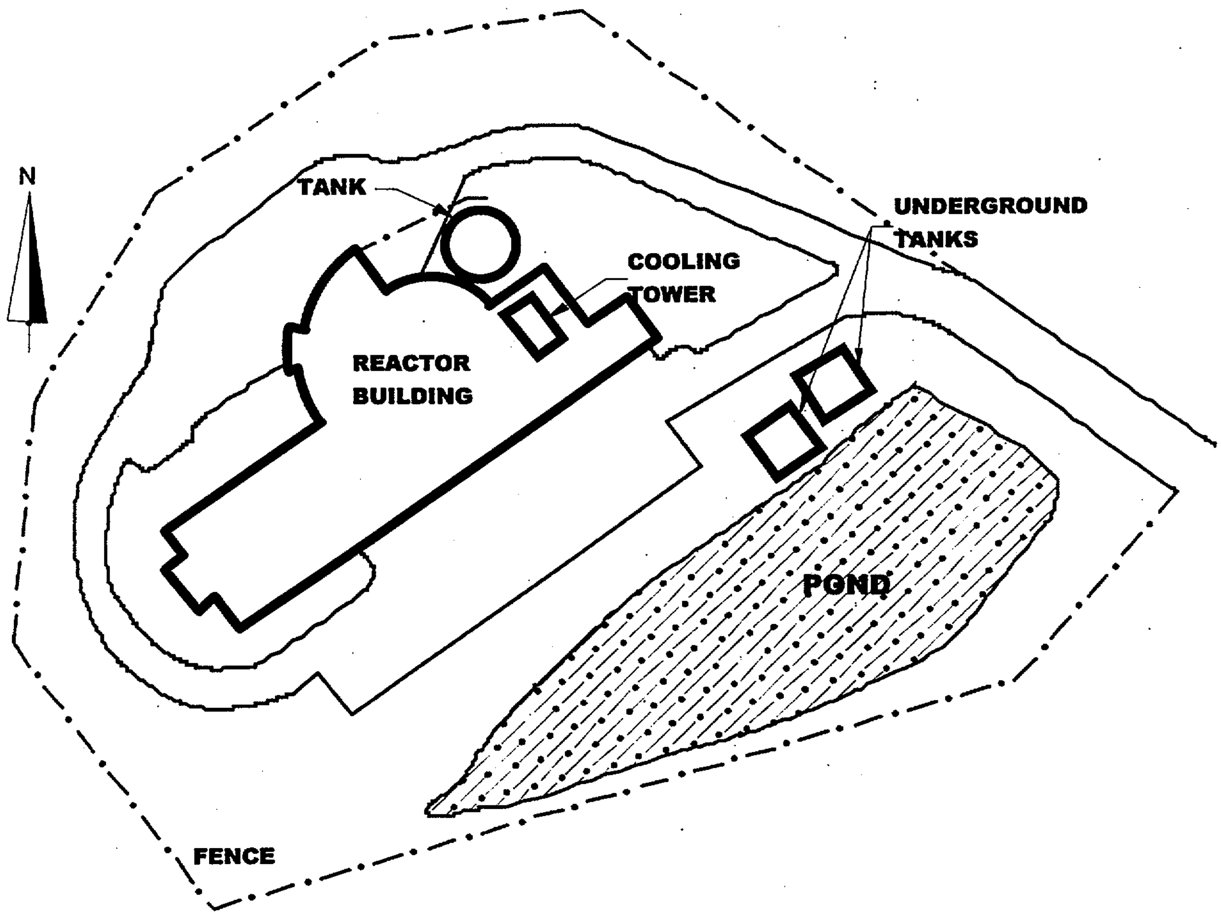


Figure 1-3 University of Virginia Reactor Site

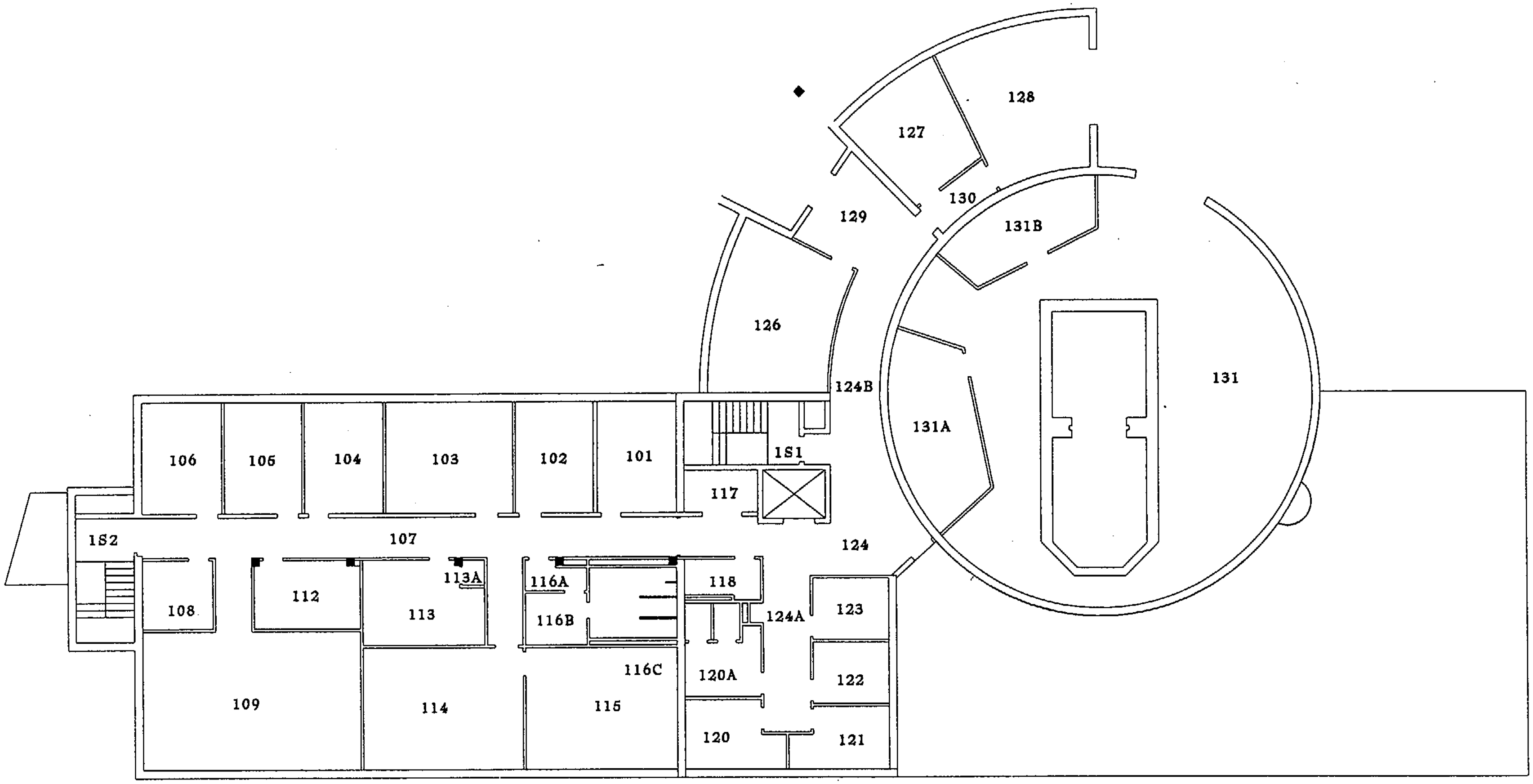


Figure 1-4 UVA Reactor First Floor Plan View

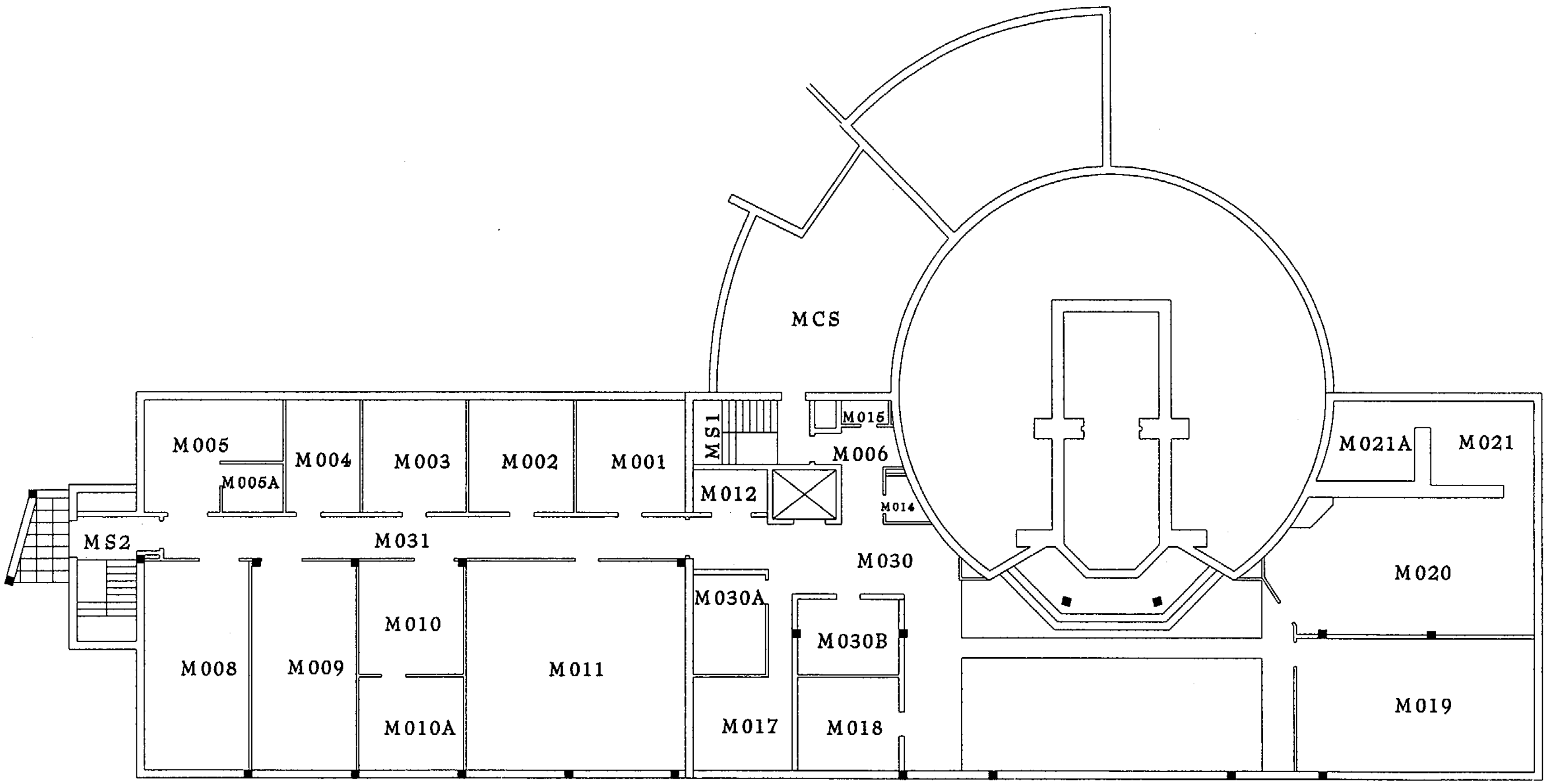


Figure 1-5 UVA Reactor Mezzanine Floor Plan View

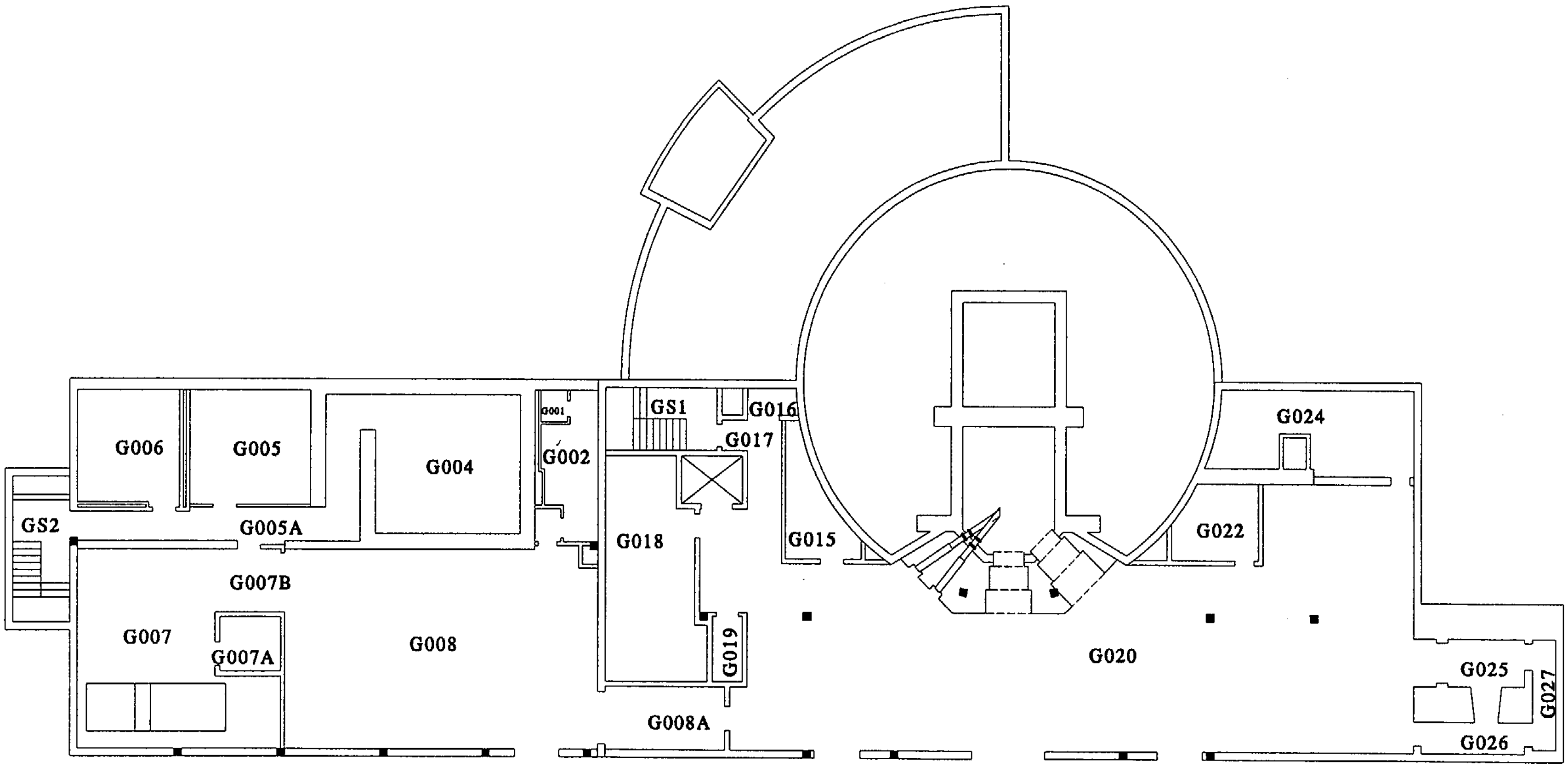


Figure 1-6 UVA Reactor Ground Floor Plan View

Table 1-1 Profile of University of Virginia Reactor

Item Description	UVAR
General Reactor information:	
Owner:	University of Virginia
Operator:	University of Virginia
Licensee:	University of Virginia
Architect/Engineer	Babcock & Wilcox
Nuclear Design:	EG&G, Idaho
Construction:	Castle Construction Co.
Principal Uses:	Training and Research
Reactor Operation and Authorization:	
Initial Criticality:	June 1960; increased licensed power from 1 to 2 MW Jan. 1971
Date Secured:	July 1, 1998
USNRC Utilization Facility Lic. #:	R-66
USNRC Facility Docket #:	50-62
Reactor Specifications:	
Maximum Power, Steady State, MW(t):	2 MW
$\phi_{thermal}$ Steady State, Graphite Reflected (nv):	2.2×10^{13}
$\phi_{thermal}$ Steady State, Water Reflected (nv):	0.17×10^{13}
Specific Power (kW/kg ^{235}U):	273.97
Core Power Density, (kW/l):	27.97
Fuel Material:	LEU, U_3Si_2
Fuel Uranium Content, vol-% ^{235}U:	3.67%
Uranium Enrichment, % ^{235}U:	<20%
Fuel Element Geometry:	Flat Plate
Element Cladding Material:	Aluminum
Element Cladding Thickness:	0.015 in
Core Configuration:	Square Array
Core Active Height:	23.5 in
No. of Available Fuel Positions:	64
Coolant:	Light Water
Moderator:	Light Water
Reflector:	Graphite or Water

1.1.2 Decommissioning Plan Provisions

This Decommissioning Plan provides the following:

1.1.2.1 A description of the present radiological condition of the UVAR facility and site environs.

1.1.2.2 A description of the planned approach to be employed to decommission the UVAR.

1.1.2.3 Descriptions of the methods that will be utilized to ensure protection of the health and safety of the workers and to protect the environment and the public from radiological hazards associated with UVAR Decommissioning Project activities.

1.1.2.4 A description of UVAR physical security and material accountability controls that will be in place during the various phases of Decommissioning Project activities.

1.1.2.5 A description of the radioactive waste management and disposal.

1.1.2.6 A cost estimate for decommissioning the UVAR, and the source of funding for these activities.

1.1.2.7 A schedule for the UVAR Decommissioning Project.

1.1.2.8 A description of the quality assurance program applicable to the UVAR Decommissioning Project.

1.1.2.9 A description of the Training Program to be established for personnel performing work in support of the UVAR Decommissioning Project.

1.1.2.10 An Environmental Report concerning the expected impact of performing the activities involved in the UVAR Decommissioning Project.

1.2 BACKGROUND

Site and Facility History

University of Virginia

The property, on which is situated the University of Virginia Reactor Site and Facility, was acquired in 1817. It was reported that the property was originally purchased by Thomas Jefferson to supply fire wood to the various buildings on the campus at that time, most of which were heated with wood. The UVAR reactor was constructed between 1957 and 1960. Figure 1-5 shows the current UVAR configuration.

Figure 1-3 shows the UVAR yard areas which are included in the scope of this Decommissioning Project. The specific yard areas to be addressed in the Decommissioning Project herein are listed below.

Underground Tanks	(~800 ft^2 area)
Transfer Tank	(~ 80 ft^2 area)
Site Environs	(~1,640 ft^2 area)

Figure 1-4 shows the UVAR first floor areas which are included in the scope of this Decommissioning Project. The specific rooms to be addressed in the Decommissioning Project herein are listed below.

Reactor Room, Rm 131	(~2,648 ft^2 area)
Instrument Shop, Rm 128	(~305 ft^2 area)
Shipping Room, Rm 127	(~175 ft^2 area)

Figure 1-5 shows the UVAR mezzanine floor areas which are included in the scope of this Decommissioning Project. The specific rooms to be addressed in the Decommissioning Project herein are listed below.

Demineralizer Room, Rm M021	(~246 ft^2 area)
Mechanical Room, Rm M020	(~507 ft^2 area)
HP Lab, Rm M019	(~492 ft^2 area)
Mezzanine Crawl Space, Rm MCS	(~576 ft^2 area)
Former HP Lab, Rm M005	(~288 ft^2 area)
Former Hot Lab, Rm M008	(~338 ft^2 area)

Figure 1-6 shows the UVAR ground floor areas which are included in the scope of this Decommissioning Project. The specific rooms to be addressed in the Decommissioning Project herein are listed below.

Heat Exchanger Room, Rm G024	(~297 ft^2 area)
Source Storage Room, Rm G022	(~110 ft^2 area)
Hot Cell, Rm G025	(~93 ft^2 area)
Large Access Facilities	(~84 ft^2 area)
Instrument Storage Room, Rm G015	(~114 ft^2 area)
Storage Room, Rm G018	(~317 ft^2 area)
Ground Floor Area, Rm G028	(~2,216 ft^2 area)
Wood Shop, Rm G008A	(~126 ft^2 area)
Machine Room, Rm G008	(~1,042 ft^2 area)
Counting Room, Rm G004	(~451 ft^2 area)
Rabbit Room, Rm G005	(~229 ft^2 area)

UVA Reactor

UVA was granted a construction permit for the UVA Reactor on September 13, 1957 from the U. S. Atomic Energy Commission (USAEC). Immediately thereafter, working with the Architect/Engineer Castle Construction Company of Charlottesville, Virginia, UVA proceeded with construction of a facility to house the UVA Reactor and supporting systems (e.g., Instrumentation and Control Systems, Forced Cooling System, Water Demineralization System, Ventilation/Exhaust System, Radiation Monitoring Systems, etc.). Following construction and reactor hardware installation, the UVA Reactor was brought to initial criticality in June of 1960. The UVAR was operational from that date until July 1998 when the reactor was permanently shut down. UVA has requested that the USNRC issue an amendment to the UVAR facility license to place the reactor in Possession-Only-Amendment (POA) status.

Current Facility Status

It is anticipated that the UVA Reactor, situated in Room 131, will be placed in "Possession-Only-Amendment" (POA) status, under Amendment No. 25 to the USNRC License No. R-66, early in the year 2000 (UVA Request dated August 16, 1999, Ref. 1-2). The UVAR is presently inoperable. All reactor fuel elements were removed from the reactor pool and returned to DOE.

UVAR building utility services required for facility operation and maintenance under POA status conditions are active.

Manually-actuated and automated fire alarm systems in the UVAR are operational.

UVAR security and radiological alarm systems required by TS will remain active and normal.

The UVAR water demineralization system remains operational.

1.2.1 Reactor Decommissioning Overview

Prior to implementing the decommissioning actions described herein, the UVAR will have been cleared of all extraneous fixtures, equipment and materials. Remediation will be required for the reactor and associated equipment, the reactor room, the demineralizer room, the heat exchanger room and in the buried tanks and vaults. In other areas of the facility only minor remediation requirements are anticipated. The general activities to complete the Plan objectives are:

1.2.1.1 Remove the reactor grid plate, the reactor support structure, equipment from the reactor pool and activated concrete from the reactor pool.

1.2.1.2 Perform additional decontamination and dismantlement of the structure and equipment associated with the UVAR in accordance with this plan.

1.2.1.3 Perform additional decontamination and dismantlement activities in outdoor areas and on equipment associated with the UVAR in accordance with this plan.

1.2.1.4 Prepare the decommissioning generated material for release or disposal (as appropriate) throughout the activities. Either decontaminate and release the material as non-radioactive waste, or package for transport as radioactive waste.

1.2.1.5 Ship all radioactive waste off-site to a licensed waste processor or disposal facility. In the event that no acceptable licensed disposal facility is available, waste may be retained onsite for interim storage.

1.2.1.6 Perform and document the final radiological survey(s) and submit a request to the USNRC for performance of confirmatory surveys and subsequent release of the former Reactor Facility to unrestricted use, through a termination of the reactor license.

1.2.2 ESTIMATED COST

The cost estimate is consistent with the scope of work covering D&D of the UVA Reactor. D&D of the UVAR will be accomplished without dismantlement of the building. The detailed estimated cost to decommission the UVAR licensed areas is presented in the Decommissioning Cost estimate for the UVA Reactor Facility, Charlottesville, VA (Ref. 1-3). This project is estimated to cost $3,065,000. The decommissioning estimate was generated using Xtreme PM℠ (Ref. 1-4). A cost breakdown is given in Table 1-2 below.

Table 1-2 Decommissioning Cost Summary - UVA Reactor

D&D Operation	Labor Plus Travel & Living $1000's	Waste Processing & Transport $1000's	Equipment Contracts & Supplies $1000's	Waste Shipping & Disposal $1000's	Total Cost $1000's
Reactor Confinement Structure	$149	$32	$37	$64	$282
Reactor, Pool & Pool Contents	$70		$47	$325	$442
Old Labs & Structure	$271	$50	$69	$132	$522
Newer Labs & Structure	$101	$13	$23	$2	$139
Underground Tanks	$31		$23	$144	$198
Controlled Yard	$99	$20	$24	$28	$170
D&D Planning	$23				$23
Characterization Surveys	$58		$7		$65
Final Surveys	$232		$29		$260
Planning, Training & Mobilization	$9				$9
Contractor Project Oversight	$167				$167
Owner Oversight & Licensing	$154				$154
NRC Verification Survey					$20
Total	**$1,364**	**$115**	**$258**	**$695**	**$2,452**
		25 % CONTINGENCY			**$613**
			GRAND TOTAL		**$3,065**

* The estimate for LLW disposal is based upon the assumption that the activated waste will be buried at the Barnwell, South Carolina site and all other radioactive waste will be buried at the Envirocare of Utah site.

1.2.3 Availability of Funds

Estimates of the costs of decommissioning of UVA USNRC licensed facility were provided in UVA's December, 1999 submittal to USNRC (Ref. 1.5). The University of Virginia is committed to providing the funding for decommissioning of the University of Virginia Reactor.

1.2.4 Program Quality Assurance

A Quality Assurance Project Plan (QAPP) will be developed to incorporate the applicable portions of 10 CFR 50, Appendix B. In addition, the QAPP will identify additional procedures and requirements that are applicable based on government and regulatory requirements, contractual commitments and supplemental quality standards.

An extensive quality assurance program will be carried on throughout the UVAR decommissioning effort to assure that work does not endanger public safety, and to assure the safety of the decommissioning staff.

Quality assurance efforts during the UVAR decommissioning period will include the following:

- Performing QA functions for procurement
- Qualifying suppliers
- Auditing all project activities
- Monitoring worker performance for compliance with work procedures
- Verifying compliance of radioactive shipments with appropriate procedures and regulations
- Performing dimensional, visual, nondestructive examinations or other required inspection services to assure compliance with work plans
- Maintaining auditable files on the QA audits
- Preparing a final report on overall performance on the UVAR Decommissioning Project with regard to the QA function

The QAPP will be issued and approved by UVA and it will be documented by written procedures and implemented throughout the decommissioning project in accordance with those procedures. The management of those organizations participating in the QAPP shall regularly review the status and adequacy of that part of the plan which they are implementing. All changes to the Plan shall be governed by measures commensurate with those applied to the original issue.

The Quality Assurance Project Plan will incorporate the following items.

1.2.4.1 Quality Assurance Responsibilities

The Quality Assurance organizations of the decommissioning contractor and UVA have the responsibility, authority and organizational freedom to:

- Identify quality problems.
- Take action to stop unsatisfactory or unsafe work and control further processing, delivery, installation or use of nonconforming items

- Initiate, recommend or provide solutions
- Verify implementation of solutions.

The decommissioning contractor has overall responsibility for the Quality Assurance (QA) Plan implementation and is responsible for verifying the effective execution of the plan.

1.2.4.2 Quality Requirements

Instrumentation Calibration

Field instruments and associated detectors shall be calibrated on a semi-annual basis using National Institute of Standards and Technology (NIST) traceable sources and appropriate calibration equipment. Laboratory instruments shall be calibrated on an annual basis.

Calibration labels showing instrument identification number, calibration date and calibration due date shall be attached to all field and laboratory instrumentation.

Instrumentation Response Testing

Functional checks (source check, battery check, high voltage check, etc.) will be performed daily on those instruments used on a daily basis, or when unusual readings are observed to verify proper performance. Instrument functional checks will also be performed prior to first use whenever instruments are repaired, cleaned or have the batteries replaced.

A performance study will be conducted for each type of instrument to determine the duration of the sampling period required to obtain a suitable LLD. The LLD should be a maximum of 50% of the release limits for contamination with an objective of less than 25% of the release limits.

Instrumentation Maintenance

Limited maintenance, such as changing Mylar windows, high voltage cables, etc., may be performed on-site by qualified personnel. Following the change of essential components for maintenance, limited calibration may be performed on-site by qualified personnel.

Instrument Record Keeping

Calibration records and maintenance records, or copies of these records, shall be maintained on-site where they will be available for review. The results of the daily instrument functional checks will be recorded on separate log sheets for each instrument and maintained on-site.

1.2.4.3 Sampling and Analysis Quality Control

Sample Collection

Direct surface beta-gamma measurements, removable contamination measurements, gamma exposure rates, soil sampling and any specialized measurements will be performed to provide data required to meet the guidance provided in 10 CFR 20.1402, *Radiological Criteria for Unrestricted Use* (Ref. 1-5), NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (Ref. 1-6), and NRC *Draft Regulatory Guide* DG-4006 (Ref. 1-7).

Sample QC

Quality Control (QC) samples will be obtained for minimum of 10% of all samples collected for radionuclide specific analysis. QC samples for direct measurements and smears are not required. The QC samples will be a combination of split, duplicate, blank, and/or spiked samples.

Sample Identification

Direct surface beta-gamma measurements, removable contamination samples, gamma exposure rates, and any specialized measurements will be identified as to location, type of measurement, specific instrument and probe used, sample time and date (as appropriate) and name of the person collecting the data.

Soil samples shall be identified with a unique sample number, sample location, survey grid designation, depth of sample, sample time and date as appropriate, and with the name of the person collecting the sample.

