AEROTEST OPERATIONS, INC.
3455 FOSTORIA WAY • SAN RAMON, CA 94583 • (925) 866-1212 • FAX (925) 866-1716

July 20, 2021

AEROTEST RADIOGRAPHY AND RESEARCH REACTOR
DOCKET NO. 50-228/LICENSE NO. R-98.

ATTENTION: Document Control Desk
U.S. Nuclear Regulatory Commission
White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Subject: AO Decommissioning Plan Submittal.

Ladies and Gentlemen:

The attached document entitled "Decommissioning Plan for the Aerotest Radiography and Research Reactor " fulfils Aerotest Operations' obligation to submit ARRR's decommissioning plan on or before July 31, 2021, as stated in AO letter dated November 18, 2020 (ML20332A032). Should you have any questions or require additional information regarding this submission, please contact AO President David M. Slaughter, Ph.D. at (801) 631 5919 or dmsraven@gmail.com.

I declare under penalty of perjury that the statements above are correct and truthful.

Sincerely yours,

David M. Slaughter, Ph.D.
President, Reactor Administrator, Manager
Aerotest Operations, Inc.

Enclosure: ARRR Decommissioning Plan

AEROTEST OPERATIONS, INC.
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7/20/2021

Decommissioning Plan for the Aerotest Radiography and Research Reactor

San Ramon, California

CS-HP-PR-007

Approved By:

Aerotest Operations President

Table of Contents

LIST OF FIGURES

LIST OF TABLES

1.0 ACRONYMS AND ABBREVIATIONS

°	Degrees
°F	Degrees Fahrenheit
Aerotest	Aerotest Operations, Inc.
AGN	Aerojet-General Nucleonics, a division of General Tire
AGNIR	Aerojet-General Nucleonics Industrial Reactor
ARRR	Aerotest Radiography and Research Reactor
CA	State of California
Ci	Curies
cm	Centimeter
cm^2	Centimeter Squared
Co	Cobalt
COC	Contaminants of Concern
D&D	Deactivating and Decommissioning
DCGL	Derived Concentration Guideline Level
DOE	U.S. Department of Energy
DOT	Department of Transportation
dps	Disintegrations per minute. It is the number of atoms in a given quantity of radioactive material that decay in one second.
EPA	Environmental Protection Agency
FSS	Final Status Survey
FSSP	Final Status Survey Plan
GPS	Global Positioning System
HSA	Historical Site Assessment
L	Liter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mCi	MilliCuries
mR/hr	MilliRoentgen per hour
mrem	Millirem one thousandth of a rem
mSv	Millisievert. One thousandth of a Sievert. Sievert is the SI unit of dose equivalent (the biological effect of ionizing radiation), equal to an effective dose of a joule of energy per kilogram of recipient mass.
NRC	U.S. Nuclear Regulatory Commission
OSHA	Occupational Health and Safety Administration
pCi	PicoCuries

pCi/g	PicoCuries per gram
pCi/L	PicoCuries per Liter
rem	the dosage in rads that will cause the same amount of biological injury as one rad of X rays or gamma rays
RHB	California Radiologic Health Branch of California Department of Health
ROC	Radionuclide(s) of Concern
SAFSTOR	A method of decommissioning in which a nuclear facility is placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.
TRIGA	Training, Research, Isotope, General Atomic reactor
TS	Technical Specification
USNRC	U.S. Nuclear Regulatory Commission

2.0 EXECUTIVE SUMMARY

Aerotest Operations performed a cost estimate for decommissioning the Aerotest Radiography and Research Reactor located in San Ramon, California.

This cost estimate was developed using a systematic approach. Decommissioning criteria were identified and survey data were reviewed. Specific and general information regarding equipment and structures was used in determining decontamination and demolition methodologies in order to minimize overall decommissioning costs.

This estimate includes itemized costs for manpower and equipment resources, radioactive waste volume reduction, packaging, shipping and burial activities, the performance of final status surveys for buildings and structures. The estimated decommissioning cost is $ 2,879,276 in terms of 2021 dollars. This estimate **does not** include the costs associated with fuel removal and transport from ARRR to the Department of Energy (DOE). However, ARRR has a DOE contract amendment that establishes the fee for the disposal of the spent nuclear fuel generated by ARRR (U.S. Department of Energy Contract Amendment to DE-CR01-83NE44484).

A significant portion of the overall decommissioning costs is attributed to the disposal of radioactive waste. The radioactive waste disposal rate used for most of the waste in this estimate was based on shipping to the disposal site at Clive Utah.

3.0 SUMMARY OF THE PLAN

3.1 INTRODUCTION

3.1.1 Overview

Aerotest Operations has provided Neutron Radiographic (N-Ray) Inspection Services since 1969 using the Aerotest Radiography and Research Reactor (ARRR) for the neutron source.

Aerotest Operations, Inc., (Aerotest) is the holder of Facility Operating License No. R-98 which authorizes the possession, use and operation of the Aerotest Radiography and Research Reactor (ARRR) located in San Ramon, California. Aerotest is a wholly owned subsidiary of Nuclear Labyrinth, LLC a Utah based company.

Aerotest plans to proceed with its decommissioning and the termination of the associated reactor license after fuel removal from site. After fuel removal Aerotest will file the appropriate decommissioning amendment requests together with this decommissioning plan with the NRC. As with other facilities of this nature, the ARRR Facility is contaminated with varying amounts of radioactive material and small amounts of hazardous material. The characterization study (Ref. 3-1) indicates that practices employed by Aerotest to minimize the spread of contamination were effective and contamination is relatively modest. Decontamination and Decommissioning (D&D) of the ARRR will eliminate the potential for future inadvertent environmental releases.

The goal of the proposed D&D activities is termination of the ARRR TRIGA Reactor Nuclear Regulatory Commission (NRC) License R-80, Docket No. 50-228 and release of the reactor portions of the ARRR 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 San Ramon zoning ordinances.

ARRR also maintains radioactive materials license number 2010-07 with the State of California. This license governs possession and use of several radioactive materials independent of the reactor. The State of California, as an Agreement State, has regulatory authority and responsibility for these radioactive materials. The state is the primary authority responsible for decommissioning the Site with respect to these materials. In addition, the State of California is authorized to implement RCRA corrective action requirements, and through this means the state can implement more restrictive cleanup requirements for the ARRR decommissioning than required by the NRC. The State rules for termination of a radioactive materials license are provided in Title 17 California Code of Regulations, Division 1, Chapter 5, Subchapter 4, Section 30256.

Currently there is no dose based release criteria in California and there is a case by case evaluation of decommissioning plans performed by the California Department of Public Health (CDPH). Experience indicates that release limits that equate to a few mrem/yr are accepted.

The decommissioning is projected to start within a year, but not be completed until fuel is removed from the site.

The decommissioning scenario to be implemented will depend on the status of fuel storage. If on-site wet fuel storage, then the water circulation and cleanup systems would remain functional. If dry fuel storage is implemented, then the water circulation system can be removed. In both of these cases, the site would still be licensed until after fuel removal when the final site decontamination, survey and license termination could take place. Remediation and removal of clean and contaminated materials, equipment and systems could proceed prior to fuel removal. It is anticipated that as much decommissioning as possible would take place prior to fuel removal.

The regional location of the ARRR is shown in Figure 3-1 and Figure 3-2 depicts the ARRR site and adjacent structures; Figure 3-3 shows an aerial image of the facility and Figure 3-4 presents a general arrangement plan of the ARRR Facility. 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. 3-1) and includes portions of the additional guidance from NUREG–1757, *Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees* (Ref. 3-3). A summary profile for the ARRR TRIGA is provided in Table 3-1.

3.1.2 Decommissioning Plan Provisions

This Decommissioning Plan provides the following:

- A description of the present radiological condition of the ARRR Facility and site environs.
- A description of planned ARRR Facility radiological conditions and facility configuration during a SAFSTOR period.
- A description of the planned approach to be employed to decommission the ARRR Facility.

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- Descriptions of the methods that will be utilized to ensure protection of the health and safety of the personnel and to protect the environment and the public from radiological hazards associated with ARRR Facility SAFSTOR and Decommissioning Project activities.
- A description of ARRR Facility physical security and material accountability controls that will be in place during the various phases of SAFSTOR and Decommissioning Project activities.
- A description of fuel management and ultimate disposition.
- A description of radioactive waste management and disposal.
- A cost estimate for decommissioning the ARRR Facility and the source of funding for these activities.
- A schedule for the ARRR Facility Decommissioning Project.
- A description of the quality assurance program applicable to the ARRR Facility Decommissioning Project.
- A description of the training program to be established for personnel performing work in support of the ARRR Facility Decommissioning Project.
- An Environmental Report concerning the expected impact of performing the activities involved in the ARRR Facility Decommissioning Project.

3.2 BACKGROUND

Site and Facility History

The property, on which the ARRR is situated, was designated for construction in 1963. The ARRR was constructed between 1963 and 1964. The land area is well defined, as there is fence around the facility except for a well-defined facility parking lot. The Reactor Building footprint is about 3,200 square feet and has two floor levels, and the total footprint for all buildings is 9,250 square feet. A layout of the ARRR buildings was provided in Figure 3-4, Figure 3-5 provides a plan view of the high bay reactor building and Figure 3-6 provides a cross section view of the Reactor Building.

The areas listed in this section of the ARRR decommissioning plan included all rooms in all buildings whether remediation could be required or not based upon the characterization study survey performed.

Table 3-2 summarizes the results of the characterization survey and identifies areas containing residual activity. The characterization survey report should be reviewed in detail when planning for the scope of remediation in each area.

TRIGA Reactor

In 1963 Aerotest began construction of a facility to house the TRIGA 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 TRIGA Reactor was brought to initial criticality in July of 1964. The TRIGA was routinely operational from that date until October 15, 2010. Aerotest amended the license that placed the reactor in a Possession-Only Status.

Current Facility Status

The TRIGA Reactor was placed in "Possession-Only-Status" (POS), through an amendment to the USNRC License No. R-98, in 2021. The following conditions are anticipated for POS status:

- ARRR utility services required for facility operation and maintenance under POS status conditions will remain active.
- Manually actuated and automated fire alarm systems in the ARRR will remain operational.
- All building utility services required for facility operation and maintenance are active.
- The license-required radiological monitoring and instrumentation systems remain operational.
- Existing physical security plan will continue to be implemented.
- The water demineralization system serving the ARRR is currently operational although the status may change as allowed in the amended license.

3.2.1 Reactor Decommissioning Overview

Prior to implementing the decommissioning actions described herein, the ARRR will have been cleared of all extraneous fixtures, equipment and materials. The facilities will have been decontaminated to meet the site criteria for unrestricted access, radioactive waste will have been removed from site and secondary support systems outside the reactor building that are no longer needed will have been removed. The facility will be placed in SAFSTOR until the fuel is removed and then the facility will be decontaminated (deferred decontamination) to levels that permit release for unrestricted use. The majority of the remediation performed during the decommissioning will focus on components with the reactor tank, the shielding surrounding the reactor tank area, the primary cooling system and the demineralizer system. In other areas of the facility only minor remediation requirements are anticipated. The general activities to complete the Plan objectives are:

- Remove the neutron beam catcher, the wood shield over the tank and the concrete block shielding around the reactor tank area.
- Remove the components within the TRIGA reactor's tank.
- Remove the primary and secondary cooling systems.

- Perform additional decontamination and dismantlement of the structure and equipment in accordance with this plan.
- Remove the TRIGA reactor's tank and any surrounding concrete if activated.
- Prepare the waste generated by decommissioning activities for release or disposal (as appropriate). Either decontaminate and release the material as non-radioactive waste, or package it for disposal as radioactive waste.
- Ship all radioactive waste off-site to a licensed waste processor or disposal facility.
- Perform and document the final status survey(s) and submit a request to the USNRC for termination of the reactor license.

3.2.2 Estimated Cost

The cost estimate is consistent with the scope of work covering D&D of the ARRR. D&D of the ARRR includes dismantlement of the reactor and reactor systems but retaining the reactor building and most other structures on site. The basis for the detailed estimated cost to decommission the ARRR is presented in the Decommissioning Cost Estimate for the Aerotest Radiography and Research Reactor, San Ramon CA (Ref. 3-4). This project is estimated to cost $2,879,276. A cost breakdown is given in Table 3-3: Decommissioning Cost Summary – ARRR.

3.2.3 Availability of Funds

Estimates of the costs of decommissioning of ARRR USNRC licensed facility are provided in this plan. Nuclear Labyrinth, LLC/Aerotest Operations, Inc are committed to providing the funding for decommissioning of the ARRR.

3.2.4 Quality Assurance

Quality Assurance activities will be performed to incorporate the applicable portions of 10 CFR 50, Appendix B and 10 CFR 71, Subpart H. In addition, the program will utilize a graded approach that bases the level of controls on the intended use of the results and the degree of confidence needed in their quality. ANSI/ASQC E4-1994 (ASQC 1995) and Appendix K of MARSSIM will be used to provide guidance in quality systems, the collection and evaluation of environmental data.

Quality Assurance activities will be implemented throughout the ARRR 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 ARRR decommissioning period will include the following:

- Auditing project activities
- Monitoring personnel performance for compliance with work procedures
- Verifying compliance of radioactive shipments with appropriate procedures and regulations
- Maintaining auditable files

3.2.4.1 Quality Requirements for Instrumentation

Calibration

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

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

Response Testing

All instrumentation will be inspected and source checked prior to use to verify calibration status and proper operation. Control checks and/or source check criteria will be established prior to the initial use of the instruments.

Maintenance

For limited maintenance, such as changing Mylar windows, high voltage cables, etc., and for more significant maintenance, such as changing essential components, will be performed on site by qualified personnel.

Record Keeping

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

3.2.4.2 Sampling and Analysis Quality Control

Sample Collection

Direct surface beta 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. 3-5), NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (Ref. 3-6), and NUREG-1757, *Consolidated MSS Decommissioning Guidance, Decommissioning Process for Materials Licenses* (Ref. 3-3).

Sample QC

Quality Control (QC) samples will be obtained for minimum of 1% 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 measurements, removable contamination samples, 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 will be identified with a unique sample number, sample location, depth of sample, sample time and date as appropriate, and the name of the person collecting the sample.

Sample Chain-of-Custody

Sample chain-of-custody shall be initiated for those samples performed in house or being sent off site 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

Aerotest has the ultimate responsibility for ensuring that decommissioning sample analysis specifications and laboratory capabilities meet data quality requirements.

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.

3.2.4.4 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 Aerotest President. 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 status survey 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, and Survey Results.

3.2.4.5 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 in the Reactor Complex 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.
- Safety requirements established for the handling, storage, and shipping of packages for radioactive material shall be followed.
- Shipments shall not be made unless all tests, 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.

3.2.4.6 Decommissioning Records

Sufficient records shall be maintained to furnish evidence of activities important to safe decommissioning as required by code, standard, and 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 personnel and the public.

Typical records would include:

- Decommissioning Plan
- Procedures
- Reports

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- 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 personnel and the public include the following:

- Work Permits
- Work Procedures
- Contamination Survey Reports
- Radiation Survey Reports
- Airborne Survey Reports
- 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

Personal Records

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

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

3.2.4.6 Audits

Audits shall be implemented to verify compliance with appropriate requirements in 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 individuals responsible for implementation of audited provisions.

Audit Corrective Action

Measures shall be established to ensure that discrepancies identified by audits are resolved. Discrepancies shall be resolved by the Aerotest President. Follow-up action, including re-audit of deficient areas, shall be taken as indicated.

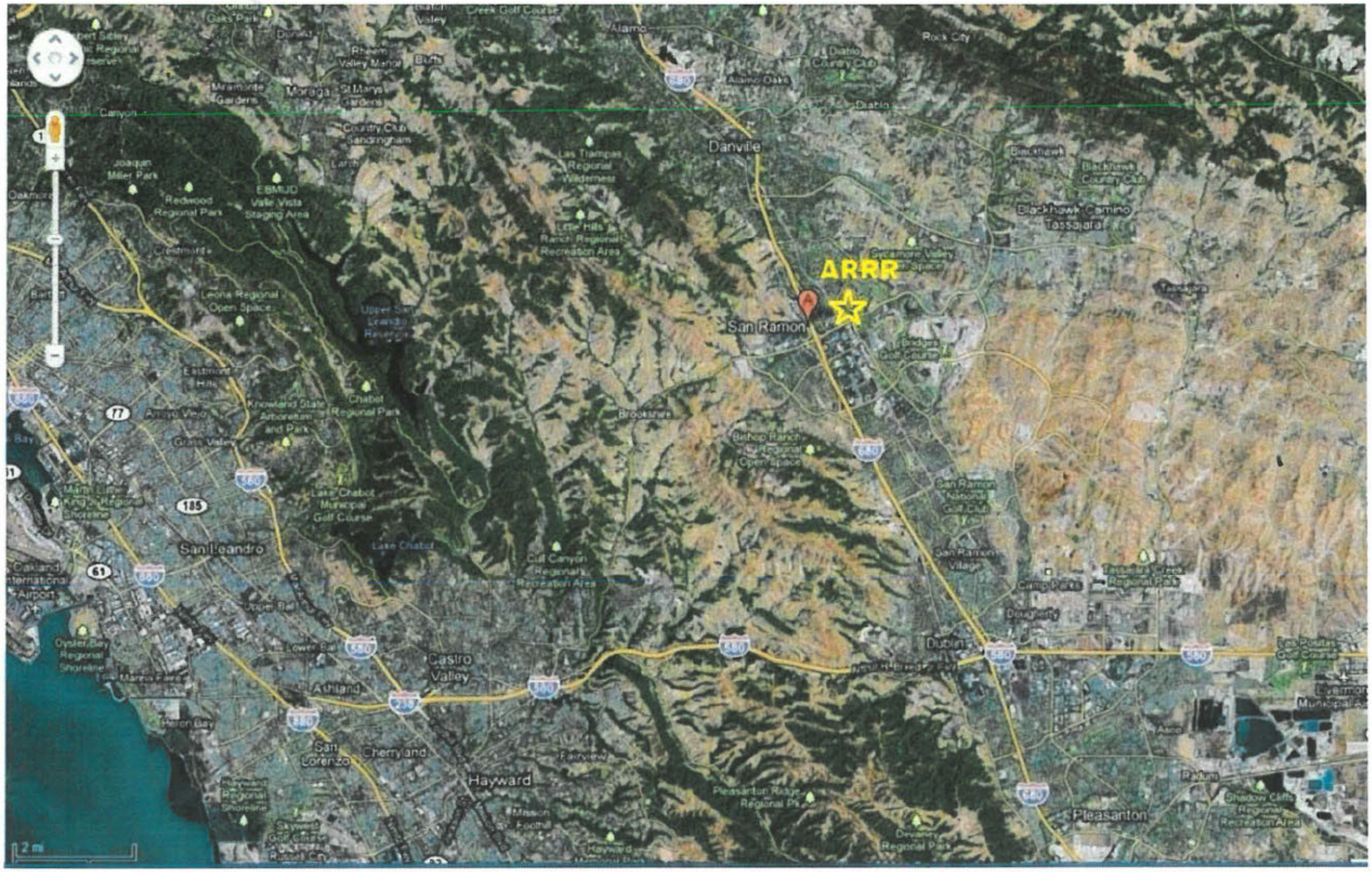

Figure 3-1: Aerotest Operations Site Location

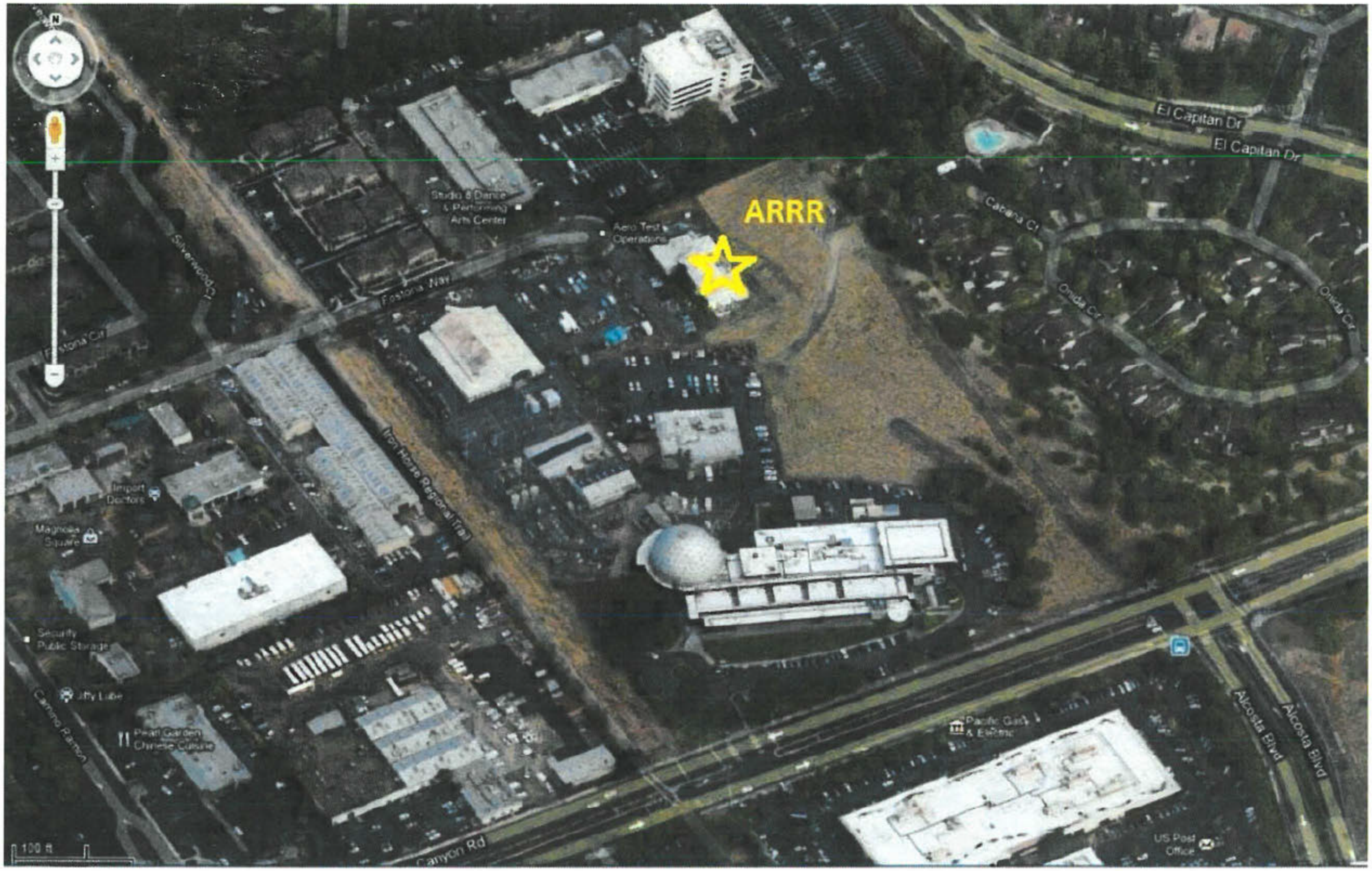

Figure 3-2: ARRR Local Area View

Figure 3-3: Aerotest Aerial Image

1. Office Space
2. Customer Viewing Room
3. Quality Control Room
4. Dark Room
5. Explosive Storage & Safe
6. Film Storage
7. Shipping & Receiving
8. N-Ray Setup Area
9. Computer and Counting Room
10. Lunch Room
11. High Bay N-Ray Exposure Area
12. Reactor Enclosure
13. Control Room
14. Men's Room
15. Ladies' Room
16. Employee's Lockers
17. General Manager's Office
18. Business Office
19. Accounting Office
20. Machine Shop
21. Office Supply Room
22. Tagging Area
23. South End Radiography
24. Demineralizer Building
25. Maintenance Office
26. Heat Exchange Building
27. Backup Cooling Tower
28. Compressor Building
29. Safe
30. Waste Storage Tanks & Sump
31. N-Ray Gauge Office
32. Preparation Lab
33. Chemical Lab
34. Storage
35. Instrument Calibration Area
36. Sheet Metal Fabrication Area
37. Electronics Lab
38. Class 1.1 Explosive Storage
39. Main Cooling Tower
42. Storage Building
43. Parking Area
44. Parking Area
45. Radioactive Material Storage Room
46. Chemical Shed

[redacted]

Figure 3-4: General Plan

[redacted]