Sample Labeling

Removable contamination samples and soil samples shall be labeled to include all the information listed under sample identification.

Sample Chain-of-Custody

Sample chain-of-custody shall be initiated for those samples being sent off-site for analysis or transferred to another organization for analysis. A sample Chain-of-Custody Record will be generated which will document the sample identification and sample transfer, and will accompany the sample during shipping to the new custodian of the sample.

Sample Analysis

Vendor laboratories should be on a QA Approved Suppliers List for the decommissioning contractor or the University of Virginia for the type of analytical services being provided. The decommissioning contractor is responsible for ensuring that sample analysis specifications and laboratory capabilities will meet NRC requirements for data quality to release the site for unrestricted use and termination of license.

Sample Documentation

Sample identification information, sample Chain-of-Custody Records, sample analysis results, vendor laboratory qualification records, or copies of these records, shall be maintained on-site where they will be available for review.

1.2.4.4 Record Keeping

Measures shall be established to control the issuance of documents and changes to documents that prescribe activities affecting quality, such as procedures, drawings and specifications. These measures shall ensure that documents and changes to documents are reviewed for adequacy, approved for release by authorized personnel and distributed to and implemented at the location where the prescribed activity is performed.

Procedure Control

Procedures shall be controlled to ensure that current copies are provided to personnel performing the prescribed activities. Procedures shall be independently reviewed by a qualified person and shall be approved by a management member of the organization responsible for the prescribed activity. Significant changes to procedures shall be reviewed and approved in the same manner as the original.

Radioactive Shipment Package Documents

All documents related to a specific shipping package for radioactive material shall be controlled by appropriate procedures. All significant changes to such documents shall be similarly controlled.

Final Survey Documents

All documents related to the final survey documentation shall be controlled by appropriate procedures. All significant changes to such documents shall be similarly controlled. This documentation would normally include a Survey Plan, Survey Packages, Survey Results and Survey Report.

1.2.4.5 Handling, Storage and Shipping

Approved procedures shall be utilized to control the handling, storage and shipping of radioactive materials.

Radioactive Material Storage

Areas shall be provided for storage of radioactive material to ensure physical protection and control of the stored material. The handling, storage and shipment of radioactive material shall be controlled through the following requirements:

- Procedures shall be provided for handling, storage and shipping operations.
- Established safety requirements concerning the handling, storage and shipping of packages for radioactive material shall be followed.
- Shipments shall not be made unless all test, certifications, acceptances and final inspections have been completed.

Shipping and Packaging

Shipping and packaging documents for radioactive material shall be consistent with pertinent regulatory requirements.

1.2.4.6 Quality Assurance Records

Sufficient records shall be maintained to furnish evidence of activities important to safe decommissioning as required by code, standard, specification or project procedures. Records shall be identifiable, available and retrievable. The records shall be reviewed to ensure their completeness and ability to serve their intended function. Requirements shall be established concerning record collection, safekeeping, retention, maintenance, updating, location, storage, preservation, administration and assigned responsibility. Requirements shall be consistent with applicable regulations and the potential for impact on quality and radiation exposure to the workers and the public.

Typical records would include:

- Proposed Decommissioning Plan
- Procedures
- Reports
- Personnel qualification records

- Radiological and environmental site characterization records, including final site release records
- Dismantlement records
- Inspection, surveillance, audit and assessment records

Health and Safety Related Activities

Records that have a potential for impact on quality and radiation exposure to the workers and the public include the following:

- Work Permits
- Work Procedures
- Contamination Survey Report
- Airborne Survey Report
- Counting data or air samples and gamma spectrum analysis
- Instrument calibrations
- Source inventory and storage
- Radioactive material inventory and storage
- Shipment records
- Incidents and accidents
- Confined space entry permits
- Monitoring records for oxygen deficient explosive atmosphere

Personal Records

Typical records containing personal information that may impact quality and radiation exposure to the workers and the public are as follows:

- Bioassay analysis
- Respiratory protection qualifications (medial/clearance and fit test)
- Training records
- Visitor logs and exposure information

1.2.4.7 Audits

Audits shall be implemented to verify compliance with appropriate requirements of the Quality Assurance Plan and to determine the effectiveness of the plan. The audits shall be performed in accordance with written procedures or checklists by trained and qualified personnel not having direct responsibility in the areas being audited.

Audit Reports

Reports of the results of each audit shall be prepared. These reports shall include a description of the area audited, identification of the individual responsible for implementation of the audited provisions and for performance of the audit, and identification of discrepant areas. The audit report shall be distributed to the appropriate level of management and to those individuals responsible for implementation of audited provisions.

Audit Corrective Action

Measures shall be established to ensure that discrepancies identified by audits are resolved. These measures shall include notification of the manager responsible for the discrepancy and verification of satisfactory resolution. Discrepancies shall be resolved by the manager responsible for the discrepancy. Higher levels of management shall resolve disputed discrepancies.

Follow-up action, including re-audit of deficient areas, shall be taken as indicated.

REFERENCES FOR SECTION 1

1-1 NUREG- 1537 Rev. 0, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors".

1-2 Amendment No. 25 to Facility License No. R-66 (UVA Reactor) — University of Virginia, Anticipated Issue in early year 2000 by the USNRC, UVA request dated August 16, 1999.

1-3 The University of Virginia, *Decommissioning Cost Estimate UVA Reactor Facility, Charlottesville, Virginia*, Revision 0, January 2000, prepared by GTS Duratek.

1-4 Xtreme PM℠, Integrated Project Management System, GTS Duratek and Merrimac.

1-5 10 CFR 20.1402 *Radiological Criteria for Unrestricted Use.*

1-6 NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).*

1-7 Draft Regulatory Guide DG-4006, *Demonstrating Compliance with the Radiological Criteria for License Termination*, August 1998.

2.0 DECOMMISSIONING ACTIVITIES

The decommissioning alternative selected for the UVA Reactor is the removal of the facility from service and reduction of the radioactivity to a level that will permit release of the property for unrestricted use and termination of the license. The facility will be surveyed and left in place. Some areas will be refurbished, such as backfilling of the pool and tank excavation areas.

2.1 DECOMMISSIONING ACTIVITIES

The objective of UVAR Decommissioning is the regulatory release of the UVAR and adjacent contiguous facility site environs, identified on Figure 1-4, to unrestricted use. On this basis the safe storage (SAFSTOR) or entombment (ENTOMB) decommissioning options were considered inappropriate to UVA's future plans.

SAFSTOR poses essentially the same potential risks and environmental impacts as the proposed project, but for a much greater period of time. This alternative would necessitate continued surveillance and maintenance of the UVAR over a substantial time period during which the risk of environmental contamination would continue to exist. Moreover, development of the land around the UVAR site over the next few years may increase the local population density and increase the potential for public exposure.

ENTOMB would necessitate continued surveillance and maintenance of the UVAR over a substantial time period. During this period, the risk of environmental contamination would continue to exist. Moreover, development of the land around the UVAR site over the next few years may increase the local population density and increase potential for public exposure.

DECON is the decommissioning option chosen by U.Va.. To the extent possible, decontamination of facility equipment and structural components will be conducted so as to minimize radioactive waste. Structural portions of the building and surrounding soils and materials found to be radiologically contaminated and/or activated shall be remediated, decontaminated, sectioned and removed or processed, as necessary. This would be followed by an extensive and comprehensive final radiation and contamination survey demonstrating that the UVAR meets the NRC criteria for release to unrestricted use. The results of this final survey will be documented in a report to be submitted to the USNRC in support of a request that the site be released to unrestricted use and the reactor license terminated.

2.2 Facility Radiological Status

2.2.1 Facility Operating History

Startup: June, 1960

Shutdown: Midnight, June 30, 1998; USNRC Utilization Facility License. #R-66 anticipated to be limited to a Possession-Only-Amendment (POA) status in early year 2000 (see Ref. 2-1).

The UVA Reactor was constructed by UVA to provide for the training of Nuclear Engineering students and for research by all Departments of Engineering and the Departments of Physics, Chemistry, Biology, and Medicine. The integrated power generated during operation of the UVA Reactor is estimated at 2,559 MW-days.

2.2.2 Current Radiological Status of the Facility

2.2.2.1 General

Routine radiological surveys show that the radiation levels and contamination levels measured at the UVAR have consistently been low. A radiological study completed in September 1999, and summarized in Appendix A, confirmed that only minor quantities of residual radioactivity or radioactive contamination are present. The information indicates that the radioactive portions of the facility are primarily confined to the reactor internals and reactor pool.

Estimates of the radioactivity inventory can be determined by considering the constituent elements of the material in question and calculating the duration of exposure to the neutron flux and the energies of the incident neutrons. Direct measurements, however, are generally more reliable and will be used during actual removal and/or dismantlement of components. This information will further define the basis for specifying the necessary safety measures and procedures for the various dismantling, removal, decontamination, waste packaging and storage operations so that exposure to personnel is maintained ALARA.

2.2.2.2 Principal Radioactive Components

This section is based upon process knowledge and direct measurements. The most highly radioactive components to be handled and processed during UVAR Decommissioning which may range over ≈ 5 R/hr at the surface are:

- Two EPRI experiment stands (Al) reading about 19 R/hr.
- Mineral Irradiation Facility (MIF) shield reading about 13 R/hr.
- An old control rod (stored in the pool) reading about 10 R/hr.
- Three tangential beamport targets reading 6 to 8 R/hr.

- Hydraulic Rabbit (Al) about 25' long reading about 6 R/hr.

2.2.2.3 Radionuclides

The radionuclides known to be present, or possibly present in detectable levels within the UVAR, are listed in Table 2-1.

2.3 Decommissioning Tasks

2.3.1 Activities and Tasks

2.3.1.1 Preparation of the UVAR for Decommissioning

2.3.1.1.1 Characterization Surveys

As part of Decommissioning Project planning actions, studies have been conducted to determine the type, quantity, condition and location of radioactive and/or hazardous materials which are, or may be, present in the UVAR and surrounding areas. A comprehensive radiological survey of the UVAR was completed in September 1999 by a contractor, GTS Duratek. Data and results from these surveys are provided in this document as Appendix A: *Summary of Characterization Results*.

2.3.1.1.2 General Cleanup of UVAR and Adjacent Controlled Yard Areas

In preparation for decommissioning activities, non-reactor related equipment and materials situated throughout the Reactor Facility have been collected, surveyed, packaged and appropriately dispositioned in accordance with established procedures. Examples of items which have been/or will be processed and removed from the UVAR during these efforts are shield blocks around the beam ports and lead shielding used in the beam port and reactor room areas.

2.3.1.1.3 Decontamination of the Facility

This Decommissioning Plan pertains to the dismantling of the reactor and associated systems in a safe manner and in accordance with ALARA principles, and the decontamination and survey of the entire UVAR facility. Views of the UVA reactor are shown in Figure 2-1 and Figure 2-2.

Table 2-1 List of Expected Radionuclides

Nuclide	Half-Life (yr)	Decay Mode/Major Radiations	Notes
^{14}C	5,730	β^-/β^-	AP; from n-activation of graphite reflector structure
^{54}Mn	0.86	ϵ/λ	AP; short-lived specie; from n-activation of SS hardware
^{55}Fe	2.73	$\epsilon/$	AP; from n-activation of SS hardware
^{60}Co	5.27	$\beta^-/\beta^-, \lambda$	AP; from n-activation of SS hardware; expected to be predominant AP specie present
^{59}Ni	76,000	ϵ/λ	AP; from n-activation of SS hardware
^{63}Ni	100	β^-/β^-	AP; from n-activation of SS hardware. Also from liquid solution in research project
^{90}Sr	29.1	β^-/β^-	FP; probable FP constituent; activity expected to be proportional to that of ^{137}Cs
^{94}Nb	20,000	$\beta^-/\beta^-, \lambda$	AP; unlikely AP inventory constituent; possible from n-activation of SS hardware, <u>if</u> Nb impurities are present
^{99}Tc	213,000	β^-/β^-	FP, and minor AP inventory constituent; possible from n-activation of SS hardware, if Mo impurities are present. Also from acidic liquid solution in research project
^{125}Sb	2.76	$\beta^-/\beta^-, \lambda$	FP; relatively short-lived specie
^{134}Cs	2.07	$\beta^-/\beta^-, \lambda$	FP; minor FP inventory constituent
^{137}Cs	30.17	$\beta^-/\beta^-, \lambda$	FP: expected to be predominant FP specie present
^{152}Eu	13.48	$\beta^-, \beta^+, \epsilon/\beta^-, \beta^+, \lambda$	FP, and minor AP inventory constituent; possible from n-activation of concrete, <u>if</u> Eu impurities exist in biological shield structure
^{226}Ra	1,600	$\alpha/\alpha, \lambda$	Natural background source, sealed & liquid sources
^{nat}U		$\alpha/\alpha, \lambda$	Natural background sources, sealed and unsealed sources
$^{233/234}U$	>159,200	$\alpha/\alpha, \lambda$	Natural and failed fuel sources, trace quantities only anticipated
^{241}Pu	14.4	$\beta^-/\beta, \alpha, \lambda$	Failed fuel source, trace quantities only anticipated, sealed sources
^{241}Am	432	$\alpha/\alpha, \lambda$	Research project
$^{235/238}U$	>7.0E+8	$\alpha/\alpha, \lambda$	SNM material used or stored at facility

Symbols/Abbreviations:

α = Alpha Particle
β^- = Beta Particle
β^+ = Positron
ϵ = Electron Capture
λ = Gamma-Ray
AP = Activation Product
FP = Fission Product

Radionuclide Half-Life values and Decay Mode information used above are taken from Ref. 2-2.

The list of expected radionuclides provided above is based on the assumption that reactor operation resulted in neutron activation of reactor core components and other integral hardware or structural members situated adjacent to, or in close proximity to, the reactor core. Specific items to be considered exposed to neutron activation include materials composed of aluminum, steel, stainless-steel, graphite, cadmium, lead, concrete and possibly others. Based on prior studies and experience gained in similar research reactor decommissioning projects, reactor core/pool structural configurations, and material composition of exposed pool structures, neutron activation of materials beyond the concrete liner/biological shield structure (i.e., 'into surrounding soil volumes') is not expected for this reactor.

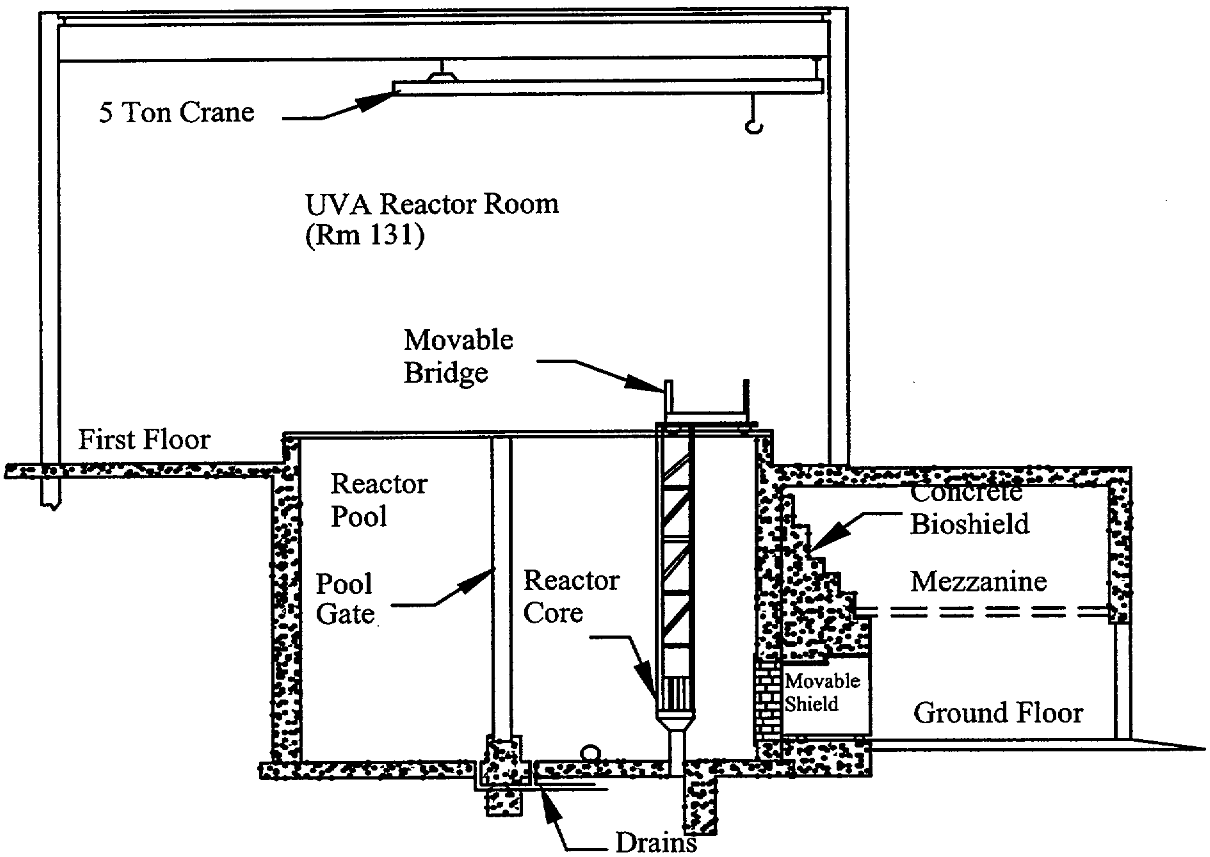


Figure 2-1 UVA Reactor Elevation View

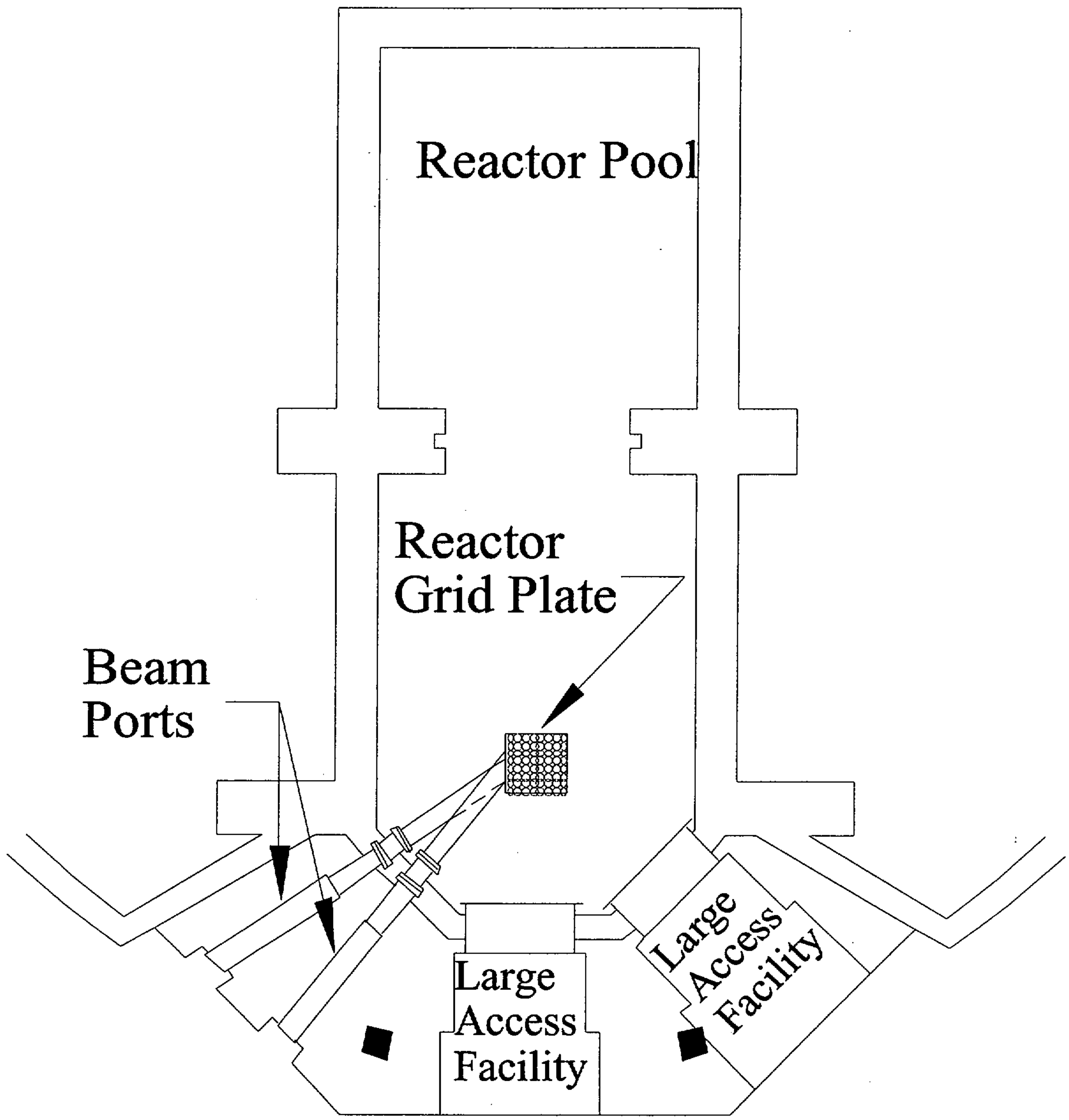


Figure 2-2 UVA Pool and Reactor Cross Section View

2.3.1.1.3.1 Reactor Confinement Structure

- All reactor confinement structure, equipment and materials will be surveyed and designated as contaminated or uncontaminated.

- Uncontaminated equipment and materials will be released for unrestricted use or disposal as clean waste.

- Contaminated equipment will be decontaminated and handled as other uncontaminated material or removed and packaged for processing and direct disposal as radioactive waste.

- Control room and equipment storage rooms will be demolished, processed and removed.

- Reactor ventilation system will be removed and packaged for processing and disposal or direct disposal as radioactive waste.

- Concrete floors will be decontaminated by removing a portion of the upper concrete surface, as necessary. Tubes and drains will be surveyed and decontaminated as required.

- Building off-gas stack will be surveyed and released for disposal as salvage, or disposal as clean waste.

- The Polar Crane will be utilized during the decommissioning activities. It will be surveyed, decontaminated in place as required and left intact and in operating condition.

2.3.1.1.3.2 Reactor and Pool

- Reactor components and activated pool hardware will be removed in hardware liners for disposal as LLRW. A cask will be brought in and loaded with the hardware liners and shipped to the Barnwell, South Carolina LLW facility for disposal. The removal of these items can take place with the pool either filled or drained.

- When no longer useful as a radiological shield, the reactor pool water will be surveyed and discharged.

- The dismantling of the reactor support structure and pool will proceed after installation of a confinement barrier in the reactor room with a dedicated ventilation system to prevent the spread of airborne contaminants.

- The beam port extension tubes (nosepieces) will be removed.

- All other hardware and debris present in the pool will be removed and similarly processed.

- Piping embedded in the concrete pool walls and floors will be surveyed and decontaminated, as necessary, and left in place if clean.

- Surface and coring samples of the pool concrete walls will be performed to determine the extent of the contaminated areas. Contaminated material will be removed and packaged. The structural integrity of the pool will not be compromised as a result of limited removal material.

- Required sampling and analysis of surrounding soils will be done by coring, and repair after sampling. Shoring and covering of the pool will provide industrial-protection until the final confirmatory release surveys have been performed.

- The portion of the pool walls that extend 3-feet above the reactor room floor slab will be cut off and may be handled as clean waste.

- The remaining tasks are dismantlement of the confinement barrier, removal of residual surface contamination in the rooms, and final confirmatory release surveys. The packaged waste is to be shipped to a licensed processing or disposal facility.

2.3.1.1.3.3 Remaining Rooms and Structure

- Reactor-associated equipment and materials will be surveyed and designated as contaminated or uncontaminated.

- Contaminated room surfaces will be decontaminated.

- Uncontaminated equipment and materials will be released for unrestricted use or disposal as clean waste.

- Contaminated equipment will be decontaminated and handled either as uncontaminated material, or removed and packaged for processing and direct disposal as radioactive waste. This includes process equipment in the demineralizer room, process equipment in the heat exchanger room, contaminated hoods in laboratory rooms, process equipment in the beam port facility and equipment in the hot cell facility.

- The 7,000 curies of Co-60 stored in a licensed cask in the facility's hot cell will be relocated prior to the end of decommissioning.

2.3.1.1.3.4 Underground Tanks and Vaults

- All underground tank and vault process piping and equipment will be removed, surveyed and designated as contaminated or uncontaminated.

- Uncontaminated piping, equipment and materials will be released for unrestricted use or disposal as clean waste.

- Contaminated piping and equipment will be decontaminated and handled as other uncontaminated material, or removed and packaged for processing and direct disposal as radioactive waste.

- The buried piping from the building will be surveyed and decontaminated if necessary.

- The soil over the top of these tanks will be excavated, surveyed, sampled and piled for later use in backfilling the hole.

- The tanks will be removed, cut to size and packaged for processing and direct disposal as radioactive waste.

2.3.1.1.3.5 Outdoor Areas, Drains & Sewers

- No remediation is anticipated for the sanitary and storm sewers, the pond, the pond discharge creek, paved areas and unpaved areas at the UVAR site.

2.3.1.2 Dismantling Sequence

Dismantling will occur sequentially by the detailed schedule shown in Section 2.3.2. Items removed will be grouped as follows:

Group 1 Equipment which does not have induced radioactivity but which may have surface contamination.

Group 2 Core components and other components which have induced radioactivity, including pool concrete which has been neutron activated.

Group 3 Reactor support systems, equipment and materials associated with laboratory and research facilities.

Group 4 Equipment, tools and systems which become contaminated during decommissioning operations.

Components and equipment in the four groups are identified in Table 2-2, Table 2-3, Table 2-4 and Table 2-5.

The control rods in the UVAR pool are expected to have the highest levels of induced radioactivity. The control rods and other Group 2 items will be hoisted from the pool within shielded containers which will have been prepared to accept the items. Additional shielding will be provided for worker protection if necessary.

After pool components, equipment and parts listed in Table 2-2 and Table 2-3 have been removed, a confinement barrier will be installed. The purpose of this barrier is to contain airborne contaminants generated during pool decontamination, and to prevent their spread in the Reactor Room and the surrounding areas.

A confinement barrier will be erected which will surround the reactor pool. An independent, localized, ventilation system to ensure a negative pressure with respect to the Reactor Room and provide high efficiency filtration on the exhausted air will be associated with the enclosure.

Table 2-2 Components with Potential Surface Contamination - Group 1

Reactor Systems	demineralizer resin, tanks, pipe loop and floor drains
	heat exchanger, heat exchanger piping loop
	pneumatic and hydraulic rabbit transfer systems
	reactor bridge structure
	reactor pool gate
Laboratory Areas	fume hoods, sink drains, floor drains, counter tops and HVAC
Beam Access Facilities	thermal access facility, large access facility, beam port facility

Hot Cell	hot cell systems, drain piping and buried filter and tanks
Liquid Waste System	plastic waste tanks, buried waste tanks, piping and holding pond

Table 2-3 Components with Induced Radioactivity - Group 2

Mineral Irradiation Facility (MIF)
Control rods
Grid plate
Grid plate plugs
Rotating Irradiation Facility (RIF)
EPRI experiment stand
Neutron beamport nosepieces and targets
Fasteners and connectors
Hydraulic and pneumatic transfer rabbits and system tips
Graphite elements
Hot Thimbles
Other experimental facilities

Table 2-4 Contaminated and Activated Reactor Pool Components - Group 3

Contaminated pool concrete
Activated pool concrete
Beamport activated concrete
Contaminated bioshield concrete

Table 2-5 Equipment Used In Decommissioning Operations - Group 4

General ventilation system
Temporary localized ventilation system
Confinement barrier
Contaminated tools and equipment
Contaminated clothing

When necessary, the Reactor Room will be maintained at a slightly negative pressure with respect to the surrounding areas but less than the pressure differential maintained between the confinement barrier and the Reactor Room. This will ensure that the air will travel from the non-contaminated area to the increasingly contaminated areas.

The contaminated and activated pool/biological shield concrete will be removed. To minimize dust dispersal, a localized HEPA vacuum system may be used in the area where concrete is being demolished. Contaminated concrete will be removed by surface removal equipment from the upper surfaces down to the floor. Activated concrete will be removed a section at a time and shoring supports will be placed in the cavity formed as needed, before proceeding with the next section. The embedded piping that passes from the pool to the heat exchanger and the demineralizer system will be surveyed and decontaminated if necessary.

At the completion of contaminated and activated concrete removal, dose rate measurements will be made to determine if all necessary portions have been removed. Post-remediation surveys may include concrete and soil coring sampling and analysis. As the removal of activated material proceeds, the radioactive material will be packaged for shipment and disposal.

There are two potential radiological safety concerns during performance of this task: 1) external exposure from the activated components in the pool, and 2) inhalation of airborne material. To minimize the risk, during occupancy, the work areas will be monitored frequently and radiation levels will be monitored continuously, to determine sudden changes in the radiological conditions.