Figure 3-5: Plan Layout of ARRR High Bay

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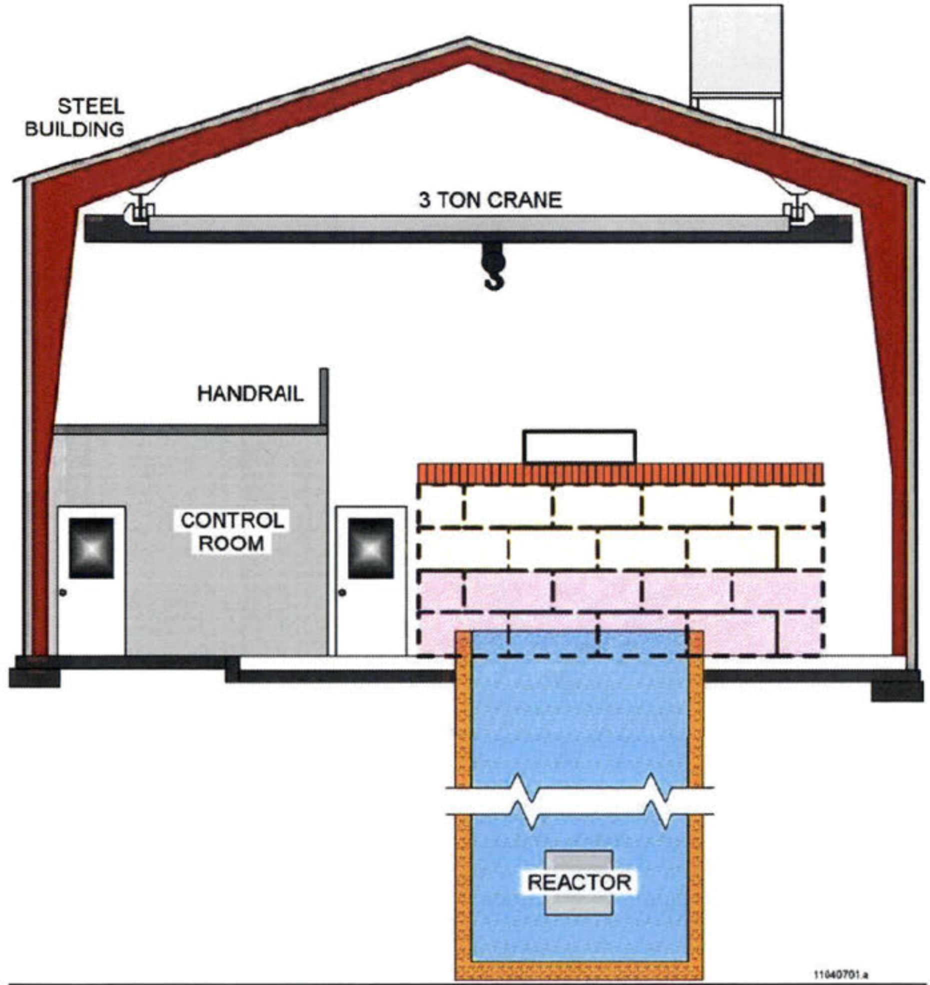

Figure 3-6: Cross Section of ARRR High Bay Reactor Building

Table 3-1: Profile of the ARRR TRIGA Reactor

General Reactor information:	
Type:	TRIGA CONV
Owner/Operator:	Nuclear Labyrinth, LLC./AEROTEST OPERATIONS INC
Licensee:	Aerotest Operations, Inc.
Nuclear Design:	General Atomic Division of General Dynamics
Principal Uses:	Radiographic Irradiations
Reactor Operation and Authorization:	
Initial Criticality:	July 9, 1964
USNRC Utilization Facility License #:	R-98
USNRC Facility Docket #:	50-228
Reactor Specifications:	
Thermal Power, Steady (kW):	250
Maximum Flux SS, Thermal (n/cm^2-s):	3.0×10^{13}
Equilibrium Core Size (Fuel Elements)	84
Coolant:	Light Water
Moderator:	H_2O, ZrH
Reflector:	Graphite
Control Rod Material	B_4C
Control Rods Number	3

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Table 3-2: Characterization Survey Summary

Survey Package Number	Location Description	Survey Results Residual Activity		Survey Package Number	Location Description	Survey Results Residual Activity
1	Reactor Building Inside Bioshield	Detected		8 con't	Building Addition 1 Hallway	Not Detected
2	Reactor Building Rad Material Storage Area	Detected			Building Addition 1 Explosive Storage Safe	Not Detected
3	Demineralizer Building	Detected			Building Addition 1 Film Storage Room	Not Detected
	Maintenance Office	Not Detected			Building Addition 1 Shipping & Receiving	Not Detected
	Heat Exchanger Building	Detected			Building Addition 1 N-Ray Setup Area	Not Detected
4	Waste Storage Tank Area	Not Detected		9	Reactor Building Men's Room	Not Detected
5	Building Addition 1 Counting Room	Not Detected			Reactor Building Ladies' Room	Not Detected
	Reactor Building Conference/Lunch Room	Not Detected			Reactor Building Business Office	Not Detected
	Reactor Building Control Room	Not Detected			Reactor Building Accounting Office	Not Detected
	Reactor Building Employee's Lockers	Not Detected		10	Tagging Building Entry Vestibule	Not Detected
	Reactor Building General Manager's Office	Not Detected			Tagging Area	Not Detected
	Reactor Building Machine Shop	Not Detected			Tagging Area Back Room	Not Detected
	Reactor Building Office Supply Room	Not Detected			Storage Building	Not Detected
	Reactor Building South End Radiography	Not Detected			Compressor Building	Not Detected
6	Tagging Building Safe	Not Detected			Chemical Shed	Not Detected
7	Reactor Mezzanine Preparation lab	Not Detected		11	Reactor Building Exterior Walls	Not Detected
	Reactor Mezzanine Chemical lab	Not Detected			Building Addition 1 Exterior Walls	Not Detected
	Reactor Mezzanine Instrument Calibration Area	Not Detected			Tagging Building Exterior Walls	Not Detected
	Reactor Mezzanine Electronics Lab	Not Detected			Storage Building Exterior Walls	Not Detected
	Reactor Mezzanine Stairway	Not Detected		12	All Other Buildings Exterior Walls	Not Detected
	Reactor Mezzanine N-Ray Gauge office	Not Detected		13	Parking Area Outside Fence	Not Detected
	Reactor Mezzanine Sheet Metal Fab Area	Not Detected		14	Paved Areas Inside Fence	Not Detected
	Reactor Mezzanine Storage area	Not Detected		15	Soil Areas Inside Fence	Not Detected
8	Building Addition 1 Office Space	Not Detected		16	Main Cooling Tower	Not Detected
	Building Addition 1 Customer Viewing Area	Not Detected			Backup Cooling Tower	Not Detected
	Building Addition 1 Quality Control Room	Not Detected		17	Waste Storage Tanks	Not Detected
	Building Addition 1 Dark Room	Not Detected				

Table 3-3: Decommissioning Cost Summary - ARRR

Operation	Man-hours	Labor Plus Trav. & Liv.	Equipment, Contracts & Supplies	Radwaste Shipping & Disposal	Total Cost
TRIGA Reactor	6,147	$591,527	$97,714	$329,135	$1,018,376
TRIGA shielding & N-Ray Components	76	$	$26,816	$76,349	$103,165
Buildings	1,364	$130,575	$64,981	$314,779	$510,335
Outdoor Areas	265	$24,465	$43,935	$365,814	$434,214
Decommissioning Planning	120	$11,400	$0	$0	$11,400
Characterization Surveys	228	$23,856	$2,335	$0	$26,191
Final Surveys	910	$95,423	$9,338	$0	$104,761
Planning, Training, & Mobilization	202	$18,272	$0	$0	$18,272
Owner Oversight & Licensing	509	$46,707	$0	$0	$46,707
NRC Verification Survey		$30,000	$0	$0	$30,000
Totals	**982**	**$972,225**	**$245,119**	**$1,086,077**	**$2,303,421**
			25% CONTINGENCY		**$575,855**
				GRAND TOTAL	**$2,879,276**

* The estimate for LLW disposal is based upon the assumption that all radioactive waste will be buried at the Clive Utah disposal site.

REFERENCES FOR SECTION 3

3-1 CS-HP-PR-007, "Characterization Report for the Aerotest Radiography & Research Reactor, San Ramon, California", Revision 0, August 2011.

3-2 NUREG- 1537 Rev. 0, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors".

3-3 NUREG–1757, "Consolidated MSS Decommissioning Guidance, Decommissioning Process for Materials Licenses", September 2002.

3-4 CS-HP-PR-006, "Decommissioning Cost Estimate for the Aerotest Radiography and Research Reactor, San Ramon", Revision 6, January 2019, prepared by EnergySolutions.

3-5 10 CFR 20.1402 Radiological Criteria for Unrestricted Use.

3-6 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

4.0 DECOMMISSIONING ACTIVITIES

The decommissioning activities for the ARRR is the removal of the facility from service, establishment of "Possession-Only-Status" (POS), reduction of the residual radioactivity to levels that allow unrestricted access to all facility areas, followed by fuel removal and final decontamination that will permit termination of the reactor licenses and beneficial reuse of the property. The facility will be surveyed and left in place.

4.1 DECOMMISSIONING ACTIVITIES

The objective of ARRR Decommissioning is the regulatory release of the property and buildings to unrestricted use.

The Proposed Actions follow:

Proposed Action - In safe storage, the Aerotest Reactor would be placed and maintained in a condition that allows it to be safely stored and subsequently decontaminated to USNRC and state of California levels permitting release of the property. This would involve retention of the fuel onsite until the Department of Energy (DOE) is able to take the spent fuel.

Implementation of the Proposed Action would include retention of the fuel on site. This could probably be accomplished by using one (or a combination) of three scenarios, either (1) storing the fuel in the pool with water where it is currently located, (2) removal of the reactor fuel from the tank to an on-site dry storage location, or (3) maintain the fuel in the current tank but under dry conditions.

Decontamination and Decommissioning of the ARRR, including the reactor, followed by license termination and subsequent release of the site for unrestricted use. This includes the possibility of burying at location low-level radioactive-contaminated concrete that may exist which surrounds the aluminum tank. All choices must meet USNRC or state of California level permitting unrestricted release of the property.

The scenarios where the fuel is maintained in the pool would likely include the following tasks:

- If wet, continued operation and maintenance of the pool water demineralizer system.
- If dry, removal of the pool water demineralizer system.
- Removal of reactor components (control rods, core structure and unused detectors)
- Removal of the pool water cooling system including heat exchanger and cooling towers.
- Decontamination of any contaminated areas outside of the reactor pool.
- Shipment of the low-level radioactive waste (LLRW) currently on site or generated as a result of decommissioning activities.
- Site monitoring of operations, similar to current site requirements, to ensure systems are performing correctly, and performing maintenance of the facility for continued occupancy.
- Existing physical security, radiological control, material control and accounting plans approved by the Nuclear Regulatory Commission will continue to be implemented.

- Once the DOE has taken the fuel off site, the facility would be decontaminated and decommissioned, including the performance of Final Status Surveys and release of the subject areas for unrestricted use and termination of the ARRR license.

The scenario where the fuel is removed from the pool to dry storage on site would likely include the following tasks:

- Removal of the reactor fuel from the tank to the existing dry storage locations.
- Removal of reactor components (control rods, core structure and unused detectors)
- Dismantlement, decontamination or packaging as low-level radioactive waste (LLRW) the ARRR Reactor components including the demineralizer system, the cooling system, the reactor area shielding and the operating and control systems, but not the tank.
- Decontamination of any contaminated areas.
- Shipment of the low-level radioactive waste (LLRW) currently on site or generated as a result of decommissioning activities.
- Existing physical security, radiological control, material control and accounting plans approved by the Nuclear Regulatory Commission will continue to be implemented.
- Once the DOE has taken the fuel off site, the facility would be decontaminated and decommissioned, including the performance of Final Status Surveys and release of the subject areas for unrestricted use and termination of the ARRR license.

4.2 FACILITY RADIOLOGICAL STATUS

4.2.1 Facility Operating History

The initial fuel loading for the ARRR utilized previously used aluminum clad fuel elements provided by GA. The reactor achieved initial criticality on July 9, 1965 with a licensed steady state thermal power limit of 250 kW.

The ARRR has provided a neutron source for research and development and services, mainly neutron radiology. Irradiation services for activation analyses have included: crude oil and hydrocarbon samples for oil companies; plastic slides impregnated with microscopic quantities of fissionable materials; ocean silt samples for the Bureau of Mines; and, silver iodide in snow samples from cloud seeding. Other irradiation services have included: calibration of power reactor fission detectors; radiation damage effects studies of solid state electronic components; detection of gunshot residue in paraffin; lattice deformation studies in ammonium perchlorate; and, spallation experiments with uranium dioxide. The reactor has accumulated a total of 14,107,874 kw hours after 69,582 hours of operation (Ref. 4-1). Reactor operations ceased on October 15, 2010.

There were no instances of releases of radioactive material (activity levels greater than public release limits for air or water to sewers). There was however, one instance of a leaking fuel element reported during the operation of the ARRR. The reactor achieved initial criticality July 9, 1965 and the ruptured fuel element was located and removed from the core in November of 1965. The fuel element was immediately shipped offsite for disposal (Ref. 4-1). The current low-level presence of fission products such as ^{137}Cs in the pool water demineralizer system indicates there may have been leaks from fuel elements.

There were no instances of surface water flooding that may have contributed to an uncontrolled release of radioactive water. There were however several instances of work area flooding from internal water sources as described below (Ref. 4-1):

> In 2002 a pipe burst and flooded the N-Ray set-up room and garage. This was a clean area and it involved normal water cleanup and disposal methods. No radioactive material was involved.
>
> There was a sewer backup that got into the trench system but there was never any overflow to the floors. The backup was resolved when the drain line was cleaned out by the city. No radioactive material was involved.
>
> There were pipe breaks several times in the Conference/Lunch-Room area and also in the QC wing area and in the High Bay area. No radioactive material was involved.
>
> The sink in the Chemistry Room has overflowed several times where water ran down the stairs before someone realized that the water had been left on in the sink and shut off the water. No radioactive material was involved.

Building gaseous effluents were continuously monitored by sampling air from the area above the reactor water tank. The air intake was either just above the reactor pool, which was the normal position, or in the ceiling of the reactor room. These locations ensured that if gaseous fission products were released they would be detected. No gaseous fission products were detected (Ref. 4-1).

In addition, while the reactor was in operation, a building particulate sampler was used to continuously withdraw an air sample from the reactor room and collect particulate material on a filter paper. The reactor room particulate samples are analyzed monthly and no activity in excess of limits was ever noted (Ref. 4-1).

4.2.2 Current Radiological Status of the Facility

4.2.2.1 General

Routine radiological surveys show that the radiation levels and contamination levels measured at the ARRR have consistently been low. A characterization survey performed in May 2011 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 radioactive waste room and the 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. These direct measurements will further define the basis for specifying the necessary safety measures and procedures for the various dismantling, removal, decontamination, and waste packaging and storage operations so that exposure to personnel is maintained ALARA.

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4.2.2.2 Radionuclides

The radionuclides possibly present in detectable levels within the ARRR, are listed in Table 4-1. The list of expected radionuclides 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. The determination of residual activity in reactor components and structures surrounding the reactor is based upon theoretical neutron activation calculations however, actions will be determined by direct measurements and sampling.

4.3 DECOMMISSIONING TASKS

4.3.1 Activities and Tasks

4.3.1.1 Preparation of the ARRR for Decommissioning

4.3.1.1.1 <u>Characterization Surveys</u>
As part of Decommissioning Project planning actions, studies have been conducted to determine the type, quantity, condition and location of radioactive materials, may be, present in the ARRR and surrounding areas. A contractor, EnergySolutions, performed a comprehensive characterization survey of the ARRR in May 2011. Detailed survey results are presented in the Characterization Report (Ref. 4-2).

4.3.1.1.2 <u>General Cleanup of</u> ARRR
In preparation for decommissioning activities, non-reactor related equipment and materials situated throughout the facility complex will be collected, surveyed, packaged and appropriately dispositioned in accordance with established procedures.

4.3.1.1.3 <u>Decontamination of the Facility</u>
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 ARRR.

<u>Disposition of Decommissioning Equipment and Materials</u>
The equipment, materials, instrumentation, and tools that are used or encountered during the decommissioning will be handled as described below:

- The above items may be surveyed and released on site as clean waste if the residual radioactivity is less than the current site release limits of 200 dpm/100 cm^2 beta above background and 30 dpm/100 cm^2 alpha above background.
- No contaminated items will be left on site, the items will be shipped directly for disposal as radioactive waste.

Reactor High Bay Building

- The equipment, materials, instrumentation, and tools that are used during the decommissioning will be handled as described in the previous section.
- All contaminated equipment will be decontaminated, surveyed and left in place or removed for disposal or processing and disposal.
- High Bay Building HVAC system filters will be removed, and the remaining system will be surveyed and left in place.
- Concrete floors will be decontaminated if required. Pipes and drains will be surveyed and left in place or decontaminated as required or removed for disposal or processing and disposal.
- Building roof exhausts will be surveyed and left in place.
- The ARRR Crane will be utilized during the decommissioning activities. It will be surveyed, decontaminated if required and left in place and in operating condition.

Reactor and Pool

- Remove beam catcher and wood shield over reactor tank, characterize them and ship them for disposal.
- Remove concrete blocks around reactor tank area, decontaminate them and survey them for disposal as clean waste.
- Remove the reactor core, core stand, thermal column, fuel racks, vertical beam tube, and other items inside the reactor pool and ship them for disposal as LLRW.
- Remove reactor tools, characterize them and if required, ship them for disposal.
- The reactor bridge and items attached to the bridge will be removed and shipped for disposal.
- When no longer useful as a radiological shield, the reactor pool water will be processed through a demineralizer system, sampled, and discharged as non-radioactive waste using the existing site discharge procedures.
- Any debris or hardware remaining present in the pool will be removed and shipped for disposal.
- The activation predictions indicated slightly elevated activity in the soil; Ca-45 and Mn54 exceed the anticipated California limits but not the NRC limits. In the case of delayed decommissioning, the Ca-45 and Mn-54 will have decayed to less than the anticipated California limits.
- In the case of delayed decommissioning, the reactor pool tank maybe decontaminated, and the tank left in place. The Co-60 in the tank walls will have decayed away and the activity in the concrete behind the aluminum tank will have decayed away also as indicated above.

- The unused beam port is not activated and will be left in place.
- The reactor pool trenches will be decontaminated and the concrete left in place.
- The remaining tasks are removal of residual surface contamination in the rooms, and performance of the final status survey. The packaged waste is to be shipped to a licensed processing or disposal facility.

Remaining Rooms and Structure

The equipment, materials, instrumentation, and tools that are used or encountered during decommissioning of the remaining rooms and structures will be handled as the same as indicated above for areas known to be potentially contaminated.

4.3.1.2 Dismantling Sequence

Dismantling will occur sequentially by the schedule shown in Figure 4-2. Items to be removed are grouped as follows:

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

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

Group 3 — Reactor support systems.

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

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

4.3.1.2.1 Reactor Area

- The Beam Catcher and wood shield over the reactor tank will be removed initially followed by removal of the N-Ray exposure tray system and a portion of the shielding blocks surrounding the pool top. This will allow good access to the reactor bridge and pool contents while still providing personnel shielding for removal of the activated pool contents. The Beam Catcher and wood shield will be disposed of as radioactive waste if necessary.
- The control rods in the TRIGA pool are expected to have the highest dose rates from induced radioactivity. The control rods and other Group 2 items will be hoisted from the pool within shielded containers that will have been prepared to accept the items.
- After pool components, equipment and parts listed in Table 4-3 and Table 4-4 have been removed; the remaining shielding around the pool will be removed. This may involve an initial surface decontamination prior to removal of the shielding depending on the surface activity levels found. If the piping in trenches that passes from the pool to the heat exchanger and the demineralizer systems is still in place it will be removed at this time.

- The control panels in the Control Room will be removed and the associated wiring in the trenches removed. The Trenches will be decontaminated by manual wipe down with cleaning agents.
- The reactor tools will be removed from the storage cabinets, characterized, and shipped for disposal. The reactor bridge and the items attached to the bridge will be removed and shipped for disposal.
- The reactor pool will be emptied, and the water processed through a demineralizer system, sampled, and discharged as non-radioactive waste using the existing site discharge procedures.
- An activation analysis performed and reported in the "Characterization Survey Report" (Ref. 4-2) indicates that near the core there may be activated concrete and activated rebar in the concrete. Radionuclides currently in excess of the anticipated California limits, Table 4-7, include C-14, Ca-41, Ca-45, Mn-54, Fe-55 and Co-60. However, if there is a lengthy storage period prior to decommissioning, the only remaining radionuclide of concern will be C-14. The C-14 will be less than NRC limits but close to anticipated California limits for soil and a good case could be made to leave it in place as it is encapsulated in concrete deeply below grade. In this case the tank will remain and rest left in place if the concrete is not contaminated.
- The activation predictions also indicated slightly elevated activity in the soil; Ca-45 and Mn54 exceed the anticipated California limits but not the NRC limits. In the case of delayed decommissioning, the Ca-45 and Mn-54 will have decayed to less than the anticipated California limits.
- In the case of delayed decommissioning, the reactor pool tank will be decontaminated and the tank left in place. The Co-60 in the tank walls and the activity in the concrete behind the aluminum tank will have decayed away.
- The unused beam port is not activated and will be left in place.
- There are two potential radiological safety concerns during performance of the above tasks: 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.
- Post-remediation surveys of the remaining building floor concrete may include concrete sampling and analysis. As the removal of activated material proceeds, the radioactive material will be packaged for shipment and disposal.
- The water treatment and demineralizer systems will be removed. The water treatment system includes the filter and demineralizer along with associated pipe, valves and instrumentation. The pool water cooling system includes a heat exchanger that utilizes chilled water from a cooling tower, pumps and associated piping valves and controls. The demineralizer system is housed in the Demineralizer Building and the primary side of the cooling system is housed in the Heat Exchanger

Building. The secondary side of the cooling system is outdoors next to the Cooling Tower. The lead shielding in the Demineralizer Building will be sent offsite for processing and disposal. The spare demineralizer in the building will be characterized and shipped offsite as radioactive waste. The concrete pads in the Demineralizer and Heat Exchange Buildings are contaminated and the pads will either be decontaminated by concrete surface removal and the remaining pads disposed of as clean waste or the pads disposed of as radioactive waste.

4.3.1.2.2 <u>Reactor High Bay Area</u>

All equipment in the Reactor High Bay Building that is not part of the structure or utilities will be removed for disposal and contaminated building surfaces will be decontaminated. It is anticipated that this activity will include the following items:

- Radwaste Room: The waste will be characterized and sent offsite for disposal as radioactive waste. The lead will be sent offsite for processing and disposal. The floor and walls will be decontaminated by a hand wipe down.

4.3.1.2.3 <u>High Bay Mezzanine Area</u>

- N-Ray Gauge Office, Preparation Lab, Hallway and Chemical Lab: In the Chemical lab the hood and support bench along with the lab benches and sinks will be surveyed and removed from site. In the Preparation Lab the marble weighing benches will be surveyed and removed from site. Any remaining equipment, furniture, supplies and cabinets in any of these rooms and will be surveyed and removed from site.
- Sheet Metal Fabrication Area, Storage Area, Calibration Area and Electronics Lab: Any remaining equipment, furniture, supplies and cabinets in any of these areas have been surveyed.

4.3.1.2.4 Other Areas and Buildings

- Machine Shop: Any remaining small tools, supplies cabinets and tables have been surveyed. The large equipment including Drill Press, Milling Machine and Lathe will also be surveyed, and if desired removed from site.
- Office Areas, Locker Room and Supply Room: Any remaining furniture, supplies cabinets and tables will be surveyed and removed from site.
- Restrooms: In general these rooms do not require any remediation. Any items and materials in the supply closet in the men's restroom will be surveyed and removed from site.
- Control Room and Lunch Room: The control room cabinets will be surveyed and removed from site if necessary. Any remaining furniture, monitors, supplies, sink, cabinets and tables will be surveyed and removed from site if necessary.
- Main High Bay Area: An area of about 40-ft by 40-ft around the reactor pit will be decontaminated. The HVAC ductwork and heating and cooling units will be surveyed and any contaminated items removed for disposal as radioactive waste. The roof insulation material will be surveyed and removed for disposal if any contamination is found. In addition, the overhead lights will be surveyed and disposed if any contamination cannot be removed.

- Tagging Building: The Tagging room furnace, stainless tables, sink, tank and dryer will be surveyed and removed from site. Any remaining equipment, furniture, supplies and cabinets in the room will be surveyed and removed from site.
- Storage Building: The Storage Building is sometimes referred to as the Forklift Garage. The materials and supplies in this building have not been in a radioactive material area and will be removed from site. The equipment could have been used in a radioactive materials area and will be surveyed and removed from site.
- Maintenance Office: The maintenance Office and the contents have never been in a radioactive materials area. The contents will be removed from site or to an appropriate hazardous material disposition site as appropriate. On the south side of the Office there is an added structure that contains a large demineralizer undergoing decay. This demineralizer will be characterized and shipped for disposal as radioactive waste.
- Chemical Shed: The Chemical Shed and the shed contents have never been in a radioactive materials area will removed to an appropriate hazardous material disposition site as appropriate.
- Compressor Building: The compressors and vacuum pump have never been in a radioactive materials area. The compressors will be surveyed and removed from site. The vacuum pump oil will be sampled to insure that the vacuum pumps are not contaminated internally and they will be surveyed and released.

4.3.1.2.5 <u>Outdoor Areas</u>

- Cooling Towers: The main and secondary cooling towers with associated pumps and controls have never been used with contaminated water and are maintained outside of radioactive materials areas. The cooling towers and the rest of the system will be demolished and removed from site.
- Spare Demineralizer Units: There are three large spare demineralizers that were obtained from the University of California at Berkeley. One unit was in the small addition to the Maintenance Office. Two of these units were never used at ARRR and are stored on the north side of the Storage Building. These units will be characterized and disposed of.
- Waste Sump and Tanks: The waste sump and waste tanks are new and not contaminated. The two waste tanks will be drained if required, surveyed for potential contamination, decontaminated if necessary and shipped offsite for disposal. The Waste Sump pump, valves, and controls will be characterized and shipped for disposal. The concrete sump will be excavated, including bottom pad, and shipped for disposal.
- Shield Blocks: There are quarter circle shield blocks in the vicinity of the waste tanks and the demineralizer system that were used to shield the fence line from high dose rates. These blocks were never in a contaminated area and will be shipped offsite.
- The sanitary and storm sewers will be surveyed at accessible areas and released for continued use.

4.3.1.3 Surveys

Following decontamination and remediation activities of the reactor, a final status survey (FSS) of the affected ARRR site will be performed and documented.

4.3.1.4 Schedule

The project schedule is presented as Figure 4-2, Aerotest estimates that a formal request for termination of Facility License No. R-98 will be submitted to the USNRC approximately eighteen months after removal of fuel. The preliminary portion of the ARRR Decommissioning (prior to fuel removal) is projected to run 6 months. Changes to the schedule may be made at Aerotest's discretion as a result of changes to fuel disposition plans, resource allocation, and availability of a radioactive waste burial site, ALARA considerations, and further characterization measurements.

4.4 DECOMMISSIONING ORGANIZATION AND RESPONSIBILITIES

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

The Aerotest President with support from the Reactor Safeguards 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.) and will approve of decommissioning procedures used during the decommissioning as described in this plan. Consistent with Aerotest policy, the Radiation Safety Committee (RSC) has certain responsibilities to review and approve policies, procedures, programs and facilities pursuant to the safe use of radiological materials and radiation producing equipment. The RSC's jurisdiction will extend to all decommissioning activities dealing with radioactive material and radiological controls.

The planned organization for the ARRR Decommissioning as shown in Figure 4-3 will be maintained, however individuals performing the functions may vary over the project duration. Specialized contractors may be utilized under the direction of the Aerotest President when necessary and appropriate.

4.4.1 Contractor Assistance

Aerotest management will maintain responsible staff to perform the ARRR Decommissioning Project. The team will consist of Aerotest personnel and selected advisors. Aerotest will be in charge of overall project management.

Aerotest will select personnel and advisors through established corporate procurement procedures and standards requiring a rigorous source evaluation and review process. The review and evaluation will include defined criteria such as qualifications, experience, and reputation.

Decommissioning project records will be hardcopy documents maintained in secure cabinets. Aerotest will maintain completed or final project records and documents. These decommissioning files will be available at the facility for inspection by the NRC.

Personnel, consultants, and subcontractors performing work under this Decommissioning Plan will be required to comply with applicable Aerotest policies and procedures.

4.4.2 Aerotest President

The Aerotest President functions include:

- Controlling and maintaining safety during decommissioning activities and protecting of the environment
- 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)
- Oversight and coordination of Aerotest functional groups and decommissioning contractors
- Ensuring that the conduct of decommissioning activities complies with applicable regulations and is in accordance with Aerotest license.

4.4.3 Reactor Administrator

The functions of the ARRR Reactor Administrator will include:

- Maintaining the new and irradiated TRIGA fuel 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 license
- Review of plans and procedures
- Providing engineering support for the decommissioning activities

4.4.4 Radiation Safety Officer

The Radiation Safety Officer shall be responsible for providing radiological support in the decommissioning of the ARRR.

The RSO is responsible for ensuring that:

a. Radiological controls are in place prior to and during any work involving radiation,

b. Applicable license conditions are satisfied, and

c. Applicable state and federal regulations are met.

4.5 TRAINING PROGRAM

Individuals (personnel, consultants, 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 trainee's 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 personnel to implement sound radiation protection practices. The following are examples of the training programs applicable to remediation activities.

4.5.1 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

4.5.2 Radiation Personnel Training

Radiation Personnel Training (RWT) will be required for all individuals directly associated with the ARRR Decommissioning, and the training will include the following topics:

- Fundamentals of Radiation
- Biological Effects of Radiation
- External Radiation Exposure Limits and Controls
- Internal Radiation Limits and Controls
- ALARA Program (Program, Objectives, Investigational Limits, Keeping Doses ALARA)
- Contamination Limits and Controls
- Management and Control of Radioactive Waste.

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

4.5.3 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. 4-3), Regulatory Guide 8.15 (Ref. 4-4), NUREG 0041 (Ref. 4-5) and 29 CFR 1910.134 (Ref. 4-6). 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.

4.6 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 5.1 RADIATION PROTECTION, 5.2 RADIOACTIVE WASTE MANAGEMENT, 5.3 GENERAL INDUSTRIAL SAFETY PROGRAM, and 5.4 RADIOLOGICAL ACCIDENT ANALYSES. Relevant documents and guides used are noted therein.

4.7 FACILITY RELEASE CRITERIA

The proposed Decommissioning Plan does not necessitate the major dismantlement of the ARRR Buildings. The results of the site and facility radiological characterization have indicated that the building structures are directly releasable without need for extensive decontamination.

This section provides the specific criteria for release of the ARRR. The Final Release survey will use the Derived Concentration Guideline Levels (DCGL's) developed from the characterization survey data (Ref. 4-2) 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. 4-7). Subpart E, 10 CFR 20.1402, Radiological Criteria for Unrestricted Use (Ref. 4-8), 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 and surface soil contamination are presented in NUREG-1757, Volume 1 Consolidated NMSS Decommissioning Guidance, Decommissioning Process for Materials Licenses, (Ref. 4-9). This information is duplicated in Table 4-6 and Table 4-7. An ALARA analysis is not needed as stated in NUREG-1757, Volume 2, (Ref. 4-10). "In light of the conservatism in the building surface and surface soil generic screening levels developed by the NRC staff, the staff presumes, absent information to the contrary, that licensees or responsible parties that remediate building surfaces or soil to the generic screening levels do not need to provide analyses to demonstrate that these levels are ALARA. In addition, if residual radioactivity cannot be detected, it may be assumed that it has been reduced to levels that are ALARA. Therefore, the licensee may not need to conduct an explicit analysis to meet the ALARA requirement" However, for the state of California, more restrictive cleanup requirements will be required. The State rules for termination of a radioactive materials license are provided in Title 17 California Code of Regulations, Division 1, Chapter 5, Subchapter 4, Section 30256. Currently no dose based release criteria in California and there is a case by case evaluation of decommissioning plans performed by the California Department of Public Health (CDPH). Experience indicates that release limits that equate to a few mrem/yr are accepted.

Upon completion of the decontamination and remediation activities (e.g. see Section 4.3 Decommissioning Tasks), a final status survey of the ARRR will be performed using the method described in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (Ref. 4-11). 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. 4-12), in support of a license termination request.

The characterization did not indicate that there was any surface soil contamination. The release criteria for surface soil 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 4-7.

If additional screening values are required for nuclides not included in Table 4-6 or Table 4-7, they will be calculated using the NRC's D and D Code with default values.

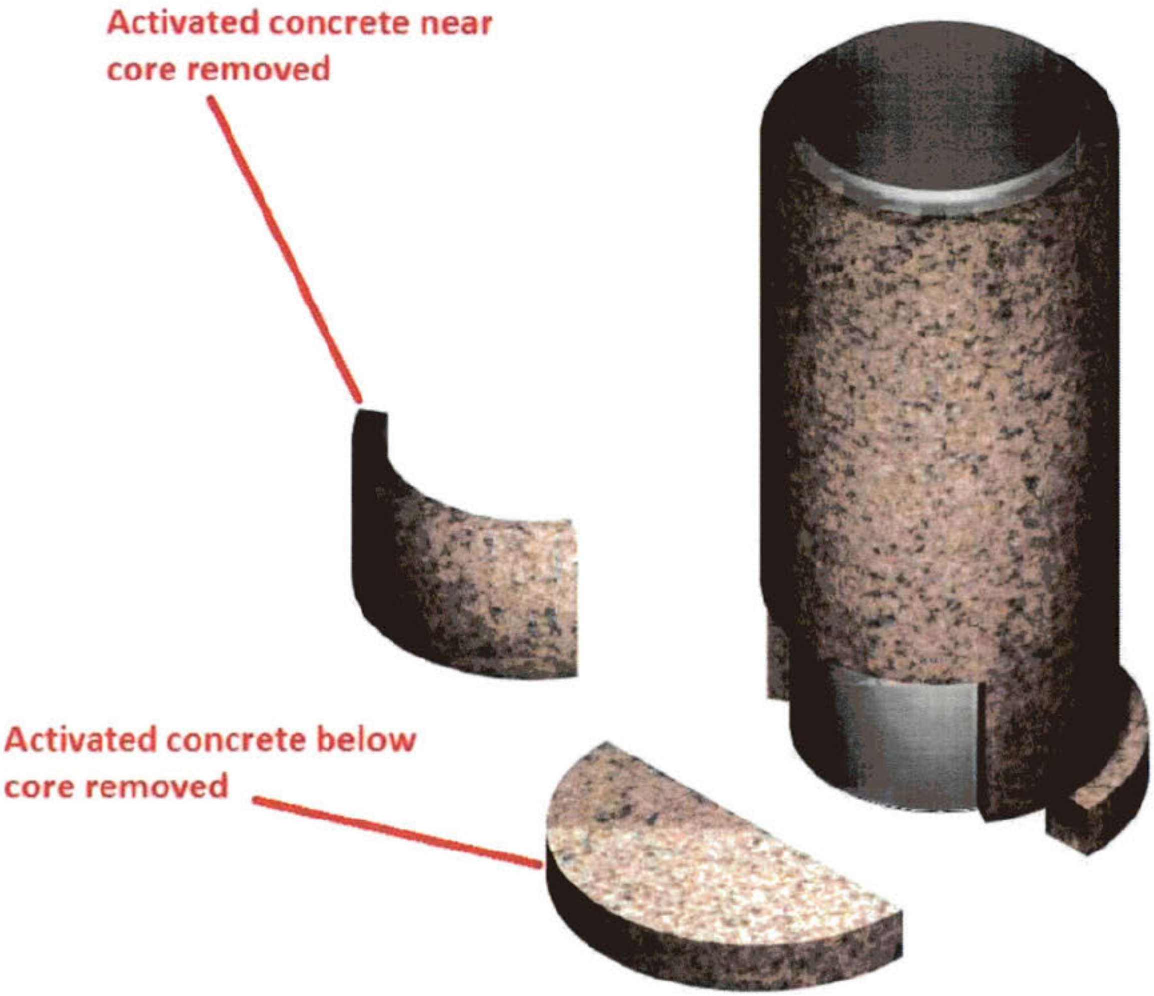

Figure 4-1: ARRR Activated Concrete

ARRR Delayed Decommissioning Schedule

WBS	Task	Duration in hours	1	1	1	Unkn	1	1	1	1	1	1	1	1	1	1	1	1	1
1	**Preparatory Work**	15,928																	
1.1	Possession Only License	1																	
1.2	Site Clean Up	90																	
1.3	Storage Period	15,612																	
1.4	Fuel Removal	30																	
1.5	Updated Commission Plan	60																	
1.6	NRC decommissioning authorization	90																	
1.7	Project planning & Contracting	45																	
2	**Decommissioning Activities**	105																	
2.1	Mobilization and training	5																	
2.2	Remove shielding around reactor area	14																	
2.3	Remove reactor and N-Ray components	14																	
2.4	Empty pool and process water	7																	
2.5	Decontaminate pool tank	21																	
2.6	Remove auxiliary systems	14																	
2.7	Decontaminate facility surfaces	7																	
2.8	Remove 6-ft tank and backfill	7																	
2.9	Perform Final Status survey	14																	
2.10	Demobilization	2																	
3	**Final Activities**	81																	
3.1	Submit FSS Report to NRC and California	1																	
3.2	NRC Review and License Termination	40																	
3.3	California Review and License Termination	40																	

Figure 4-2: ARRR Decommissioning Schedule

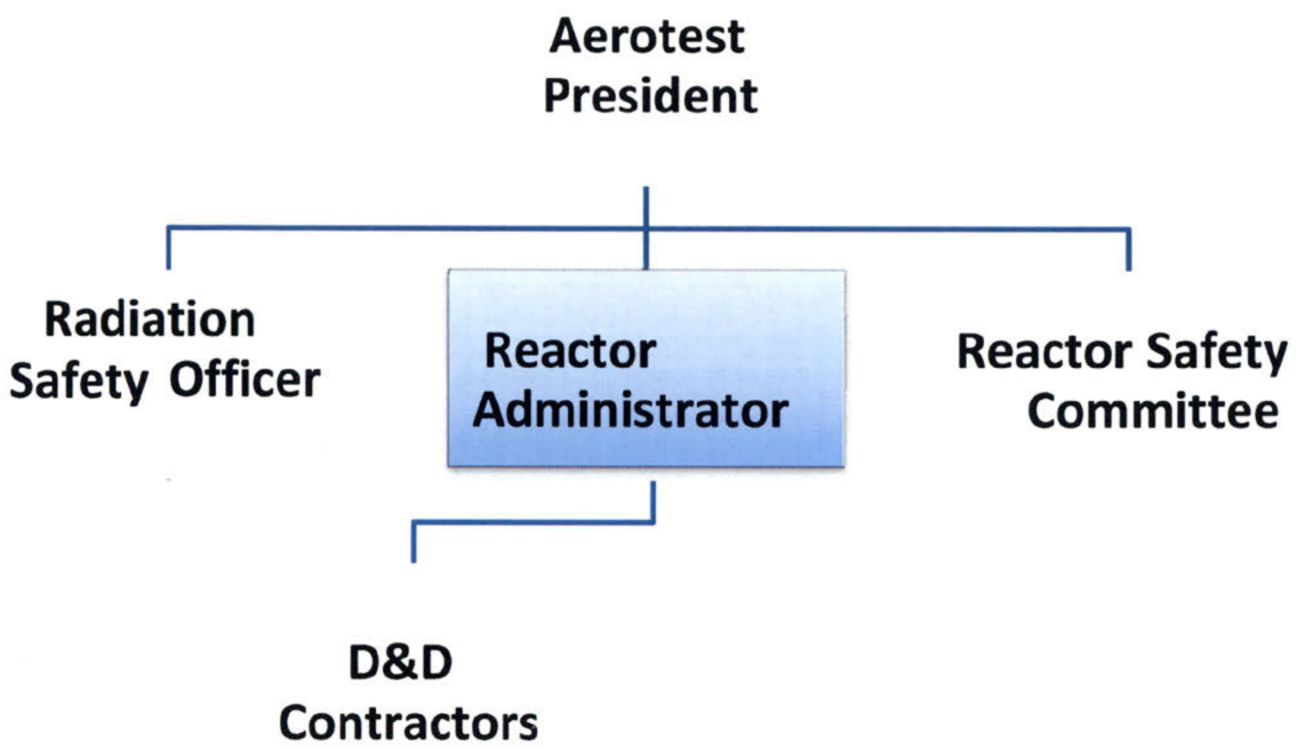

Figure 4-3: ARRR Decommissioning Organization

Table 4-1: List of Expected Radionuclides

Nuclide	Half-Life (yr)	Decay Mode	Inventory Ci	Nuclide	Half-Life (yr)	Decay Mode	Inventory Ci
3 H*	12.28	β-	<28.7	113 Sn	0.315	β+	6.74 x 10-4
10 Be	1,510,000	β-	7.25 x 10-7	119m Sn	0.803	IT	2.17 x 10-2
14 C	5,730	β-	6.48 x 10-3	121m Sn	55	IT,β-	2.82 x 10-5
22 Na	2.6	β-	1.67 x 10-2	123 Sn	0.354	β-	2.40 x 10-4
35 S	0.2392	β-	2.99 x 10-4	124 Sb	0.16	β-	8.51 x 10-3
36 Cl	301,000	β-	2.85 x 10-4	125 Sb	2.76	β-	3.00 x 10-3
39 Ar*	269	β-	2.61 x 10-7	123m Te	0.328	IT	3.69 x 10-5
41 Ca	103,000	ε	1.10 x 10-4	125m Te	0.157	IT	7.31 x 10-4
45 Ca	0.446	β-	2.54 x 10-3	134 Cs	2.7	β-	9.16 x 10-7
46 Sc	0.233	β-	2.04 x 10-5	137 Cs	30.17	β-	0.283
54 Mn	0.86	ε	2.26 x 10-3	133 Ba	10.51	ε	6.17 x 10-4
55 Fe	2.73	ε	0.385	139 Ce	0.377	ε	6.94 x 10-9
59 Fe	0.1222	β-	1.56 x 10-4	144 Ce	0.78	β-	0.185
58 Co	0.194	ε	1.00 x 10-4	152 Eu	13.48	β-,β+,ε	1.59
60 Co	5.27	β–	0.896	154 Eu	8.8	β-	0.161
59 Ni	76,000	ε	1.34 x 10-4	155 Eu	4.96	β-	1.73 x 10-2
63 Ni	100	β-	1.75 x 10-2	153 Gd	0.659	ε	8.93 x 10-5
65 Zn	0.67	ε	0.203	181 W	0.332	ε	1.12 x 10-7
90 Sr	29.1	β–	0.454	185 W	0.206	β–	5.12 x 10-7
93m Nb	13.6	IT	3.68 x 10-9	203 Hg	0.128	β-	4.42 x 10-6
94 Nb	20,000	β-	2.15 x 10-8	204 Tl	3.78	β+	5.82 x 10-5
93 Mo	4,000	ε	1.19 x 10-8	205 Pb	153,000,000	ε	9.80 x 10-5
95 Zr	0.175	β-	1.21 x 10-2	210 Po	0.3791	α	1.75 x 10-2
108m Ag	418	IT,β-	0.159	238 Pu	87.7	α	4.35 x 10-4
110m Ag	418	IT,β-	0.878	239/40 Pu	24,110	α	6.95 x 10-4
109 Cd	1.27	ε	0.12	241 Pu	14.35	β-	1.32 x 10-2
113m Cd	14.1	β-,IT	1.07 x 10-3	241 Am	432.2	α	3.59 x 10-3
115m Cd	0.122	β-	8.13 x 10-6	242 Cm	0.446	α	5.62 x 10-4

Symbols/Abbreviations:

α = Alpha
β^- = Beta
β^+ = Positron
ε = Electron Capture
IT` = Isomeric Transition

Radionuclide Half-Life values and Decay Mode information used above are taken from Reference 4-13.

Table 4-2: Components with Potential Surface Contamination –Group 1

Area or System	Component
TRIGA Reactor	Demineralizer resin, tanks, pipe loop and floor drains
	Heat exchanger, heat exchanger piping loop
	N-Ray Tray System
	Beam Catcher
	Reactor Bridge
	Shielding blocks
Laboratory Areas	Fume hoods, sink drains, and samples
High Bay Building	Radwaste Room Items
	Pool Tools
	Mezzanine High-Rad storage items
	Storage Wells
Pool Area	Concrete floor Surrounding Pool

Table 4-3: Components with Induced Radioactivity - Group 2

Induced Radioactivity Component
Vertical Beam Tube
Vertical Beam Mounting Assembly
Neutron Shutter
N-Ray Facility
Grid Plates
Control Support Structure
Graphite Reflector Elements
Instrument Guide Tubes
Control Rod Guide Tubes
Control Rods
Neutron Source Holder
Ion Chambers and Mounting Assembly
Fasteners and connectors
Graphite Thermal Column
Activated concrete

Table 4-4: Reactor Support System - Group 3

Reactor Support System
Heat Exchange System
Demineralizer System
Purge System
Drains

Table 4-5 Table: Equipment Used in Decommissioning Operations – Group 4

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

Decommissioning Supplies and Equipment

Table 4-6: License Termination Screening Values for Building Surface Contamination

Radionuclide	Symbol	NRC Acceptable screening levels[1] for unrestricted release (dpm/100 cm²)[2]	California screening levels[3] for unrestricted release (dpm/100 cm²)[2]
Hydrogen-3 (Tritium)	^{3}H	1.2E+08	1.4E+07
Carbon-14	^{14}C	3.7E+06	4.4E+05
Sodium-22	^{22}Na	9.5E+03	1.1E+03
Sulfur –35	^{35}S	1.3E+07	1.6E+06
Chlorine-36	^{36}Cl	5.0E+05	6.0E+04
Manganese-54	^{54}Mn	3.2E+04	3.8E+03
Iron-55	^{55}Fe	4.5E+06	5.4E+05
Cobalt-60	^{60}Co	7.1E+03	8.8E+02
Nickel-63	^{63}Ni	1.8E+06	2.2E+05
Strontium-90	^{90}Sr	8.7E+03	1.0E+03
Technetium-99	^{99}Tc	1.3E+06	1.6E+05
Iodine-129	^{129}I	3.5E+04	4.2E+03
Cesium-137	^{137}Cs	2.8E+04	3.4E+03
Iridium-192	^{192}Ir	7.4E+04	8.8E+03

1 Screening levels are based on the assumption that the fraction of removable surface contamination is equal to 0.1. For cases when the fraction of removable contamination is undetermined or higher than 0.1, users may assume, for screening purposes, that 100 percent of surface contamination is removable, and therefore the screening levels should be decreased by a factor of 10. Alternatively, users having site-specific data on the fraction of removable contamination, based on site-specific resuspension factors, (e.g., within 10 percent to 100 percent range) may calculate site-specific screening levels using D and D Version 2.

2 Units are disintegrations per minute (dpm) per 100 square centimeters (dpm/100 cm2). One dpm is equivalent to 0.0167 becquerel (Bq). Therefore, to convert to units of Bq/m2 multiply each value by 1.67. 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 Part 20, Appendix B, Note 4.

3 For the purposes of this estimate, it was assumed that license termination screening values of 12% (3/25th) of the 10 CFR 20.1402 criteria would be acceptable to California (equivalent to 3 mr/yr above background).

Table 4-7: License Termination Screening Values for Surface Soil

Radionuclide	Symbol	NRC Surface Soil Screening Values for unrestricted release (pCi/g)[2]	California Surface Soil Screening Values for unrestricted release (pCi/g)[3]
Hydrogen-3 (Tritium)	3 H	1.10E+02	1.30E+01
Carbon-14	14 C	1.20E+01	1.40E+00
Sodium-22	22 Na	4.30E+00	5.20E-01
Sulfur –35	35 S	2.7 E+02	3.20E+01
Chlorine-36	36 Cl	3.6 E-01	4.30E-02
Calcium-41	41 Ca	6.4 E+01	7.70E+00
Calcium-45	45 Ca	5.7 E+01	6.80E+00
Scandium-46	46 Sc	1.50E+01	1.80E+00
Manganese-54	54 Mn	1.50E+01	1.80E+00
Iron-55	55 Fe	1.00E+04	1.20E+03
Cobalt-57	57 Co	1.50E+02	1.80E+01
Cobalt-60	60 Co	3.80E+00	4.60E-01
Nickel-59	59 Ni	5.50E+03	6.60E+02
Nickel-63	63 Ni	2.10E+03	2.50E+02
Strontium-90	90 Sr	1.70E+00	2.00E-01
Niobium-94	94 Nb	5.80E+00	7.00E-01
Technetium-99	99 Tc	1.90E+01	2.30E+00
Iodine-129	129 I	5.00E-01	6.00E-02
Cesium-134	134 Cs	5.70E+00	6.80E-01
Cesium-137	137 Cs	2.80E+04	3.40E+03
Europium-152	152 Eu	8.70E+00	1.00E+00
Europium-154	154 Eu	8.00E+00	9.60E-01
Iridium-192	192 Ir	4.10E+01	4.90E+00
Lead-210	210 Pb	9.00E-01	1.10E-01
Radium-226	226 Ra	7.00E-01	8.40E-02
Radium-226+C	226 Ra+C	6.00E-01	7.20E-02
Actinium-227	227 Ac	5.00E-01	6.00E-02
Actinium-227+C	227 Ac+C	5.00E-01	6.00E-02
Thorium-228	228 Th	4.7 E+00	5.60E-01
Thorium-228+C	228 Th+C	4.7 E+00	5.60E-01
Thorium-230	230 Th	1.8 E+00	2.20E-01
Thorium-230+C	230 Th+C	6.0 E-01	7.20E-02
Thorium-232	232 Th	1.1 E+00	1.30E-01
Thorium-232+C	232 Th+C	1.1 E+00	1.30E-01
Protactinium-231	231 Pa	3.0 E-01	3.60E-02
Protactinium-231+C	231Pa+C	3.0 E-01	3.60E-02
Uranium-234	234 U	1.3 E+01	1.60E+00
Uranium-235	235 U	8.0 E+00	9.60E-01
Uranium-235+C	235 U+C	2.9 E-01	3.50E-02
Uranium-238	238 U	1.4 E+01	1.70E+00
Uranium-238+C	238 U+C	5.0 E-01	6.00E-02
Plutonium-238	238 Pu	2.5 E+00	3.00E-01
Plutonium-239	239 Pu	2.3 E+00	2.80E-01
Plutonium-241	241Pu	7.2 E+01	8.60E+00
Americium-241	241Am	2.1 E+00	2.50E-01
Curium-242	242 Cm	1.6 E+02	1.90E+01
Curium-243	243 Cm	3.2 E+00	3.80E-01

1 These values represent surficial surface soil concentrations of individual radionuclides that would be deemed in compliance with the 25 mrem/y (0.25 mSv/y) unrestricted release dose limit in 10 CFR 20.1402. For radionuclides in a mixture, the "sum of fractions" rule applies; see Part 20, Appendix B, Note 4.