Upon completion of dismantlement tasks in the reactor pool, the confinement barrier will be dismantled and the plastic sheets compacted and packaged. Surface contamination will be removed from contaminated portions of the ventilation system and they will then be packaged for disposal. The reactor room will then be cleared and all surface contamination removed. Following remediation and surveys the pool pit will be backfilled and capped with a concrete slab.

All process equipment in the waste tank vault and hot cell tank vault will be removed. The piping that passes underground to the reactor building and to the pond will be surveyed and decontaminated, if necessary. The soil over the top of the buried waste tanks and hot cell tanks will be excavated, surveyed, sampled and piled for later use in backfilling the hole. The tanks will be removed, cut to size and packaged for processing and disposal or direct disposal as radioactive waste. Following remediation and surveys the buried tank area will be backfilled to grade.

2.3.1.3 Surveys

Following decontamination and remediation activities of the reactor, a final radiation survey of each of the reactor rooms and other applicable locations covering the entire UVAR Facility will be performed and documented.

2.3.2 Schedule

The project schedule is presented as Figure 2-3. This schedule was developed using Xtreme PM℠ (Ref. 2-3). The scheduled time from regulatory approval of the Decommissioning Plan to submittal for release of the site to unrestricted use is 13 months. Based on project schedule information documented here in Figure 2-3, UVA estimates that a formal request for termination of Facility License No. R-66 will be submitted to the USNRC approximately twelve months after the approval of the decommissioning plan is received from the USNRC. The UVAR Decommissioning Project is currently scheduled to run from August 2000 to August 2001. Changes to the schedule may be made at UVA's discretion as a result of resource allocation, availability of a radioactive waste burial site, interference with ongoing UVA activities, ALARA considerations, further characterization measurements and/or temporary on- site radioactive waste storage operations.

2.4 Decommissioning Organization and Responsibilities

UVA is committed to, and retains ultimate responsibility for full compliance with the existing USNRC reactor licenses and the applicable regulatory requirements during decommissioning. University policies and goals will be followed to ensure high standards of performance in accomplishing the decommissioning tasks.

The Reactor Decommissioning Committee will monitor decommissioning operations to ensure they are being performed safely and according to federal, state, and local regulatory requirements (NRC, EPA, DOT, etc.). The Reactor Decommissioning Committee will review major decommissioning activities dealing with radioactive material and radiological controls. In addition, the Reactor Decommissioning Committee and/or the Reactor Director will review and approve changes to the Decommissioning Plan that do not require prior NRC approval.

The planned organization for the UVAR Decommissioning as shown in Figure 2-4 will be maintained, however individuals performing the functions may vary over the project duration. Specialized contractors may be utilized under the direction of the UVA Reactor Facility Director, when necessary and appropriate.

2.4.1 Contractor Assistance

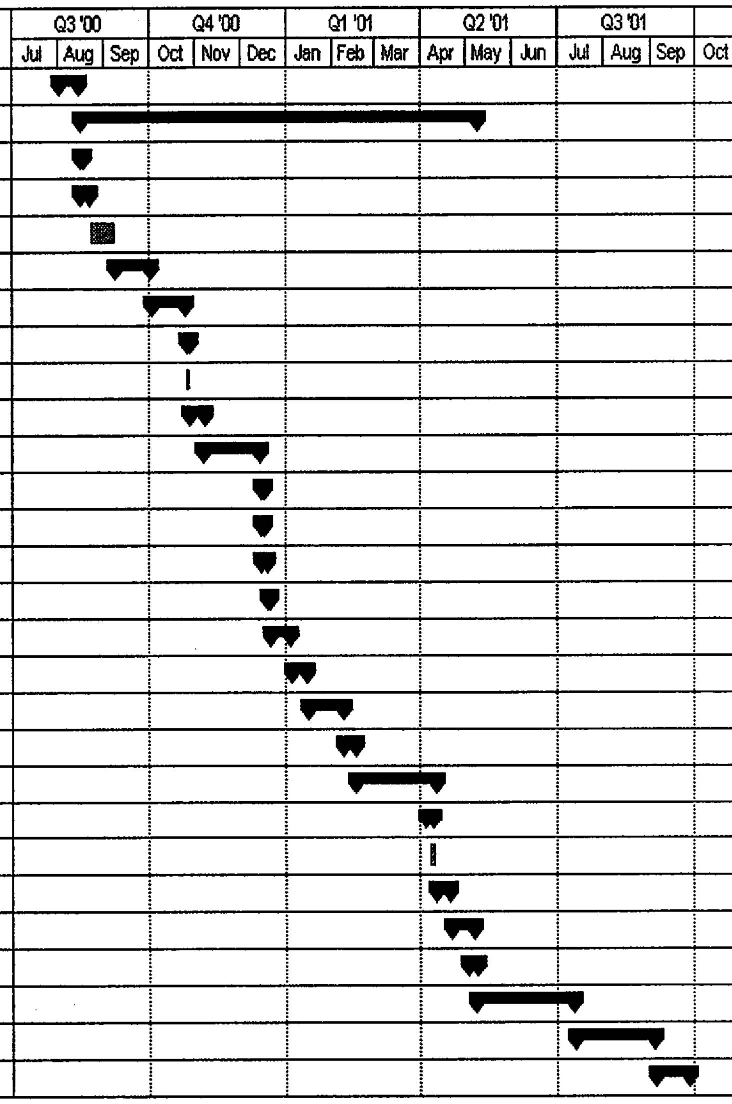
UVA management will select a qualified contractor to perform the UVAR Decommissioning Project. The team will consist of UVA personnel and the selected contractor. UVA will be in charge of overall project management; a decommissioning operations contractor (DOC) will manage the physical decommissioning work, provide Health Physics support, radiation surveys, and waste packaging, processing, and shipping.

The Xtreme PM℠ system (Ref. 2-3) which was used to develop the project estimate and schedule can be used to assist the project team in effectively managing the decommissioning project. Cost, schedule, worker exposure, waste, survey results, training, equipment use, consumables, etc. can be tracked using Xtreme PM℠. The system's advanced estimating tools can be used to generate various project scenarios to evaluate impacts from schedule changes, waste disposal options, decontamination techniques, outsourcing, etc.

Contractors and subcontractors performing work under this Decommissioning Plan will be required to comply with applicable UVA policies and procedures.

Figure 2-3 UVAR Decommissioning Schedule

WBS	Task Name
1	**Planning**
2	**Decontamination and Dismantling**
2.1	**Undistributed Costs**
2.2	**Mobilization and Training**
2.3	Site Verification Survey
2.4	**Remove Reactor Room Components**
2.5	**Remove Reactor Components in Pool**
2.6	**Reactor Pool Water**
2.7	Install Confinement Barrier Around Pool
2.8	**Reactor Hardware Removal**
2.9	**Pool Remediation**
2.10	**Ship Activated Material to Barnwell**
2.11	**Dismantle Barrier and Package for Disposal**
2.12	**Remove Control Rm & Equip. Rm**
2.13	**Decontaminate Reactor Room**
2.14	**Decommission Demineralizer Room**
2.15	**Decommission Heat Exchanger Rm**
2.16	**Decommission Beamport Facilities**
2.17	**Decommission Hot Cell**
2.18	**Decommission Labs and Structure**
2.19	**General Outside Clean-Up**
2.20	Remove Fuel Transfer Tank
2.21	**Remove Cooling Tower**
2.22	**Remove Buried Waste Tanks**
2.23	**Remove Buried Hot Cell Tanks**
3	**Perform MARSSIM Site Release Survey**
4	**NRC Verification Survey & Site release**
5	**Facility Remediation**



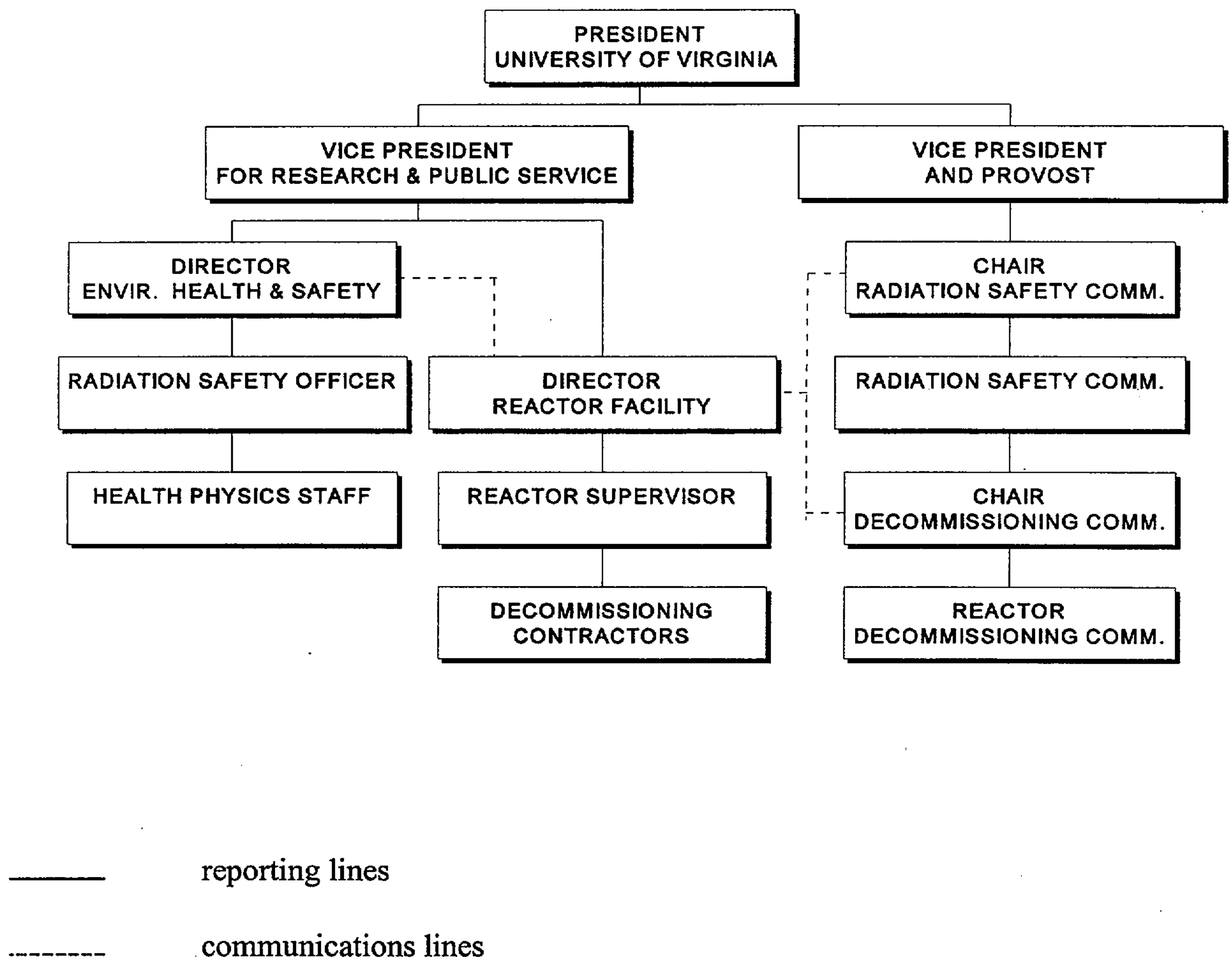


Figure 2-4 UVAR Decommissioning Organization

Key Positions

2.4.2 Reactor Facility Director

The Reactor Facility Director has the overall responsibility for successful completion of the Project. The UVA Reactor Facility Director functions include:

- Controlling and maintaining safety during decommissioning activities and protecting of the environment
- Determining UVA project staffing and organization
- Assuring performance to cost and schedule
- Reporting of performance
- Approving minor changes to the decommissioning plan and procedures (which do not change the original intent and do not involve an unreviewed safety question)
- Approving subcontracts
- Approving budgets and schedules
- Oversight and coordination of UVA functional groups and decommissioning contractors
- Ensuring that the conduct of decommissioning activities complies with applicable regulations and is in accordance with UVA licenses.

The minimum qualifications for the UVA Reactor Director are:

- A four-year degree in engineering or natural science
- Five years of management experience in the nuclear industry
- Familiarity with the UVA Reactor Facility
- Appropriate training in radiation protection, nuclear safety, hazardous communication and industrial safety.

2.4.3 Reactor Supervisor

The functions of the UVA Reactor Supervisor include:

- Maintaining the UVAR in a safe and proper condition during the evolution of Decommissioning Project activities, in accordance with the requirements set forth in the applicable USNRC facility licenses
- Review of plans and procedures
- Providing engineering support for the decommissioning activities

The minimum qualifications for this position are:

- A four-year degree in Engineering or Natural Science

- Five years experience in a research reactor facility environment
- Substantial knowledge of the UVAR and associated systems

2.4.4 Radiation Safety Officer

The Radiation Safety Officer is responsible for providing radiological support in the decommissioning of the UVAR. This function ensures that the activities involving potential radiological exposure are conducted in compliance with the applicable licenses, Federal and State regulations and UVA procedures. The position includes responsibility for maintaining the UVAR surveillance and monitoring program and for HP radiological protection procedures.

The minimum qualifications for this position are:

- A four-year degree in Health Physics or a related field
- Three years supervisory experience in Health Physics
- Five years operational experience related to radiation safety

2.5 Training Program

Individuals (employees, contractors and visitors) who require access to the work areas or a radiologically restricted area will receive training commensurate with the potential hazards to which they may be exposed.

Radiation protection training will be provided to personnel who will be performing remediation work in radiological areas or handling radioactive materials. The training will ensure that decommissioning project personnel have sufficient knowledge to perform work activities in accordance with the requirements of the radiation protection program and accomplish ALARA goals and objectives. The principle objective of the training program is to ensure personnel understand the responsibilities and the required techniques for safe handling of radioactive materials and for minimizing exposure to radiation.

Records of training will be maintained which will include trainees names, dates of training, type of training, test results, authorization for protective equipment use, and instructor's name. Radiation protection training provides the necessary information for workers to implement sound radiation protection practices. The following are examples of the training programs applicable to remediation activities.

2.5.1 General Site Training

A general training program designed to provide orientation to project personnel and meet the requirements of 10 CFR Part 19 will be implemented. General Site Training (GST) will be required for all personnel assigned on a regular basis to the remediation project. This training will include:

- Project orientation/access control
- Introduction to radiation protection
- Quality assurance
- Industrial safety
- Emergency procedures

2.5.2 Radiation Worker Training

Radiation Worker Training (RWT) will be required for remediation project personnel working in restricted areas and will be commensurate with the duties and responsibilities being performed. Personnel completing RWT are required to pass a written examination on the material presented. Completion of this training qualifies an individual for unescorted access to radiologically controlled areas. RWT will include the following topics:

- Fundamentals of radiation
- Biological effects of radiation
- External radiation exposure limits and controls
- Internal radiation limits and controls
- Contamination limits and controls
- Management and control of radioactive waste, including waste minimization practices
- Response to emergencies
- Worker rights and responsibilities.

In addition to a presentation of the topics identified above, participants in RWT are required to participate in the following demonstrations:

- The proper procedures for donning and removing a complete set of protective clothing (excluding respiratory protection equipment)
- The ability to read and interpret self-reading and/or electronic dosimeters
- The proper procedures for entering and exiting a contaminated area, including use of proper frisking techniques
- An understanding of the use of an Radiation Work Permit (RWP) by working within the requirements of a given RWP.

Personnel who have documented equivalent RWT from another site may be waived from taking training except for training on UVA administrative limits and emergency response, and will be required to pass the written examination and demonstration exercises.

2.5.3 Respiratory Protection Training

Personnel whose work assignments require the use of respiratory protection devices will receive respiratory protection training in the devices and techniques that they will be required to use. The training program will follow the requirements of 10 CFR 20 Subpart H (Ref. 2-4), Regulatory Guide 8.15 (Ref. 2-5), NUREG 0041 (Ref. 2-6) and 29 CFR 1910.134 (Ref. 2-7). Training will consist of a lecture session and a simulated work session. Personnel who have documented equivalent respiratory protection training may be waived from this training.

2.6 Decontamination and Decommissioning Documents and Guides

Health Physics, Industrial Health criteria and other standards that guide the activities described in this Decommissioning Plan are discussed in Section 3.1, Radiation Protection, Section 3.2, Radioactive Waste Management, Section 3.3, General Industrial Safety Program and Section 3.4 Radiological Accident Analysis. Relevant documents and guides used are noted therein.

2.7 Facility Release Criteria

The proposed decommissioning alternative that has been presented in this Decommissioning Plan does not necessitate the major dismantlement of the UVAR Facility building. The results of the site and facility radiological characterization have indicated that the building structures may be directly releasable without need for extensive decontamination.

This section provides the specific criteria for release of the UVAR Facility. The Final Release survey will use the Derived Concentration Guideline Levels (DCGL's) developed from the characterization survey data (Ref. 2-8) and the current NRC guidance for license termination in Subpart E, *Radiological Criteria for License Termination*, of 10 CFR Part 20, *Standards of Protection Against Radiation* (Ref. 2-9). Subpart E, 10 CFR 20.1402, *Radiological Criteria for Unrestricted Use* (Ref. 2-10), allows termination of a license and release of a site for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent to an average member of a critical group that does not exceed 25 millirem (0.25 millisevert) per year and the residual radioactivity has been reduced to levels that are as low as is reasonably achievable (ALARA). The current NRC guidance for acceptable license termination screening values (meeting the 10 CFR 20.1402 criteria) of common radionuclides for building surface contamination is presented in *Supplemental Information on the Implementation of the Final Rule on Radiological Criteria for Licence Termination,* (Ref. 2-11). The DCGL's for soil areas were developed using the regulatory positions on dose modeling in *Draft Regulatory Guide DG-4006* (Ref. 2-12).

Upon completion of the decontamination and remediation activities (e.g. see Section 2.3), a final radiation and radiological contamination survey of the UVAR Facility will be performed using the method described in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation*

Manual (MARSSIM) (Ref. 2-13). In addition, NRC DG-4006 will be used for additional specific guidance on acceptable values for use in the MARSSIM method, how to use the MARSSIM method in a way that is consistent with the dose modeling, how to use the MARSSIM method to meet NRC's regulations, and how to extend or supplement the MARSSIM method to address subsurface residual radioactivity. The results of the survey(s) will be summarized in a report which will be submitted to NRC, as required by the U.S. Nuclear Regulatory Commission NUREG 1537 (Ref. 2-14), in support of a license termination request.

Removable surface contamination will be eliminated, where possible, by wiping or other proven decontamination methods. Release criteria for fixed and smearable residual radioactivity for beta-gamma emitters will be based upon the relative concentrations of isotopes on the material and their respective release criteria if more than one category of nuclide for beta-gamma emitters applies from Table 2-6.

If it is impractical or not possible to satisfy release criteria (or conclusively demonstrate that they have been met), the location/item will be treated as radioactively contaminated and dispositioned as low-level waste.

Table 2-6 License Termination Screening Values for Building Surface Contamination

Radionuclide	Symbol	Acceptable screening levels[1] for unrestricted release (dpm/100 cm^2)[2]
Hydrogen-3 (Tritium)	^{3}H	1.2E+08
Carbon-14	^{14}C	3.7E+6
Sodium-22	^{22}Na	9.5E+03
Sulfur-35	^{35}S	1.3E+07
Chlorine-36	^{36}Cl	6.0E+05
Manganese-54	^{54}Mn	3.2E+04
Iron-55	^{55}Fe	4.5E+06
Cobalt-60	^{60}Co	7.1E+03
Nickel-63	^{63}Ni	1.8E+06
Strontium-90	^{90}Sr	8.7E+03
Technetium-99	^{99}Tc	1.3E+06
Iodine-129	^{129}I	3.5E+04
Cesium-137	^{137}Cs	2.8E+04
Iridium-192	^{192}Ir	7.4E+04

[1] Screening levels are based on the assumption that the fraction of removable surface contamination is equal to 0.1.

[2] Units are disintegrations per minute per 100 square centimeters (dpm/100 cm^2). 1 dpm is equivalent to 0.0167 becquerel (Bq). The screening values represent surface concentrations of individual radionuclides that would be deemed in compliance with the 0.25 mSv/yr (25 mrem/yr) unrestricted release dose limit in 10 CFR 20.1402. For radionuclides in a mixture, the "sum of fractions" rule applies; see 10 CFR Part 20, Appendix B, Note 4. NRC Draft Guidance DG-4006 for provides further information on application of the values in this table.

REFERENCES FOR SECTION 2

2-1 Amendment No. 25 to Facility License No. R-66 (UVA Reactor) — University of Virginia, Anticipated Issue in early year 2000 by the USNRC, UVA request dated August 16, 1999.

2-2 *The Health Physics and Radiological Health Handbook*, Revised Edition 1992, Editor by B. Shleien.

2-3 Xtreme PM℠, Integrated Project Management System, GTS Duratek and Merrimac.

2-4 10 CFR 20 Subpart H, *Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas.*

2-5 Regulatory Guide 8.15, *Acceptable Programs for Respiratory Protection*; Revision 1, October, 1999

2-6 NUREG 0041, *Manual of Respiratory Protection Against Airborne Radioactive Materials*

2-7 29 CFR 1910.134, *Respiratory Protection*

2-8 UVAR Characterization Survey Report

2-9 10 CFR 20 Subpart E, *Radiological Criteria for License Termination*

2-10 10 CFR 20.1402 *Radiological Criteria for Unrestricted Use*

2-11 *Supplemental Information on the Implementation of the Final Rule on Radiological Criteria for Licence Termination,* the Federal Register (63 FR 64132, 11/18/98)

2-12 Draft Regulatory Guide DG-4006, *Demonstrating Compliance with the Radiological Criteria for License Termination*, August 1998

2-13 NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*

2-14 NUREG 1537, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors*, February 1996.

3.0 OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

3.1 Radiation Protection

3.1.1 Ensuring As Low As Reasonably Achievable (ALARA) Radiation Exposures

Decommissioning activities at the UVA Reactor Facility involving the use and handling of radioactive materials will be conducted in a manner such that radiation exposure will be maintained As Low As Reasonably Achievable (ALARA), taking into account the current state of technology and economics of improvements in relation to the benefits.

ALARA Program

The UVA practice during this project will be as follows:

- A documented ALARA evaluation will be required for specific tasks if a Project HP determines that 5% of the applicable dose limits for the following may be exceeded:
  - Total Effective Dose Equivalent (TEDE)
  - The sum of the Deep-Dose Equivalent (DDE) and the Committed Dose Equivalent (CDE) to any individual organ or tissue other than the lens of the eye
  - Eye Dose Equivalent (EDE)
  - Shallow-Dose Equivalent (SDE)
- A documented ALARA evaluation will be required if a Project HP determines that UVAR effluent averaged over one year is expected to exceed 20% of applicable concentration in 10 CFR 20, Appendix B, Table 2, Columns 1 and 2.

Decommissioning Project management positions responsible for radiation protection and maintaining exposures ALARA during decommissioning include the Reactor Facility Director and Radiation Safety Officer.

Methods for Occupational Exposure Reduction

Various methods will be utilized during the Decommissioning Project work to ensure that occupational exposure to radioactive materials is kept ALARA. The methods include the Radiological Work Permit (RWP), special equipment, technique, and practices as described in the following subsections. Work will be performed in accordance with reactor licenses and/or this Decommissioning Plan.

Radiological Work Permits (RWPs)

A Radiation Work Permit (RWP) will be used for the administrative control of personnel entering or working in areas that have radiological hazards present. Work techniques will be specified in such a manner that the exposure for all personnel, individually and collectively, are maintained ALARA. RWPs will not replace work procedures, but will act as a supplement to procedures. Radiation work practices will be considered when procedures are developed for work which will take place in a radiologically controlled area.

Project RWPs will describe the job to be performed, define protective clothing and equipment to be used, and personnel monitoring requirements. RWPs will also specify any special instructions or precautions pertinent to radiation hazards in the area including listing the radiological hazards present, area dose rates and the presence and intensity of hot spots, loose surface radioactivity, and other hazards as appropriate. The HP organization will ensure that radiation, surface radioactivity and airborne surveys are performed as required to define and document the radiological conditions for each job.

RWPs for jobs with low dose commitments will be approved at the HP technician or HP supervisory level while RWPs for jobs with potentially high dose commitment or significant radiological hazards will be approved by the RSO. Examples of topics covered by implementing procedures for the Radiation Work Permits are:

- Requirements, classifications and scope for RWPs;
- Initiating, preparing and using RWPs;
- Extending expiration dates of an RWP; and
- Terminating RWPs.

Respiratory Protection and TEDE ALARA Evaluations

The use of engineering controls to mitigate the airborne radiological hazard at the source will be the first choice with respect to controlling the concentrations of airborne radioactive material. There may be, however, circumstances where engineering controls are not practical, or may not be sufficient to prevent airborne concentrations in excess of those that constitute an airborne radioactivity area. In such circumstances where worker access is required, respiratory protective equipment will be utilized to limit internal exposures. Any situation wherein workers are allowed access to an airborne radioactivity area, or allowed to perform work that has a high degree of likelihood to generate airborne radioactivity in excess of 0.1 DAC, the decision to allow access will be accompanied by the performance of representative measurements of airborne radioactivity to assess worker intake. The results of DAC-hour tracking and air sample results for intake will be documented in accordance with appropriate regulations. Workers will provide nasal smears for HP evaluation following the use of respiratory protective equipment for radiological purposes, as necessary.

Control and Storage of Radioactive Materials

The UVA HP Program establishes radioactive material controls that ensure:

- Deterrence of inadvertent release of licensed radioactive materials to unrestricted areas.
- Confidence that personnel are not inadvertently exposed to licensed radioactive materials.
- Minimization of the volume of radioactive wastes generated during the decommissioning.

All material leaving the Restricted Area will be surveyed to ensure that radioactive material is not inadvertently released from the UVAR. See Section 3.1.3 "Radioactive Material Controls" for a description of the specific survey methods that will be used.

3.1.2 Health Physics Program

Project Health Physics Program - General

UVAR Health Physics has procedures in place which will be implemented during the UVAR Decommissioning Project. If additional Health Physics procedures are required at some point in the work to support the decommissioning, they will be developed and approved in accordance with UVA Health Physics policy and procedure.

UVA senior management is readily accessible to ensure timely resolution of difficulties that may be encountered. The RSO and Reactor H.P., while organizationally independent of the Project staff, have direct access to the Reactor Facility Director on a daily basis, and have full authority to act in all aspects of protection of workers and the public from the effects of radiation. Conduct of the UVAR Decommissioning Project HP program will be evaluated according to UVA policy.

Audits, Inspections, and Management Review

During Decommissioning Project work, aspects of the Project may be assessed and reported by the Contractor's Quality Assurance Department, through audits, assessments and inspections of various aspects of decommissioning performance, including HP, as described in Section 1.2.4.

Audits of the UVA Health Physics program are conducted in accordance with the requirements of 10 CFR 20. These audits will include aspects of the UVAR Decommissioning Project.

Additional assessments or management reviews may be performed when deemed appropriate by the Director of Environmental Health and Safety and/or the Reactor Facility Director.

Health Physics Equipment and Instrumentation

HP equipment and instrumentation suitable to permit ready detection and quantification of radiological hazards to workers and the public will be chosen to ensure the validity of measurements taken during remediation and final release surveys. The selection of equipment and instrumentation to be utilized will be based upon detailed knowledge of the radiological contaminants, concentrations, chemical forms and chemical behaviors that are expected to exist as demonstrated during radiological characterization, and as known from process knowledge of the working history of the UVAR. Equipment and instrumentation selection also takes into account the working conditions, contamination levels and source terms that are reasonably expected to be encountered during the performance of decommissioning work, as presented in this Plan.

The following sections present details of the equipment and instrumentation planned for use during the decommissioning. It is anticipated that through retirement of worn or damaged equipment/instrumentation or increase in quantities of available components or instruments, that new technology will permit upgrades or, at a minimum, like-for-like replacements. UVA is committed to maintaining conformance to minimum performance capabilities stated in this Plan whenever new components or instruments are selected.

Criteria for Selecting Equipment and Instrumentation for Conduct of Radiation and Contamination Surveys and Personnel Monitoring

A sufficient inventory and variety of instrumentation will be maintained on-site to facilitate effective measurement of radiological conditions and control of worker exposure consistent with ALARA, and to evaluate the suitability of materials for release to unrestricted use. Instrumentation and equipment will be capable of measuring the range of dose rates and radioactivity concentrations expected to be encountered during conduct of remediation and decontamination of the UVAR, as well as for final survey measurements, and to less than the minimum values required for release or ALARA decision-making.

Project HP staff will select instrumentation that is sensitive to the minimum detection limits for the particular task being performed, but also with sufficient range to ensure that the full spectrum of anticipated conditions for a task or survey can be met by the instrumentation in use. Consumable supplies will conform to manufacturer and/or regulatory recommendation to ensure that measurements meet desired sensitivity and are valid for the intended purpose. UVA will continue review of regulatory information notices and bulletins for applicability to Project HP instrumentation.