2 Screening values are in units of (pCi/g) equivalent to 25 mrem/y (0.25 mSv/y). To convert from pCi/g to units of becquerel per kilogram (Bq/kg) divide each value by 0.027. These values were derived using D and D screening methodology (NUREG/CR-5512, Volume 3). They were derived based on selection of the 90th percentile of the output dose distribution for each specific radionuclide (or radionuclide with the specific decay chain). Behavioral parameters were set at the mean of the distribution of the assumed critical group. The metabolic parameters were set at "Standard Man" or at the mean of the distribution for an average man.

3 "Plus Chain (+C) " indicates a value for a radionuclide with its decay progeny present in equilibrium. The values are concentrations of the parent radionuclide, but account for contributions from the complete chain of progeny in equilibrium with the parent radionuclide (NUREG/CR-5512 Volumes 1, 2, and 3).

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REFERENCES FOR SECTION 4

4-1 CS-HP-PR-004, *Historical Site Assessment of the Aerotest Radiography and Research Reactor, San Ramon, California*, Revision 0, July 2011.

4-2 CS-HP-PR-007, *Characterization Report for the Aerotest Radiography & Research Reactor, San Ramon, California*, Revision 0, August 2011.

4-3 10 CFR 20 Subpart H, *Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas.*

4-4 Regulatory Guide 8.15, *Acceptable Programs for Respiratory Protection*; Revision 1, October, 1999

4-5 NUREG 0041, *Manual of Respiratory Protection Against Airborne Radioactive Materials*

4-6 29 CFR 1910.134, Respiratory Protection

4-7 10 CFR 20 Subpart E, Radiological Criteria for License Termination

4-8 10 CFR 20.1402 Radiological Criteria for Unrestricted Use

4-9 NUREG-1757, *Consolidated MSS Decommissioning Guidance, Decommissioning Process for Materials Licenses*, September 2006

4-10 NUREG-1757, *Consolidated MSS Decommissioning Guidance, Decommissioning Process for Materials Licenses, Appendix N, ALARA Analyses*, September 2006

4-11 NUREG-1575, Revision 1, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, August 2000

4-12 NUREG 1537, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors*, February 1996

4-13 *The Health Physics and Radiological Health Handbook*, Revised Edition 1992, Editor by B. Shleien.

5.0 OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

5.1 RADIATION PROTECTION

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

Decommissioning activities at the ARRR 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 Aerotest practice during this project will be as follows:

A documented ALARA evaluation will be required for specific tasks if the RSO determines that 50% of the applicable dose limits (collective dose) for the following may be exceeded:

- Total Effective Dose Equivalent (TEDE) (5 rem)
- 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 (50 rem)
- Eye Dose Equivalent (EDE) (15 rem)
- Shallow-Dose Equivalent to the skin or any extremity (SDE) (50 rem)

Aerotest Management positions responsible for radiation protection and maintaining exposures ALARA during decommissioning include the ARRR President, Reactor Administrator, and Radiation Safety Officer.

Methods for Occupational Exposure Reduction

Various methods will be utilized during the Decommissioning 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. The use of RWPs already exist and simply will be implemented when necessary. Radiation work practices will be considered when procedures are developed for work that 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 RSO 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 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; 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 personnel access is required, respiratory protective equipment will be utilized to limit internal exposures. Any situation wherein personnel 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 personnel intake. The results of DAC-hour tracking and air sample results for intake will be documented in accordance with appropriate regulations. Personnel 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 Aerotest 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 ARRR. See Section 5.1.3 "Radioactive Materials Controls" for a description of the specific survey methods that will be used.

5.1.2 Health Physics Program

Project Health Physics Program - General

Aerotest has procedures in place that will be implemented during the ARRR 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 Aerotest Health Physics policy and procedure.

Aerotest President is readily accessible to ensure timely resolution of difficulties that may be encountered. The RSO, while organizationally independent of the Project staff, has direct access to the ARRR President on a daily basis, and have full authority to act in all aspects of protection of personnel and the public from the effects of radiation.

Audits, Inspections, and Reviews

During Decommissioning Project work, aspects of the Project may be assessed through audits, assessments and inspections of various aspects of decommissioning performance.

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

Additional assessments or reviews may be performed when deemed appropriate by the Aerotest President.

Health Physics Equipment and Instrumentation

Health physics (HP) equipment and instrumentation suitable to permit ready detection and quantification of radiological hazards to personnel and the public are available 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 ARRR. 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. Aerotest 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 personnel 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 the decontamination and decommissioning activities associated with the ARRR, including implementation of a final status survey.

HP personnel 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.

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

Survey instruments will be stored in a common location under the control of ARRR 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 ARRR 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 when in use. The personnel contamination monitors are operationally tested on a basis when work is being performed.

Specific Health Physics Equipment and Instrumentation Use and Capabilities

Table 5-1 provides details of typical HP equipment and instrumentation that is planned for use in the ARRR Decommissioning Project. This list is neither inclusive nor exclusive.

Policy, Method, Frequency and Procedures

The ARRR Decommissioning Project will utilize the existing Aerotest HP procedures for the 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 personnel, (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. RSO 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 personnel 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 prior to initiating decommissioning activities and whenever changes in conditions warrant. Visitors to the ARRR will be monitored in accordance with requirements specified in Aerotest 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 ARRR to evaluate personnel 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 personnel 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 – If necessary, 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 Aerotest RSO to ensure adherence to the requirements of 10CFR20.

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:

- Personnel training will incorporate methods and techniques for the control of radioactive materials, and proper use of protective clothing
- Procedures will incorporate HP controls to minimize spread of contamination during work
- Radiological surveys will be scheduled and conducted by the RSO
- Containment devices such as designed barriers, containers and plastic bags will be used to prevent the spread of radioactive material
- Physical decontamination of ARRR areas or items
- 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 may consist of a suitable combination of items such as the following, dependent upon the conditions outlined in the RWP:

- Lab coat
- Canvas, cotton, or cotton/polyester coveralls
- Head covering
- Rubber, plastic or cloth shoe covers
- Gloves
- 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 and monitored to prevent unauthorized access.

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

- Ventilation devices — in-place or portable HEPA filters or ARRR 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 personnel, 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 personnel 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

RSO will use technical judgment in determining the situations that necessitate air sampling.

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 personnel 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).

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 the Aerotest President and RSO 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 the Aerotest President and RSO 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 Personnel 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.

Personnel 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. Personnel exposure to airborne radioactivity may occur during decontamination operations/work evolutions that 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 personnel 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.

5.1.3 Radioactive Materials Controls

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

- Prevention of inadvertent decommissioning radioactive waste (licensed) material release to uncontrolled areas.
- Assurance that personnel are not inadvertently exposed to radiation from licensed radioactive decommissioning waste materials.
- Minimization of the amount of radioactive waste material generated during decommissioning.

Decommissioning waste materials that can released will be removed for general deposal while contaminated materials will be shipped to an off-site licensed radioactive waste processing facility for survey, processing and disposal.

Pool water releases will be analyzed and filtered to ensure that discharges to sanitary sewerage will meet the requirements of 10 CFR 20.2003 disposal by release into sanitary sewerage and Aerotest liquid discharge procedures.

5.1.4 Dose Estimates

The total projected occupational exposure to complete the decommissioning of the ARRR is estimated to be 18.34 person-rem. This estimated was taken from NUREG/CR-1756 (Ref. 5-1). The estimate in this document was developed for a reference research reactor, a 1,000 kW TRIGA reactor.

This estimate is provided for planning purposes only. Detailed exposure estimates and exposure controls shall be developed 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 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. 5-2). 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 person-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.

5.2 RADIOACTIVE WASTE MANAGEMENT

5.2.1 Radioactive Waste Processing

The processes of decontamination, remediation and dismantlement of the ARRR 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, California Department of Public Health requirements, ARRR 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.

5.2.2 Radioactive Waste Disposal

Low-level radioactive waste will be processed and packaged for disposal at a licensed low-level waste site such as the Clive Utah site. Mixed low-level waste will be prepared for shipment to off-site commercial processing and disposal facilities such as the Clive Utah site.

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 for the contractor selected disposal site(s) 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.

10 CFR 71, Packaging and Transportation of Radioactive Material, establishes requirements for packaging, shipment preparation and transportation of licensed material. 10 CFR 71 requirements will be met through the implementation of Aerotest 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 a Aerotest 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 Aerotest packaging and shipping procedures with the oversight of the Aerotest President and RSC.

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 (California) and Treatment/Storage/Disposal Facility States (Utah, 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 California Department of Public Health requirements and

Utah Department of Environmental Quality Rules (R313) for the control of ionizing radiation reflected in the Clive Utah Radioactive Material License.

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 (RWP).

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 Aerotest procedures and consistent with 10 CFR 20.

5.3 GENERAL INDUSTRIAL SAFETY PROGRAM

The ARRR President shall be responsible to ensure that the project meets all occupational health and safety requirements. The primary functional responsibility is to ensure compliance with the OSHA of 1973. Specific responsibilities include conducting an industrial training program to instruct personnel 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.

All personnel working on the ARRR 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 ARRR. The Health and Safety training implemented at the ARRR is to ensure compliance with the requirements of the USNRC (10 CFR), the EPA (40 CFR), and OSHA (29 CFR). Personnel and regular visitors will be familiarized with plans, procedures and operation of equipment to conduct their selves safely. In addition, each personnel must be familiar with procedures that provide for good quality control. Section 4.5, *Training Program*, provides additional information.

5.4 RADIOLOGICAL ACCIDENT ANALYSES

Radiological Accident Analyses Potential radiological accidents during decommissioning the ARRR were evaluated by determining ARRR components and areas that contain the highest radioactive material inventory. The proposed decommissioning activities and methods in which radioactive material could be released to the work area or environment were considered. Since all special nuclear material will have been removed prior to decommissioning, the majority of the accidents discussed in the current license are not applicable. The accident identification process was supplemented by reviewing experiences at other non-power reactor decommissioning projects. The following radiological accidents were considered to present the highest potential consequences:

- Fire in Waste Storage Area
- Fire in activated graphite
- Dropped and damaged ion exchange column
- Dropped irradiated hardware liner
- Transportation accident

5.4.1 Fire in Waste Storage Area

The consequences, of a fire during decommissioning of the ARRR were considered and are not significantly different than the consequences of a fire during reactor operations. Most materials are metals, concrete, or similar non-combustible materials. Although some torch cutting operations may be performed during decommissioning, the likelihood is low that a fire would start or that a fire could become intense enough to release radioactive material.

Dry radioactive waste is normally collected and packaged in metal containers to limit the volume of dry radioactive waste available for consumption by fire. The accident scenario is for a fire to occur in the dry solid waste. It was assumed that the activity concentration in this material will be 10% of the concentration for the pool cleanup resin. This is very conservative as the resin column concentrates activity and most of the dry solid waste will have minimal contamination. A waste inventory of 360 cubic feet of dry solid waste was estimated to contain 0.11 millicuries assuming it would have the same activity distribution as the resin. It is estimated that combustion of this material would release approximately 25% of the contamination in a respirable form. The total exposure was estimated to be 30 mrem, to which the external dose is a negligible contributor.

5.4.2 Fire in Activated Graphite

As part of the decommissioning process there will be activated graphite removed. The accident scenario is for a fire in the graphite material. The graphite is approximately 2-feet by 2-feet by 4-feet and was assumed it would catch fire even though it is currently contained in aluminum. The graphite volume of 16 cubic feet was estimated to contain 1.41 Ci based upon an independent activation analysis of this graphite material. The calculated inventory is Eu-152 (93.3%), Eu-154 (6.5%) with other radionuclides less than 1%. It is estimated that combustion of this structural material would release approximately 25% of the contamination in a respirable form. The total exposure was estimated to be 182 mrem, to which the external dose is a negligible contributor.

5.4.3 Dropped Ion Exchange Column

An uncontrolled release of airborne radioactivity could occur during demolition activities involving contaminated or activated materials such as the pool water demineralizer. The pool water demineralizer was estimated to contain 3.3 cubic feet of resin and 79 millicuries based upon an independent laboratory analysis of the resin. Most of the inventory is Sr-90 (38%), Cs137 (24%), Ce-144 (15%), Cd-109 (10%), Eu-154 (4%), Fe-55 (1.5%), Eu-155(1.4%), Nb95(1.1%), Pu-241 (1.1%), Zr-95 (1.0%), with other radionuclides less than 1%. The worst-case accident scenario would be dropping the resin column liner as it is being lifted. It was conservatively assumed that 1 percent of the activity of this column was respirable and 10 percent of the respirable material escaped the column and became airborne during the accident.

The TEDE is less than 1 mrem, to which the external dose is a negligible contributor.

5.4.4 Dropped Irradiated Hardware Liner

Most of the activity in the reactor pool is contained in activated components that include control rods, instrument tubes, etc. Because cutting operations for components will be performed underwater, no cutting accident releases were postulated. However a liner filled with irradiated hardware could be dropped while it is lifted for placement into a shipping container. The activity in irradiated hardware is contained within the metal structure of the hardware item except for surface contamination. It would be highly unlikely for a component in the liner to break. If it did break, the diameters of any particles produced would be large enough that it is unlikely that the particles would remain airborne and be respirable. However, even though it is not plausible that an accident could result in measurable exposures at the site boundary, this scenario was evaluated because it includes the largest curie inventory and it demonstrates that potential exposures to the public are acceptable even when worst case assumptions are utilized.

A waste shipping liner containing 120 cubic feet of activated hardware was estimated to contain 1,460 curies (NUREG/CR-1756-v1, Tables E1-2, E.1-3, E.1-5 and E.1-6, for Reference Research Reactor). Most of the activity is Co-60 (84%), with Fe-55 (8.6%), Mn-54 (4.7%), and smaller inventories of other radionuclides. The worst-case accident scenario would be dropping the filled liner as it is being lifted. It was assumed that 1 percent of the activity of this liner was respirable and 1 percent of the respirable material escaped the liner and became airborne during the accident. The total exposure was estimated to be 143 mrem, to which the external dose is a negligible contributor.

5.4.5 Transportation Accidents

Various forms and quantities of radioactive waste will be shipped from the ARRR during the D&D project. The dose consequence from transportation accidents could be higher than the contamination accident scenarios described above because high-activity reactor components could be involved. As such, there is a potential for a moderate dose consequence of between 1 and 25 mrem for the public following a transportation accident. However, adherence to NRC and (DOT) radioactive material packaging and transportation requirements is considered a sufficient control measure for mitigating transportation-related incidents.

5.4.6 Accident Analysis Summary

The accident analysis shows that the postulated accident scenarios would result in TEDE's to the nearest member of the public that are less than the U.S. EPA's lower PAG of 1 rem (1,000 mrem), USEPA 1992 (Ref.5-3) but for some scenarios, somewhat larger than the NRC normal operational annual dose limits for individual members of the public of 0.1 rem/yr (100 mrem/yr) 10 CFR 20.1301 (Ref. 5-4).

The results of the accident analysis show that off-site consequences from accidents are well below the U.S. EPA's PAGs; therefore, off-site emergency plans are not needed.

Table 5-1: Health Physics Equipment and Instrumentation

MFG	Model	Radiation Detected	Notes
Victoreen	450B	Alpha above 4 MeV, Beta above 100keV, Gamma above 7 keV	2 Each
Victoreen	190N, RP-N Detector	Neutron	
Technical Assoc	Pug-1, probe P-8	Alpha, Beta, Gamma	
Technical Assoc	Pug-1, probe P-10	Beta, Gamma	
Eberline	RM-12A	Gamma	2 Each
Baird Atomic	870	Alpha Particle Detector	
Tracer lab		Beta Flow Detector	
Haeshaw	Well Type	Gamma Spectrometer NaI (Tl) Photo Multiplier Tube, gamma scintillation detector 2" x 2" scintillation crystal	

REFERENCES FOR SECTION 5

5-1 NUREG/CR-1756, *Technology, Safety and Costs of Decommissioning Reference Nuclear Research and Test Reactors*, March 1982

5-2 NUREG-0586, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, August 1988

5-3 U.S. EPA, *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*, 400-R-92-001, 1992

5-4 USNRC, 10 CFR Part 20.1301, *Dose Limits for Individual Members of the Public*

6.0 PROPOSED FINAL RADIATION SURVEY PLAN

The intended course of action for ARRR 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 ARRR systems to the extent necessary for remediation, and packaging for burial those materials that cannot reasonably be decontaminated. As such, the Final Status Survey Plan (FSSP) (and subsequent Final Status Survey Report) discussed in this section deals with release of the ARRR building structures and grounds to unrestricted use. This section will also discuss the survey methods that will be utilized.

6.1 DESCRIPTION OF FINAL STATUS SURVEY PLAN

The purpose of the Final Status Survey is to demonstrate that the radiological condition of the ARRR structures is at or below established release criteria (see Section 4.7). It is anticipated that the USNRC will then terminate the ARRR reactor licenses and release all areas of the ARRR.

Note that within the context of this section, the term DCGL refers to the release criteria specified in section 4.7, *Facility Release Criteria.*

The guidance as contained in the following regulatory documents was used in the development of this section of the decommissioning plan and should be used as guidance for the development of the FSSP.

- NUREG 1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (Ref. 6-1);
- NUREG–1757, Vol. 2, Consolidated NMSS Decommissioning Guidance; Characterization, Survey, and Determination of Radiological Criteria (Ref. 6-2); and
- NUREG 1507, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions (Ref. 6-3).

When developed, the FSSP should also incorporate the following major elements:

- Radiological contaminants;
- DCGL summary;
- Area classification;
- Survey areas and units;
- Survey methodology;
- Survey instrumentation;
- Survey design;
- Data assessment; and
- Quality control.

The FSS will be designed to demonstrate that licensed radioactive materials have been removed from the Site to the extent that any remaining residual radioactivity is below the radiological criterion for unrestricted release. If the survey results pass the requirements of the FSSP, the survey unit will be suitable for unrestricted release. If survey results do not meet the criteria and testing requirements as specified, additional investigation and remediation as required will be performed. Additional investigations will include an evaluation of the survey design, instrumentation used and the statistical evaluations, as necessary.

6.1.1 Area Classification

Based upon information collected during the historical site assessment and measurements and sampling during the characterization, all soils and building structures were assigned a classification. The initial area classifications for the ARRR are provided Table 6-1.

6.1.2 Non-Impacted Areas

Non-impacted areas are defined as areas that have no reasonable potential for residual contamination. These include areas that have no impact from Site operations based upon the location(s) of licensed operations, Site use, topography, Site discharge locations, and other Site physical characteristics. These areas include the outlying land areas of the Site and would not require FSS surveys to satisfy regulatory requirements for unrestricted release.

6.1.3 Impacted Areas

Impacted areas may contain residual radioactivity from licensed activities. Based on the levels of residual radioactivity present, impacted areas are further divided into Class 1, Class 2, or Class 3 designations as listed below.

- Class 1 areas are impacted areas that have or are expected to have concentrations of residual radioactivity that exceed the DCGL(s) or areas identified to have contamination in excess of the DCGL(s) prior to remediation will be considered Class 1;
- Class 2 areas are impacted areas that are not likely to have concentrations of residual radioactivity that exceed the DCGL(s); and
- Class 3 areas are impacted areas that are not expected to contain residual radioactivity or residual radioactivity levels are a small fraction of the DCGL(s).

Class 1 areas receive the highest degree of survey effort because they have the greatest potential for contamination, followed by Class 2 then Class 3 areas. When the available information was not sufficient to designate an area as a particular class, the area was classified as Class 1. Areas that are considered to be on the borderline between classes received the more restrictive classification.

Areas that have been classified based on contamination potential shall be further divided into survey units. An FSS will be performed in each survey unit and the data evaluated to demonstrate compliance with the release criterion. However, specific survey units are not defined in this document and shall be defined in the FSSP.

6.1.4 Background Reference Areas

Background reference area measurements are required when using statistical application of the Wilcoxon Rank Sum (WRS) test, and when background subtraction is required to correct gross activity measurements for natural activity present in materials prior to applying the Sign test.

Due to the age and location of the ARRR building structures, background reference areas may not be readily available for assessment and it may be appropriate to use typical material specific backgrounds per NUREG 1507 and/or other guidance documents.

Open land (soil) reference areas have a soil type similar to the soil type within the impacted survey units. If additional reference areas are required, consideration will be given to selecting reference areas that are most similar in terms of physical, chemical, geological, and biological characteristics.

6.1.8 Integrated Survey Strategy

The integration of survey techniques and the systematic sampling and measurement is the final step in the survey design. This integration produces an overall strategy for performing the survey.

6.1.9 Scan Coverage

The amount of area to be covered by scan measurements is based upon the survey unit classification as described in Table 5.9 of MARSSIM and Table A.2 of NUREG 1757, Vol. 2, and is summarized in Table 6-2. The emphasis will be placed on a higher frequency of scans in areas of higher risk. This is referred to as a graded approach.

For Class 3 survey areas, biased surface scans will typically be performed on areas with the greatest potential of contamination. For open land areas, this may include surface drainage areas and collection points. For building and structural surfaces such as overhead surveys, this will include overhead horizontal surfaces and air collection systems.

6.1.10 Reference Grid

A reference grid will be used for reference purposes and to locate the sampling and measurement locations. The reference grid may be physically marked during the survey to aid in the collection of samples and measurements.

6.1.11 Systematic Sampling and Measurement Locations

Systematic sampling and measurement locations for Class 1 and Class 2 survey units will be located in a systematic pattern or grid. The grid spacing, L, will be determined using MARSSIM Equation 5-5 based upon the survey unit size and the minimum number of sampling or measurement locations determined. For Class 3 survey units, each sampling and measurement location will be randomly selected.

The systematic sampling and measurement locations within each survey unit will be clearly identified and documented for the purposes of reproducibility. Actual measurement locations will be marked and identified by tags, labels, flags, stakes, paint marks, photographic record, or equivalent.

6.1.12 Remediation and Reclassification

Based upon the survey data, it may be necessary to remediate the entire survey unit or only a portion of it. If an individual survey measurement (scan or direct) in a Class 2 survey unit exceeds the DCGL, the survey unit, or portion of the survey unit, will be evaluated, and if necessary, be reclassified to a Class 1 area and the survey re-designed and re-performed accordingly. If an individual survey measurement in a Class 3 survey unit exceeds 25% of the DCGL, the survey unit, or portion of a survey unit, will be evaluated, and if necessary, reclassified to a Class 2 survey unit and the survey re-designed and re-performed accordingly. After the elevated survey measurement is confirmed but cannot be thoroughly described as an isolated condition, i.e., it cannot be demonstrated with great certainty that this condition does not exist elsewhere in the survey unit; the survey unit will be reclassified. If the result cannot be duplicated, the individual and average measurement results with respect to the DCGL will be reviewed, and if the variability does not suggest the initial classification was inappropriate, the survey unit will not be reclassified.

6.1.13 Survey Instrumentation

Radiation detection and measurement instrumentation for the FSS will be selected to provide both reliable operation and with the best possible sensitivity to detect the Radionuclides of Concern (ROCs). When possible, instrumentation selection will be made to identify the ROC at levels sufficiently below the DCGL. Detector selection will be based upon detection sensitivity, operating characteristics, and expected performance in the field. The instrumentation will, to the extent practicable, use data logging to automatically record measurements to minimize transcription errors.

Commercially available portable and laboratory instruments and detectors that will be used to perform survey measurements and sample quantification may include:

- Surface scanning;
- Direct surface contamination measurements;
- Gamma spectroscopy analysis of soil and other bulk materials; and
- Alpha spectroscopy analysis of soil and other bulk materials; .

Radiation detection and measurement instrumentation will be selected based on the type and quantity of radiation to be measured. The instruments used for direct measurements will be capable of detecting the minimum detectable concentrations (MDC). Instruments and detectors will be calibrated for the radiation types and energies of interest or to a conservative energy source. Instrument calibrations will be documented with calibration certificates and/or forms and maintained with the instrumentation and project records. Calibration labels will also be attached to all portable survey instruments. Prior to using any survey instrument, the current calibration will be verified and all operational source and background checks will be performed.