Storage, Calibration, Testing and Maintenance of Health Physics Equipment and Instrumentation

Survey instruments will be stored in a common location under the control of UVAR Decommissioning Project HP personnel. A program to identify and remove from service inoperable or out-of-calibration instruments or equipment as described in HP procedures will be adhered to throughout the UVAR Decommissioning Project. Survey instruments, counting equipment, air samplers, air monitors and personnel contamination monitors will be calibrated at license-required intervals, manufacturer-prescribed intervals (if shorter frequency) or prior to use against standards that are NIST traceable in accordance with approved calibration laboratory procedures, HP procedures, or vendor technical manuals. Survey instruments will be operationally checked daily when in use. Counting equipment operability will be verified daily when in use. The personnel contamination monitors are operationally tested on a daily basis when work is being performed.

Specific Health Physics Equipment and Instrumentation Use and Capabilities

Table 3-1 provides details of typical HP equipment and instrumentation that is planned for use in the UVAR Decommissioning Project. This list is neither inclusive or exclusive.

Table 3-1 Specific Health Physics Equipment and Instrumentation Use and Capabilities

Instrument Model	Detector Type	Instrument Range	Application
Eberline-RO-2 and 2A Eberline-RO-20	Ionization chamber	RO-2 0-5,000 mR/hr RO-2A 0-50 R/hr RO-20 0-60 R/hr	Beta/gamma exposure rate measurements
Eberline Teletector-6112/B	GM tube	0-1,000 R/hr	Telescoping detector for high range
Ludlum Model 2350/2350-1 Data Logger with 43-37 probe	Gas Flow Proportional	0-500,000 cpm	Alpha and beta/gamma floor monitor 550 cm^2 ^{137}Cs efficiency approximately 30% 4π ^{239}Pu efficiency appropriately 17% 4π
Ludlum Model 44-2 probe for use with 2350	1" x 1" NaI Scintillator	0-2,860 µR/hr (i.e., 0-2.8 mR/hr)	Gamma exposure rates
Ludlum Model 44-40 probe for use with 2350	GM tube	0-500,000 cpm	Shielded pancake detector ^{137}Cs efficiency approximately 19% 4π ^{239}Pu efficiency appropriately 15% 4π
Ludlum Model 43-68 probe for use with 2350	Gas Flow Proportional	0-500,000 cpm	Alpha and beta/gamma monitor 125 cm^2 ^{137}Cs efficiency approximately 30% 4π ^{239}Pu efficiency appropriately 20% 4π
Ludlum Model 43-94 pipe probe for use with 2350	Gas Flow Proportional	0-500,000 cpm	0.5 inch probe for 0.75 to 1 inch pipe diameters
Ludlum Model 43-98 pipe probe for use with 2350	Gas Flow Proportional	0-500,000 cpm	1.5 inch probe for 2 to 3 inch pipe diameters
Ludlum Model SP-113-3M pipe probe for use with 2350	3 GM tubes	0-500,000 cpm	Motorized spider probe with three 1.13" OD probes total area 19.4 cm^2 for 3 to 6 inch straight pipe
Ludlum Model SP-113-3T pipe probe for use with 2350	3 GM tubes	0-500,000 cpm	Motorized spider probe with three 1.13" OD probes total area 19.4 cm^2 for 3 to 6 inch pipe with bends
Ludlum Model SP-175-3 M pipe probe for use with 2350	3 GM tubes	0-500,000 cpm	Motorized spider probe with three 1.75" OD probes total area 46.5 cm^2 for 4 to 12 inch straight pipe
Tennelec Model LB 5100 W	Gas Flow Proportional	CPU operated	Low-Level α/β smear samples
Ludlum-177	ZnS(Ag) scintillation	0-500,000 cpm	Hand-held alpha frisker (50 cm^2 area) ^{239}Pu efficiency 15% 4π ^{230}Th efficiency 23% 4π
Ludlum Model 19 µR	NaI (Tl) Scintillator	0-5,000 µR/hr (i.e., 0mR/hr)	Low gamma exposure rates
Eberline Model RO-7	Ionization chamber	0-200 R/hr	Low to high gamma exposure rate measurements
EG&G NOMAD or equivalent Gamma Spectroscopy System	HPGe	N/A	Gamma spectrometry measurement of water, air, smear/media samples (e.g., soil, asphalt, concrete, tar, vegetation)
Eberline Personnel Contamination Monitor PCM-1B	Gas Flow Proportional	N/A	Personnel contamination monitor/walk-in monitor with microprocessor control

Instrument Model	Detector Type	Instrument Range	Application
F&J Model HV-1 "Hi-Vol"	N/A	5-30 cfm	High volume air sampling for minimum detection capability
F&J Model LV-14M Gooseneck "Lo-Vol"	N/A	0.35-3.5 cfm	Low volume air sampling for long term air sampling
Ludlum Model 333-2 air monitor	GM	10-10^5 cpm	Local airborne monitor with alarm capability

Policy, Method, Frequency and Procedures

The UVAR Decommissioning Project will utilize the existing UVA HP Program for the Project. This Program prescribes policy, method and frequency for effluent monitoring, conduct of radiological surveys, personnel monitoring, contamination control methods and protective clothing usage. This program may be augmented on a temporary basis to provide additional items related only to the UVAR decommissioning project.

Airborne Effluent Monitoring — During the decommissioning effort where a temporary barrier with an exhaust system is in use, the ventilation system exhaust points from the temporary barrier will be sampled continuously downstream of the HEPA filtration system.

Radiation Surveys — Radiation, airborne radioactivity and contamination surveys during decommissioning will be conducted in accordance with approved HP procedure(s). The purposes of these surveys will be to (1) protect the health and safety of workers, (2) protect the health and safety of the general public, and (3) demonstrate compliance with applicable license, federal and state requirements, as well as Decommissioning Plan commitments. HP personnel will verify the validity of posted radiological warning signs during the conduct of these surveys. Surveys will be conducted in accordance with procedures utilizing survey instrumentation and equipment suitable for the nature and range of hazards anticipated. Equipment and instrumentation will be calibrated and, where applicable, operationally tested prior to use in accordance with procedural requirements. Routine surveys are conducted at a specified frequency to ensure that contamination and radiation levels in unrestricted areas do not exceed license, federal, state or site limits. HP staff will also perform surveys during decommissioning whenever work activities create a potential to impact radiological conditions.

Personnel Monitoring - Internal and External — External monitoring will be conducted in accordance with approved procedures. Prospective external exposure evaluations will be performed, at a minimum, on an annual basis, or whenever changes in worker exposures warrant. Visitors to the UVAR will be monitored in accordance with requirements specified in UVA HP procedures and according to the radiological hazards of areas to be entered.

Internal monitoring will be conducted in accordance with approved procedures. This prospective internal exposure evaluation will be evaluated on an annual basis, at a minimum, or whenever significant changes in planned work evolutions warrant it. A comprehensive air sampling program will be conducted at the UVAR to evaluate worker exposures regardless of whether internal monitoring is specified. The results of this air sampling program will be utilized to ensure validity of specified internal monitoring requirements for decommissioning personnel. If, at any time during the decommissioning, hazards that may not be readily detected by the preceding measures are encountered, special measures or bioassay, as appropriate, will be instituted to ensure the adequate surveillance of worker internal exposure.

Monitoring will be required if the prospective dose evaluation shows that an individual(s) dose is likely to exceed 10% of the applicable limits, and for individuals entering a high or very high radiation area.

Respiratory Protection - The Decommissioning Project respiratory protection program will include direction for use of National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA) certified equipment. This program will be reviewed and approved by UVA HP and UVA Industrial Hygiene to ensure adherence to the requirements of 10CFR20.

NIOSH/MSHA approved air purifying respirators include full face piece assemblies with air purifying elements to provide respiratory protection against hazardous vapors, gases, and/or particulate matter to individuals in airborne radioactive materials areas. Individuals may be required to use continuous or constant flow full-face airline respirators for work in areas with actual or potential airborne radioactivity. The RSO will also ensure that the respiratory protection program meets the requirements of 10 CFR Part 20, subpart H.

Maintenance — When respiratory protection equipment requires cleaning, the filter cartridges will be removed. The respirator will be cleaned and sanitized after every use with a cleaner/sanitizer and then rinsed thoroughly in plain warm water in accordance with HP procedures.

Storage — Respiratory protective equipment will be kept in proper working order. When any respirator shows evidence of excessive wear or has failed inspection, it will be repaired or replaced. Respiratory protective equipment that is not in use will be stored in a clean dry location.

Contamination Control - Contamination control measures that will be employed include, as appropriate, the following:

- Worker training will incorporate methods and techniques for the control of radioactive materials, and proper use and donning/doffing of protective clothing
- Procedures will incorporate HP controls to minimize spread of contamination during work
- Radiological surveys will be scheduled and conducted by HP

- Containment devices such as designed barriers, containers and plastic bags will be used to prevent the spread of radioactive material
- Physical decontamination of UVAR areas or items
- Physical barriers such as Herculite sheeting, strippable paint, and tacky mat step-off pads to limit contamination spread
- Posting, physical area boundaries and barricades
- Clean step-off pads at the entrance point to contaminated areas

Personnel entries into radiological contaminated areas will require the use of protective clothing. This clothing will consist of a suitable combination of items such as the following, dependent upon the conditions outlined in the RWP:

- Heavyweight lab coat
- Heavyweight canvas, cotton, or cotton/polyester coveralls
- Heavyweight hoods
- Plastic calf-high booties
- Rubber, plastic or cloth shoe covers
- Plastic or rubber gloves which may require cloth liners.
- Tyvek paper coveralls or plastic rain suit disposable outer clothing
- Face shield or other protective device

Access Control - A Restricted Area (RA) will be established and properly posted so as to prevent unauthorized access.

Engineered Controls - Personnel exposure to airborne radioactive materials will be minimized by utilizing engineering controls such as the following:

- Ventilation devices — in-place or portable HEPA filters or UVAR ventilation systems, local exhaust by use of vacuums
- Containment devices — designed containment barriers, containers, plastic bags, tents, and glove-bags
- Source term reduction — application of fixatives prior to handling, misting of surfaces to minimize dust and resuspension

Airborne Radioactivity Monitoring - Monitoring for the intake of radioactive material is required by 10 CFR 20.1502(b) if the intake is likely to exceed 0.1 ALI (annual limit on intake) during the year for an adult worker, or if the committed effective dose equivalent is likely to exceed 0.10 rem (1.0 mSv) for the occupationally exposed minor or declared pregnant woman. Air sampling will be performed in areas where airborne radioactivity is present or likely.

Prospective estimates of worker intakes and air concentrations used to establish monitoring requirements will be based on consideration of the following:

- The quantity of material(s) handled
- The ALI for the nuclides of interest
- The release fraction for the radioactive material(s) based upon its physical form and use
- The type of confinement being used for the material(s) being handled
- Other factors that may be applicable

HP personnel will use technical judgment in determining the situations that necessitate air sampling regardless of generalized, prospective evaluations done for the UVAR.

Prior to identifying the location for an air sampler, the purpose of the radiological air sample will be identified. Various reasons exist for collecting air samples. The following are a few examples:

- Estimation of worker intakes
- Verification of confinement of radioactive materials
- Early warning of abnormal airborne concentrations of radioactive materials
- Determining the existence of criteria for posting an Airborne Radioactivity Area (ARA).

Smoke tubes and buoyant markers may then be used to determine air flow patterns in the area. Air flow patterns may be reevaluated if there are changes at the UVAR that may impact the validity of the sampling locations. Such factors might include the following:

- Changes in the work process
- Changes in the ventilation system
- Use of portable ventilation that might alter earlier assessments

After identifying the purpose for the air sample and establishing flow patterns, air sample locations are chosen as follows:

- For verification of confinement of radioactive materials:

  - Locate samplers in the air flow near the potential or actual release point.
  - More than one sampling point may be appropriate when there are more than one potential or actual release points.

- For estimation of a worker intake:

  - Sampler intakes will be located as close to the workers breathing zones as practical without interfering with the work or worker

General workplace air sampler intakes will not be placed in or near ventilation exhaust ducts unless their purpose is to detect system leakage during normal operation, and if quantitative measurements of workplace concentrations are not required. Locations or number of air samplers will be changed when dictated by modifications to facility structure, changes in work processes, or elimination of potential sources.

A sufficient inventory and variety of operable and calibrated portable and semi-portable air sampling equipment will be maintained to allow for effective collection, evaluation, and control of airborne radioactive material and to provide backup capability for inoperable equipment. Air sampling equipment will be calibrated at prescribed intervals or prior to use against certified equipment having known valid relationships to nationally recognized standards. Table 3-1 lists anticipated air sampling equipment.

When the work being performed is a continuous process, a continuous sample with a weekly exchange frequency is appropriate. For situations where short-lived radionuclides are important considerations, the exchange frequency will be adjusted accordingly. Longer sample exchange frequencies may be approved by HP management for situations where airborne radioactive material and nuisance dust are expected to be relatively low. Grab sampling for continuous processes may also be approved by HP management based upon consideration of variability of the expected source term for the facility and process. Grab sampling is the appropriate means of airborne sampling for processes conducted intermittently, and for short duration radiological work that involves a potential for airborne release.

Potential Sources of Radiation or Contamination Exposure to Workers and Public as a Result of Decommissioning Activities

Sources of radiation or contamination exposure may be assessed by process knowledge, radiological survey data, surveys performed during characterization, previous and current job coverage surveys, or daily, weekly and monthly routine surveys.

Classification of potential sources may also be identified by radionuclide, physical properties, volatility and radioactivity.

Worker exposure to significant external deep-dose radiation fields is considered unlikely during this project due to the nature of the contaminants and/or the work precautions and techniques employed. Worker exposure to airborne radioactivity may occur during decontamination operations/work evolutions which may involve abrasives or methods that volatilize loose and/or fixed contamination.

Exposure of the public to external or internal radiation from this Decommissioning Project is not considered credible because of the confinement provided by the Facility and the access control provided for the Facility and the area surrounding it.

The types of exposure controls used take into account the current state of technology and the economics of improvements in relation to the benefits. Control of potential sources of radiation exposure to workers and public as a result of decommissioning activities will be achieved through, but not limited to, the use of administrative, engineering and physical controls.

Administrative controls consist of, but are not limited to:

- Administrative dose limits that are lower than regulatory limits
- Training
- Radiological surveys.

Physical barriers such as radiological warning rope/ribbon, in combination with radiological warning tape, lockable doors/gates as well as information signs and flashing lights or other applicable barriers may also be used.

Engineering controls may consist of but are not limited to:

- HEPA ventilation/enclosures
- Protective clothing/equipment
- Access restrictions/barriers
- Confinement.

Health Physics Policies for Contractor Personnel

Contractor personnel will be used during the UVAR Decommissioning Project. Contractors who will work with licensed radioactive materials will be required to:

- Attend and complete appropriate radiation safety course
- Provide required exposure history information
- Read and sign an applicable RWP and comply with instructions
- Follow all special instructions given by HP.

3.1.3 Radioactive Materials Controls

UVA's radiation protection program establishes radioactive material controls that ensure the following:

- Prevention of inadvertent radioactive material (licensed material) release to uncontrolled areas.

- Assurance that personnel are not inadvertently exposed to radiation from licensed radioactive materials.

- Minimization of the amount of radioactive waste material generated during decommissioning.

All materials leaving the UVAR Restricted Area will be radiologically surveyed to ensure that radioactive materials (i.e., licensed materials) are not removed inadvertently. Decommissioning Project and UVA Health Physics procedures will be used to ensure that potentially radioactive or contaminated items removed from the UVAR site are surveyed. The performance of these surveys will incorporate the guidance presented in *Supplemental Information on the Implementation of the Final Rule on Radiological Criteria for Licence Termination* (Ref. 3-1). The following survey methods will be used:

- **Materials and Equipment** - Direct frisking with a portable Geiger-Mueller detector (e.g., Ludlum Model 2300 with 43-68 probe, or equivalent) having a minimum level of detection of less than or equal to the lowest acceptable license termination screening values provided by the NRC in *Table 1 - Acceptable License Termination Screening Values of Common Radionuclides for Building Surface Contamination* (Ref. 3-2) or 7,100 dpm/100 cm^2.

- **Smear Samples** - Analysis with a Gas Flow Proportional detector (e.g., Tennelec Model LB 5100 W or equivalent) having a minimum level of detection of less than or equal to 10% of the lowest acceptable license termination screening values provided by the NRC in *Table 1 - Acceptable License Termination Screening Values of Common Radionuclides for Building Surface Contamination* (Ref. 3-2) or 710 dpm/100 cm^2.

- **Bulk Liquids or Bulk Materials** - Nuclide determinations of waste samples collected at the project site will be used to establish ratios between radionuclides that are gamma emitters and easily measured on-site and other nuclides which are either non-gamma emitters or require a more extensive analysis of quantity. Section 61.55(a)(8) of 10 CFR 61 permits licensees to determine the concentration of a radionuclide by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements.

  Liquids will be analyzed to insure that discharges to sanitary sewerage will meet the requirements of 10 CFR 20.2003 *Disposal by release into sanitary sewerage* and University of Virginia liquid discharge procedures.

Materials will be released if no discernable facility-related activity is detected within the capability of the survey methods presented above.

In evaluation of equipment and materials for fixed or smearable licensed radioactive materials, items painted with other than original manufacturer's paint will not be released unless clear process knowledge demonstrates that the paint was applied to a clean, non-radioactive surface prior to use in the UVAR Restricted Area or approval from Decommissioning Project Health Physics, has been obtained and an acceptable survey course for this situation has been approved. If the potential exists for contamination on inaccessible surfaces, the equipment will be assumed to be internally contaminated unless (1) the equipment is dismantled allowing access for surveys, (2) appropriate tool or pipe monitors with acceptable detection capabilities are utilized that would provide sufficient confidence that no licensed materials were present, or (3) it may readily be concluded that surveys from accessible areas are representative of the inaccessible surfaces (i.e., surveying the internal surface from both ends of a straight pipe from a nonradioactive process system with cotton swabs would be representative of the inaccessible areas).

If it is impractical or not possible to satisfy release criteria (or conclusively demonstrate that they have been met), the item will be dispositioned as radioactive waste.

3.1.4 Dose Estimates

The total projected occupational exposure to complete the Decommissioning of the UVAR is estimated to be 4 person-rem (estimated using Xtreme PM℠ (Ref. 3-3). A task-by-task breakdown of this dose estimate is provided herein as Table 3-2. Task-specific dose estimates are based on the nature of the work involved in each task item, the expected number of persons to be assigned to each task, and the individual task duration periods as shown on the overall project Schedule for UVAR D&D (see Figure 2-3).

This estimate is provided for planning purposes only. Detailed exposure estimates and exposure controls shall be developed in accordance with the requirements of the UVA ALARA program during detailed planning of the decommissioning activities. Area dose rates used for this estimate are based on process knowledge and current survey maps (where available). The Xtreme PM℠ system (Ref. 3-3) can be used to assist the project team in effectively managing the worker exposure and training and to document radiological conditions in work areas.

Table 3-2 UVAR Estimated Decommissioning Occupational Exposure

Task No.	Task Description	Subtotal pers-rem	Total Dose pers-rem
0.0	**Total Project**		**3.903**
1.0	**Prepare Plans and Procedures**		**0.000**
2.0	**Decontamination and Dismantling**		**3.875**
2.1	Undistributed Labor and Costs	0.137	
2.2	Mobilization and Training	0.001	
2.3	Site Verification Survey	0.018	
2.4	Remove Reactor Room Components	0.026	
2.5	Remove Reactor Components in Pool	1.234	
2.6	Reactor Pool Water	0.024	
2.7	Install Confinement Barrier Around Pool	0.006	
2.8	Reactor Hardware Removal	0.215	
2.9	Pool Remediation	1.247	
2.10	Ship Activated Material to Barnwell	0.000	
2.11	Dismantle Barrier and Package for Disposal	0.001	
2.12	Remove Control Rm and Equipment Rm	0.001	
2.13	Decontaminate Reactor Room	0.002	
2.14	Decommission Demineralizer Room	0.171	
2.15	Decommission Heat Exchanger Room	0.441	
2.16	Decommission BeamPort Facilities	0.162	
2.17	Decommission Hot Cells	0.035	
2.18	Decommission Labs and Structure	0.018	
2.19	General Outside Clean-Up	0.001	
2.20	Remove Fuel Transfer Tank	0.001	
2.21	Remove Cooling Tower	0.003	
2.22	Remove Buried Waste Tanks	0.088	
2.23	Remove Buried Hot Cell Tanks	0.033	
3.0	**Perform MARSSIM Site Release Survey**		**0.019**
4.0	**NRC Verification Survey**		**0.000**
5.0	**Facility Remediation**		**0.007**

The dose estimate to members of the public as a result of decommissioning activities is estimated to be negligible. This is because site perimeter controls will restrict members of the public from the area where decommissioning activities are taking place. This is consistent with the estimate given for the "reference research reactor" in the *"Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities"* (NUREG-0586) (Ref. 3-4). The dose to the public during decommissioning (DECON) and truck transport transportation of radioactive waste from the reference research reactor referred to in the Final Generic Impact Statement is estimated to be "negligible (less than 0.1 man-rem)."

Activated pieces and any contaminated debris will be removed and shielded if required to meet U.S. DOT shipping requirements and disposal site Waste Acceptance Criteria.

3.2 Radioactive Waste management

3.2.1 Radioactive Waste Processing

The processes of decontamination, remediation and dismantlement of the UVAR will result in solid and liquid low-level radioactive waste, mixed waste and hazardous waste. Limited soil remediation is anticipated which will result in solid radioactive waste. This waste will be handled (processed and packaged), stored and disposed of in accordance with applicable sections of the Code of Federal Regulations (CFR), disposal site Waste Acceptance Criteria, Virginia Administrative Codes, UVA Licenses and Permits, and the applicable implementing plans and procedures. Radioactive waste processing includes waste minimization or volume reduction, radioactive and hazardous waste segregation, waste characterization, neutralization, stabilization, solidification and packaging. The Xtreme PM℠ system (Ref. 3-3) can be used to assist the project team in effectively managing project waste, analytical results, waste stream characterization, waste related training, etc. The system's advanced estimating tools can be used to generate various waste handling scenarios to evaluate impacts from waste disposal options, waste processing options, transportation options, etc.

3.2.2 Radioactive Waste Disposal

Low-level radioactive waste will be processed and packaged for disposal at a licensed low-level waste site such as the Envirocare of Utah site or the Barnwell, South Carolina site. The volume of low-level radioactive waste is estimated at 12,500 Cu. ft. Mixed low-level waste will be prepared for shipment to off-site commercial processing and disposal facilities such as Envirocare of Utah.

10 CFR 61, *Licensing Requirements for Land Disposal of Radioactive Waste, Subpart D — Technical Requirements for Land Disposal Facilities*, establishes minimum radioactive waste classification, characterization and labeling requirements. These requirements will be ensured

through the implementation of project packaging and characterization procedures, Disposal Site Waste Acceptance Criteria and the Project-Specific Quality Assurance Plan. Training/ Qualifications will be provided for project waste management personnel to assure conformance to applicable 10 CFR 61 requirements as stated in the specific implementing procedures and plans. Audits and surveillances will be conducted per the Project-Specific Quality Assurance Plan based on ASME-NQA-1 and the requirements of 10 CFR 71.

10 CFR 71, Packaging and Transportation of Radioactive Material, establishes requirements for packaging, shipment preparation and transportation of licensed material. UVA is licensed by the USNRC to receive, possess, use and transfer licensed byproduct and source materials. 10 CFR 71 requirements will be met through the implementation of UVA approved packaging and shipping procedures. Training will be provided for waste management personnel to assure conformance to applicable 10 CFR 71 requirements. Quality Assurance will confirm conformance to 10 CFR 71 Subpart H (Quality Assurance) requirements through the implementation of an UVA approved Project-Specific Quality Assurance Plan.

10 CFR 20.2006, *Transfer for Disposal and Manifests*, establishes requirements for controlling transfers of low-level radioactive waste intended for disposal at a land disposal facility; establishes a manifest tracking system; supplements requirements concerning transfers and record keeping; and requires generator certification that transported materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transport. These requirements will be met through the implementation of project and UVA packaging and shipping procedures with the oversight of DOC and UVA Quality Assurance.

Radiological and mixed wastes will be disposed of at disposal sites per the applicable Disposal Site's Acceptance Criteria. Associated implementing plans and procedures will reflect the characterization, processing, removal of prohibited items, packaging and transportation requirements. Appropriate documentation will be submitted to designated disposal sites including, as required, certification plans, qualification statements, assessments, waste stream analysis, evaluations and profiles, transportation plans, and waste stream volume forecasts. Waste characterization, waste designation, waste traceability, waste segregation, waste packaging, waste minimization, and quality assurance and training requirements of the designated disposal sites will be incorporated in implementing procedures to assure conformance to disposal site requirements.

Generator State (Virginia) and Treatment/Storage/Disposal Facility States (Utah, South Carolina, etc.) requirements for radioactive and mixed waste management will be incorporated into plans and procedures to assure conformance with applicable state regulations, licenses and permits. Applicable state regulations include Virginia Hazardous Waste Management Regulations (Code of Virginia, Title 9), and Utah Department of Environmental Quality Rules (R313) for the control of ionizing radiation reflected in Envirocare's Utah Radioactive Material License, UT 2300249.

Radioactive waste will be staged in designated controlled areas in accordance with USNRC 10 CFR 19 and 20 requirements. Mixed wastes will be staged in designated controlled areas per EPA 40 CFR requirements, 10 CFR 19 and 20, and per local and state permits. Measures will be implemented through plans and procedures to control the spread of contamination, limit radiation levels, prevent unauthorized access, prevent unauthorized material removal, prevent tampering, and prevent weather damage. The designated controlled areas will be approved by Radiological Work Permits, and/or Hazardous Work Permits.

Radioactive and mixed waste material will be packaged for shipment per 10 CFR, 40 CFR, 49 CFR, and the designated Disposal Site Criteria and placed in permitted interim storage (staged) until shipped. The quantity of waste packages staged for shipment will be a function of waste generation and packaging rate, shipment preparation rate, shipment rate, and disposal site acceptance rate. To meet this objective, shipments will be scheduled throughout the life of the Project to designated treatment, storage, and disposal facilities.

Radioactive material storage areas will be contained inside posted restricted areas according to existing UVA procedures and consistent with 10 CFR 20.

3.3 General Industrial Safety Program

Industrial Safety and Industrial Hygiene personnel, with Project Management, shall be responsible to ensure that the Project meets occupational health and safety requirements of Project personnel and the general public. The primary functional responsibility is to ensure compliance with the OSHA of 1973. Specific responsibilities include conducting an industrial training program to instruct employees in general safe work practices; reviewing Decommissioning Project procedures to verify adequate coverage of industrial safety and industrial hygiene concerns and requirements; performing periodic inspections of work areas and activities to identify and correct any unsafe conditions and work practices; providing industrial hygiene services as required; and advising Project management on industrial safety matters and on the results of periodic safety inspections.

All personnel working on the UVAR Decommissioning Project will receive Health and Safety training in order to recognize and understand the potential risks involving personnel health and safety associated with the work at the UVAR. The Health and Safety training implemented at the UVAR is to ensure compliance with the requirements of the USNRC (10 CFR), the EPA (40 CFR), and OSHA (29 CFR). Workers and regular visitors will be familiarized with plans, procedures and operation of equipment to conduct themselves safely. In addition, each worker must be familiar with procedures that provide for good quality control. Section 2.5, Training Program, provides additional information. The Xtreme PM℠ system (Ref. 3-3) can be used to assist the project team in effectively managing training requirements, training status, safety equipment, etc.

3.4 Radiological Accident Analyses

Ppotential radiological accidents during the decommissioning of the UVAR will be mainly associated with the reactor pool. Factors considered in assessing potential radiological accidents are:

1) Pool hardware storage and removal
2) Fire
3) Other considerations.

Pool Hardware Storage and Removal

Radiological accidents could occur during removal and packaging of activated components and equipment. However, this risk is very low considering the administrative precautions which will be taken during decommissioning. UVAR and contractor experience in handling of activated/contaminated components, and control of job activities utilizing written and approved procedures, will ensure the safe conduct of the project.

The water-filled pool provides shielding for workers positioned near or over the reactor during hardware handling. Any failure to meet shielding requirements would result in worker restrictions on approach to the pool until the requirement could be met.

Fire

Portable extinguishers will be provided as needed. External fire department support is provided for by the UVAR Emergency Plan. The radiological hazard resulting from a fire would be minimal.

Other Considerations

Consequences of a pool leak are low because the poolwater is continuously filtered and deionized and contains negligible radioactivity. The potential leak could result in flowing water carrying loose contamination to a new location within the facility, outside the facility, or into the soil. Since loose contamination is minimal the risk of spread of contamination is low. There is no potential for airborne contamination from such an event.