Instrumentation used for FSS will be calibrated and maintained in accordance with approved calibration procedures. Radioactive sources used for calibration will be traceable to NIST and have been obtained in standard geometries to match the type of samples being counted. When a gamma spectrometer (with NaI or HPGe detector) is used, suitable NIST-traceable sources will be used for calibration, and the software are set up appropriately for the desired geometry.

It will be necessary to determine the scan sensitivity for field instrumentation utilized during the FSS. This will determine the effectiveness of the surface scans in the ability to determine whether an area meets the criteria for release and will also be a factor in determining the number of samples and measurements that will be required to demonstrate compliance. Scan speeds will be established to the maximum extent practical to detect contamination at or below the release criteria for both open land soil and structural subsurface contamination surveys.

The scan MDC for open land areas may be reduced further by using the field instrumentation coupled with a GPS unit by enabling the scan data to be logged, downloaded, and mapped. By logging and mapping the data, it enables the scan data to be reviewed in its entirety as a data set in correlation with survey unit characteristics such as paved areas and surface soils vs. subsurface soils, etc. By being able to statistically review the data by color coding and adjusting ranges of data values, patterns and areas of concern can be identified more readily than during real time scanning by the survey technician. Additionally, by using the GPS system, it is more readily available to relocate specific areas for further investigation, survey, and sampling as necessary. This effectively maximizes the surveyor efficiency, thereby reducing the scan MDC.

Table 6-3 provides a list of typical laboratory analysis methods and the associated MDCs (sensitivities) expected for FSS for the site. Methods listed are standard industry methods from the EPA and the Environmental Measurements Laboratory (EML).

Upon completion of the decontamination and remediation activities, a FSS will be performed per the guidance described in MARSSIM (Ref. 6-1). The results of the FSS will be summarized in a FSSR which will be submitted to the NRC.

6.1.14 Survey Design

Survey measurements and sample collection will be performed by personnel trained and qualified in accordance with applicable decommissioning procedures. The techniques for performing survey measurements and collecting samples, such as chain-of-custody, will also be specified in decommissioning procedures.

A gamma walkover survey (GWS) will be performed in outdoor soil areas with portable survey instruments sensitive to gamma radiation, to locate contamination in soil or other media. The survey instrument typically used will be a 2-in by 2-in NaI gamma scintillation detector. Scanning will generally be conducted by moving the detector in a serpentine pattern over the surface at a rate that does not exceed 1.5 feet per second (0.5 meters per second). A surface contamination monitor (sensitive to alpha or beta radiations, or both) will be used to monitor structural surfaces. The surface scans will be conducted by moving the detector at a rate of approximately one detector width per second with the detector held as close to the surface as possible without touching the surface.

Both random and biased surveys will be performed. Biased surveys will be based on results of historical surveys, walk-downs, historical use of the area, areas remediated, characterization surveys, and professional judgment.

Soil samples should be collected from areas of elevated radiation identified during the GWS requiring investigation to evaluate if the soil activity concentration meets remediation criteria.

6.1.14.1 Survey Methods

Survey measurements and sample collection are performed by personnel trained and qualified in accordance with the applicable procedure. The techniques for performing survey measurements or collecting samples are specified in approved procedures.

The survey methods to be employed in the FSS will consist of combinations of gamma scans, scanning and static measurements of total surface contamination, and soil sampling.

6.1.14.2 Scanning

Scanning is the process by which the survey technician passes a portable radiation detector within close proximity to the surface of a soil volume, or the surfaces of buildings/equipment with the intent of identifying residual radioactivity. Scan surveys that identify locations where the magnitude of the detector response exceeds an investigation level indicating that further investigation is warranted to determine the amount of residual radioactivity.

6.1.14.3 Total Surface Contamination Measurements

Static measurements of total surface contamination are obtained by stationing the detector in close proximity to the surface, counting for a pre-determined time interval, and recording the reading. Total surface contamination measurements may be collected at random locations within a survey unit, or may be collected at systematic locations. Total surface contamination measurements may also be collected at locations of elevated radioactivity identified by scan surveys as part of an investigation to determine the source of the elevated instrument response, or at locations likely to contain residual radioactivity based on knowledge of operational history and professional judgment.

6.1.14.4 Removable Surface Contamination (Smears)

Removable contamination or smear surveys will be performed to verify that the average removable contamination within a survey unit meets the release limit per Section 4.7. A smear will be performed at each direct surface radioactivity measurement location. A 100 cm^2 surface area will be wiped with a dampened circular cloth or paper filter using moderate pressure. Smear samples will normally only be obtained in building surfaces or in open land areas where hard standing structures are identified (concrete, asphalt, etc.).

6.1.14.5 Volumetric Sampling

Sampling is the process of collecting a portion of a medium as a representation of the locally remaining medium. The collected portion of the medium is then analyzed to determine the radionuclide concentration.

When and if necessary, bulk material samples may be analyzed via gamma spectroscopy, alpha spectroscopy or liquid scintillation counting as appropriate.

6.1.15 Soil Surveys

If the survey instrument scan MDC is less than the DCGL (using the unity rule), then scanning will be the primary method of surveying areas post-remediation. The average net count rate corresponding to the DCGL (or some fraction of) will be determined and used to guide the remediation. Once the area surface scans indicate levels below the DCGL, samples may be collected to confirm the scan results.

If the scan MDC is greater than the DCGL, scanning will still likely be initially used to guide remediation, but additional soil samples may be needed as the area approaches the level that can be released for unrestricted use. Suspect contaminated soil will be sampled and analyzed to determine if the levels are below DCGL.

6.1.16 Building Structural Surveys

For areas to be remediated or where there is a potential for residual surface activity, operational type surveys with surface contamination monitors will be performed. Scanning the surface at a rate of approximately one detector width per second will be performed to identify any areas of residual activity that exceed the gross activity DCGL. The count rate that corresponds to the gross activity DCGL will be determined for the instrument used and the surveyor will mark areas exceeding this value with paint, a marker, or other identifying means.

Following remediation, the area will be rescanned. When the area has been effectively remediated, a post-remediation survey will be documented. The results will be provided to the FSS engineer for evaluation and FSS.

Once the area has been determined to be ready for FSS, isolation and control measures will be established to ensure the area does not become further impacted by the surrounding remediation efforts. The isolation and control process may include posting or restricting access to the area.

6.1.17 Field Screening – Capability of Detection at DCGL

Table 5-1 form the previous section shows typical field instruments for performing in-process surveys. The same, or similar, instruments will be used during FSS. The typical MDCs are noted to be low enough to measure concentrations at the DCGL for field instruments used for scanning.

6.1.18 Investigation Levels

During the FSS, any areas of concern will be identified and investigated. This will include any areas as identified during the scan survey and any results identified during survey data post processing and review that exceed the investigation levels. Based on this review, the suspect areas will be addressed by further biased surveys and sampling as necessary. In Class 1 and 2 areas, the investigation level will be set at the scan MDC for scan surveys and at the DCGL for direct measurement / sample results to ensure elevated areas are identified. In Class 3 areas, the investigation level will be set at the scan MDC for scan surveys and at 50% of DCGL based on MARSSIM guidance.

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6.2 FINAL STATUS SURVEY REPORT

The FSS planning, data, and assessment information will be compiled for each survey unit. The documentation shall provide a complete and unambiguous record of the radiological status of each survey unit relative to the established DCGLs. The information provided will also allow for an independent evaluation of the FSS results at a later time, including a repeat survey, commonly referred to as a confirmatory survey.

The following list provides a summary of the information that will be provided in the FSS report as a minimum.

- Overview of the results of the FSS;
- Discussion of changes that were made in the FSS from what was proposed in this document;
- Description of the method by which the number of samples was determined for each survey unit;
- Number of measurements/samples performed/collected in the survey unit;
- Description of the survey unit, including maps of measurement and sampling locations showing random start systematic locations for Class 1 and 2 survey units and random locations for Class 3 survey units;
- Discussion of remedial actions and unique features;
- Measured sample concentrations in units that are comparable to the DCGL;
- Statistical evaluation of the measured concentrations;
- Judgmental and miscellaneous sample data sets reported separately from systematic data;
- Discussion of anomalous data, including areas of elevated direct radiation detected during scanning that exceeded investigation levels or measurement locations in excess of the DCGL;
- A statement that the survey unit satisfied the DCGL and the maximum, as necessary;
- Description of any changes in the initial survey unit assumptions relative to the extent of residual radioactivity;
- Description of how ALARA practices were employed to achieve final activity levels; and
- If a survey unit fails, a description of the investigation process and a discussion of the impact of the failure on other survey units and the site in general.

Table 6-1: ARRR Initial Classifications

Building / Structure / Site Area	Section	Subsection	Classification
Reactor High Bay Building	Reactor Area	Reactor Enclosure	1
		N-Ray Exposure	2
		South End Radiography	2
		Rad Material Storage Room	1
		Office Supply Room	2
		Machine Shop	2
		Employee Lockers	2
	Mezzanine	N-Ray Gauge Office	2
		Preparation lab	2
		Chemical lab	2
		Sheet Metal Fabrication Area	2
		Instrument Calibration Area	2
		Storage	1
		Electronics Lab	2
	Office Area	General Managers Office	2
		Accounting Office	3
		Business Office	3
		Ladies' Room	3
		Men's Room	3
		Control Room	2
		Lunch/Conference Room	2
	Outside	Walls & Roof	3
Building Addition 1	Office Area	Office Space	3
		Customer Viewing Area	3
		Quality Control Room	3
		Dark Room	3
		Hallway	3
	High Ceiling Area	Explosive Storage Safe	3
		Film Storage Room	3
		Shipping & Receiving	3
		N-Ray Setup Area	3
		Counting Room	1
	Outside	Walls & Roof	3

Building / Structure / Site Area	Section	Subsection	Classification
Tagging Building	High Roof Area	Entry Vestibule	3
		Tagging Room	3
		Back Room	3
		Safe	1
	Outside	Walls & Roof	3
Storage Building	Inside	All Surfaces	3
	Outside	Walls & Roof	3
Demineralizer Building	Inside	All Surfaces	1
	Outside	Walls & Roof	3
Heat Exchanger Building	Inside	All Surfaces	1
	Outside	Walls & Roof	3
Compressor Building	Inside	All Surfaces	3
	Outside	Walls & Roof	3
Maintenance Office Bldg	Inside	All Surfaces	2
	Outside	Walls & Roof	3
Chemical Storage Shed	Inside	All Surfaces	3
	Outside	Walls & Roof	3
Waste Storage Tank Area	Above Grade	Tank Pads	2
	Sump Area	Sump	1
Soil Areas	Inside Fence	All Areas	3
Paved Areas	Inside Fence	North parking Area	3
		East of Buildings	3
	Outside Fence	Front Parking lot	3

Table 6-2: Scan Coverage

Area Classification	Scan Coverage	Surface Activity Measurements or Soil Samples
Class 1	100%	As determined by statistical tests; additional measurements/samples to account for small areas of elevated activity as necessary
Class 2	10 to 100%	As determined by statistical tests
Class 3	1 to 10% (Judgmental)	

Table 6-3:Table: Laboratory Analysis Methods and Sensitivities

Analyte	Medium	Method	Sensitivity Soil (pCi/g)	Sensitivity Smears (dpm/100 cm^2)	Description
H-3	Soil and Smears	EML-LV-539-17 or equivalent	10	100	Liquid Scintillation
Co-60	Soil	EML GA-01-R MOD, EPA 901.1 or equivalent	0.5	N/A	Gamma Spectrometry
Cs-137	Soil	EML GA-01-R MOD. EPA 901.1 or equivalent	1.0		Gamma Spectrometry
Pu-238/239	Soil	EML A-01-R MOD, STM D-3972 or equivalent	0.2		Alpha Spectrometry

REFERENCES FOR SECTION 6

6-1 NUREG-1575, Revision 1, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, August 2000

6-2 NUREG-1757, Volume 2, Revision 1, *Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria*, September 2006

6-3 NUREG 1507, *Minimum Detectable Concentrations with typical Radiation Survey Instruments for Various Various Contaminants and Field Conditions*

7.0 TECHNICAL SPECIFICATIONS

After the nuclear fuel is removed from the reactor and shipped off site, most of the amended technical specification for possession – only Facility License No. R-98, Docket No. 50-228 will not be needed. The inoperable Technical Specifications for the ARRR TRIGA Reactor will be altered if necessary following NUREG-1537 (Ref. 7-1).

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 7

7-1 NUREG- 1537 Rev. 0, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors*

8.0 PHYSICAL SECURITY PLAN

All radiation restricted areas are secured from unauthorized entry. [redacted]

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

These existing plans meet the requirements in NUREG-1537, Chapter 17 (Ref. 8-1)

REFERENCES FOR SECTION 8

8-1 NUREG- 1537, Rev. 0, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors*.

9.0 EMERGENCY PLAN

As required by the USNRC, Aerotest 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 would significantly reduce the potential for significant release of radioactive material off site. Any airborne or liquid releases due to decommissioning activities would have negligible impact off site. 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.

10.0 ENVIRONMENTAL REPORT

The Environmental Report (Ref. 10-1) is provided as Appendix A.

REFERENCES FOR SECTION 10

10-1 *Environmental Report Aerotest Radiography and Research Reactor San Ramon, California*, July 2011.

11.0 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. 11-1).

Aerotest requests that changes to the Decommissioning Plan be allowed with local approval by the Aerotest President and the Reactor Safeguard Committee 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. 11-2).

REFERENCES FOR SECTION 11

11-1 10 CFR 50.90, Application for amendment of license or construction permit.

11-2 10 CFR 50.59, Changes, tests and experiments.

APPENDIX A

ENVIRONMENTAL REPORT for DECCOMMISSIONING ARRR

ENERGYSOLUTIONS

CS-HP-PR-0[illegible]5

Environmental Report

Aerotest Radiography and Research Reactor

San Ramon, California

Project No. 313150 **Revision 0**

Prepared for:
Aerotest Operations, Inc.

Prepared by:
Energy*Solutions*, LLC
Commercial Services Division
1009 Commerce Park Drive, Suite 100
Oak Ridge, TN 37830

Authored By: Paul Ely, Engineer — Date 8/11/11

Reviewed By: Steve Croslin, CHP — Date 8/11/11

Approved By: Ben Sklar, Project Manager — Date 8/11/11

- [X] New Report
- [ ] Title Change
- [ ] Report Revision
- [ ] Report Rewrite

Effective Date ____________

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TABLE OF CONTENTS

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LIST OF FIGURES

LIST OF TABLES

1.0 PURPOSE AND NEED FOR ACTION

Aerotest Operations has provided Neutron Radiographic (N-Ray) Inspection Services since 1969 using the Aerotest Radiography and Research Reactor (ARRR) for the neutron source.

Aerotest Operations, Inc., (Aerotest) is the holder of Facility Operating License No. R-98 which authorizes the possession, use and operation of the ARRR, located in San Ramon, California. Aerotest is a wholly owned subsidiary of OEA Aerospace, Inc., which is wholly owned by OEA, Inc. OEA, Inc., was purchased by Autoliv ASP, Inc., (Autoliv) in 2000. Autoliv is owned by Autoliv, Inc., a Delaware corporation with a Board of Directors and Executive Officers, the majority of whom are non-U.S. citizens. As a result of the purchase, Aerotest became a subsidiary of Autoliv and Autoliv, Inc.

The NRC's position and regulations in 10 CFR 50.38 do not allow issuing a license for a production or utilization facility to an alien or an entity that is owned , controlled, or dominated by foreign interests. There was a good faith effort over several years to sell the facility and transfer the license to a non-foreign entity. This effort failed and Aerotest was forced to close its neutron radiography testing facility in the latter part of 2010. Aerotest plans to submit a request for a possession only license (POL) in 2011. The POL period will continue until all fuel is removed from site, at which time the process for decommissioning and license termination will commence. The TRIGA reactor is currently operated for short periods of time at low power levels in order to maintain operator qualifications. There are no plans to resume regular reactor operations.

Consequently, Aerotest plans to proceed with decommissioning and termination of the associated reactor license after removal of fuel from the site. After fuel removal, Aerotest will file the appropriate decommissioning amendment requests, together with a decommissioning plan with the NRC. As with other facilities of this nature, the ARRR Facility is contaminated with varying small amounts of radioactive material and small amounts of hazardous material. Decontamination and Decommissioning (D&D) of the ARRR will eliminate the potential for future inadvertent environmental releases. The goal of the proposed D&D activities is termination of the ARRR TRIGA Reactor Nuclear Regulatory Commission (NRC) License R-80, Docket No. 50-228 and release of the ARRR 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 San Ramon zoning ordinances.

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

2.1 Facility Description

The property on which the ARRR is situated was designated for construction in 1963. The ARRR was constructed between 1963 and 1964. The ARRR site configuration is shown in, Figure 2-1, Figure 2-2 **Error! Reference source not found.**and Figure 2-3. The land area is well defined, as there is fence around the facility except for the facility parking lot. The Reactor Building footprint is about 3,200 square feet and has two floor levels, and the total footprint for all buildings is 9,250 square feet. Figure 2-4 provides a layout of the ARRR buildings, Figure 2-5 provides a plan view of the reactor building and Figure 2-6 provides a cross section view of the Reactor Building.

In 1963 Aerotest began construction of a facility to house the TRIGA 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 TRIGA Reactor was brought to initial criticality in July of 1964. The TRIGA was routinely operational from that date until October 15, 2010. The TRIGA is currently operated only for short periods of time at low power levels in order to maintain operator qualifications. Aerotest plans to request that the USNRC issue an amendment to the TRIGA facility license to place the reactor in a Possession-Only-Status. The specific detailed conditions of this status are not known at this time. Some anticipated conditions are listed below.

Current Facility Status

It is anticipated that the TRIGA Reactor will be placed in "Possession-Only-Status" (POS), through an amendment to the USNRC License No. R-98, in 2011. The following conditions are anticipated for POS status:

- ARRR utility services required for facility operation and maintenance under POS status conditions will remain active.
- Manually actuated and automated fire alarm systems in the ARRR will remain operational.
- All building utility services required for facility operation and maintenance are active.
- The license-required radiological monitoring and instrumentation systems remain operational.
- 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 ARRR is currently operational although the status may change depending on requirements that are implemented in the amended license.

2.2 Proposed Action and Alternatives

The Proposed Action and the Alternatives are as follows:

- Proposed Action (Modified SAFSTOR) - In safe storage, the Aerotest Reactor would be placed and maintained in a condition that allows it to be safely stored and subsequently decontaminated to a USNRC or state of California level permitting release of the property. This would involve retention of the fuel onsite until the Department of Energy (DOE) is able to take the spent fuel. The DOE has agreed to take the fuel in 2055 at the earliest.
- Alternative 1 (DECON) - Decontamination and Decommissioning of the ARRR, including the reactor, followed by license termination and subsequent release of the site for unrestricted use. This is not currently a viable option as there is not a possibility for fuel removal in the near future.
- 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 USNRC or state of California level permitting release of the property. This is not currently a viable option as the fuel must first be removed from the site and there is not a possibility for fuel removal in the near future.
- No Action Alternative - A no-action alternative would leave the facility in its current status with the current support staff having to maintain the facility under the existing license conditions. This action would not be allowed without a license transfer to a new facility owner. This action would involve maintaining:
    - The facility reactor operating license
    - Personnel to support facility maintenance and surveillance
    - Surveillance and maintenance of Reactor Pool Water Level, Purity and pH
    - The Reactor Facility physical security plan

  The reactor tank still contains fuel and activated hardware with some items reading over an estimated 500 R/hr on contact. The reactor tank does not have a history of leakage. However keeping the facility in this status over a long period of time may lead to a degradation of the tank. That degradation will require either the repair or the decommissioning of that portion of the facility. Aerotest would incur expenses for maintenance of the facility without making beneficial use of the facility.

  The NRC requirement in 10 CFR 50.82(b)(1)(ii) providing for non-power reactor decommissioning without significant delay following permanent shutdown would have to be waived.

Implementation of the Proposed Action would include retention of the fuel on site until the DOE is able to take the spent fuel. This could probably be accomplished using one of two scenarios, either (1) storing the fuel in the pool where it is currently located or (2) removal of the reactor fuel from the tank to an on-site dry storage location.

The scenario where the fuel is maintained in the pool would likely include the following tasks:

- Move some or all of the fuel out of the core to storage racks on the pool floor or on the pool walls.
- Continued operation and maintenance of the pool water demineralizer system.
- Optional removal of the pool water cooling system including heat exchanger and cooling towers.
- Decontamination of any contaminated areas.
- Shipment of the low level radioactive waste (LLRW) currently on site or generated as a result of decommissioning activities.
- Performance of surveys to confirm the facility status and submission of a request to the USNRC for a Possession Only Status (POS) through an amendment to the USNRC License No. R-98, in 2011.
- Daily site monitoring of operations, similar to current site requirements, to ensure systems are performing correctly, and performing maintenance of the facility for continued occupancy.
- Existing physical security, radiological control, material control and accounting plans approved by the Nuclear Regulatory Commission (as may be amended) will continue to be implemented.
- Once the DOE has taken the fuel off site, a revision of the decommissioning plan would be made, if required.
- The facility would be decontaminated and decommissioned, including the performance of Final Status Surveys and release of the subject areas for unrestricted use and termination of the ARRR license.

The scenario where the fuel is removed from the pool to dry storage on site would likely include the following tasks:

- Removal of the reactor fuel from the tank to an on-site dry storage location.
- Dismantlement, decontamination or packaging as low-level radioactive waste (LLRW) the ARRR Reactor components including the demineralizer system, the cooling system, the bioshield and the operating and control systems, but not the tank.
- Decontamination of any contaminated areas.
- Shipment of the low level radioactive waste (LLRW) currently on site or generated as a result of decommissioning activities.

- Performance of surveys to confirm the facility status and submission of a request to the USNRC for a Possession Only Status (POS), through an amendment to the USNRC License No. R-98, in 2011.
- Existing physical security, radiological control, material control and accounting plans approved by the Nuclear Regulatory Commission (as may be amended) will continue to be implemented.
- Once the DOE has taken the fuel off site, a revision of the decommissioning plan would be made, if required
- The facility would be decontaminated and decommissioned, including the performance of Final Status Surveys and release of the subject areas for unrestricted use and termination of the ARRR 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:

- Performance of all project work pursuant to approved procedures implementing a USNRC-approved Decommissioning Plan. ARRR 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.
- 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.
- Employment of monitored, high-efficiency particulate air (HEPA) filtration systems for air ventilation in contaminated work areas.
- Maintenance of emergency ventilation, electrical power and supplies, as appropriate.
- 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. ARRR 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.
- Maintenance of security access control to the work site and facility to restrict unauthorized individuals from the work area.

Figure 2-1: Aerotest Operations Site location

Figure 2-2: ARRR Local Area View

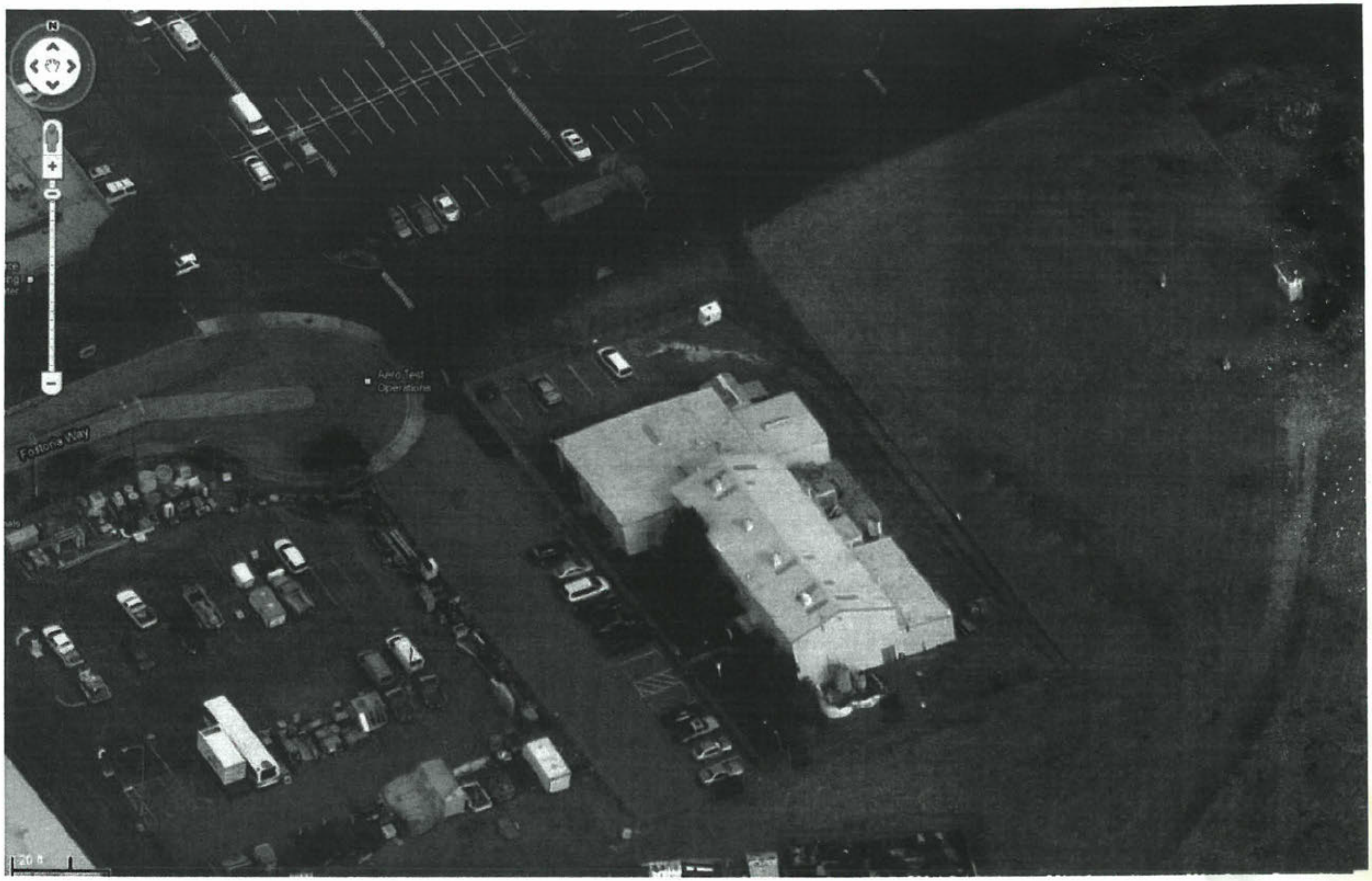

Figure 2-3: Aerotest Aerial Image

1. Office Space
2. Customer Viewing Room
3. Quality Control Room
4. Dark Room
5. Explosive Storage & Safe
6. Film Storage
7. Shipping & Receiving
8. N-Ray Setup Area
9. Computer and Counting Room
10. Lunch Room
11. High Bay N-Ray Exposure Area
12. Reactor Enclosure
13. Control Room
14. Men's Room
15. Ladies' Room
16. Employee's Lockers
17. General Manager's Office
18. Business Office
19. Accounting Office
20. Machine Shop
21. Office Supply Room
22. Tagging Area
23. South End Radiography
24. Demineralizer Building
25. Maintenance Office
26. Heat Exchange Building
27. Backup Cooling Tower
28. Compressor Building
29. Safe
30. Waste Storage Tanks & Sump
31. N-Ray Gauge Office
32. Preparation Lab
33. Chemical Lab
34. Storage
35. Instrument Calibration Area
36. Sheet Metal Fabrication Area
37. Electronics Lab
38. Class 1.1 Explosive Storage
39. Main Cooling Tower
42. Storage Building
43. Parking Area
44. Parking Area
45. Radioactive Material Storage Room
46. Chemical Shed

[redacted]

Figure 2-4: General ARRR Arrangement Plan

[redacted]

Figure 2-5: Plan layout of ARRR Reactor Building

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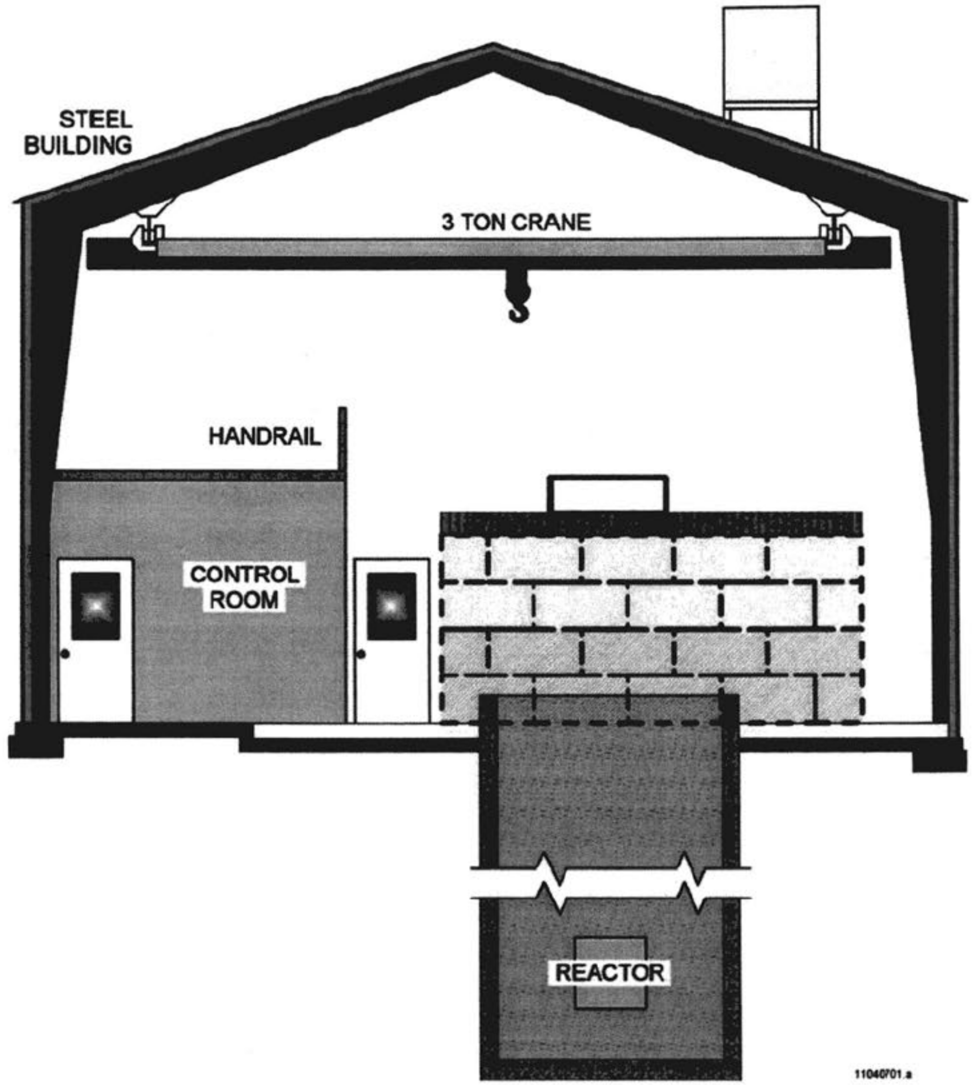

Figure 2-6: Cross Section of ARRR Reactor Building

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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 310 mrem/yr from natural sources of radiation; approximately 300 mrem/yr from medical procedures; and approximately 10 mrem/yr from consumer products, for a total of about 620 mrem/yr (Ref. 5-1).

Residual radioactive contamination resulting from past reactor operations is contained within the ARRR Facility, which is continuously monitored. Existing monitoring data, historical information, and current surveys indicate that building contamination is comprised of low levels of fission and activation products. The radionuclides listed in Table 3-1 potentially exist in the ARRR 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. 5-2). The adverse biological reactions associated with ionizing radiation, and hence with radioactive materials, are skin injury, cancer, genetic mutation and birth defects (Ref. 5-3).

Table 3-1: List of Expected Radionuclides

Nuclide	Half-Life (yr)	Decay Mode
^{3}H	12.28	β^-
^{14}C	5730	β^-
^{54}Mn	0.86	ε
^{55}Fe	2.73	ε
^{57}Co	0.74	ε
^{58}Co	0.19	ε
^{60}Co	5.27	β^-
^{59}Ni	76000	ε
^{63}Ni	100	β^-
^{65}Zn	0.67	ε

Nuclide	Half-Life (yr)	Decay Mode
^{90}Sr	29.1	β^-
^{94}Nb	20000	β^-
^{99}Tc	213000	β^-
^{109}Cd	1.27	β^-
^{113}Sn	0.32	β^-
^{124}Sb	0.16	β^-
^{125}Sb	2.76	β^-
^{129}I	15,700,000	β^-
^{134}Cs	2.07	β^-
^{137}Cs	30.17	β^-
^{144}Ce	0.78	β^-
^{152}Eu	13.48	β^-, β^+, ε
^{154}Eu	8.8	β^-
^{155}Eu	4.96	β^-
^{210}Pb	22.26	β^-
^{230}Th	77,000.	∀

Symbols/Abbreviations: α = Alpha, β^- = Beta, β^+ = Positron, ε = Electron Capture

The radionuclide half-life values and decay mode information used above are taken from Ref. 5-4.

The list of expected radionuclides provided above is based on the assumption that operations of the ARRR 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, lead, concrete and possibly others.

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 because gamma radiation is very penetrating.

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 ARRR employees and off-site persons are elemental lead, non-friable asbestos, solvents, film developers, mercury and polychlorinated biphenyls (PCBs).

3.1.2.1 Elemental Lead

The predominant hazardous material in ARRR, 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 ARRR 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 in the ARRR will be removed, if required, by a licensed asbestos abatement contractor.

3.1.2.3 Solvents

Three solvents (acetone, methanol, and ethanol) were used in small amounts to remove adhesive from the aluminum trays used for the neutron radiography process.

Acetone is hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, and of inhalation. It is slightly hazardous in case of skin contact (permeator). The substance is toxic to central nervous system (CNS). The substance may be toxic to kidneys, the reproductive system, liver, skin. Repeated or prolonged exposure to the substance can produce target organs damage.

Methanol may be fatal or cause blindness if swallowed, the vapor is harmful. It is flammable as a liquid and vapor. It is harmful if swallowed, inhaled, or absorbed through the skin. It causes eye, skin, and respiratory tract irritation and may cause central nervous system depression. It cannot be made non-poisonous. The target organs include eyes, nervous system, and optic nerves.

Ethanol is flammable as a liquid and a vapor. It may cause central nervous system depression. It causes severe eye irritation, it causes respiratory tract irritation and moderate skin irritation. This substance has caused adverse reproductive and fetal effects in humans. Ethanol may cause liver, kidney and heart damage. The target organs include kidneys, heart, central nervous system and liver.

3.1.2.4 Film Developer

Kodak Industrex developer and fixer were used in film processing. There is a contractor who removes the used film processing chemicals at the Aerotest facility. The developer and fixer may contain Ammonium thiosulphate, Ammonium bisulphite, Sodium bisulphite, Sodium tetraborate, Sulphuric acid and Aluminum sulphate. Some of these chemicals can cause skin and eye irritation and burns, may be harmful if absorbed through skin or swallowed and the dried product residue can act as a reducing agent. They have maximum NFPA Hazard Ratings of 3 for Health, 1 for Flammability, and 0 for Instability.

3.1.2.5 Mercury

Mercury is normally used in a large variety of electrical switches, which would classify these switches as hazardous waste. Because the switches are sealed, switches in a radiological controlled area can normally be surveyed for contamination and free released and not managed as mixed waste. Mercury exists in three forms: elemental mercury, inorganic mercury compounds (primarily mercuric chloride), and organic mercury compounds (primarily methyl mercury). Metallic mercury is used in electrical switches. The major systems impacted by human inhalation of elemental mercury are the kidneys and central nervous system (CNS). Acute exposure to high levels of elemental mercury in humans results in CNS effects, such as tremors, irritability, insomnia, memory loss, neuromuscular changes, headaches, slowed sensory and motor nerve function, and reduction in cognitive function. Gastrointestinal effects and respiratory effects, such as chest pains, dyspnea, cough, pulmonary function impairment, and interstitial pneumonitis have also been noted from human inhalation exposure to elemental mercury.

3.1.2.6 Polychlorinated Biphenyls (PCBs)

Inspections noted some potentially PCB-containing materials. Due to the age, fluorescent light ballasts probably contain PCBs and should be treated as PCB waste. Fluorescent lights in radiologically controlled areas can normally be surveyed for contamination and free released. PCBs belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned in 1979. PCBs have been demonstrated to cause cancer, as well as a variety of other adverse health effects on the immune system, reproductive system, nervous system, and endocrine system.

3.1.3 Transportation

The principal roadways in the San Ramon area are illustrated in Figure 3-1. The urban principal arterials are I-680 that runs nearly north and south through San Ramon and it intersects California 24 to the north and I-580 to the south. Access to the site from I-680 is via Crow Canyon Road, a local arterial street to Camino Ramon a collector street and Fostoria Way a two lane collector street. These roads are part of the highway system that provides access to the ARRR from all directions.

There is paved parking in front of the facility and inside the security fence there is additional paved parking.

3.1.4 Cultural and Historical Resources

No significant archeological or cultural resources have been found in surveys of the ARRR site. The National Register of Historic Places does not list ARRR as a historical structure or site.

ARRR decommissioning will have no impact on cultural and historic resources as the ARRR building is basically a nondescript warehouse and with other similar structures in the area, the appearance of the area will be only slightly changed by its removal.

3.1.5 Population and Land Use

Residential areas are found to the east and north at approximately 200 feet and 325 feet respectively and business districts to the north, south and west at approximately 150 feet, 125 feet and 225 feet respectively. The California Department of Finance estimated the population of San Ramon to be 63,176 in 2009. Within a ½-mile radius of ARRR, there are department stores, hotels, restaurants, banks, an automobile dealer, Pacific Gas and Electric research laboratory, a membership warehouse, the San Ramon Post Office, the San Ramon Valley Conference Center and the Crow Canyon Country Club as well as general residential areas. Surrounding land uses are shown graphically on Figure 3-2.

Nearby human populations include:

- Employees and patrons of Integrated Security Professionals, Inc, located about 125 feet to the west;
- Employees and patrons of Danville Materials, located about 150 feet to the north west;
- Employees and visitors of Contra Costa Republican party, located about 150 feet to the north;
- Employees and patrons of Diablo Motors, located about 465 feet to the southwest;
- Employees and patrons of Pacific Gas and Electric San Ramon Research Laboratory (the Mini Epcot), located about 285 feet to the south;
- Employees and patrons of Pacific Gas and Electric San Ramon Research Laboratory, located about 670 feet to the south;
- I-680 located 5/8-mile to the southwest;
- Condominium residences in Fostoria Terrace, beginning at about 670 feet to the west;
- Townhome and Condominium residences on Shoshone Circle, beginning at about 340 feet to the north and;
- Condominium residences on Cabana Court and Oneida Circle, beginning at about 270 feet to the east.

3.1.6 Noise

Nearby vehicular traffic and building, heating, ventilating and air conditioning equipment generate the ambient noise environment.

3.1.7 Aesthetics

ARRR is located at the end of Fostoria Way, which currently ends in a cul-de-sac. ARRR is a low building visible from all directions.

3.2 Natural Environment

3.2.1 Topography, Stratigraphy, Geology and Seismology

3.2.1.1 Topography

The ARRR is located in the San Ramon Valley about 23 miles east of San Francisco and 10 miles east of Oakland. It is separated from the East Bay urban complex by a series of ridges and hills up to 1,600 feet high. The site's ground surfaces slope gently to the southwest. The topography of the surrounding area slopes gently downward to the north and to the south as shown in Figure 3-3.

3.2.1.2 Stratigraphy

Bedrock formations in Contra Costa County are divided into six Assemblages with a unique stratigraphic sequence bounded by faults. The distinction may be either the presence of rock types not present in other Assemblages (e.g. the diatomite (Tdi) in Assemblage III) or a different stratigraphic relationship among similar rock units (e.g. The Domingene Formation (Td) is depositional on Cretaceous rocks in Assemblage V, but is underlain by other Tertiary rocks (Tm, Tmz) in Assemblage VI). The stratigraphic differences between Assemblages are almost certainly due to angular unconformities and changes in depositional environment in one or more large depositional basins. The significant differences in the stratigraphy of different Assemblages, originally separated but now in close proximity, denotes the juxtaposition of different basins or parts of basins by large offsets along the faults that bound them (as much as hundreds of kilometers, see below).

The Great Valley Sequence is depositionally linked to the Coast Range Ophiolite. Although the contact between the two is a fault everywhere in Contra Costa County, elsewhere in California (as close as Alameda County) the lowest part of the Great Valley Sequence (the Knoxville Formation) is clearly deposited on the ophiolite.

The Franciscan Complex presumably underlies all of Contra Costa County. It was emplaced below the Coast Range Ophiolite by accretionary faulting during Cretaceous time, so the contact between the Franciscan and Coast Range Ophiolite and the overlying Great Valley Sequence is everywhere faulted. This fault is known as the Coast Range fault.

Two types of Tertiary intrusive rocks occur in Contra Costa County, both of which intrude the strata of Assemblage V. In the Concord area, the Markley Formation is intruded by plugs and dikes of Pliocene basalt. East of Mount Diablo, the Great Valley Sequence rocks are intruded by fine grained, quartz bearing rhyolite stocks, dikes, and sills of late Miocene age. The relationship of these hypabyssal intrusives is unknown. Although they occur only in the rocks of Assemblage V, these rocks are not included in the Assemblage because of their intrusive nature. The stratigraphy of San Ramon was provided by USGS Information Services (Ref. 5-6).

Figure 3-4 illustrates the stratigraphy of San Ramon/Danville area located in the southwest corner of Contra Costa County. The geologic data descriptors on the map are described in Table 3-2.

Table 3-2: Gelogic Formation Descriptors

Value	Definition
Qu	Surficial deposits, undivided (Pleistocene and Holocene)
Tbe	E member of Wagner (1978) - Briones Formation (Miocene)
Tbg	G member of Wagner (1978) - Briones Formation (Miocene)
Tbr	Briones Formation (Miocene)
Tc	Cierbo Sandstone (Miocene)
Tgvt	Green Valley and Tassajara Formations of Conduit (1938), undivided (Miocene and Pliocene)
Tn	Neroly Sandstone (Miocene)
Tro	Rodeo Shale, Hambre Sandstone, Tice Shale, and Oursan Sandstone, undivided (Miocene)
Tus	Unnamed sedimentary and volcanic rocks (Miocene and Pliocene)

3.2.1.3 Geology

Geology is the science that deals with the history of the earth as recorded in rocks. The geological information for the area is summarized below (Ref. 5-7).

San Ramon is located within the California Coast Ranges geomorphic province. In general the geologic structure and topography of the san Ramon Valley are characteristic of the San Francisco Bay Area. The region is generally defined by northwest-trending ridges and valleys that generally parallel the geologic structures, including the major fault systems. San Ramon Valley fill includes quaternary-aged alluvium up to approximately 300 feet thickness. The valley is drained by both San Ramon and South San Ramon creeks that are actively cutting into the alluvial surface soils.

The San Ramon valley is surrounded by the East Bay Hills. The hills were formed from younger rocks, uplifted between the Hayward and Calaveras fault zones. The San Ramon area is underlain by Tertiary (about 2 to 62 million years ago) marine and non-marine sedimentary rocks. Sandstone bedrock crops out locally on ridge crests and underlies upper hill slopes at shallow depths.

Soils within the general area consist of clays and loams. Diablo Clay, Clear Lake Clay, Botella Clay Loam, Alo Clay, Cropley Clay, Los Osos Clay Loam, Conejo Clay Loam, and Pescadero Clay Loam are among the most common soils found in the general area. Properties of the soils vary, with well-drained clay soils and the clay loams being moderate or poorly drained. In addition, clay soils often exhibit substantial shrink-swell potential, endemic of expansive soils. The site is on the boundary of two soil types based on soil survey data provided by in the U.S. Department of Agriculture. The two types of soil indicated are DdE (Diablo Clay, 15 to 30 percent slopes) and Cc (Clear Lake Clay) (Ref. 5-8).

Figure 3-5 displays soil survey data for the area around San Ramon.

3.2.1.4 Seismology

The ARRR is located in the San Ramon Valley which is surrounded by the East Bay Hills. The hills were formed from younger rocks, uplifted between the Hayward and Calaveras fault zones. The San Ramon area is underlain by Tertiary (approximately 2 million to 62 million years ago) marine and non-marine sedimentary rocks. Sandstone bedrock crops out locally on ridge crests and underlies upper hill slopes at shallow depths.

There are several active faults in the immediate and surrounding areas that could affect the San Ramon area. The nearest major active fault is the Calaveras Fault, which lies parallel to and just west of San Ramon Valley Boulevard. The California Legislature has established an Alquist-Priolo Earthquake Fault Zone along the Calaveras Fault, requiring detailed studies of rupture hazards prior to construction. The seismic activity, along with the approximate distance and direction of all known mapped active faults with the potential to affect San Ramon, is summarized in Table 3-3 (Ref. 5-7).

Table 3-3: Fault Summary for San Ramon California

Fault/Fault Zone	Distance from San Ramon (miles)	Relationship to San Ramon	Slip Rate (inches/year)	Maximum Movement Magnitude
Calaveras	0	Southwest	0.24	6.8
Concord-Green Valley	8	North	0.24	6.9
Hayward	9	Southwest	0.35	7.1
Greenville	10	Northeast	0.08	6.9
Great Valley	16	Northeast	0.06	6.7
San Andreas	27	Southwest	0.94	7.9
Monte Vista-Shannon	28	Southwest	0.02	6.5
Rodgers Creek	30	Northwest	0.35	7.0
San Gregorio	33	Southwest	0.2	7.3
West Napa	41	Northwest	0.04	6.5
Sargent	44	South	0.12	6.8
Ortigalita	49	Southeast	0.04	6.9
Point Rayes	59	Northwest	0.01	6.8

The San Francisco Bay area experiences relatively frequent earthquakes as illustrated in the earthquake hazard map shown in Figure 3-6 (Ref. 5-8). The region in which the ARRR is located has experienced relatively frequent earthquakes. The nearest known fault, the Calaveras

Fault, is about 0.7 miles from the site as can be estimated from the San Ramon Geotechnical Hazards Map shown in Figure 3-7 (Ref. 5-7).

There is a high level of earthquake activity and intensity in this area, but considering the below grade reinforced construction of the reactor tank, that the fuel will be removed from the core and stored in racks or dry, earthquake activity is not considered to present a danger to the facility.

3.2.2 Climate and Air Quality

3.2.2.1 Meteorology

San Ramon is characterized by a Mediterranean climate, with mild winters and warm summers. Temperatures range from an average low of 36.6 degrees Fahrenheit (°F) in January to an average high of 89.0°F in July. Average rainfall is approximately 14 inches.

Table 3-4 summarizes local meteorology, as measured at Livermore Municipal Airport, which is about 10 air miles southwest of the ARRR site (Ref. 5-7).

Table 3-4: Meteorological Summary for San Ramon California

Month	Temperature (°F)		Precipitation (inches)
	Average Minimum	Average Maximum	
January	36.6	56.7	3.00
February	39.4	61.2	2.48
March	41.2	65.3	2.14
April	43.5	70.5	0.99
May	47.6	76.4	0.44
June	51.6	83.1	0.1
July	54.2	89.0	0.02
August	54.0	88.2	0.04
September	52.4	85.8	0.22
October	47.6	77.8	0.64
November	41.0	66.4	1.56
December	37.0	57.5	2.57
Annual Average	**45.5**	**73.2**	**14.21**

Notes:
Measurements taken at Livermore Municipal Airport, the nearest weather station to the ARRR (10.1 miles).
Period of Record: January 1, 1903 through August 31, 2009
Source: Western Regional Climate Center, 2010.

The Contra Costa County data indicates an estimated annual rainfall of 20.5 inches as indicated in Figure 3-8 relative to approximately 14 inches at the Livermore Municipal Airport (Ref. 5-10).

3.2.2.2 Local Winds and Dispersion Data

The wind speeds in the Crow Canyon, Diablo and San Ramon valleys rank as some of the lowest in the Bay Area. For example, in the middle of the Diablo Valley, the District station in Concord reports annual average wind speeds of 4.7 mph, and Danville in the middle of the San Ramon Valley reports annual average wind speeds of 5.0 mph. However, winds can pick up in the afternoon near the town of San Ramon because it is located at the eastern end of the Crow Canyon gap. Through this gap, polluted air from cities near the bay is able to travel across Hayward to the valley during the summer months (Ref. 5-7).

Pollution potential is relatively high in these valleys. On winter evenings, light winds combined with surface-based inversions and terrain that restricts air flow can cause pollutant levels to build up. San Ramon valley can experience high pollution concentrations due to motor vehicle emissions and emissions from fireplaces and wood stoves. In the summer months, ozone and ozone precursors are often transported into the valleys from both the central basin and the Central Valley (Ref. 5-7).

3.2.2.3 Precipitation

Table 3-5 presents a summary of monthly averages for temperature, precipitation, and evapotranspiration. These averages are combined from 20 years of data from a nearby CIMIS station number 65 located in Walnut Creek, CA.

Table 3-5: San Ramon Climate Data

Monthly Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°F)	47	51	54	58	63	68	72	72	70	64	53	47
Precipitation (in)	4.4	4.2	3.3	1.8	0.6	0.1	0	0	0.2	1	2.3	3.1
Evapotranspiration (in)	0.82	1.47	2.92	4.4	5.57	6.66	7.4	6.35	4.73	3.34	1.54	1.01

3.2.2.4 Air Quality

In the Bay Area, as in the entire state of California, a certain amount of air pollution comes from stationary industrial sources, such as refineries and power plants. But a greater percentage of harmful air emissions come from cars and trucks, construction equipment, and other mobile sources. California has more cars per household (1.8) than any other state, along with a thriving business economy and a continually expanding population. All of these factors contribute to the state and regional air quality challenges.