REFERENCES FOR SECTION 3

3-1 *Supplemental Information on the Implementation of the Final Rule on Radiological Criteria for Licence Termination,* the Federal Register (63 FR 64132, 11/18/98)

3-2 *Table 1 - Acceptable License Termination Screening Values of Common Radionuclides for Building Surface Contamination*

3-3 Xtreme PM℠, Integrated Project Management System, GTS Duratek and Merrimac.

3-4 NUREG-0586, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*

4.0 PROPOSED FINAL RADIATION SURVEY PLAN

The intended course of action for UVAR decommissioning, based upon consideration of site and facility radiological characterization results, is to decontaminate structural materials to the extent practicable in balance with radioactive waste minimization considerations, and dismantle UVAR systems to the extent necessary for remediation, and packaging for burial those materials that cannot reasonably be decontaminated. As such, the Final Release Survey Plan (and subsequent Final Survey Report) discussed in this section deals with release of the UVAR building structure and grounds to unrestricted use. This section will also discuss the survey methods that will be utilized.

4.1 Description of Final Radiation Survey Plan

The purpose of the Final Radiation Survey is to demonstrate that the radiological condition of the UVAR site structures are at or below established release criteria (see Section 2.7) in anticipation of U.S. NRC approval to terminate the UVAR Reactor licenses and to release the facility housing the UVAR for unrestricted use. The Final Release Survey Plan (and report) will deal with release of the UVAR structure and site to unrestricted use.

UVA will develop its Final Release Survey Plan using the guidance provided in DG-4006, *Demonstrating Compliance with the Radiological Criteria for License Termination* (Ref. 4-1) and NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (Ref. 4-2).

4.1.1 Means for Ensuring that all Equipment, Systems, Structures and Site are Included in the Survey Plan

Every item that is to be removed from the UVAR will be evaluated for its ability to be decontaminated. Further, items will be radiologically surveyed to ensure that radioactive (i.e., licensed) materials are not inadvertently removed from the facility (see Section 3.1.3). When it is impractical or not possible to decontaminate an item such that it exhibits no discernable facility-related activity when surveyed following methods presented in Section 3.1.3, the item will be treated as radioactive waste. The systematic approach to UVAR decommissioning will ensure that every item or structural component in the UVAR is specifically evaluated for release before beginning the Final Release Survey. The Final Release Survey will break the UVAR into three classes (as suggested in MARSSIM) to ensure adequate survey coverage in support of a license termination request and subsequent release of the property for unrestricted use.

4.1.2 Means for Ensuring that Sufficient Data is Included to Achieve Statistical Goals

UVA will develop the UVAR Final Release Survey Plan using the guidance presented in DG-4006, *Demonstrating Compliance with the Radiological Criteria for License Termination* (Ref. 4-1) and NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (Ref. 4-2). By using this guidance, the Project will satisfy the U.S. NRC recommended statistical goals.

4.2 Background Survey Results

The Final Release Survey Guideline values for residual activity are taken to be levels above the naturally occurring background radiation. However, if the final release survey values are significantly below the release guideline levels, the licensee may opt not to use background subtraction. The number of samples collected in each survey unit and in background reference areas will be sufficient to satisfy the statistical goals. The final release measurements will consist of a combination of direct beta/gamma measurements, samples for removable alpha and beta contamination and samples for radionuclide specific analysis.

Background radiation as encountered at any location includes contributions due to soil natural radiation sources and man-made sources. Natural radiation sources include terrestrial radioactivity due to naturally-occurring radioisotopes in soils and construction media, airborne radioactivity (principally radon and radon progeny) from the radioactive decay of certain of these naturally occurring radioisotopes, and cosmic radiation from high-speed particle interactions in the earth's atmosphere. Man-made background radiation, as it would impact the Final Release Survey, would consist primarily of atmospheric of fission product fall-out due to weapons testing and reactor accidents and any contribution that might exist as a result of activities of other licensees.

The general area background radiation, as would be measured with a micro-R meter, is influenced by a number of factors, principally the naturally-occurring radioactivity in soils and other nearby materials, radon and radon progeny concentrations in the air, and extent of cosmic radiation (which varies with elevation). Due to the number of influences, the natural background varies appreciably from location to location, day-to-day (even time of day) and season-to-season as related to changing weather conditions and materials in the surroundings.

The *Characterization Survey Report for the University of Virginia Reactor Facility* (Ref. 4-3) includes measurements to establish background radioactivity in soils, concrete and asphalt considered representative of those that would be encountered in the Final Release Survey. One of the principal constituents of global fallout, ^{137}Cs, found as a result of atmospheric weapons testing, is also the principal fission product contaminant at the UVAR. ^{137}Cs has been seen to be persistent in the upper 15 cm (6 in.) of soil with concentrations decreasing beyond this depth.

Release guideline values were established as an increment in excess of background values. Therefore, the Final Release Survey will include the establishment of background area radiation levels using the guidance in MARSSIM and RG-4006. Asphalt, concrete and other construction material background values have been established by taking measurements on unaffected UVA construction materials.

4.3 Final Release Criteria - Residual Radiation and Contamination Levels

The criteria for release of the UVAR facility/site to unrestricted use, after completion of the decommissioning activities described in this plan, are presented in Section 2.7. In summary, they are: 1) those given in the *Supplemental Information on the Implementation of the Final Rule on Radiological Criteria for Licence Termination,* the Federal Register (63 FR 64132, 11/18/98) (Ref. 4-4), and 2) a 25 mR/yr unrestricted release dose limit in 10 CFR 20.1402 *Radiological Criteria for Unrestricted Use* (Ref. 4-5).

4.4 Measurements for Demonstrating Compliance with Release Criteria

4.4.1 Instrumentation - Type, Specifications and Operating Conditions

Instrumentation utilized during the Final Release Survey (and equipment and materials survey) will be selected based upon the need to ensure that site residual radiation will not exceed the release criteria. In order to achieve this goal, instrumentation sensitive to the isotopes of concern and capable of measuring levels below 50% of the guideline values for those isotopes will be selected. Instrumentation available for the Final Release Survey, and their respective detection range capability is presented in Table 3-1 of this plan. Instrumentation sensitivities were determined following the guidance of NUREG-1507 (Ref. 4-6) using nominal literature values for background, response and site conditions. Refinements to these detection sensitivity estimates will be made, as necessary, on the basis of actual instrument response and background data gathered during site survey activities. Instrumentation used in the surveys will be calibrated against sources and standards that are NIST-traceable and representative of the isotopes encountered at the UVAR. When to be used, instruments will be operationally tested daily, or prior to each use, whichever is less frequent. Instruments will not be used in conditions that are not in conformance with manufacturer recommendations.

4.4.2 Measurement Methodology for Conduct of Surveys

This Decommissioning Plan presumes that the UVAR will have been decontaminated to the extent practicable prior to the Final Release Survey. The UVAR structure and site will be methodically remediated, as necessary, prior to conduct of the Final Release Survey. The characterization results and the continuous feedback from remediation surveys will be the basis for remediation efforts. The UVAR Final Release Survey Plan will include several steps to calculate the number of measurements and samples required, according to MARSSIM guidance, to release the site without restrictions. These steps include:

- Classify survey units
- Specify the decision error
- Determine the DCGL
- Calculate the relative shift
- Obtain the number of samples per survey unit
- Estimate the sample grid spacing
- Perform evaluation for small areas with elevated radioactivity
- Determine if the number of samples is reasonable.

Classify Survey Units

The UVAR site will be broken into four classes of survey areas. Class 1 is an area with the highest potential for contamination. Class 2 is an area that was impacted or has a low potential for delivering a dose above the release criteria and has little or no potential for containing small areas of elevated activity. Class 3 is an area with the lowest potential for contamination. Class 4 is a non-impacted area where there is no potential for contamination. The characterization survey document (Ref. 4-3) indicates the survey classification for the various parts of the UVAR facility.

Specify the Decision Error

There are two types of decision error (applied here to analytical results): Type I (alpha) and Type II (beta). A Type I error is described as the probability of determining that a result is above a criterion when it actually is not (false positive). A Type II error is described as the probability of determining that a result is below a criterion when it actually is above it (false negative). Both types of error are typically set at 0.05 (5%) at first, but the final values may differ depending on the data quality objectives.

Determine the DCGL

The derived concentration guideline level (DCGL) is defined in MARSSIM as the radionuclide-specific concentration within a survey unit corresponding to the release criterion. The radionuclides identified in the UVAR and adjacent yards during radiological characterization efforts were ^{137}Cs (predominant nuclide), ^{60}Co, ^{54}Mn, ^{55}Fe, ^{57}Co, ^{63}Ni, ^{65}Zn, ^{125}Sb, ^{154}Eu, $^{233/234}U$ and ^{241}Pu. The DCGL values were discussed in Section 2.7.

Calculate the Relative Shift

The relative shift is defined as the Δ/σ, where Δ is the DCGL = LBGR (lower bound of the gray region) and σ is the standard deviation of the contaminant distribution. MARSSIM suggests that the LBGR initially be set at one-half of the $DCGL_W$, but it can be adjusted later to provide a Δ/σ value in the recommended range of 1 to 3. The weighted DCGL, or $DCGL_W$, is the concentration *averaged over a survey unit* that can be present while still satisfying the criterion (averaging accounts for the commonly inhomogeneous nature of contamination). Site specific data will be used to estimate σ.

Obtain the Number of Samples per Survey Unit

The calculated value for Δ/σ can be used to obtain the minimum number of samples necessary to satisfy requirements. Table 5.3 in MARSSIM contains the number of samples necessary for a given Type I error (α) or Type II error (β) and Δ/σ if the radionuclide(s) is present in background. Table 5.5 in MARSSIM contains the number of samples in each survey unit when the radionuclide(s) is not present in background.

Estimate the Sample Grid Spacing

The grid spacing, L, will be determined based upon A, the surface area in the survey unit, and n, the number of samples. The grid spacing for a triangular grid is estimated as follows:

$$L = \sqrt{\frac{A}{0.866 \; x \; n}}$$

Perform Evaluation for Small Areas with Elevated Radioactivity

After the grid spacing has been calculated, the area between samples can also be calculated. For example, if the grid spacing is 10 m for a square grid, then there can be an undetected pocket of elevated radionuclide concentrations 100 m^2 in area. Adjustments to the grid spacing (i.e., additional sampling) may be necessary depending on the following three factors:

- The class of the survey unit;
- The ability to scan for the radionuclide; and
- The minimum potential size of the elevated activity that could produce an exposure above the dose or risk criterion.

Determine if the Number of Samples is Reasonable

Assuming that the number of samples per unit has been calculated, it should then be determined if that number is reasonable. It is possible, even if MARSSIM guidance was strictly followed, that there are too few samples to produce the desired level of comfort. It is the responsibility of the site managers and health physicists to evaluate whether the number of samples is reasonable. If it is determined that the number of samples is inadequate or excessive, the data quality objectives should be reevaluated.

4.4.3 Scan Surveys

Following remediation and prior to conducting sampling, screening beta/gamma scans for surfaces and structures and gamma scans for environs will be performed over 100% of surfaces of both Class 1 and Class 2 survey units and 25% of the Class 3 survey unit. A scanning response exceeding an action level set based on Section 6.8.2 of NUREG-1507 will be investigated/sampled/re-surveyed and, if necessary, remediated. If remediation is performed, scanning shall be repeated to demonstrate effectiveness of the remediation.

4.4.4 Soil Sampling

Soil samples will be obtained to a depth of 15 cm; samples will be packaged and uniquely identified in accordance with chain-of-custody and site-specific procedures.

4.4.5 Sample Analysis

Samples will be transferred to a radio-analytical laboratory for analyses in accordance with documented laboratory-specific standard methods. In accordance with MARSSIM, analytical techniques will provide a minimum detection level of 50% of the individual radionuclide $DCGL_W$ (or $DCGL_{EMC}$) values for all primary contaminants. If these analyses indicate residual activity exceeding guideline levels, further remediation will be performed, as required, and scans and sampling of the remediated area will be repeated.

4.4.6 Investigation Levels

Radiation levels identified by scans that indicate potential residual radioactive contamination above background will be investigated to identify the source, level and extent of such residual activity. Areas which contain residual radioactivity concentrations of individual radionuclides, or sum-of-ratio concentrations above respective guideline values, will be remediated, reclassified (as necessary) and re-surveyed.

4.5 Methods to be Employed for Reviewing, Analyzing, and Auditing Data

4.5.1 Laboratory/Radiological Measurements Quality Assurance

During decommissioning survey activities, many direct and indirect measurements and sample media samples will be collected, measured and analyzed for radiological contaminants. The results of these surveys will be utilized to evaluate the suitability of the material or item for release to unrestricted use, or whether decontamination of structures, components, and the surrounding site have achieved the desired result. Sample collection, analysis, and the associated documentation will adhere to written procedures and meet the guidance of the U.S. NRC, as well as comply with recognized industry recommendations and good practices. Outside (i.e., non-UVA) laboratories selected to analyze UVAR decommissioning samples shall be approved by UVA and listed on the QA Approved Suppliers List.

Organizations that perform radiological monitoring measurements recognize the need to establish quality assurance programs to assure that radiological monitoring measurements are valid. These programs are established for the following reasons: (1) to readily identify deficiencies in the sampling and measurement processes to those individuals responsible for these activities so that prompt corrective action can be taken, and (2) to routinely monitor the survey and laboratory measurement results in order to assure that results and conclusions are valid.

4.5.2 Supervisory and Management Review of Results

Radiological surveys will be conducted by Health Physics technicians who are trained and qualified. In addition, radiological surveys and sample results will be reviewed by a senior level member of the Health Physics staff other than the individual that performed the survey. Final Radiation Survey data will also be reviewed by the RSO.

REFERENCES FOR SECTION 4

4-1 DG-4006, *Demonstrating Compliance with the Radiological Criteria for License Termination*

4-2 NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*

4-3 *Characterization Survey Report for the University of Virginia Reactor Facility*, December 1999.

4-4 *Supplemental Information on the Implementation of the Final Rule on Radiological Criteria for Licence Termination*, the Federal Register (63 FR 64132, 11/18/98)

4-5 10 CFR 20.1402 *Radiological Criteria for Unrestricted Use*

4-6 NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*

5.0 TECHNICAL SPECIFICATIONS

It is anticipated that for decommissioning the applicable Technical Specifications for the UVA Reactor will be set forth in Amendment No. 25 to Facility License No. R-66, University of Virginia Reactor, Docket No. 50-62, issued by the USNRC in early year 2000, as per UVA request dated August 16, 1999 (Ref. 5-1).

As decommissioning progresses, further requests for changes to the Technical Specifications may be submitted in an application for amendment to the license pursuant to 10 CFR 50.59.

REFERENCES FOR SECTION 5

5-1 Amendment No. 25 to Facility License No. R-66 (UVA Reactor) — University of Virginia, Anticipated Issue in early year 2000 by the USNRC, as per UVA request dated August 16, 1999.

6.0 PHYSICAL SECURITY PLAN

All UVA radiation restricted areas are secured from unauthorized entry. During non-working hours, all nuclear facility sensitive areas are locked. UVA maintains routine, periodic police surveillance of the reactor site.

Existing physical security and material control and accounting plans approved by the Nuclear Regulatory Commission, as may be amended, will continue to be implemented.

These existing plans meet the requirements in NUREG-1537 Chapter 17 *Decommissioning and Possession-Only Amendments,* and will be maintained as required by the UVAR Possession Only Amendment (Ref. 6-1).

REFERENCES FOR SECTION 6

6-1 Amendment No. 25 to Facility License No. R-66 (UVA Reactor) — University of Virginia, Anticipated Issue in early year 2000 by the USNRC, as per UVA request dated August 16, 1999.

7.0 EMERGENCY PLAN

As required by the USNRC, The University of Virginia has a Reactor Facility Emergency Plan for responding to emergencies at the Reactor Facility. The purpose of this plan is to minimize any emergency's effect on the public, personnel, reactor facility and the environment surrounding the facility. Removal of spent fuel from the site, and storage of on-site Co-60 pins in an approved cask, have significantly reduced the potential for significant release of radioactive material offsite. Any airborne or liquid releases due to decommissioning activities would have negligible impact offsite. The most likely accident scenario is a contaminated and/or injured individual. This scenario is adequately addressed by the existing emergency plan. Training will be provided to key personnel to ensure their familiarity with the emergency plan and their expected responses.

8.0 ENVIRONMENTAL REPORT

The Environmental Report (Ref. 8-1) is provided as Appendix B.

REFERENCES FOR SECTION 8

8-1 *Environmental Report for the University of Virginia Reactor Decommissioning*, February 2000.

9.0 CHANGES TO THE DECOMMISSIONING PLAN

As the decommissioning progresses, and up until the termination of the license, changes to the Technical Specifications will be via a Request for License Amendment pursuant to 10 CFR 50.90 (Ref. 9-1).

UVA requests that changes to the Decommissioning Plan be allowed with local approval by the Reactor Director or the Reactor Decommissioning Committee, and without prior USNRC approval, unless an unreviewed safety question is involved. An unreviewed safety question involves:

1. The increase of probability of occurrence or the increase of consequences of an accident or malfunction of equipment important to safety compared to that situation previously evaluated in the SAR, or

2. The possibility for an accident or malfunction of a different type than previously analyzed in the SAR, or

3. The reduction in margin of safety as defined in the SAR.

Reports and records of changes to the Decommissioning Plan, and retention of documents, will be in accordance with the applicable portions of 10 CFR 50.59 (Ref. 9-2).

REFERENCES FOR SECTION 9

9-1 10 CFR 50.90, *Application for amendment of license or construction permit.*
9-2 10 CFR 50.59, *Changes, tests and experiments.*

APPENDIX A

SUMMARY OF CHARACTERIZATION RESULTS

SUMMARY OF CHARACTERIZATION RESULTS

The University of Virginia Reactor (UVAR) was permanently shut down in June of 1998 following the decision to cease operations and to decontaminate and decommission (D&D) the facility. GTS Duratek (GTSD) was awarded a contract to assist the University of Virginia (UVA) in its efforts to characterize the UVAR facility and site. GTSD assisted UVA by performing a characterization survey of the UVAR, as well as the surrounding buildings and environs.

The characterization followed guidance provided in NUREG-1575, MARSSIM, and it entailed performing a site investigation, preparing plans, performing a comprehensive radiation survey and sampling for potential hazardous materials at the site. The site investigation involved a site walk-down, historical site assessment, operational history investigation, and determination of the facility source term. The Characterization Survey Plan, the Quality Assurance Plan, the Site Health and Safety Plan and the Project Management Plan were developed using the information obtained from the site investigation. The plans were developed by GTSD staff from the Radiological Engineering and Field Services office in Kingston, Tennessee and reviewed and approved by UVA for use at the project site. Data quality objectives (DQO's) were included in the plans. Characterization of the UVAR facility and site was performed according to these plans, and the characterization survey met the DQO objectives.

Included in the planning was the development of derived concentration guideline levels (DCGL's) for radionuclides assumed to be present at the site. The characterization DCGL's were developed to meet the intent of Subpart E, 10 CFR 20.1402, *Radiological Criteria for Unrestricted Use*. The DCGL's were used to select instruments and to develop parameters for instrument operation so that the level of sensitivity for radiation measurements taken during the survey would be less than 50% of the characterization DCGL's.

Once the planning phase was completed, the survey team mobilized to the site and a kick-off meeting was held between GTSD and UVA personnel. Survey equipment was set up and all required training was completed. Over the course of eight and one-half weeks, eighteen survey packages describing rooms and areas of the UVAR facility and site surfaces, structures and environs were completed. Each survey package contained detailed instructions, drawings and location codes to perform or collect the 2,655 measurements and/or samples for the characterization.

The measurements and samples collected for the radiological characterization included direct alpha measurements, direct beta measurements, smear samples for removable alpha and beta contamination, smear samples for removable tritium contamination, exposure rate measurements and soil, sediment and water samples for gamma spectrum analysis. During the hazardous material assessment, survey package instructions were developed and measurements were performed and/or collected for lead and asbestos at the facility. In addition, samples were collected and sent offsite for analysis of potential hazardous material constituents. The purpose of the hazardous material assessment was to recognize hazardous materials that may be present for the D&D phase of the work, and to meet the Waste Acceptance Criteria for waste shipments to Envirocare of Utah.

Survey package instructions were developed and measurements performed for background surface, structure and environs reference areas. Direct beta background values were determined for naturally occurring radioactive materials (NORM) in asphalt, brick, ceramic tile, cinder block and concrete. These background values were applied to the direct beta measurements collected at the UVAR facility surfaces and structures to determine the net beta activity results per 100 cm^2 from the measured activity results. Also, survey measurements and samples collected from sediment and water of the environs were used to determine background values for NORM and from weapons testing. These values are included in the characterization report (Ref. A-1) but were not applied to UVAR survey results.

One resin sample from the UVAR poolwater clean-up system and one pond sediment sample (taken where the facility drains enter the pond) were collected and sent offsite for 10 CFR Part 61 radionuclide analysis. These sample results and the other onsite characterization results were used to develop UVAR site-specific DCGL's for site clean-up and release for unrestricted use.

The UVAR facility and site, for the most part, are below the radiological characterization DCGL and are mostly free from hazardous material concerns. However, some areas and locations at the UVAR facility and site will require decontamination before the site is suitable for NRC license termination. Of the 2,655 total samples and measurements collected and performed for the survey, 1,142 of them were direct measurements collected for the radiological characterization. Twelve (12) direct beta measurement results were greater than the MDA goal (50 % of the 5,000 dpm/100 cm^2 characterization DCGL) and five (5) of these direct beta measurements were greater than the characterization DCGL (12,730 dpm/100 cm^2). Of the 198 samples collected for gamma spectrum analysis, 18 sample results were greater than the characterization soil concentration DCGL's (1.32 pCi/g for Co-60 and/or 2.73 pCi/g for Cs-137). Details of these surveys and complete results are provided in the UVAR Characterization Survey Report (Ref. A-1).

The areas that will require remediation or further investigation and evaluation are presented in the discussions that follow. The location of the elevated measurements are depicted in Figures A-1 to A-4 by number on each figure.

1. Figure A-1, *Reactor Facility First Floor Level,* Location No. 1, one confinement room elevated measurement result of 12,593 dpm/100 cm^2 was obtained on the East wall. However, this result may have been influenced by elevated background radiation levels due to radioactive materials stored in the area. The radioactive materials stored in the reactor confinement room during this survey period will be removed prior to, or as a part

of, the facility decommissioning. Measurement results from the three floor drains in the confinement room showed contamination levels up to 6,398 dpm/100 cm^2 in floor drain number 2 on the east side of the reactor pool.

2. Figure A-1, *Reactor Facility First Floor Level*, Location No. 2, the reactor pool will require remediation based upon the operational history, radioactive materials known to be present in the pool and activation products from reactor operations in the concrete walls and floor.

3. Figure A-1, *Reactor Facility First Floor Level*, Location No. 3, a composite sediment sample, collected from the exhaust of the confinement building stack during the building exterior surfaces survey, measured 0.8 pCi/g of Co-60 and 2.8 pCi/g of Cs-137.

4. Figure A-2, *Reactor Facility Mezzanine Level*, Location No. 4, in room M008 one elevated direct measurement result of 26,365 dpm/100 cm^2 total beta activity was obtained from the laboratory sink. The contaminant was suspected to be Nickel-63 based on research experiment history and the low-energy of the measured activity.

5. Figure A-2, *Reactor Facility Mezzanine Level*, Location No. 5, in room M021A one elevated direct measurement result of 8,318 dpm/100 cm^2 total beta activity was obtained from the equipment surface of the reactor pool water clean-up system. However, this surface contamination measurement result may have been influenced by elevated background radiation levels from the water clean-up system internal contamination. The water clean-up system tanks, pumps and piping and the prototype water clean-up system tank and piping located in the adjacent room M021 will be removed as a part of the facility decommissioning.

6. Figure A-3, *Reactor Facility Ground Level*, Location No. 6, the measurement results from the survey indicate that room G007 excluding any CAVALIER Reactor, supporting systems, the sub-critical reactor assembly and pit for the most part was radiologically clean. Measurements performed on the sub-critical reactor assembly and pit were inconclusive due to elevated natural radon activity. An NRC approved decommissioning plan and decommissioning order is in place for the CAVALIER Reactor, supporting systems. The sub-critical reactor assembly located in room G007 is scheduled for shipment back to Oak Ridge (DOE). The CAVALIER Reactor, and supporting systems and the sub-critical reactor assembly will be decommissioned in accordance with the approved plan.

7. Figure A-3, *Reactor Facility Ground Level*, Location No. 7, the Hot Cell rooms G026 and G027 each had one elevated direct measurement result greater than 12,730 dpm/100 cm^2 total beta activity. Results of measurements collected ranged up to 63,661 dpm/100 cm^2 on the floor in room G026 and up to19,268 dpm/100 cm^2 on the floor in room G027.

Results from a concrete core bore slice indicated Cs-137 contamination of 7,650 pCi/g in the first 1/4" depth at the elevated reading location in room G026.

8. Figure A-3, *Reactor Facility Ground Level*, Location No. 8, the sump in the heat exchanger room G024 had a gamma spectrum analysis result indicating radionuclide activity above the characterization DCGL's for Co-60 and Cs-137. The sump in this room will require decontamination and the heat exchanger system, pumps and piping in the room G024 will be removed during decommissioning.

9. Figure A-3, *Reactor Facility Ground Level*, Location No. 9, in room G028 one elevated direct measurement result of 8,246 dpm/100 cm^2 total beta activity was obtained from the east wall mid-way between rooms G024 and G025 and one elevated direct measurement result of 7,522 dpm/100 cm^2 total beta activity was obtained from the north wall outside of room G022. However, these surface contamination measurement results may have been influenced by elevated background radiation levels from radioactive materials stored in the area during the time of the survey. Rooms G007, G007A, G018, G019, G022 and G028 were used for, and posted as, radioactive material storage areas. The radioactive materials stored in the rooms during this characterization survey will be removed as a part of the facility decommissioning.

10. Figure A-3, *Reactor Facility Ground Level*, Location No. 10, one elevated direct measurement result of 5,758 dpm/100 cm^2 total beta activity was obtained from the beam tube pipe end in the southeast port movable shield plug on the side oriented toward the reactor. However, this measurement result may have been influenced by elevated background radiation levels from radioactive materials stored in room G022 during this survey. A gamma scan survey profiling of the North and South Fast Neutron Beam Ports in conjunction with knowledge of the operational history indicates that the beam ports will need to be removed as a part of the facility decommissioning.

11. Figure A-4, *Reactor Facility Grounds*, Location No. 11, the Buried Liquid Waste Holding Tank Bunker dirt floor and tank interiors had gamma spectrum analysis results above the characterization DCGL's for Co-60 and Cs-137. The radionuclides contamination was present in the dirt floor to a 30" depth. Two elevated direct measurement results were obtained, 5,541 dpm/100 cm^2 total beta activity from the east tank and 6,600 dpm/100 cm^2 total beta activity from the west tank.

12. Figure A-4, *Reactor Facility Grounds*, Location No. 12, the Hot Cell Buried Waste Holding Tanks had elevated direct measurements ranging up to 16,907 dpm/100 cm^2 total beta activity in the piping leading to the tanks. A sample of sediment collected from inside the pipe indicated the presence of Cs-137. Five (5) water and sediment samples were collected from the tank contents for gamma spectral analysis and one result indicated the presence of Cs-137 activity above the characterization DCGL.

13. Figure A-4, *Reactor Facility Grounds*, Location No. 13, a pond sediment sample collected and sent offsite for 10 CFR Part 61 analysis indicated the presence of Co-60 and Cs-137 activity above the characterization DCGL. The sample was a composite of surface sediment collected around the vertical end of the reactor facility drain pipe at the pond.

14. Figure A-4, *Reactor Facility Grounds*, Location No. 14, soil samples in the outfall area between the buried liquid waste holding tank bunker and the pond indicated activity above the characterization DCGL's for Co-60 and Cs-137. Samples were taken at 0-6" and 6-12" depths approximately half-way down the bank at the location of the drain pipe from the bunker.

15. Figure A-4, *Reactor Facility Grounds*, Location No 15., one sediment sample collected for gamma spectrum analysis from the storm drain in the parking lot area on the south side of the facility indicated activity above characterization DCGL's for Co-60 and Cs-137.

REFERENCES FOR APPENDIX A

3-1 UVAR Characterization Survey Report

Figure A-1 UVA Reactor Facility First Floor Level

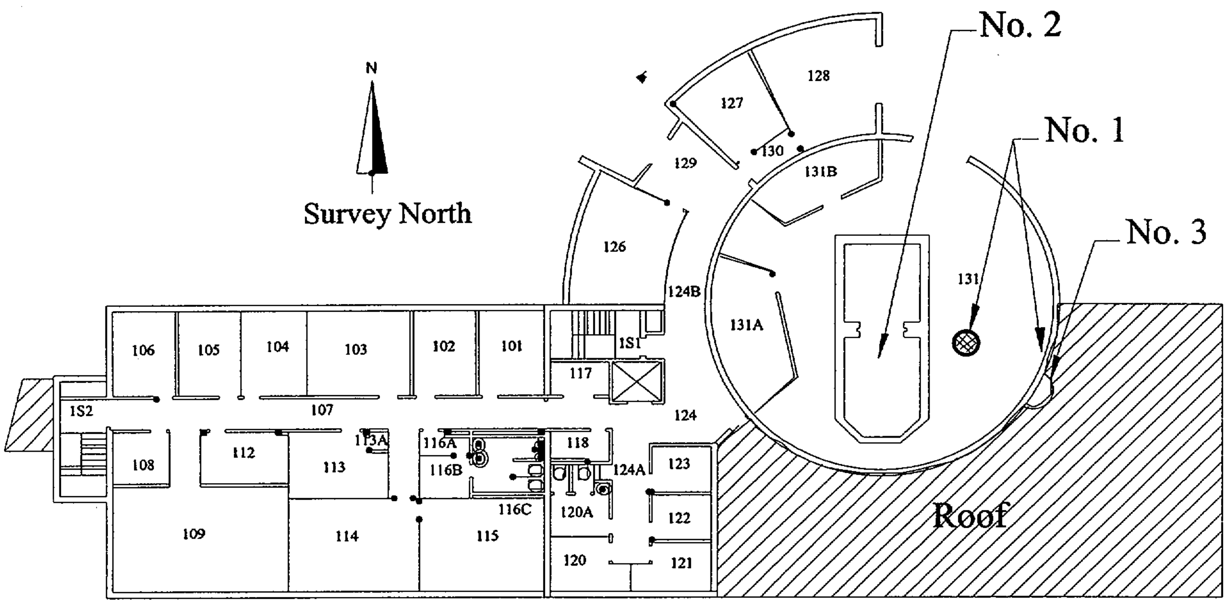


Figure A-2 UVA Reactor Facility Mezzanine Level

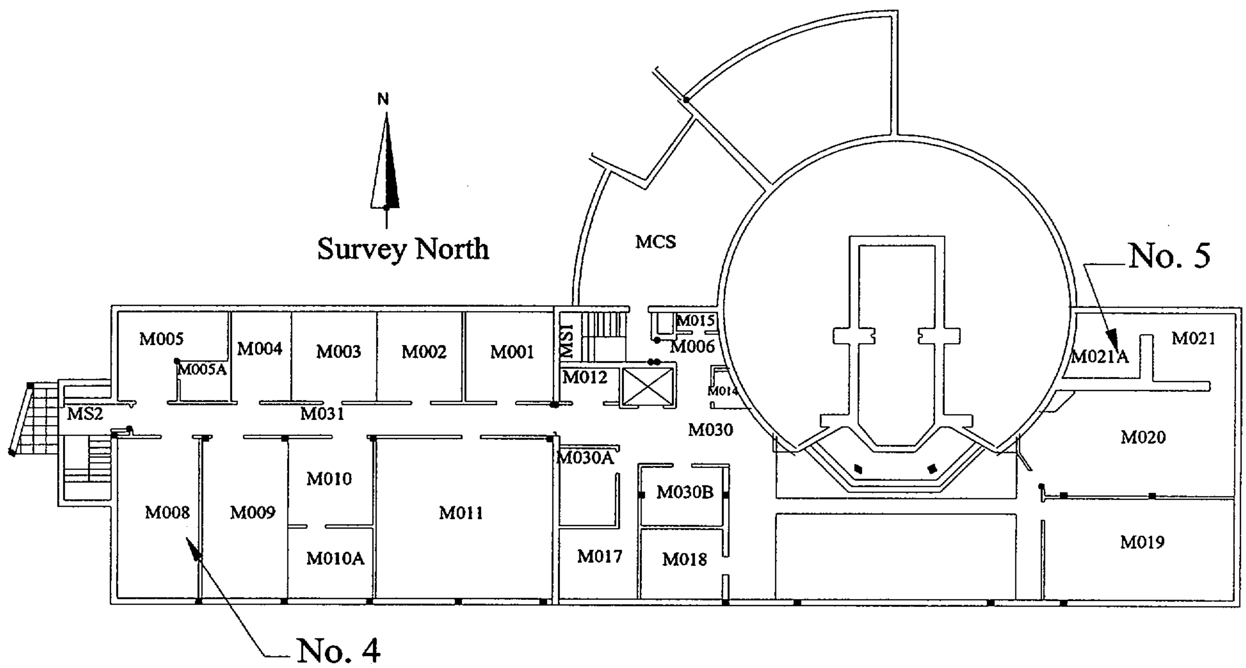


Figure A-3 UVA Reactor Facility Ground Level

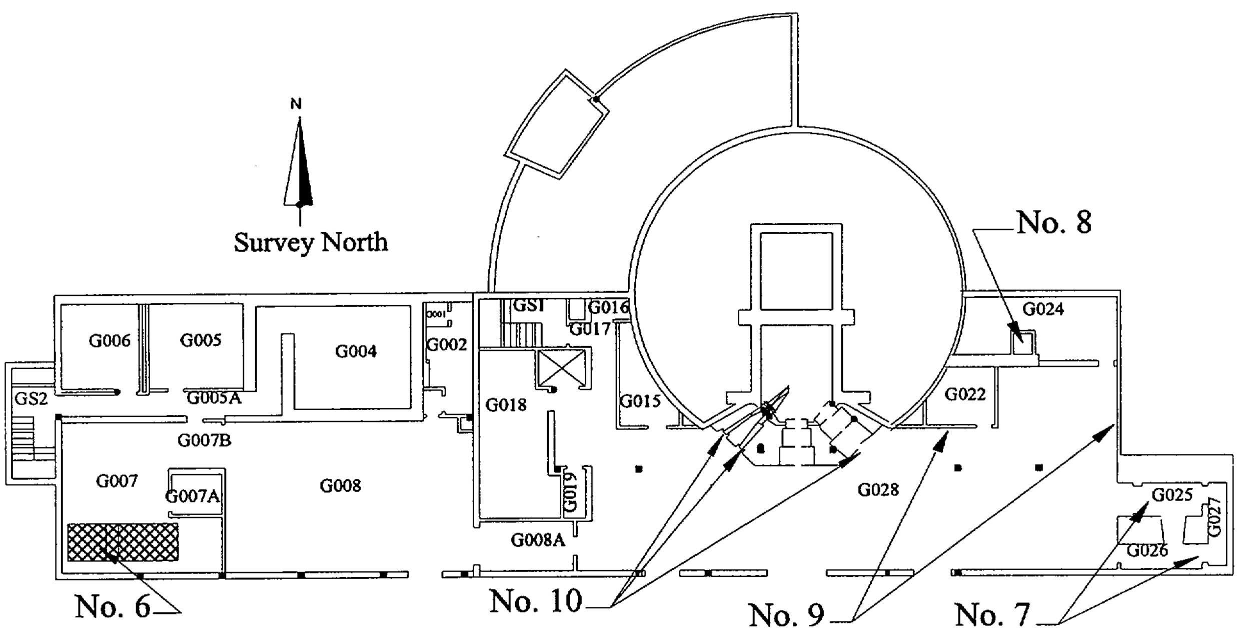
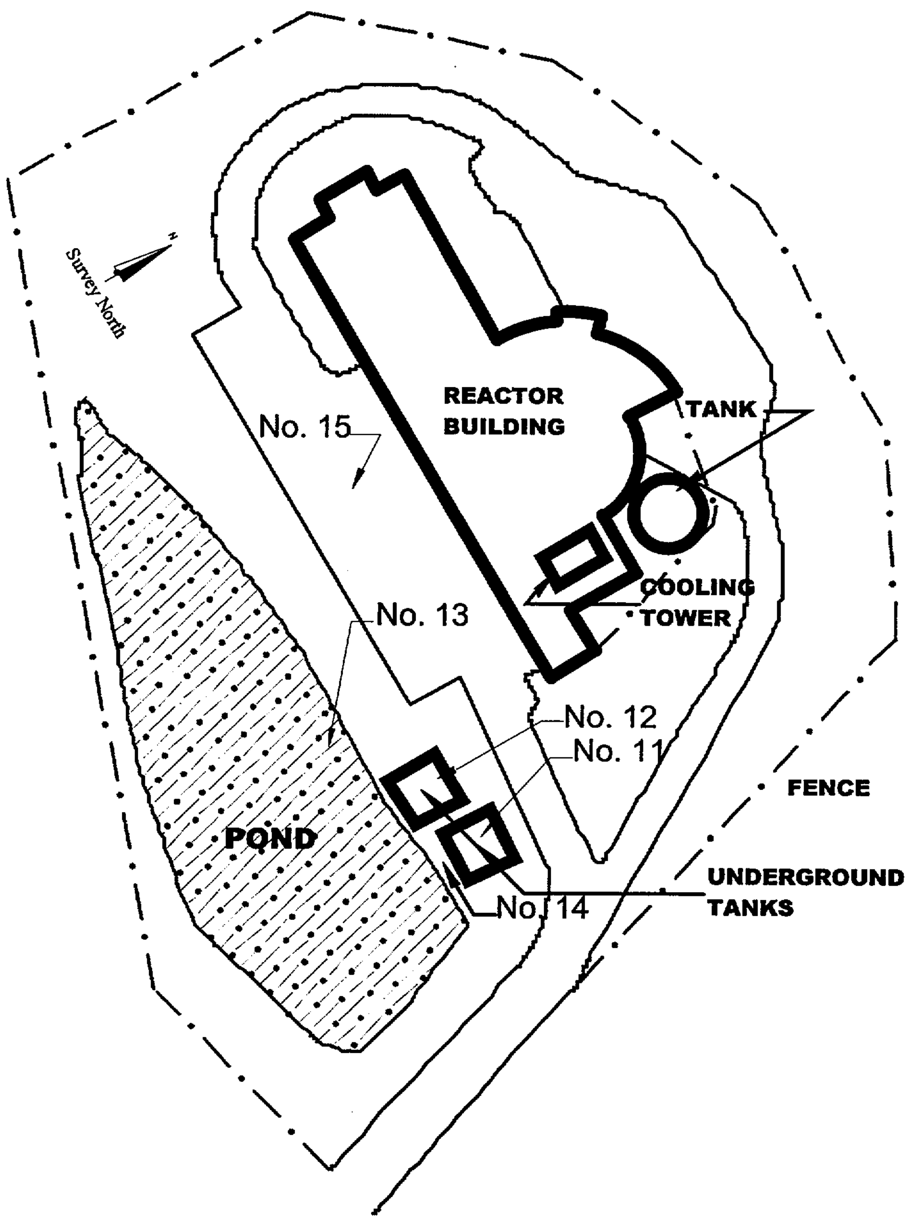


Figure A-4 UVA Reactor Facility Grounds



APPENDIX B

ENVIRONMENTAL REPORT

ENVIRONMENTAL REPORT

FOR THE
UNIVERSITY OF VIRGINIA
REACTOR DECOMMISSIONING

Prepared For
University of Virginia

Prepared By
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February 2000

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1.0 PURPOSE AND NEED FOR ACTION

The UVA Reactor Facility (UVAR) provided training for Nuclear Engineering students and various services for researchers in all departments of engineering, the Departments of Physics, Chemistry, Biology, and Medicine. As with other facilities of this nature, the UVAR is contaminated with varying amounts of radioactive material and small amounts of hazardous material. Decontamination and Decommissioning (D&D) of the UVAR will eliminate the potential for future inadvertent environmental releases. The goal of the proposed D&D activities is termination of the UVAR Nuclear Regulatory Commission (NRC) license and release of the site for "unrestricted use." The term "unrestricted use" means that there will be no future restrictions on the use of the site other than those imposed by the City of Charlottesville zoning ordinances.

2.0 FACILITY, DESCRIPTION, PROPOSED ACTIONS, ALTERNATIVES AND ADMINISTRATIVE CONTROLS

2.1 Facility Description

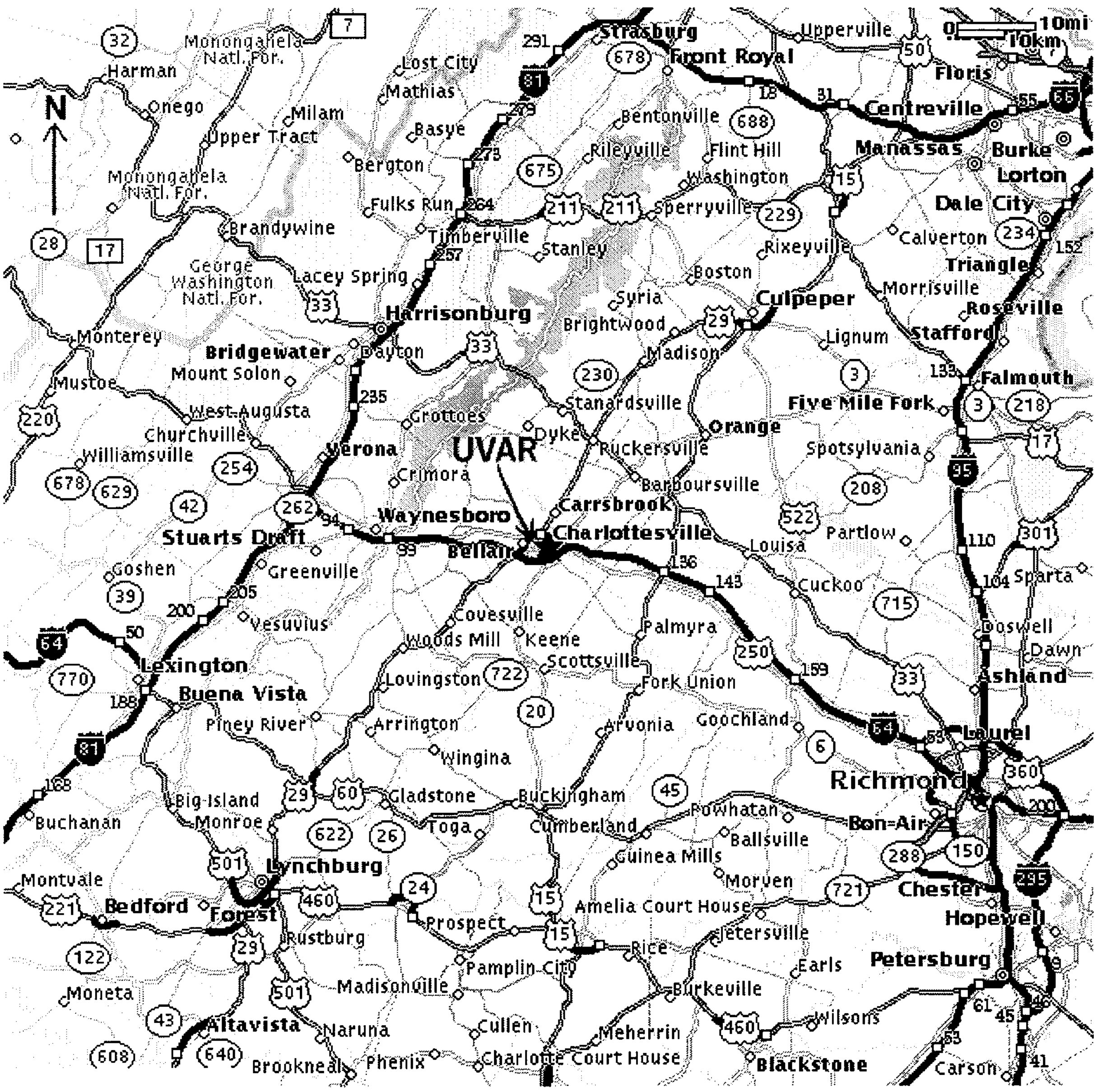
The UVAR site, (hereafter referred to as Site) is located in west central Virginia in Albemarle County (see Figure B-1). The UVAR Reactor location is in the north portion of the University of Virginia Grounds. The Grounds are situated near the town of Charlottesville, at latitude 38°E, 2'30" N, longitude 78°, 31' W and at an elevation of 700 feet (see Figures B-2 and B-3). The site is located at an abandoned reservoir 200 feet up the ridge that runs between Mt. Jefferson and Lewis Mountain, approximately two (2) miles from the downtown business district of the City of Charlottesville. The reservoir is located in a draw that begins at the top of the ridge, collecting water over a watershed area of 105 square feet. The reactor building is on the side of this draw approximately 50 feet above the water level of the pond. The Site is approximately 2.3 acres and contains the Reactor Facility building, paved roads, parking lots and the reservoir/pond (see Figure B-3). Locally, Mt. Jefferson is also known as Observatory Hill as UVA maintains an astronomy observatory on the mountain. Northeast, and south of the site, no closer than 2,000 feet, are residential districts. Approximately 3/4-mile west over the ridge are suburban developments.

The High Energy Physics Laboratory is located approximately 125 meters southeast of the Reactor Facility. The Special Materials Handling Facility lies approximately 110 meters northeast of the reactor and the National Radio Astronomy Observatory at about 250 meters. The Aerospace Research Laboratory is located approximately 90 meters to the northwest. To the east, are Slaughter Recreation Center located at approximately 190 meters and a group of dormitories at 250 meters.

The UVAR Facility (see Figures B-5 to B-7) has approximately 22,000 ft^2 of floor space consisting of the main reactor room, radiation laboratories, other supporting laboratories, machine shop, hot cell and office space. The building is surrounded by a 102,000 ft^2 of fenced yard.

The Reactor Facility houses a pool type reactor that has been variously used since 1960 to provide controlled neutron and gamma irradiation for diverse educational and laboratory research projects.

Figure B-1 Regional Location



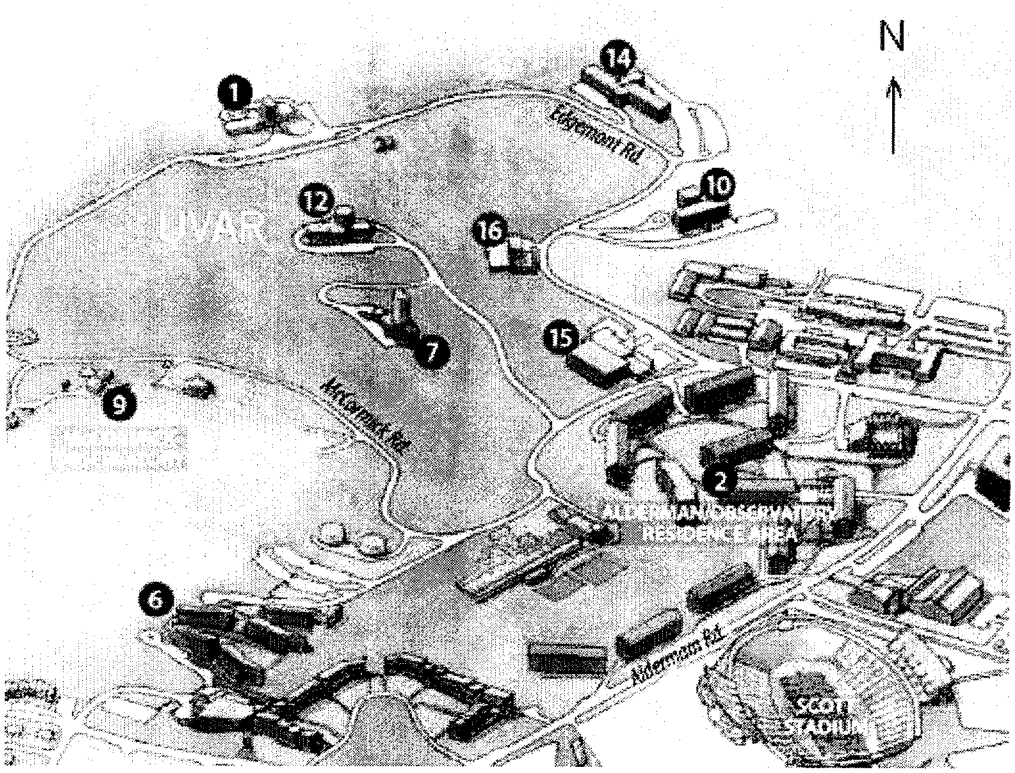


Figure B-2 Northern Grounds of the University of Virginia

Location 12:	Reactor Facility
Location 1:	Aerospace Research Laboratory
Location 2:	Alderman Observatory Residence Area
Location 6:	Hereford Residential College
Location 7:	High Energy Physics Laboratory
Location 9:	McCormick Observatory
Location 10:	National Radio Astronomy Observatory
Location 14:	Shelbourne Hall
Location 15:	Slaughter Recreation Facility
Location 16:	Special Materials Handling Facility