Airborne pollutant concentrations are measured throughout California at air quality monitoring sites. The California Air Resources Board (CARB) operates a statewide network of monitors. The air quality monitoring station closest to San Ramon is located in Hayward on La Mesa

Drive, approximately 8 miles to the south-southwest. The only pollutant measured at this station is ozone. The nearest monitoring station measuring ozone, particulate matter, carbon monoxide, and nitrogen dioxide is located in Livermore on Rincon Avenue, approximately 11 miles east-southeast of the San Ramon. Table 3-6 summarizes 2006 to 2008 published monitoring data. The data shows that federal ozone standards were exceeded on multiple days at the Livermore air monitoring station and two days in 2006 and one day in 2008 at the Hayward station. The state 1-hour standard for ozone was exceeded in year 2006 and 2008 at the Hayward station, and the state standard for PM_{10} (inhalable Particulate Matter) was exceeded during a 24-hour period and as an annual average in 2006 and 2007. $PM_{2.5}$ (fine Particulate Matter) standards were exceeded on 9 days during 2006 and 2007 and on two days during 2008. The data shows that no exceedances of state or federal standards for carbon monoxide or nitrogen dioxide were observed during this three-year period (Ref. 5-7).

Table 3-6: Ambient Air Monitoring Data (2006–2008)

Air Pollutant, Averaging Time (Units)	2006	2007	2008
Ozone (Livermore)			
Max 1 Hour (ppm)	0.127	0.120	0.141
Days > State Standard (0.09 ppm)	13	2	5
Max 8 Hour (ppm)	0.101	0.091	0.110
Days > State Standard (0.07 ppm)	15	3	8
Days > National Standard (0.08 ppm)	10	2	6
Ozone (Hayward)			
Max 1 Hour (ppm)	0.101	0.075	0.114
Days > State Standard (0.09 ppm)	2	0	1
Max 8 Hour (ppm)	0.071	0.065	0.087
Days > State Standard (0.07 ppm)	1	0	3
Days > National Standard (0.08 ppm)	0	0	1
Particulate Matter (PM_{10}) (Livermore)			
Mean ($\mu g/m^3$)	21.8	19.8	18.9
24 Hour ($\mu g/m^3$)	69.2	74.8	46.8
Days > State Standard (50 $\mu g/m^3$)	3	2	0
Days > National Standard (150 $\mu g/m^3$)	0	0	0
Particulate Matter ($PM_{2.5}$) (Livermore)			
Mean ($\mu g/m^3$)	11.1	9.0	10.1
24 Hour ($\mu g/m^3$)	50.8	54.9	52.7
Days > National Standard (35 $\mu g/m^3$)	9	9	2
Carbon Monoxide (Livermore)			
Max 8 Hour (ppm)	1.79	1.83	1.43
Days > State Standard (9.0 ppm)	0	0	0
Days > National Standard (9 ppm)	0	0	0
Nitrogen dioxide (Livermore)			
Mean (ppm)	0.014	0.013	0.013
Max 1 Hour (ppm)	0.064	0.052	0.058
Days > State Standard (0.25 ppm)	0	0	0

Abbreviations:
> = exceed ppm = parts per million $\mu g/m^3$ = micrograms per cubic meter max = maximum
Mean = Annual Arithmetic Mean State Standard = California Ambient Air Quality Standard
National Standard = National Ambient Air Quality Standard

3.2.3 Hydrology

The ARRR site is in the Upper South San Ramon Creek Watershed, which is part of the Upper Alameda Creek Watershed, which is in turn part of the South County Watershed. The Upper South San Ramon Creek Watershed has a drainage area of 13.1 square miles. The valley floor area of San Ramon, the western-most area of the watershed, is highly urbanized and continues the recent trend of urbanization of the Interstate 680 corridor from the Town of Danville to the north, to the City of Dublin to the south. Surface water of the South San Ramon Creek is channelized and often times runs underground to accommodate residential and commercial development areas (Ref. 5-7).

The following are general characteristics of the Upper South San Ramon Creek Sub- Watershed (Ref. 5-7):

- Sub-Watershed Size - 8,357 acres
- Elevation of Headwaters - 1739 feet
- Total Length of Channels - 26.2 miles
- Longest Channel Reach - 4.7 miles
- Major Water Bodies: Watson Canyon Creek, Big Canyon Creek, Coyote Creek, Oak Creek, and Norris Creek.

3.2.3.1 Groundwater

Groundwater for the site is located in the San Ramon Valley Groundwater Basin as described by the San Francisco Regional Water Quality Control Board (RWQCB) Basin Plan Report. The Basin has limited existing municipal, domestic, and agricultural water supply use according to the RWQCB's Basin Plan Report. Similar to the Basin Plan Report, the Department of Water Resources published Bulletin 118 in 2003. Bulletin 118 details the groundwater basins throughout California. According to Bulletin 118, there are no historical records of groundwater elevations in the San Ramon Valley Groundwater Basin (Ref. 5-11).

The study for the San Ramon City Center Project (Ref. 5-11) for a site about ¼ mile south of the ARRR indicated that groundwater was approximately 11 feet below the surface.

The East Bay Municipal Utility District (EBMUD) is the local water purveyor providing potable water to the residents and businesses in this region, including the developed portions of the subject property.

3.2.3.2 Surface Water

The ARRR is between two watersheds: Alameda Creek and Walnut Creek. As noted in the section on Topography, the surrounding area slopes gently downward to the north and to the south. The site storm water runoff is to the north and west toward Walnut Creek. San Ramon Creek is the principal local drainage, with Bollinger Creek and San Catanio Creek being tributary. San Ramon Creek meanders northward through Danville and Alamo, and ultimately joins Walnut Creek, which discharges into Suisun Bay near Martinez (Ref. 5-7). There is a drainage ditch located just past the site boundary to the north of the facility.

Figure 3-9 shows surface water near the ARRR site (Ref. 5-8).

3.2.4 Biology

3.2.4.1 Vegetation

Vegetation on the ARRR site includes a very limited amount of turf grass with ornamental trees and shrubs. No rare or endangered species are present. Low growing shrubs are the predominant landscape type. The existing landscape design can generally be characterized as formal rows of shrubs paralleling walkways.

3.2.4.2 Regional Wetlands

Storm water run-off from the ARRR site flows into the ditch at the north side of the site that eventually flows into San Ramon Creek. There are no wetlands located on or within the vicinity of the site based on a review of the United States Fish and Wildlife Service Wetlands Inventory.

3.2.4.3 Wildlife

The site does not support a wildlife population because of its small size, the highly developed nature of this site, and lack of cover. The area surrounding the site supports a small population of migratory songbirds, insects, and rodents. The ditch and San Ramon Creek are expected to support aquatic organisms such as frogs, salamanders, newts, and insect larvae.

3.2.4.4 Endangered or Threatened Federal or State Species

Four special-status plant species have been recorded as occurring within the San Ramon Planning Area boundaries. These species include Congdon's tar plant, Diablo helianthella, Mt. Diablo buckwheat, and San Joaquin spearscale. None of these species has been noted to occur at the ARRR site as indicated in Figure 3-10 (Ref. 5-11).

Fifteen special-status wildlife species have been recorded as occurring within the San Ramon Planning Area boundaries. These species include:

Alameda Whip Snake
American Badger
California Horned Lark
California Linderiella
California Red-Legged Frog
California Tiger Salamander
San Joaquin Kit Fox
Burrowing Owl
Ferruginous Hawk
Golden Eagle
Northern Harrier
Prairie Falcon
Tricolored Blackbird
Western Pond Turtle
White-Tailed Kite

None of these species has been noted to occur at the ARRR site as indicated in Figure 3-11 (Ref. 5-11).

3.2.5 Socioeconomics and Environmental Justice

The socioeconomic environment of the ARRR consists of a well-established, diverse, middle-income community. Several corporate parks operating under the name 'Bishop Ranch' provide a healthy tax base for the city and tenants include Chevron Corporation (formerly ChevronTexaco) which is headquartered in San Ramon, as well as AT&T, whose West Coast operation is headquartered in San Ramon. United Parcel Service has a regional distribution center in Bishop Ranch. The setting is attractive, with the hills alongside a lengthy valley. The road system is adequate with both interstate highways and secondary roads. ARRR operations constitute a very small percentage of the area's economy.

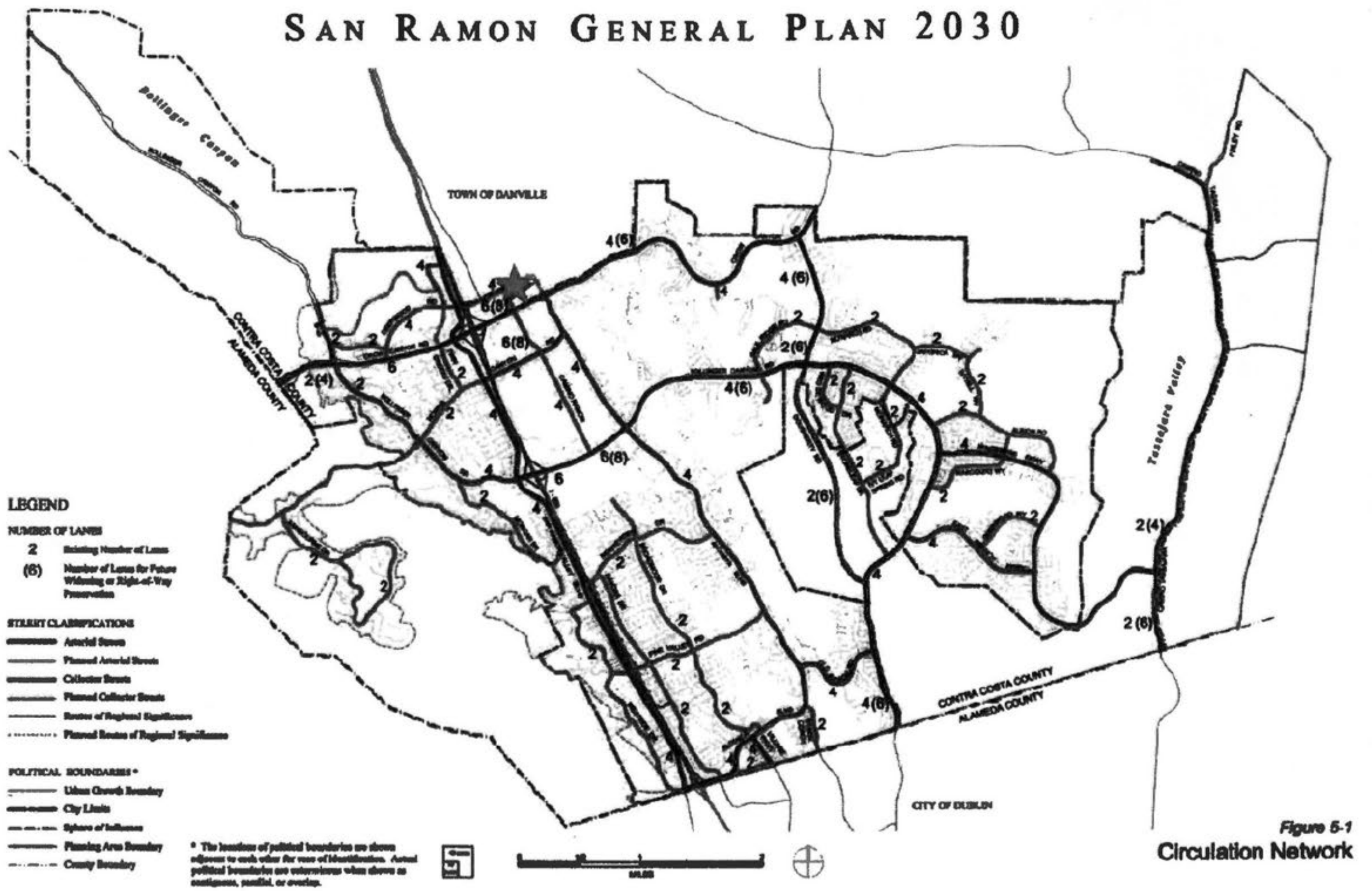

Figure 3-1: Principal Roadways of the San Ramon Area

Figure 3-2: ARRR Local Area View

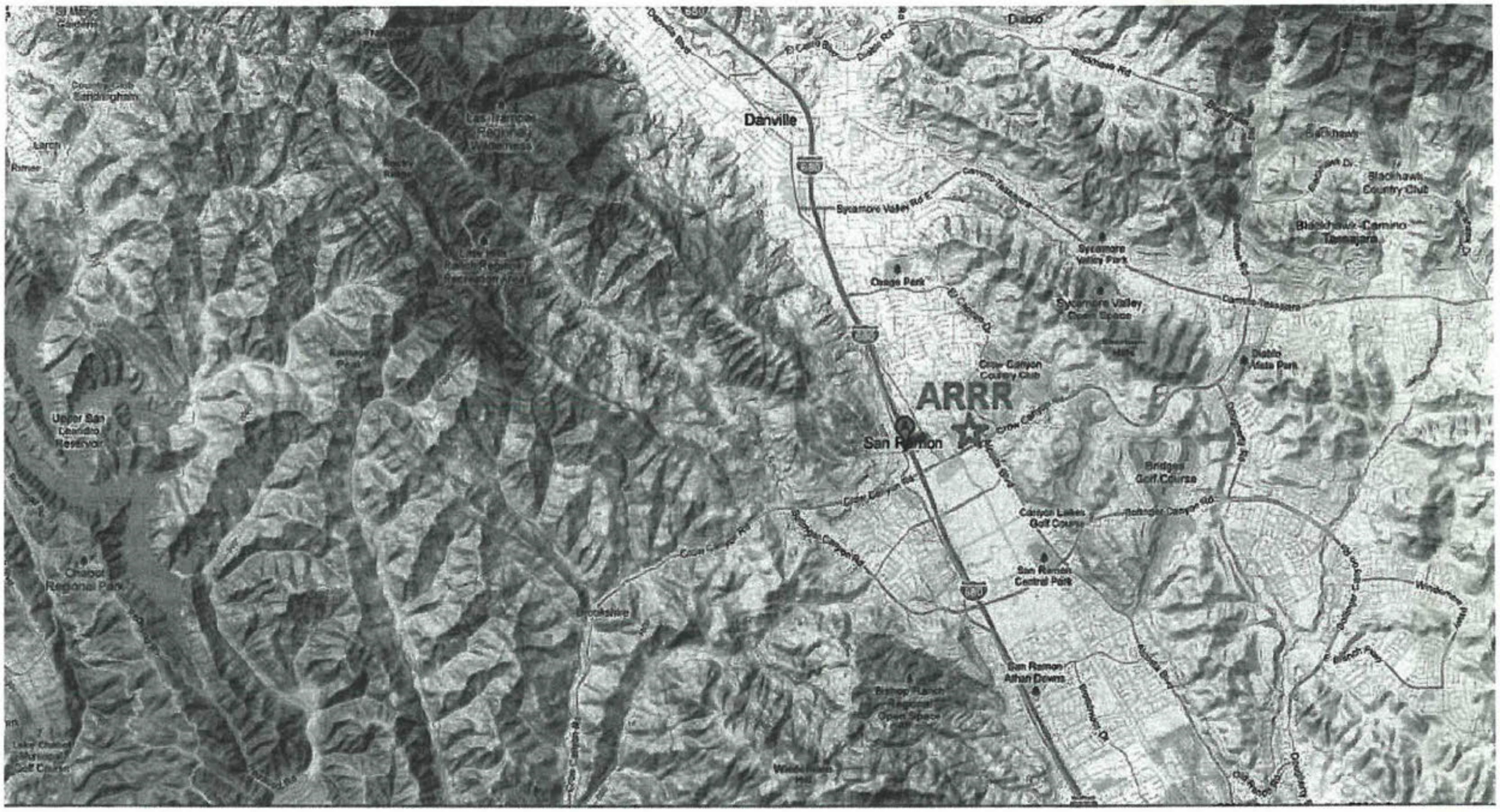

Figure 3-3: ARRR Site and Surrounding Area Topography

Figure 3-4: Stratigraphy of ARRR Site Region

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Figure 3-5: Regional Soil Survey Data

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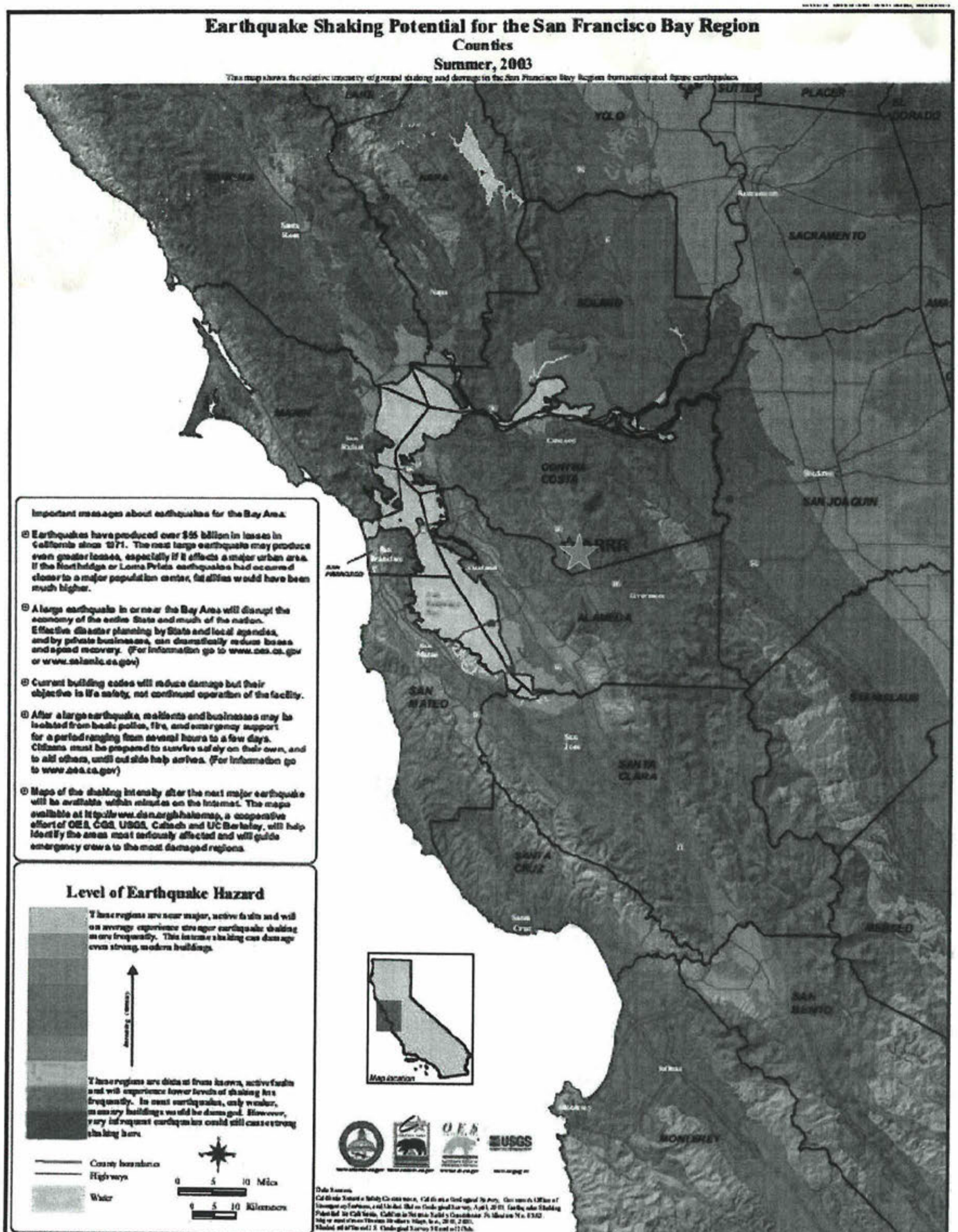