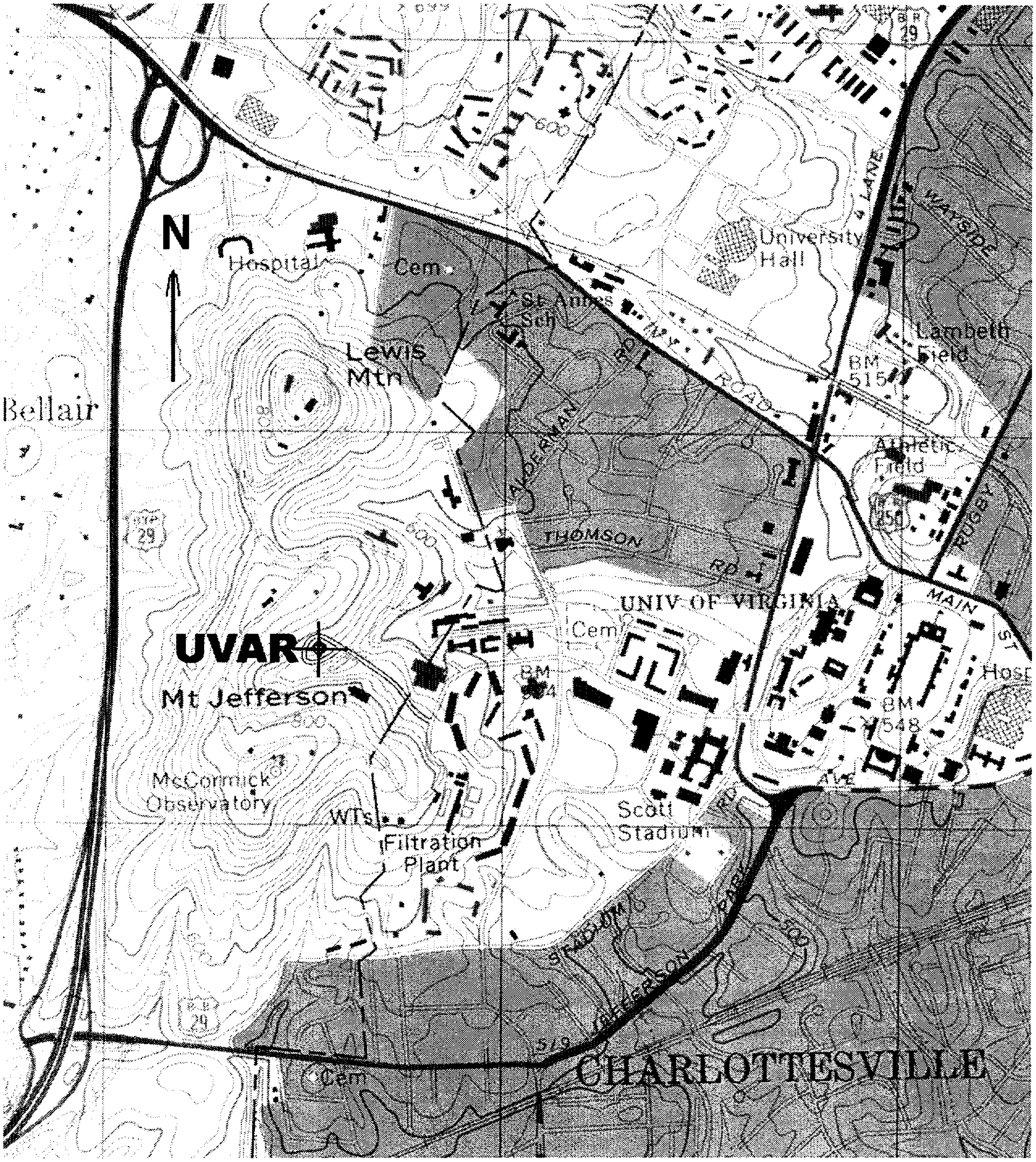


Figure B-3 Topographic Location

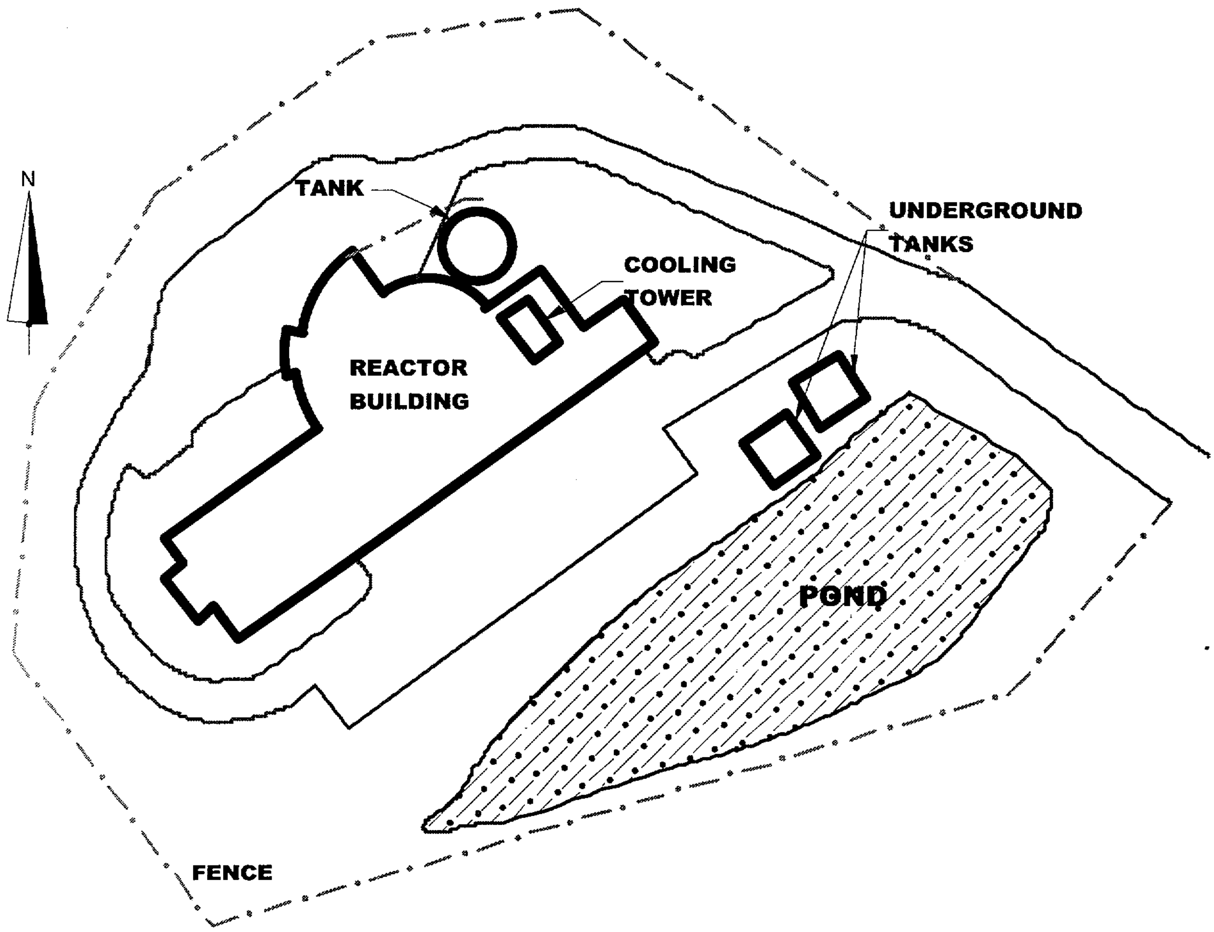


Figure B-4 University of Virginia Reactor Site

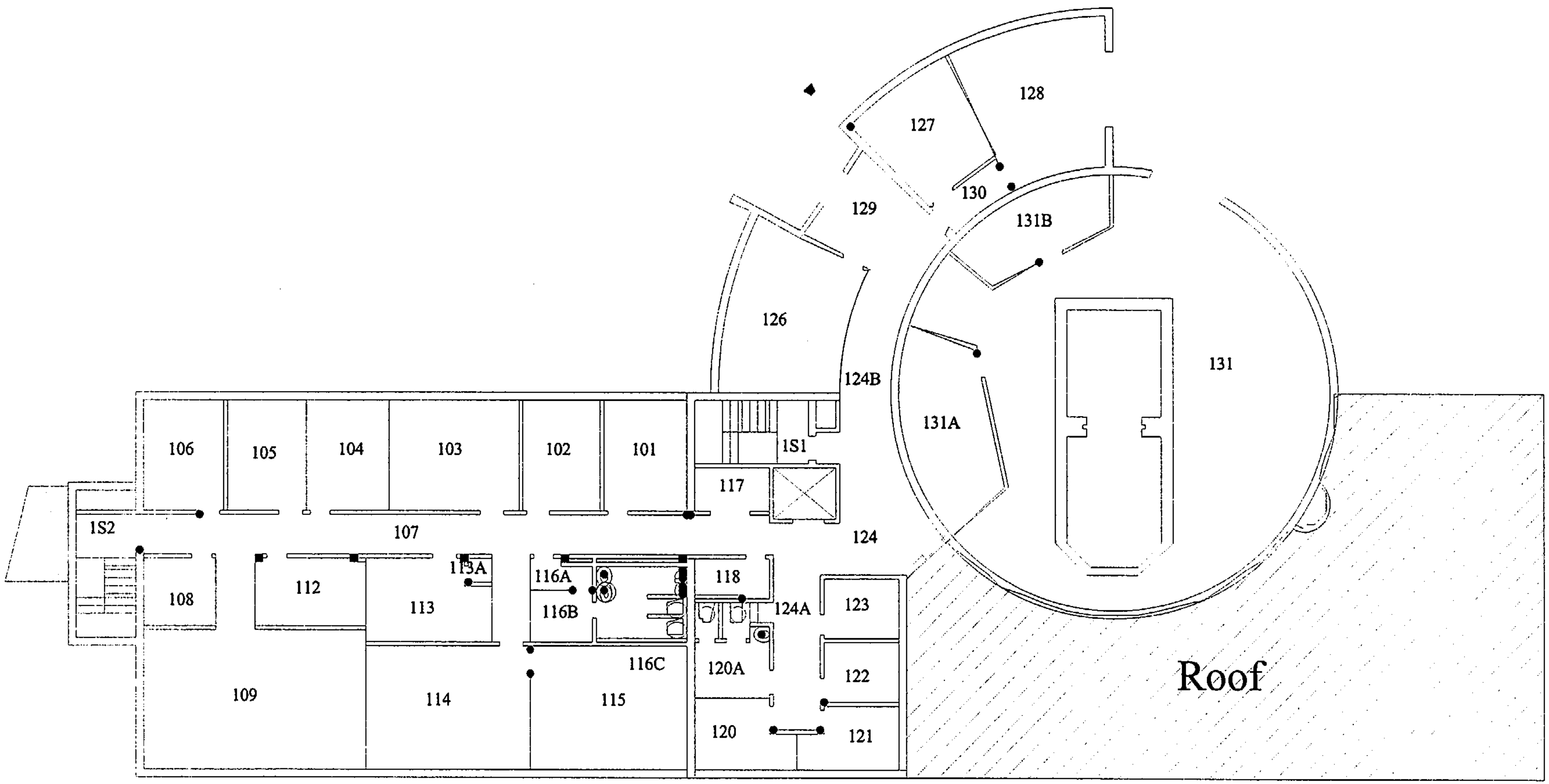


Figure B-5 UVA Reactor First Floor Plan View

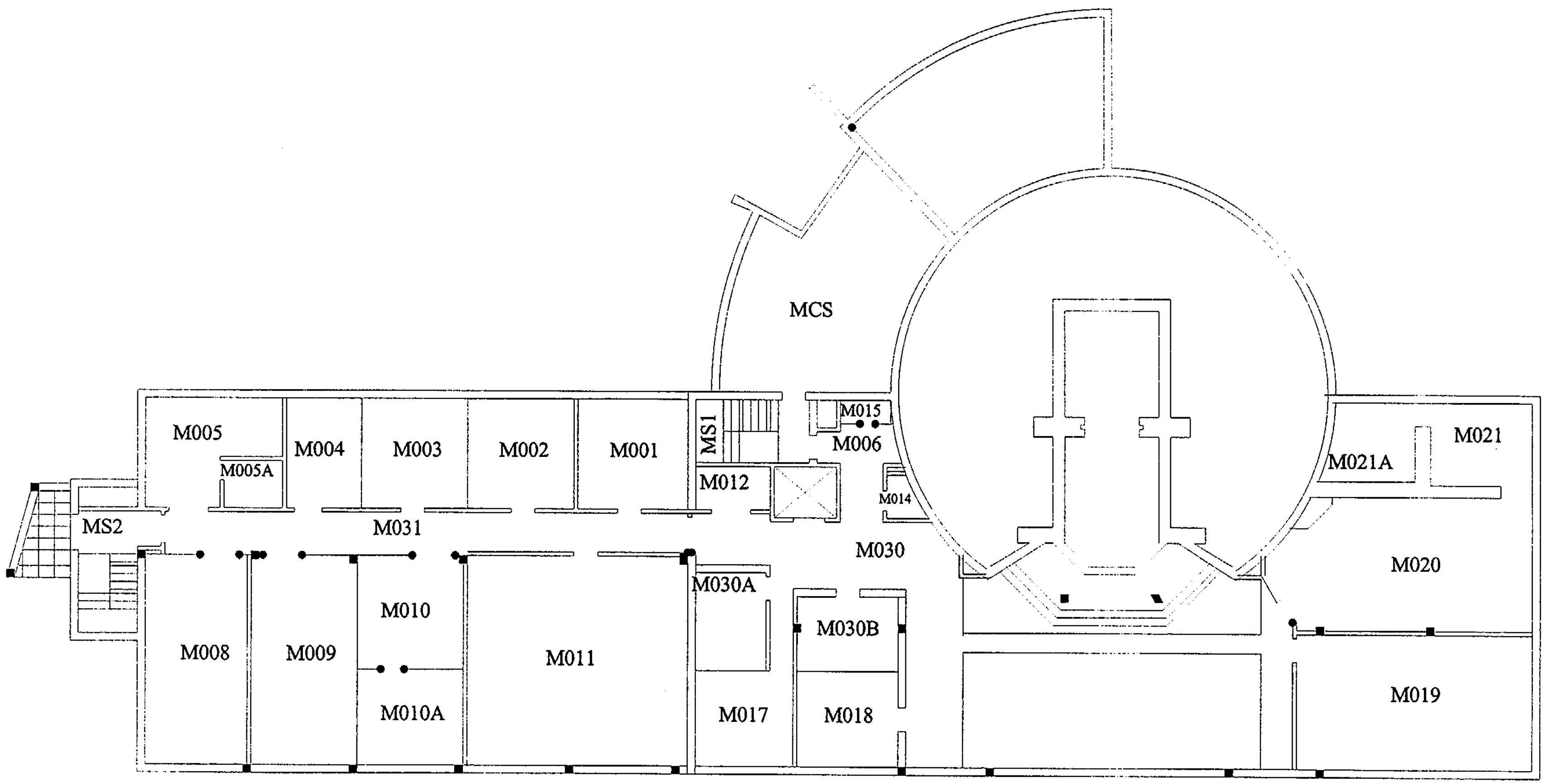


Figure B-6 UVA Reactor Mezzanine Floor Plan View

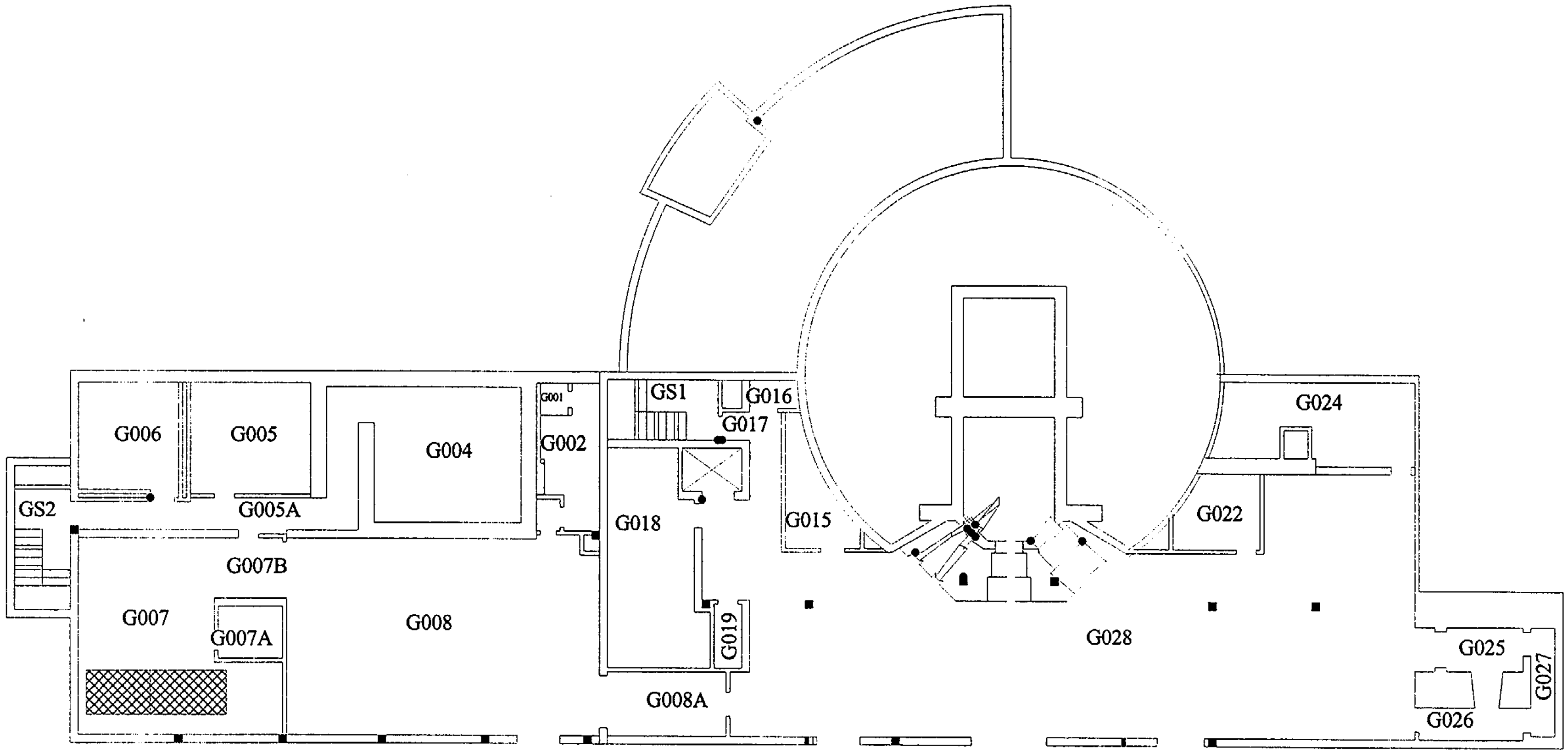


Figure B-7 UVA Reactor Ground Floor Plan View

It is anticipated that the University of Virginia will be issued a "Possession-Only-License Amendment" (POLA), Amendment No. 25 to the USNRC License No. R-66, early in the year 2000 (UVA request dated August 16, 1999, Ref. 1-2). The UVAR is presently inoperable. All spent reactor fuel elements have been removed from the reactor pool, and returned to DOE.

All UVAR building utility services required for facility operation and maintenance are active as required by current license conditions.

UVAR building air ventilation, HEPA-filtered exhaust systems, air supply compressors, and license-required radiological monitoring and instrumentation systems are in normal continuous operation.

There are manually actuated and automated fire alarm/suppression systems present in the UVAR Facility.

Existing physical security and material control and accounting plans approved by the Nuclear Regulatory Commission (as may be amended) will continue to be implemented.

The water demineralization system serving the UVAR remains fully operational.

The forced-water cooling system serving the UVAR during operation is no longer in use.

2.2 Proposed Action and Alternatives

The Proposed Action and the Alternatives are as follows:

- Proposed Action (DECON) - Decontamination and Decommissioning of the UVAR followed by UVAR license termination and subsequent release of the site for unrestricted use.

- Alternative 1 (SAFSTOR) - In safe storage, the UVAR is placed and maintained in a condition that allows it to be safely stored and subsequently decontaminated to a level permitting release of the property by the USNRC.

- Alternative 2 (ENTOMB) - In entombment, radioactive materials are encased in a structurally long-lived material such as concrete. The entombed structure is appropriately maintained and surveillance is continued until the radioactivity decays to a level permitting release of the property by the USNRC.

Implementation of the Proposed Action will involve performance of the following tasks:

2.2.1 Dismantlement, decontamination or packaging as low-level radioactive waste (LLRW) the UVAR components and pool.

2.2.2 Decontamination of any remaining contaminated areas.

2.2.3 Shipment of the LLRW generated as a result of decommissioning activities.

2.2.4 Performance of a final radiological survey and submission of a request to the USNRC for release of the subject areas for unrestricted use and termination of the UVAR license.

2.3 Administrative Controls

To minimize the risks of inadvertent exposure, contamination and/or radioactive releases, all decommissioning operations will be implemented in accordance with appropriate technical and administrative controls, including:

2.3.1 Performance of all project work pursuant to approved procedures implementing a USNRC-approved Decommissioning Plan. UVA will continue to be responsible for assuring and demonstrating compliance with USNRC licenses, as well as other applicable federal, state or local laws, regulations, licenses and/or permits.

2.3.2 Utilization of containment structures, tents and bags under negative pressure and/or appropriate contamination barriers to isolate operation areas and prevent inadvertent release of contaminants.

2.3.3 Employment of monitored, high-efficiency particulate air (HEPA) filtration systems for air ventilation in contaminated work areas.

2.3.4 Maintenance of emergency ventilation, power and supplies, as appropriate.

2.3.5 Application of ALARA principles by emphasizing radiation protection for workers and the general public, employing personnel and area dosimetry, using personal protective equipment and clothing and conducting work through approved Radiological Work Permits. The term "ALARA" means as low as is reasonably achievable, taking into account the state of technology and the economics of improvements in relation to the benefits to public health and safety, and other societal and socioeconomic considerations. UVA Health Physics staff will have the authority to stop any operations that they believe may involve unusual, unnecessary or excessive radiological risk to the worker, the public or the environment.

2.3.6 Maintenance of industrial security access control to the work site and facility to restrict unauthorized individuals from the work area.

2.3.7 Integration of UVA Quality Assurance and UVA Health and Safety requirements into Decommissioning Project documents.

3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Man-Made Environment

3.1.1 Radioactive Materials

The public is continuously exposed to radiation from natural sources, primarily from: cosmic radiation, external radiation from natural radioactive material in the earth and global fallout, and internal radiation from natural radioactive materials taken into the body via air, water, and food. The public receives and accepts the risks associated with radiation exposures from medical X-rays, nuclear medicine procedures and consumer products. On average, a member of the public in the United States receives approximately 300 mrem/yr from natural sources of radiation; approximately 50 mrem/yr from medical procedures; and approximately 10 mrem/yr from consumer products, for a total of 360 mrem/yr (Ref. 5-2). At the UVA Reactor, elevation 700 feet, the background radiation from natural sources is about 240 mrem/yr and the total background radiation is approximately 300 mrem/yr.

Residual radioactive contamination resulting from past reactor operations is contained within the UVAR Facility, which is continuously monitored through an extensive surveillance and maintenance program. Existing monitoring data, historical information, and current surveys indicate that building contamination is comprised of low levels of certain fission and activation product nuclides. Certain reactor components are also contaminated with a variety of radionuclides. This is primarily the result of deposition and adherence of airborne and water-soluble contaminants. The radionuclides listed in Table B-1 potentially exist in the UVAR Facility.

Radioactive atoms undergo spontaneous nuclear transformations and release excess energy in the form of ionizing radiation. Such transformations are referred to as radioactive decay. As a result of the radioactive decay process, one element is transformed into another; the newly formed element, called a decay product, will possess physical and chemical properties different from those of its parent, and may also be radioactive. A radioactive species of a particular element is referred to as a radionuclide or radioisotope. Radiation emitted by radioactive substances can transfer sufficient localized energy to atoms to remove electrons from the electric field of their nucleus (ionization). In living tissue this energy transfer can destroy cellular constituents and produce electrically charged molecules (i.e., free radicals). Extensive biological damage can lead to adverse health effects (Ref.5-3). The adverse biological reactions associated with ionizing radiation, and hence with radioactive materials, are skin injury, cancer, genetic mutation and birth defects (Ref. 5-4).

Table B-1 – List of Expected Radionuclides

Nuclide	Half-Life (yr)	Decay Mode	Notes
^{14}C	5730	β^-	AP; from n-activation of graphite
^{54}Mn	0.86	ε, λ	AP; short-lived specie; from n-activation of SS hardware
^{55}Fe	2.73	ε	AP; from n-activation of SS hardware
^{60}Co	5.27	β^-, λ	AP; from n-activation of SS hardware; expected to be predominant AP specie present
^{59}Ni	76000	ε, λ	AP; from n-activation of SS hardware
^{63}Ni	100	β^-	AP; from n-activation of SS hardware
^{90}Sr	29.1	β^-	FP; probable FP constituent; activity expected to be proportional to that of ^{137}Cs
^{94}Nb	20000	β^-, λ	AP; unlikely AP inventory constituent; possible from n-activation of SS hardware, <u>if</u> Nb impurities are present
^{99}Tc	213000	β^-, λ	FP, and minor AP inventory constituent; possible from n-activation of SS hardware, <u>if</u> Mo impurities are present
^{125}Sb	2.76	β^-, λ	FP; relatively short-lived specie
^{134}Cs	2.07	β^-, λ	FP; minor FP inventory constituent
^{137}Cs	30.17	β^-, λ	FP: expected to be predominant FP specie present
^{144}Ce	0.78	β^-, λ	FP; short-lived specie
^{152}Eu	13.48	$\beta^-, \beta^+, \varepsilon, \lambda$	FP, and minor AP inventory constituent; possible from n-activation of concrete, <u>if</u> Eu impurities exist in biological shield structure

Symbols/Abbreviations:
β^- = Beta
β^+ = Positron
ε = Electron Capture
λ = Gamma-Ray
AP = Activation Product
FP = Fission Product

The radionuclide half-life values and decay mode information used above are taken from Ref. 5-5.

The list of expected radionuclides provided above is based on the assumption that operations of the UVA Reactor has resulted in the neutron activation of reactor core components and other integral hardware or structural members which were situated adjacent to, or in close proximity to, the reactor core during operations. Specific items which are considered to have been exposed to neutron activation include materials composed of aluminum, steel, stainless-steel, graphite, cadmium, lead, concrete and possibly others. Based on earlier studies and experience from similar research reactor decommissioning projects, and reactor-specific calculations which considered measured values for neutron leakage fluence, integrated operating power histories, reactor core/pool structural configurations, and material composition of exposed pool structures, neutron activation of materials beyond the concrete liner/biological shield structure (i.e., into surrounding soil volumes) is <u>not</u> expected for the UVA Reactor.

Major types of ionizing radiation include alpha particles, beta, and gamma or X-ray radiation. Alpha particles expend their energy in short distances and will not usually penetrate the outer layer of skin. Alpha particles represent a significant hazard only when taken into the body, where their energy is completely absorbed by small volumes of tissues. Beta particles constitute external hazards if the radiation is within a few centimeters of exposed skin surfaces and if the beta energy is greater than 70 keV. Internally, beta particles deposit much less energy to small volumes of tissue and, consequently, inflict much less damage than alpha particles. Gamma radiation is of the most concern as an external hazard.

3.1.2 Hazardous Materials

Based on preliminary surveys and inspections of the subject work areas, the specific hazardous materials of concern in terms of potential exposure to project workers, on-site UVA employees and off-site persons are elemental lead, asbestos and cadmium.

3.1.2.1 Elemental Lead - The predominant hazardous material in the UVAR, in terms of mass, is elemental lead (used primarily in various radiation shielding applications). Most lead contained in the facility consists of solid, non-dispersible bricks, fittings, liners and weights. Lead is a cumulative poison. Increasing amounts can build up in the body eventually reaching a point where symptoms and disability occur. The effects of exposure to lead dust through inhalation and ingestion may not develop quickly. Symptoms may include decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, constipation, abdominal pains and decreased appetite. Lead can also cause irritation to the skin and eyes. These effects are reported to be reversible if exposure ceases. Systemic effects are possible if a long-term exposure occurs and birth defects have been reported.

3.1.2.2 Asbestos - Asbestos is present in UVAR construction materials (e.g., floor tiles, roofing material). Asbestos is not a hazard unless it is "friable," that is in powder or fiber form. Inhalation of the fibers can cause asbestosis and lung cancer. Gastrointestinal cancer can be caused by ingestion. Asbestos found to be present in the UVAR would be removed by a licensed asbestos abatement contractor.

3.1.2.3 Cadmium - Cadmium is present in the UVAR in small quantities in isolated locations in the form of metal foil and cast metal. Inhalation or ingestion of the cadmium dust or fumes can affect the respiratory system, kidneys, prostrate and blood. Symptoms are: pulmonary edema, dyspnea, cough, tight chest, substernal pain, headache, chills, muscular aches, nausea, diarrhea, anosmia and emphysema.

3.1.3 Transportation

The roadways in the vicinity of the UVA site are shown on Figures B-1 and B-2. The closest roads include Old Reservoir Road (where the reactor facility is located), Edgemont Road and Observatory Road, which encircles the facility. The major roads include Interstate 64 to the south, US 29 on the west and US 250 to the north. US 29 is a four to six-lane primary arterial. US 250 is a four-lane beltway and Interstate 64 is a four-lane highway.

The UVAR site is generally accessed from US 29, exiting on McCormick Road and traveling west, crossing Alderman Road turning south on Observatory Road and west on Old Reservoir Road. Traffic onto the site is through a gate across a dike. The access road circles the facility. There is paved parking on the north and south sides of the facility.

3.1.4 Cultural and Historical Resources

UVA has owned the property since 1817. It was reported that the property was originally purchased by Thomas Jefferson to supply firewood to the various buildings on the UVa Grounds at that time, most of which were heated with wood. No significant archeological or cultural resources have been found in surveys of the UVAR site. The National Register of Historic Places mentions no historical structures or sites within the boundary of the facility. No historical, archaeological or cultural properties are believed to be under consideration on or near the UVAR site.

3.1.5 Population and Land Use

As shown in Figure B-3 residential areas are found to the north, east, and south, with major business districts to the northeast and east at approximately 2,500 meters and 3,500 meters respectively. The US Census Bureau estimated the population of Charlottesville to be 40,341 in 1996. The facility has an exclusion fence as shown in Figure B-4. This fence is approximately 70 meters from the building in the unshielded direction. Within a 600 meter radius of the UVAR there are very few buildings and all of these, with the exception of approximately a dozen privately owned homes just inside this radius, are operated by the University, City of Charlottesville or Commonwealth of Virginia.

The Site is located within the UVA Grounds area. Land use areas surrounding the UVAR site include: university facilities for research and development to the south, Birdwood Golf Course and conference center and residential areas to the east, north and west across US 29. Surrounding land uses are shown graphically on Figure B-3.

The present population on University Grounds consists of 1,817 full-time faculty, 12,381 full-time undergraduate students and 5,148 full-time graduate students. Research facilities and office areas occupy the immediate vicinity of the UVAR facility.

Estimates of future growth indicate that the University could expect an increased number of students. Because of terrain and current land use, future student residential development is expected to occur beyond a 1,000-foot radius from the site.

Nearby sensitive human populations include:

- UVA non-radiological workers;
- UVA dormitories located as close as 1,200 feet to the east;
- UVA student recreation building located 900 feet to the east;
- Highway US 29 located 1,600 feet over a ridge to the west;
- University Hospital, located 1.1 miles to the east; and
- Residences, beginning at about 0.4 miles to the northeast.

3.1.6 Noise

Within UVA site boundaries, vehicular traffic, jet aircraft, general aviation aircraft and building, heating, ventilating and air conditioning equipment generate the ambient noise environment.

3.1.7 Aesthetics

The UVAR is located in a wooded area at an abandoned reservoir on a ridge that runs between Mt. Jefferson and Lewis Mountain. It is located on the western side of the UVA Grounds and is not visible from adjacent areas because of the natural terrain ridges that shield the facility for approximately 270 degrees of its circumference and the heavily wooded slopes. The UVAR is visible, however, from the Special Materials Handling Facility (SMHF) during Fall and Winter months when leaves are not present on the trees. The SMHF lies to the northeast at a 110-meter distance.

3.2 Natural Environment

3.2.1 Topology, Geology and Seismicity

3.2.1.1 Topology

Site topography is typical of Albemarle County. Hilly areas with intersecting ridges and draws between them provide for wet weather drainage. The abandoned reservoir is located in a draw that begins on the top of Mt. Jefferson. The elevation of the wooded slopes around the UVAR range from 215 meters at the lowest point, to 265 meters at the point of highest elevation. In the easterly direction, the elevation drops rapidly, so that approximately 1,200 meters from the reactor, the elevation is 150 meters.

3.2.1.2 Geology

Geologically, the Site is located on the eastern edge of the Blue Ridge Province as defined by the Virginia Division of Mines Minerals and Energy (Geologic Map of Virginia, 1993). The Site is underlain by bedrock of the Lynchburg Group. These metasedimentary rocks consists of metagraywackes, graphitic phyllites and metasandstones. Specifically, the Site is underlain by the Rockfish conglomerate which consists of metamorphosed conglomeratic sandstone that was originally deposited in a series of coalescing submarine fans and associated submarine distributary channels.

3.2.1.3 Soils

Above bedrock in this area, the in-place chemical weathering of the underlying bedrock has formed saprolitic soils. Generally, the contact between the bedrock and the saprolite is gradational and occurs at depths ranging between a few inches and forty feet below the surface. At this Site, bedrock outcrops occur along the northwest side of the site while on the southeast side of the site the soil cover is observed to vary from a few feet thick to over twenty feet thick. The saprolite retains relic structure of the underlying bedrock. Bedding planes, joints, and mineralogical changes can be observed.

According to the Albemarle County Soil Survey, the subject site contains predominantly deep, well-drained soils of the Braddock-Thurmon-Unison unit mostly found in woodland areas. More specifically, the soils are identified as Albemarle, very stoney, fine sandy loam, 25 to 45 percent slope on the northern portion of the site and Culpepper fine sandy loam, 0 to 15 percent slope on the southern portion of the site. This soil is generally found on side slopes that are about 200 to 500 feet wide, with 3 to 15 percent of the surface covered by stone. Typically, the surface layer of the soil is dark grayish to brownish yellow, fine sandy loam about 5 inches thick. The subsoil is mostly strong brown and yellowish-red clay loam about 25 inches thick. The substratum is mostly yellowish-brown, light gray and yellow sandy loam. Bedrock rock is normally located at a depth of 50 inches. Permeability and available water capacity for this soil type are considered to be moderate with medium to rapid surface runoff. Generally, the hazard of erosion is moderate to very severe.

3.2.1.4 Seismicity

According to information provided by the USGS National Earthquake Information Center Virginia is considered to be a relatively low risk for earthquakes, however, earthquakes can occur just about any place in the state (Figure 7). The Town of Manassas, 81 miles to the

3.2.1.4 Seismicity

According to information provided by the USGS National Earthquake Information Center Virginia is considered to be a relatively low risk for earthquakes, however, earthquakes can occur just about any place in the state (Figure 7). The Town of Manassas, 81 miles to the northeast of Charlottesville, was hit by a tremor in 1997, and an equivalent earthquake was felt in Culpepper, 45 miles to the northeast two months earlier. These towns are located in the Mesozoic basin.

In general, two zones in Virginia are more susceptible to earthquakes than others. Both are fault lines in which rivers occur within a segment of the fault zone. Closest to Charlottesville is the Virginia Seismic Zone that runs along the James between Richmond and Albemarle County, parallel to 1-64) (Figure 8). The other zone runs along the New River from Radford to the West Virginia border. Since 1977, there have been about 200 earthquakes in Virginia of which only about 16% are felt. Virginia is expected to experience a 5+ quake every century or so.

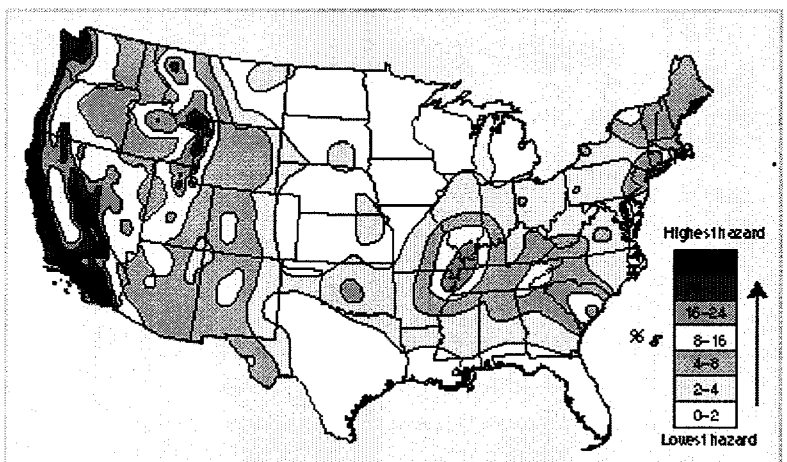


Figure B-7 Earthquake Hazard Map, From USGS

Considering the low level of earthquake activity and intensity in this area and the reinforced construction of the pool earthquake activity is not considered to present a danger to the facility.

Table B-2 presents the earthquake history of Virginia as abridged from *Earthquake Information Bulletin* by Cal A. von Hake (Ref. *5-6).*

Table B-2 – Earthquake History of Virginia

Date	Location	Effects	Magnitude
2/21/1774	much of Virginia and southward into North Carolina	many houses were moved considerably off their foundations at Petersburg and Blandford	MM VII
12/11/1811 1/23/1812 2/ 7/1812	three great earthquakes centered near New Madrid, Missouri	strongly felt in Virginia	
3/9/1828	Pennsylvania to South Carolina and the Atlantic Coastal Plain to Ohio	doors and windows rattled in Virginia	MM V
8/ 27/1833	Norfolk to Lexington and Baltimore, MD, to Raleigh, NC	at Charlottesville, Fredericksburg, Lynchburg, and Norfold, windows rattled violently, loose objects shook, and building walls were visibly agitated	MM V
4/29/1852	Virginia, Washington D.C., Baltimore, MD, Philadelphia, PA, and North Carolina	at Buckingham and Wytheville, chimneys were damaged	MM VI
8/31/1861	epicenter in extreme southwestern Virginia or western North Carolina	at Wilkesboro, North Carolina, bricks were shaken from chimneys	MM VI
12/22/1875	eastern two-thirds of Virginia and a portion of North Carolina	at Manakin, many chimneys were broken and shingles on one store were shaken off	MM VII
5/ 31/1897	epicenter was in Giles County	in Pearisburg, the walls of old brick houses were cracked and bricks were thrown from chimney tops. Springs were muddied and a few earth fissures appeared. Chimneys were shaken down at Bedford City, Houston, Pulaski, Radford, and Roanoke. Chimneys were also broken at Raleigh, North Carolina, Bristol and Knoxville, Tennessee, and Bluefied, West Virginia	MM VIII
2/5/1898	Pulaski and East Radford	Pulaski reported additional chimney damage	MM VI
2/11/1907	Arvonia, Ashby, and Buckingham	minor damage at Arvonia, Ashby, and Buckingham	MM VI
4/ 9/1918	Shenadoah Valley region	broken windows were reported at Washington, D.C.	MM VI
9/ 5/1919	strongest in the Blue Ridge Mountains south of Front Royal	plaster fell and some chimneys were damaged. Springs and streams were muddied in the epicentral area.	MM VI
12/26/1929	Charlottesville	shook bricks from a few chimneys	MM VI
4/23/1959	southwestern Virginia	several chimneys were damaged, plaster cracked, and pictures fell from walls	MM VI
7/ 27/1997	Central Virginia: Culpepper Basin		M=2.5
9/29/1997	Manassas		M=2.5

3.2.2 **Climate and Air Quality**

3.2.2.1 Climatology

The climate of Charlottesville and Albemarle County is modified continental with mild winters and mild and humid summers. Information supplied by the National Climate Data Center is based on climatic normals from 1961-1990. The mean annual average temperature is 56.4 degrees (Fahrenheit), from June through August the mean temperature is 75 degrees, and from December through February the mean temperature is 37 degrees. The mean annual rainfall average is 47.37 inches, the mean annual snowfall average 23.8 inches, and the mean annual humidity average (afternoon) is 52%.

The climate in Charlottesville and Albemarle County is influenced significantly by the Blue Ridge Mountains, some 15 miles to the west, and the Chesapeake Bay and Atlantic Ocean to the east. They act in concert to modify extremes. Winter high temperatures are usually in the upper 40's with lows in the upper 20's which is considerably warmer than areas immediately to the west at approximately the same elevation. Summers are warm and humid, with daytime temperatures averaging in the middle to upper 80's to lows in the 60's. Maximum persisting dewpoints are in the mid 70's.

3.2.2.2 Local Winds and Dispersion Data

During the first few years of operation of the UVAR, records of wind velocity and direction at the reactor site were maintained. Tables B-3 and B-4 represent the equivalent of one year of observations from 21 June 1961 to 21 June 1962. For the year, the prevailing winds were from the Northeast to Northwest quadrant with a strong contribution from the west. The summer season has a high percentage of calms with principal winds from the Southeast to Southwest quadrant. Hurricane force winds have never been reported at any local observing station.

Table B-3 – Relative Frequency of Hourly Wind Speeds in Percent by Season

Wind Speed Type	Wind Speed mph	Summer	Fall	Winter	Spring	Year
Calm	**0-1**	43.5	9.0	3.5	20.7	**18.7**
Light	**1-3**	15.3	2.0	1.4	8.1	**6.4**
Gentle	**4-10**	28.0	10.7	14.3	31.7	**20.0**
Moderate	**11-21**	11.6	33.3	61.8	37.9	**36.3**
Strong	**21 - up**	1.6	45.0	19.0	1.6	**18.6**
Total		100.0	100.0	100.0	100.0	100.0
Avg. Speed		**4.26**	**15.0**	**13.1**	**7.71**	**10.36**

Table B-4 – Relative Frequency of Hourly Wind Directions in Percent by Season

Wind Direction	Summer	Fall	Winter	Spring	Year
North	5.6	27.4	30.3	8.4	**16.9**
Northeast	7.4	10.2	28.3	24.5	**16.8**
East	5.7	0.0	2.6	0.0	**2.6**
Southeast	7.8	12.4	8.0	2.6	**8.1**
South	10.6	3.8	3.0	10.2	**7.8**
Southwest	8.5	10.3	4.6	5.0	**7.7**
West	3.8	15.9	12.5	9.2	**10.0**
Northwest	7.1	10.9	7.5	10.4	**11.4**
Calms	43.5	9.1	3.5	20.7	**18.7**
Total	100.0	100.0	100.0	100.0	100.0

3.2.2.3 Precipitation

The average annual rainfall for Charlottesville is 47.37 inches with little monthly and seasonal variation. The average monthly precipitation from 1961 through 1990 ranges from 3.15 inches in January to 4.88 inches in May.

Atmospheric moisture usually originates from either the Gulf of Mexico or the Atlantic Ocean, and contributes to a fairly regular seasonality of precipitation. During a typical summer, an average of 40 afternoon or evening thunderstorms produces a total rainfall of 14 inches. However, the storms are usually quite weak from the influence of downward motion as they cross the Blue Ridge. Winter and transitional season precipitation usually lasts longer, due to fronts. Charlottesville is far enough from the ocean that any tropical storms or hurricanes generally cause only beneficial rains.

3.2.2.4 Air Quality

Albemarle County is within the Virginia DEQ Valley Region. This region is in an "attainment area" for all measured pollutants. The county and most of Virginia is within a Class II PSD (Prevention of Significant Deterioration) area. In Class II areas, limited amounts of new emissions are allowed. There are no Class III areas and two Class I areas in Virginia: Shenandoah National Park and James River Face Wilderness.

3.2.3 Hydrology

3.2.3.1 Groundwater

Groundwater can occur in both the saprolite and the underlying bedrock under unconfined conditions. At this site, ground water occurs at depths ranging from a few inches below the surface in the ravine bottom to 50 or more feet in the upland areas. Most of the metamorphic rocks of the eastern Blue Ridge are not known as good aquifers. Drilled wells in the area generally have yields that range from two gallons per minute (gpm) to 20 gpm, with the average closer to three to five gpm with depths ranging from 75 feet to 400 feet. In some cases, bored or hand dug wells have been utilized. These shallow wells rely on groundwater produced from the highly weathered bedrock at the bedrock-saprolite gradational interface.

For the most part, the bedrock does not have appreciable primary porosity or permeability, but transports water through secondary features such as the fractures, joints, and faults. In order for a bedrock well to be good water producer, the well must intersect these fractures and joints that are capable of yielding groundwater at rates required by the end user. The typical low yield produced by wells in the Blue Ridge and Piedmont Physiographic Provinces has resulted in the development of public water supplies for larger towns and cities that are almost always reliant on surface-water sources such as the Rivanna River for the City of Charlottesville.

Recharge to the groundwater in the area occurs over broad areas as infiltration of precipitation into the saprolite. The Virginia Department of Mines, Minerals, and Energy estimates that 15% of all precipitation infiltrates as recharge to groundwater. With an average rainfall of 47 inches (station Charlottesville 2W, 1961 - 1990), 7.0 inches of rainfall is recharged to the aquifer in an average year.

The water table in the Blue Ridge Physiographic Province generally mimics the topographic surface with the water table being closer to the surface in valleys than in uplands. The resulting groundwater flow is from the upland areas to perennial streams and rivers, providing base flow when no storm water runoff is occurring. Based on the topography in the local area and information from existing wells on site, groundwater is expected to flow to the southeast discharging into the abandoned reservoir (Pond) that overflows to the northeast to an unnamed tributary of Meadowbrook Creek. Meadowbrook Creek flows east and joins with the Rivanna River east of Charlottesville.

Test borings on the UVAR site ranging from approximately 6 to 30 feet deep did not encounter groundwater except for the well bore installed on the upper slope of the pond bank. No contamination was found in a sample from this well and there is no reason to suspect that any groundwater contamination exists at the UVAR site. Further studies may be conducted if warranted during D&D activities.

3.2.3.2 Surface Water

Based on ground surface elevations and surface drainage patterns, surface run-off from the UVAR Controlled Yard Area currently flows primarily east, across paved and unpaved surfaces in the service yard to the abandoned reservoir (pond).

Floods do not represent a danger to the site as it is situated over 100 feet above the valley floor. Also, drainage downstream from the site is unrestricted. The UVAR is not located within a 100-Year Flood Zone.

The Rivanna Water and Sewer Authority supply wastewater collection services to the UVA site. Wastewater from the site is discharged through the City's sewer system to the Moores Creek Plant. Any wastewater released to the city treatment system must meet the requirements of the 10 CFR 20 limits for wastewater discharge.

3.2.4 **Biology**

3.2.4.1 Vegetation

The UVAR site is almost entirely disturbed and developed. The building, paved areas and pond cover most of the site. However, the site perimeter and areas adjacent to the site are heavily wooded. The trees range in size from seedlings to one and a half-foot in diameter mature trees. The trees are typical mixed Virginia forest species including Virginia Pine, Tulip Poplar, Red and Silver Maples, White and Red Oaks, Flowering Dogwood, and Hickory.

3.2.4.2 Regional Wetlands

Storm water run-off from the UVAR site flows into the Meadowbrook Creek that joins with the Rivanna River east of Charlottesville. There are no wetlands located on or within the vicinity of the site or within two miles along the UVAR storm water run-off path based on a review of the United States Fish and Wildlife Service Wetlands Inventory (U.S. Geological Survey Charlottesville West Quadrangle).

A review of the Federal Insurance Rate Maps- (Community Panel 510006 0220B, Dec. 16, 1980) indicated that this site is between one-half and three-quarter-mile east over the ridge from the nearest 100-year flood plain boundary.

3.2.4.3 Wildlife

The site does not support a large wildlife population because of its small size, the highly developed nature of this site, and lack of cover. The wooded area surrounding the site supports a small population of animals including migratory songbirds, geese, insects, occasional deer, groundhogs, fox, raccoons, skunks, snakes, gray squirrels, and other rodents. The area is expected to support aquatic organisms such as frogs, salamanders, turtles, newts, and insect larvae.

3.2.5 Socioeconomics and Environmental Justice

The socioeconomic environment of the UVA facility consists of a well-established, diverse, middle-income community consisting of research institutions, a large university, light industry, tourism, and residences. The setting is attractive, with the mountains and the town of Charlottesville nearby. The road system is adequate with both interstate highways and secondary roads. UVAR operations constitute a very small percentage of the area's economy.

4.0 POTENTIAL ENVIRONMENTAL CONSEQUENCES OF PROPOSED ACTION AND ALTERNATIVES

This section discusses the potential direct and cumulative effects of the proposed action on human health and the environment.

4.1 Human Health Effects

Types of exposures that could lead to human health effects considered in this report are worker and off-site exposures to hazardous chemicals or radioactive materials during routine activities or potential accidents on site, or during a transportation accident off-site (involving hazardous or radioactive waste removal). This section identifies and discusses potential hazards that may affect workers on-site or people off-site during normal or routine UVAR Decommissioning activities. Impacts of the hazards relative to human health and safety are summarized in Section 4.1.2.

4.1.1 Hazard Identification

During the site characterization and ongoing during the decommissioning, site workers will be taking readings and measurements of any contamination using direct reading instruments and sampling techniques. Hazards during this work are mostly those involving external radiation, inhalation of hazardous or radioactive materials, or dermal contact with these materials.

For the Decommissioning activities, the key hazards include external radiation, inhalation of hazardous or radioactive materials, or dermal contact with those materials during decontamination, dismantling, packaging and disposal of reactor and ancillary equipment, the UVAR structure, and contaminated soil.

Generally, the Decommissioning steps described in Section 2 of the Decommissioning Plan could involve the hazards as itemized below:

4.1.1.1 Hazards

Hazards include:

- External radiation for workers working around radioactively contaminated equipment and materials.
- Dermal contact with both radioactive and hazardous materials.
- Inhalation of any hazardous or radioactive materials.
- Possible confined spaces in tents, bags or small rooms with associated oxygen content and asphyxiant concerns.

- Heavy equipment movement dangers.

  Note: No flammables or explosive materials are expected to be present.

4.1.1.2 Controls -- For workers, project procedures and conformance with UVA licenses and regulatory requirements including but not limited to:

- Radiological Work Permits and Hazardous Work Authorization procedures, as required;
- 29 CFR 1910.120 requirements for PPE, air monitoring, work zone controls, medical surveillance and bio-assay program, personnel training, emergency response, and health and safety plan;
- personal dosimetry per 10 CFR 20;
- confined space entry procedures per 29 CFR 1910.146;
- HEPA filter removal of contaminants;
- Dust filter removal of contaminants.

4.1.2 Potential Exposures

The collective dose equivalent estimate to workers for the entire Decommissioning project is about 4 person-rem. The decommissioning tasks will take approximately 12 months. Total person hours involving radiological exposure is estimated to be 6,000 hours.

The potential exposures to the public as a result of decommissioning activities and radioactive waste shipments are estimated to be negligible. This is consistent with the estimate given for the "reference research reactor" in the "*Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*" (NUREG-0586) (Ref. 5-7). The estimated dose to the public during decommissioning (DECON) and truck transport transportation of radioactive waste from the "reference research reactor" as given in the Final Generic Impact Statement is "negligible (less than 0.1 person-rem)."

The anticipated potential exposures to the public after license termination are also negligible. The site will have been released to unrestricted use, with all areas having been remediated to levels not to exceed those given in the *Supplemental Information on the Implementation of the*

Final Rule on Radiological Criteria for License Termination, the Federal Register (63 FR 64132, 11/18/98) (Ref. 5-8) and the 25 mR/yr unrestricted release dose limit in 10 CFR 20.1402 *Radiological Criteria for Unrestricted Use* (Ref. 5-9).

4.1.3 Transportation

The primary project impacts to the environment due to transportation could occur when shipments of waste travel from the site. Transportation would be conducted in accordance with applicable USDOT, USEPA, and USNRC regulations. During such transport, hazardous and radioactive materials would be effectively packaged to prevent significant radiation external to the truck. Thus, the primary impacts are accident risk and emissions/noise from the trucks themselves.

There are several alternative truck routes into or from the UVAR property but they all connect to Interstate 64 as the entry to the interstate freeway system. The shortest route to Interstate 64 is to proceed east on Old Reservoir Road, turn north on Observatory Road, turn east on McCormick Road, turn south on Alderman Road (which becomes Maury Avenue), turn west on Fontaine Avenue (US 29 Business), turn south onto the US 29 freeway and finally east or west onto Interstate 64. The entire route from the UVAR Interstate 64 covers a distance of about 2-miles.

Truck shipments of concern consist of hazardous waste and radioactive waste leaving the site. During UVAR Decommissioning activities, short-term transportation effects would include employee and contractor trips, which occur under existing conditions and less than 6 truck trips for hazardous and radiological waste transfer. Traffic, circulation and parking effects are expected to be minor due to the small increase in onsite personnel and trips, and the short duration of this action and would not significantly impact the surrounding roadways.

4.2 Waste Disposal

4.2.1 Hazardous Waste

Small amounts of solid and liquid hazardous waste from UVAR Decommissioning activities would be accumulated in satellite accumulation areas. After accumulation for up to 90 days, a licensed contractor would transfer the waste to authorized off-site commercial treatment and disposal facilities or recyclers. The Hazardous Only waste will be included as part of the regular shipments made by UVA's contractor.

4.2.2 Low-Level Radioactive and Mixed Waste

Low-level radioactive waste, including any contaminated soil, would be packaged in accordance with waste processor or disposal site Waste Acceptance Criteria. Liquid waste is filtered or solidified and solid waste is compacted, whenever possible, in accordance with the appropriate regulations prior to disposal. The waste for disposal would be shipped to either the Barnwell, South Carolina or the Envirocare of Utah disposal sites. The waste to be processed prior to disposal would be shipped to a licensed waste processor.

Low-level radioactive waste generated during the UVAR Decommissioning are expected to consist of two (2) shipments (approximately 220 ft^3) of irradiated hardware requiring a Type B shipping cask, four (4) truck shipments (approximately 2,700 ft^3) of "strong tight" containers to a waste processing facility, and nine (9) truck shipments (approximately 9,700 ft^3) of "strong tight" containers to the Envirocare of Utah disposal facility.

Mixed Waste generated during the UVAR Decommissioning is expected to consist primarily of activated/contaminated lead and cadmium. The estimated volume of activated/contaminated lead and cadmium are 43 cubic feet of lead and 1 cubic foot of cadmium. Disposal of these wastes was included in the waste shipments above.

4.2.3 Non-Hazardous Solid Waste

UVAR Decommissioning activities will generate uncontaminated construction debris that would be sent to a local sanitary landfill.

4.3 Noise

During UVAR Decommissioning activities, noise will be generated indoors by equipment such as jackhammers, scabblers and concrete saws. Backhoes and other heavy equipment could also be used for outdoor remediation activities.

On-site workers will be outfitted with ear protection devices as required by the project health and safety plan. The closest off-site residential area northeast across Alderman Road is approximately 0.4 miles away. Noise from UVAR Decommissioning activities would not impact employees or off-site residences.

4.4 Seismicity

UVAR Decommissioning activities would involve the removal of surface contamination but not structural dismantlement activities. If structural dismantlement activities are added at a later date any dismantlement plans and specifications would be reviewed by a structural engineer to assure that activities would not render the UVAR building structurally unsafe, should an earthquake occur. Decommissioning activities would not increase the risk to UVAR workers during a seismic event.

4.5 Air Quality

Several Decommissioning related activities could minimally impact air quality due to both mobile and stationary source emissions. A small increase in the amount of mobile source emissions such as carbon monoxide and nitrogen oxides could be released from contractor's trucks and cars. Due to the temporary nature and small number of truck trips, mobile source emissions would be low.

Stationary source emissions that could occur during decontamination and solid remediation are expected to be negligible. Any releases from decontamination would occur within the UVAR. Hazardous materials would be located inside the building. Standard asbestos abatement procedures implemented by a contractor licensed by the Commonwealth of Virginia will be used to remove any asbestos.

Site workers would be protected during decontamination and soil excavation activities through air monitoring and the use of PPE and respirators when required.

The proposed action would only be a temporary potential source of air emissions. Negligible amounts of mobile sources, stationary sources, and soil remediation emissions would be produced and would not affect regional attainment standards.

4.6 Regulatory Issues

Table B-8 discusses the applicability of various state and federal regulations for the proposed action.

Table B-5 Applicability of Environmental Statutes and Regulations

Statute/Regulation	Evaluation	Applicability
National Environmental Policy Act (NEPA)	The evaluation for potential environmental impacts are contained in the document	Yes
Endangered Species Act	No critical habitats exist in the affected area, and no adverse impacts to threatened or endangered species are expected to result form the proposed action	No
Floodplain/Wetlands Regulations	The proposed action is not located within a wetland or in a floodplain.	No
Fish and Wildlife Coordination Act	The proposed action does not modify or impact fish and wildlife in any way or modify any bodies of water more than 10 acres in surface area.	No
Farmland Protection Policy Act	The proposed action does not affect prime or unique farmlands.	No
National Historic Preservation Act	There are no historical sites or areas in the location of the proposed action.	No
American Indian Religious Freedom Act	The proposed action does not interfere with the right of Native Americans to exercise their traditional freedom.	No
Wild and Scenic Rivers Act	The proposed action does not involve waterways designated as wild and scenic rivers.	No
Resource and Conservation Recovery Act (RCRA)	The proposed action may include the generation, packaging and transportation of mixed waste.	Yes
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	Any required release reporting would be performed in compliance with CERCLA requirements.	Yes
Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)	The proposed action is not involved in the distribution, use or disposal of any insecticides, fungicides or rodenticides.	No
Toxic Substance Control Act (TSCA)	Asbestos may be encountered during D&D operations that would be properly packaged and disposed of in accordance with TSCA.	Yes
Clean Air Act (CAA)	Asbestos may be encountered during the project that will be contained in enclosed spaces, properly packaged and disposed of.	No
Clean Water Act and Safe Drinking Water Act	The proposed action is not expected to affect surface water bodies or water supplies. Air emissions would be below warning levels.	No
Noise Control Act	Noise levels that could adversely affect workers and staff will be mitigated by providing ear protection for workers and relocation of staff to areas away from the activities. No impact to the public is expected from the noise.	No
Hazardous Materials Transportation Act (HMTA)	The proposed action will require shipment of radioactive materials and mixed wastes. All waste will be packaged and shipped in appropriate containers and disposed of at licensed facilities.	Yes
National Emissions Standards for Hazardous Air Pollutants (NESHAPS)	The EPA has stated that NESHAPS are applicable to NRC licensed facilities. Compliance with emission standard would be demonstrated.	Yes
Atomic Energy Act	License required. Compliance with environmental and worker protection standard.	Yes
Virginia Department of Environmental Quality (DEQ)	Proposed action does not trigger discretionary review by a state agency	No
Virginia Department of Labor and Industry, Title 40.1- Labor and Employment	Proposed action must comply with worker safety regulations.	Yes
Virginia Waste Management Act	Transportation of hazardous and low-level waste would require notification, permit and manifest.	Yes

4.7 Areas Not Affected

The proposed action would not affect the following areas:

Population and Land Use - The proposed action would increase the compatibility of the site with other science research activities on-going at UVA. Future use of the UVAR site is expected to result in the addition of students and professors at UVA.

Cultural Resources - There are no cultural resources on the UVAR site.

Aesthetics - The proposed action would only be visible in the immediate vicinity of the UVAR. The UVAR is not visible from adjacent buildings except for the Special Materials Handling Facility when the leaves are off the trees. Temporary Decommissioning activities will be compatible with continuing development of the surrounding areas.

Biology - There are no known sensitive or endangered species on the UVAR site.

Hydrology - The site elevation is over 100 feet above the main area terrain. It is not in a wetland, nor is it in a 100-year flood plain.

4.8 Cumulative Effects

No significant cumulative effects are expected from the proposed action, as discussed below:

Human Health - The total dose estimated for decommissioning workers is 4 person-rem for the entire project evolution. This estimate will be achieved by utilizing ALARA practices including planning of work activities, utilization of engineered safeguards, and minimization of exposure times. The decommissioning will be conducted under a Radiation Work Permit system using written procedures to ensure proper planning, training, and evaluation of potential risks. It should be noted that a total dose of 4 person-rem is consistent with collective exposures reported in Figure 17 of *Decommissioning Techniques for Research Reactors* (Ref 5-10). This figure reported collective exposures during research reactor decommissioning relative to reactor power. These collective exposures ranged from 3 person-rem to 15 person-rem for reactor power ranging from 1 to 3 MW. The average was about 3 person-rem and is less than the 4 person-rem anticipated for the 2 MW UVAR reactor decommissioning.

The doses to members of the general public, as a result of decommissioning activities described in the UVAR Decommissioning Plan, are expected to be negligible. The dominant internal exposure pathway for members of the public is inhalation. The dose to the public is estimated to be negligible as access to the area surrounding the facility is restricted and decontamination activities with potential for airborne activity will be conducted utilizing engineered safeguards such as HEPA equipped enclosures. In addition, temporary barriers with a HEPA filter system will be utilized during activities that have the potential to generate airborne radioactivity.

Potential airborne radioactivity should be negligible, resulting in a negligible potential internal dose to the general public.

The estimate of negligible dose to members of the public can also be obtained from the estimate given for the reference research reactor in the *Final Generic Environmental Impact Statement on Decommissioning Nuclear Facilities* (NUREG-0586) (Ref. 5-7). In Section 7.3.1 of NUREG-0586, the dose to the public as a result of decommissioning operations at the reference research reactor - including truck transportation of radioactive waste - is "estimated to be negligible (less than 0.1 person-rem)." This estimate of less than 0.1 person-rem includes both internal (from inhalation and ingestion) and external exposure doses.

Waste Generation – The proposed action could generate approximately 12,000 cubic feet of low-level radioactive waste. The waste requiring disposal would be shipped to either the Barnwell, South Carolina or the Envirocare of Utah disposal site. Both waste sites have sufficient capacity to receive the waste. The waste to be processed prior to disposal would be shipped to a licensed waste processor.

Cultural Resources - No cultural resources would be impacted by the proposed action.

Population and Land Use - Only temporary employment for a few contractors would be provided by the proposed action. No increase in population would occur. Land use would not change.

Noise - UVAR Decommissioning activities would occur in a non-residential area and would largely occur within the UVAR Building. The proposed action would not contribute significantly to off-site background noise levels due to the relative isolation of the work site.

Aesthetics - UVAR Decommissioning activities would not be visible to adjacent site neighbors, with the exception of the Special Materials Handling Facility when the leaves are off the trees. Following release to unrestricted use, the UVAR site would be used in a manner consistent with the existing UVA site land use practices.

Traffic - The temporary contractor and waste transport trips would result in an insignificant increase in the average number of daily trips designed for the local roads.

Geology, Soils, Seismicity and Hydrology - All UVAR decommissioning activities would be localized; storm water runoff from exposed areas considered to be radiologically contaminated would be contained and tested.

Regional Air Quality - Albemarle County is within the Virginia DEQ Valley Region. This region is in an "attainment area" for all measured pollutants. The proposed decommissioning action is temporary in nature. A small number of vehicle trips would be generated during off-site shipment of waste materials and would contribute only negligible amounts of these pollutants to the region.

Hydrology - No changes to any landforms would occur and no radioactive or hazardous materials would be released to storm water run-off as a result of the proposed action.

Biological Resources - No biological resources have been identified on the UVAR site; moreover, UVAR decommissioning activities are not expected to affect off-site biological resources.

4.9 Alternatives to Proposed Action

Alternative 1 to Proposed Action - Safe Storage (SAFSTOR)

This alternative poses essentially the same potential risks and environmental impacts as the proposed project, but for a potentially, much greater time period. This alternative would necessitate continued surveillance and maintenance of the UVAR over a substantial time period. During this period, the risk of environmental contamination would continue to exist. Moreover, development of the land around the UVAR site over the next few years may increase the local population density and increase potential for public exposure. This alternative is not environmentally preferable.

Alternative 2 to Proposed Action - Entombment (ENTOMB)

This alternative would necessitate continued surveillance and maintenance of the UVAR over a substantial time period. During this period, the risk of environmental contamination would continue to exist. Moreover, development of the land around the UVAR site over the next few years may significantly increase the local population density and increase potential for public exposure. This alternative is not environmentally preferable.

5.0 REFERENCES

5-1 Amendment No. 25 to Facility License No. R-66 (UVA Reactor) - University of Virginia for "Possession-Only-License" (POL), Anticipated issue in early year 2000 by the USNRC, UVA request dated August 16, 1999

5-2 National Council on Radiation Protection and Measurements (NCRP). Ionizing Radiation Exposure of the Population of the United States. Report No. 93. 1987.

5-3 U.S. EPA. "Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A)." Office of Emergency and Remedial Response, U.S. EPA, Washington D.C. 1989.

5-4 U.S. EPA. "Risk Assessment Methodology Draft Environmental Impact Statement for Proposed NESHAPS for Radionuclides." Vol. 1. U.S. Environmental Protection Agency, Office of Radiation Programs. Washington D.C.

5-5 *Nuclides and Isotopes, Chart of Nuclides; 14th Edition*, Nuclear Energy Operations, General Electric Company, San Jose, CA; 1989.

5-6 *Earthquake Information Bulletin*, Volume 9, Number 6, November - December 1977, by Cal A. von Hake.

5-7 US NRC, NUREG-0586, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, August 1988.

5-8 10 CFR 20.1402 *Radiological Criteria for Unrestricted Use*

5-9 NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*

5-10 *Decommissioning Techniques for Research Reactors*, Vienna, International Atomic Energy Agency, 1994, (Technical reports series ISSN 0074-1914; 373)