Figure 3-6: San Francisco Regional Earthquake Hazard Map

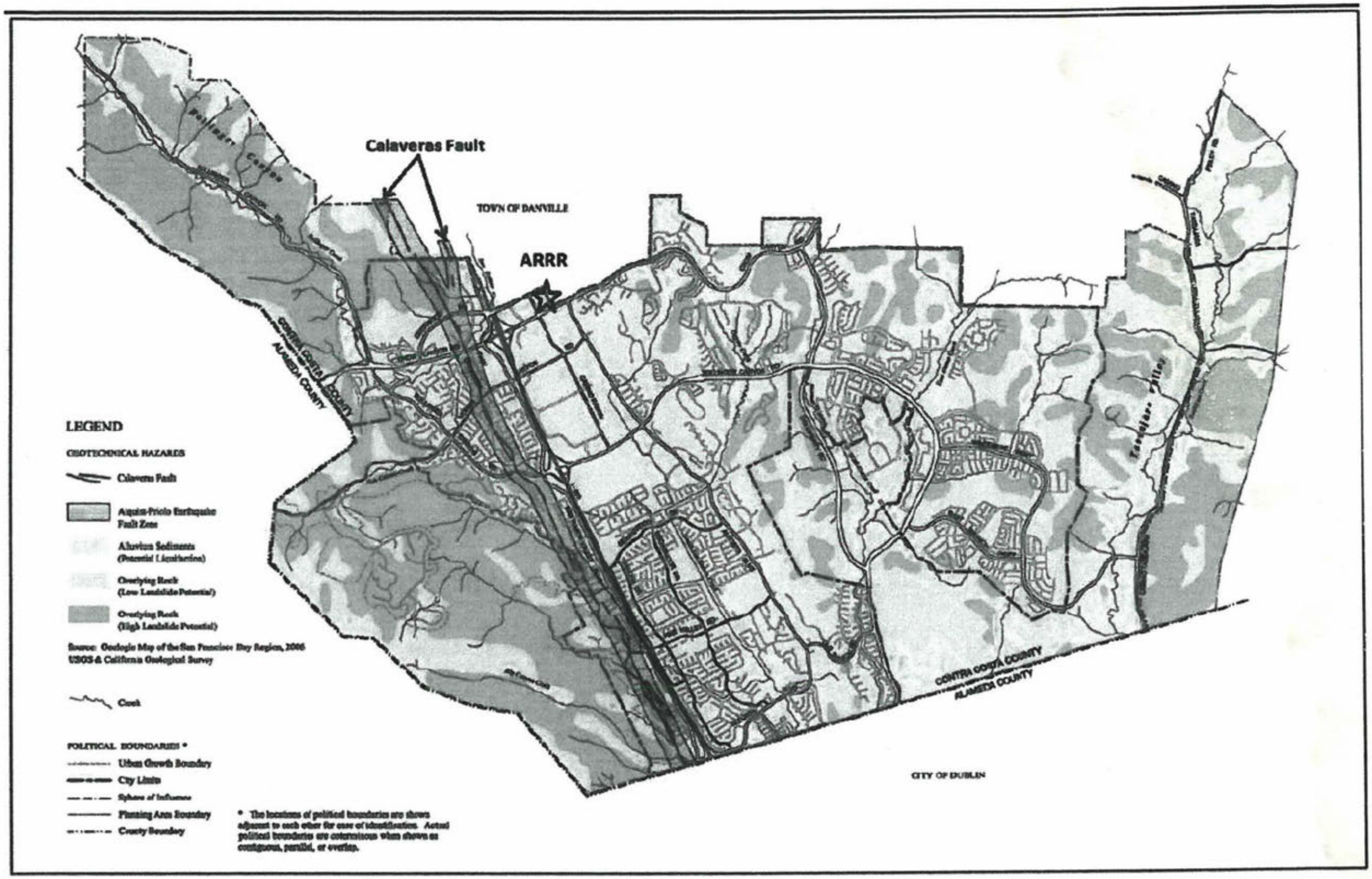

Figure 3-7: San Ramon Geotechnical Hazards Map

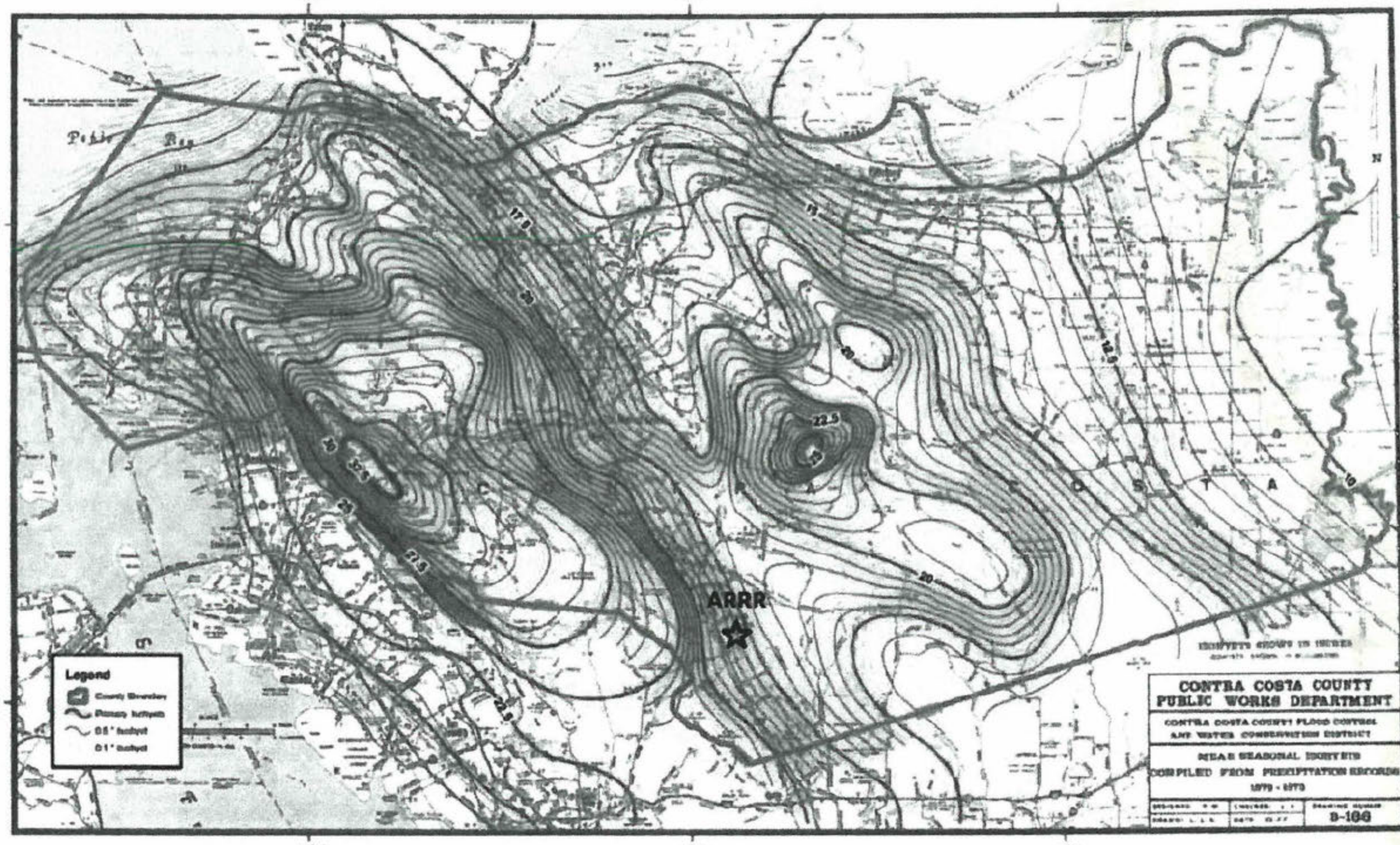

Figure 3-8: Contra Costa County Mean Seasonal Isohyets

Figure 3-9: Surface Water

Figure 3-10: Special Status Plant Species

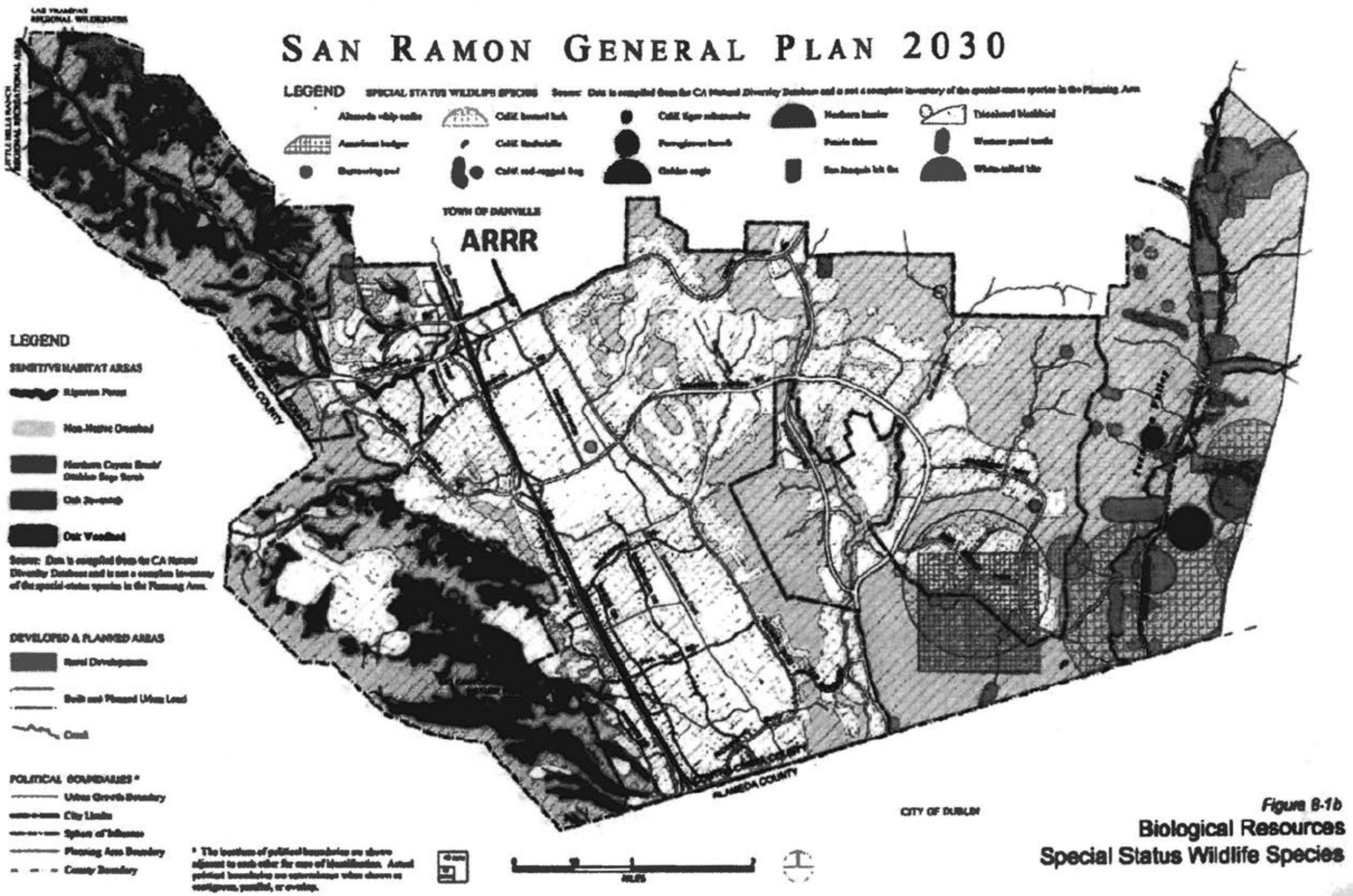

Figure 3-11: Special Status Wildlife Species

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 or radioactive materials during decommissioning 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 members of the public off site during normal or routine ARRR 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. The key hazards during this work 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 ARRR structures, and contaminated soil.

Generally, the Decommissioning steps described in 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 hazardous or radioactive materials.
- Possible confined spaces in tents, bags, small rooms or other enclosures 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 ARRR licenses and regulatory requirements include but are not limited to:

- Radiological Work Permits and Hazardous Work Authorization procedures, as required;
- Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120 requirements for PPE, air monitoring, work zone controls, medical surveillance and bioassay 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;
- removal of contaminants in air by HEPA filter;
- removal of contaminants in air by dust filter.

4.1.2 Potential Exposures

The collective dose equivalent estimate to workers for the entire Decommissioning project is about 3.8 person-rem. The decommissioning tasks will take approximately 6 months. Total person hours involving radiological exposure is estimated to be 12,000 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. 5-5). 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 the US Nuclear Regulatory Commission (NRC) provided screening values provided in NUREG-1727, *NMSS Decommissioning Standard Review Plan* (Ref. 5-13) or NUREG-1757 Vol. 1, *Consolidated NMSS Decommissioning Guidance Decommissioning Process for Materials Licenses* (Ref. 5-14).

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 US Department of Transportation (DOT), US Environmental Protection Agency (EPA), 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.

The city of San Ramon has a Residential Traffic Calming (RTC) program that outlines a variety of traffic calming measures to improve the quality of life in local residential neighborhoods.

The decommissioning of the ARR will have little impact on the area and little change in truck traffic. Truck shipments of concern consist of hazardous waste and radioactive waste leaving the site. During ARRR Decommissioning activities, short-term transportation effects would include employee and contractor trips, which occur under existing conditions, and fewer than 16 truck trips for hazardous and radiological waste transfer. Traffic, circulation and parking effects are expected to be minor due to the small increase in on-site personnel and trips and the short duration of this action, and would not significantly impact the surrounding roadways.

Large trucks routinely deliver to adjacent businesses and the slight increase in traffic volume will not be noticeable and there will be no increase in noise levels. The site is located on main traffic routes as indicated on the San Ramon planning map shown in Figure 4-1.

4.2 Waste Disposal

4.2.1 Hazardous Waste

Small amounts of solid and liquid hazardous waste from ARRR decommissioning activities would be accumulated and 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 waste will be included as part of the regular shipments made by the Aerotest Operations 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 the Clive Utah disposal site or other licensed disposal facility. Any waste to be processed prior to disposal would be shipped to a licensed waste processor.

Low-level radioactive waste generated during the ARRR Decommissioning is expected to consist of one (1) shipment (approximately 120 ft^3) of irradiated hardware requiring a Type B shipping cask and three (3) truck shipments (approximately 3,000 ft^3) of "strong tight" containers to the Clive Utah disposal facility.

Mixed waste on site or generated during the ARRR Decommissioning is expected to consist of activated/contaminated lead from the Beam Tube and other shielding in the beam area and other miscellaneous activated materials. Disposal of these wastes is included in the waste shipments above.

4.2.3 Non-Hazardous Solid Waste

Bulk waste that is not hazardous and not expected to be radioactive may be shipped to an off-site licensed processing facility for surveying and disposal. Some of this waste may also be surveyed and released at ARRR for disposal at a local licensed disposal facility (landfill).

4.3 Noise

During Aerotest TRIGA Reactor 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 short time periods 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 residential area is behind a berm approximately 250 feet east of the site. Noise from ARRR Decommissioning activities would be limited to normal work hours and would not impact off-site residences.

4.4 Seismicity

ARRR Decommissioning activities would involve the removal of surface contamination, minor concrete surface removal in some areas, demolition of the demineralizer shed and the heat exchanger shed, but no structural dismantlement activities for major structures. Decommissioning activities would not increase the risk to ARRR 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 ARRR. Hazardous materials would be located inside the building. Standard asbestos abatement procedures implemented by a contractor licensed by the state of California will be used to remove any asbestos.

Site workers would be protected during decontamination 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 4-1 discusses the applicability of various state and federal regulations for the proposed action.

Table 4-1: 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 from 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 and hazardous 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. Other air emissions would be below warning levels.	Yes
Clean Water Act and Safe Drinking Water Act	The proposed action is not expected to affect surface water bodies or water supplies.	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, hazardous materials and mixed wastes. All waste will be packaged and shipped in appropriate containers and disposed of at licensed facilities.	Yes

Statute/Regulation	Evaluation	Applicability
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
California Department of Health, Radiologic Health Branch	License required by the State of California for several radioactive materials independent of the reactor. License 2010-07 issued.	Yes
California Department of Health, Radiologic Health Branch	Proposed decommissioning of State of California License 2010-07 must comply with Title 17 California Code of Regulations, Division 1, Chapter 5, Sub Chapter 4, Section 30256, "Vacating Installations: Records and Notice". The time needed for the Department to complete the review of a specific license for decommissioning and termination now takes from six to twelve months.	Yes
California Department of Health, Radiologic Health Branch	Transportation of radioactive material would require compliance Title 17 California Code of Regulations, Division 1, Chapter 5, Sub Chapter 4, Section 30373 "Transportation Regulations".	Yes
California Department of Industrial Relations, Division of Occupational Safety and Health (DOSH)	Proposed action must comply with worker safety regulations.	Yes

4.7 Areas Not Affected

The proposed action would not affect the following areas:

Population and Land Use - The proposed action would not result in a change to business activities going on in the area. Future use of the ARRR site is expected to result in the addition of a new or expanded business in this area of San Ramon.

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

Aesthetics - The proposed action would only be visible in the immediate vicinity of ARRR. Aerotest is visible from adjacent buildings to the south, west and north. However the externally visible activities will occur at the traffic circle at the end of Fostoria Way. This is not a through street and has limited non-commercial traffic. Temporary Decommissioning activities will be compatible with continuing development of the surrounding areas.

Biology - There are no known sensitive or endangered species on the ARRR site as discussed previously in section 3.2.4.4.

Hydrology - The site elevation is not in a wetland, nor is it in a 100-year flood plain as shown in Figure 4-2.

4.8 Cumulative Effects

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

Human Health - The total radiation dose estimated for decommissioning workers is 3.8 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 3.8 person-rem is consistent with collective exposures reported in Figure 17 of *Decommissioning Techniques for Research Reactors* (Ref 5-15). 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 near 3 person-rem and is less than the 3.8 person-rem anticipated for the ARRR decommissioning.

The radiation doses to members of the general public, as a result of decommissioning activities described in the ARRR Decommissioning Plan, are expected to be negligible. The dominant internal exposure pathway for members of the public is inhalation. The potential for 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. 5-5). 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 3,000 cubic feet of low-level radioactive waste. The waste requiring disposal would be shipped to the Clive Utah disposal site or other licensed disposal facility. The Clive Utah site has 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 - ARRR decommissioning activities would occur in a non-residential area and would largely occur within the ARRR Buildings. The proposed action would not contribute significantly to off-site background noise levels due to the relative isolation of the work site.

Aesthetics - ARRR Decommissioning activities would not be visible to adjacent residential neighbors and to adjacent industrial neighbors only when outside equipment removal activities take place. Following release to unrestricted use, the ARRR site would be used in a manner consistent with the existing land use practices or more likely sold to PG&E (which surrounds the site on three sides) or other light industrial user.

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 ARRR decommissioning activities would be localized; no changes to any landforms would occur; there are no exposed areas that are radiologically contaminated and no radioactive or hazardous materials would be released to storm water runoff as a result of the proposed action.

Regional Air Quality – Data from nearby monitoring stations, as noted in section 3.2.2.4, indicates that federal and state standards for some pollutants were exceeded during several days, during monitoring years from 2006 through 2008. 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.

Biological Resources - No biological resources have been identified on the ARRR site; moreover, ARRR 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 action but for a potentially much greater time period. This would involve retention of the fuel on site until the DOE is able to take the spent fuel. This alternative would necessitate continued surveillance and maintenance of ARRR over a substantial time period. During this period, the risk of environmental contamination would continue to exist. This alternative is not environmentally preferable.

Alternative 2 to Proposed Action - Entombment (ENTOMB)

This alternative would necessitate continued surveillance and maintenance of the ARRR Reactor over a substantial time period. During this period, the risk of environmental contamination would continue to exist. This is not currently a viable option as the fuel must first be removed from the site and there is not a possibility for fuel removal in the near future. This alternative is not environmentally preferable.

No Action Alternative - A no-action alternative would leave the facility in its current status with the current support staff having to maintain the facility under the existing license conditions. This action is specifically prohibited by the NRC for this facility without a license transfer to a new facility owner.

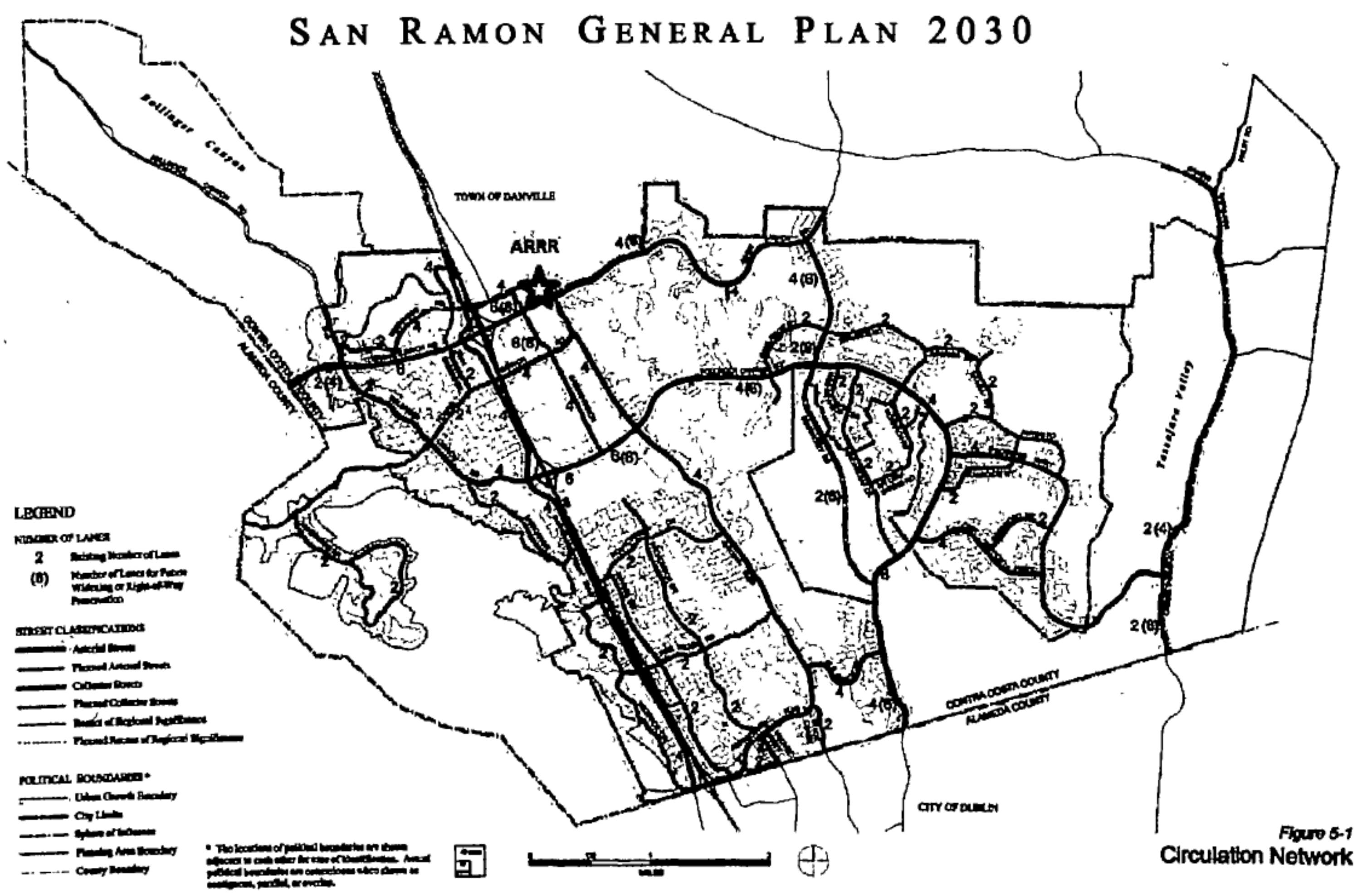

Figure 4-1: City of San Ramon Traffic Plans

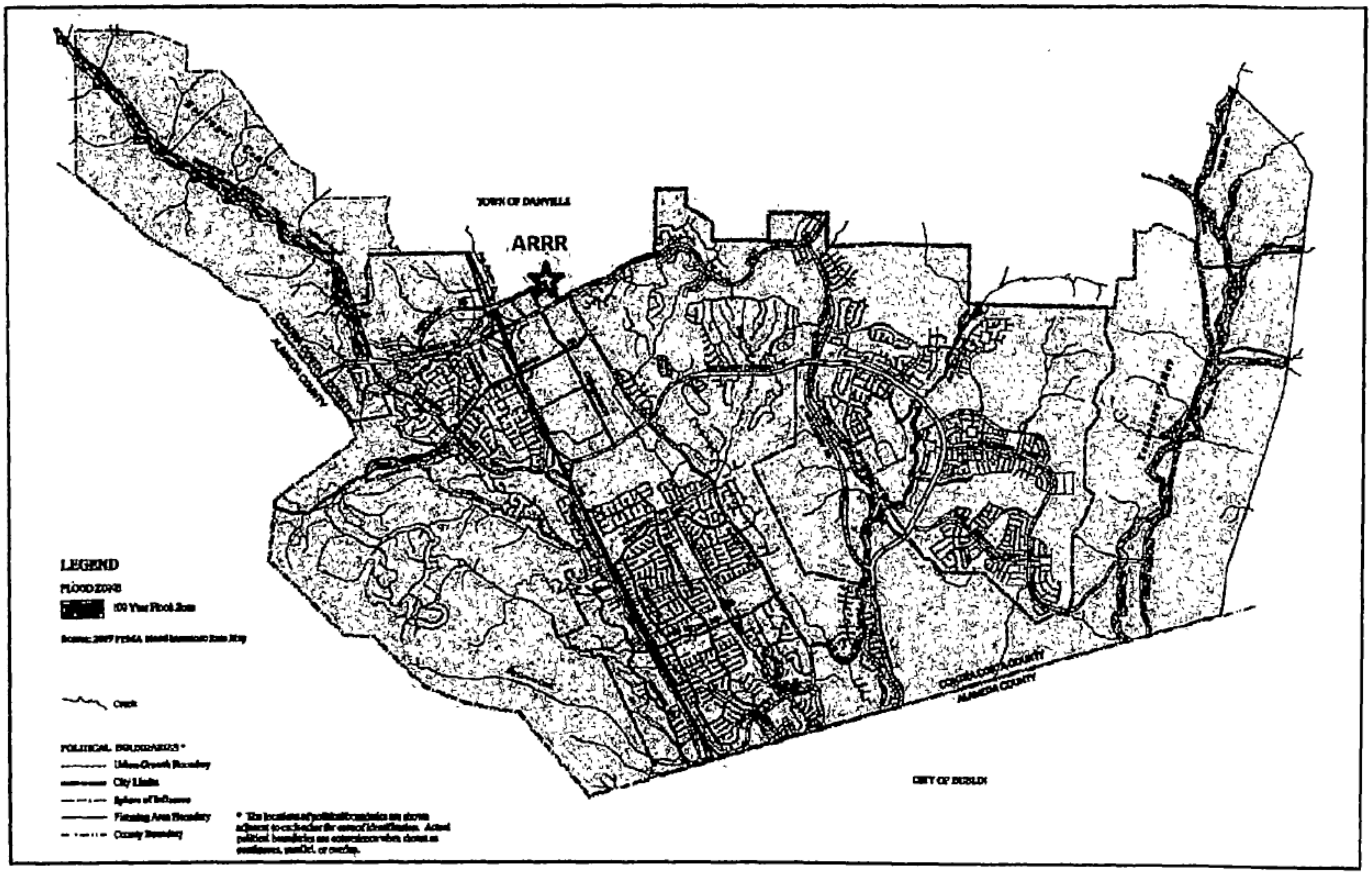

Figure 4-2: City of San Ramon Flood Zone Map

5.0 REFERENCES

5-1 National Council on Radiation Protection and Measurements (NCRP). Ionizing Radiation Exposure of the Population of the United States. Report No. 160. 2008.

5-2 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.

5-3 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.

5-4 *Nuclides and Isotopes, Chart of Nuclides; 14th Edition*, Nuclear Energy Operations, General Electric Company, San Jose, CA; 1989.

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

5-6 USGS Information Services, Box 25286, Denver Federal Center, Denver, Colorado 80255-0046, *Preliminary Geologic Map Emphasizing Bedrock Formations in Contra Costa County, California: A Digital Database*, 1994.

5-7 City of San Ramon, City of San Ramon General Plan 2030, Draft EIR, April 5, 2010.

5-8 United States Department of Agriculture, National Cooperative Soil Survey, *Web Soil Survey Data for the State of California, Contra Costa County*, with Area of Interest around San Ramon California.

5-9 Aerojet-General Nucleonics, AN-1405, *Aerojet-General Nucleonics Industrial Reactor (AGNIR) Technical Specifications*, April 1965.

5-10 Contra Costa County Flood Control & Water Conservation District, *Mean Seasonal Precipitation Raster from Drawing B-166*, December 1, 2009.

5-11 City of San Ramon, *Phase I Environmental Site Assessment San Ramon City Center Project, Appendix F: Preliminary Hydrology Report*, April 2, 2007.

5-12 NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*

5-13 US NRC, NUREG-1727, *NMSS Decommissioning Standard Review Plan*, September 2000

5-14 US NRC, NUREG-1757 Vol. 1, *Consolidated NMSS Decommissioning Guidance Decommissioning Process for Materials Licenses*, September 2002.

5-15 *Decommissioning Techniques for Research Reactors*, Vienna, International Atomic Energy Agency, 1994, (Technical reports series ISSN 0074-1914; 373)