REPORT OF UCLA REACTOR DECOMMISSIONING

Guide for Phase II, Final Phase

License R-71
Docket 50-142

June 9, 1988

1.0 PLAN BACKGROUND AND MANAGEMENT

The dismantlement and decommissioning of the UCLA nuclear reactor facility was planned as a two-phase program.

The Decommissioning Plan for Phase I was submitted to the Nuclear Regulatory Commission (NRC) on October 29, 1985. Phase I commenced after approval of the plan by the NRC on July 14, 1986. A report on Phase I reactor decommissioning was submitted to the NRC on April 12, 1988.

The goal of Phase II is the dismantlement and removal of the concrete biological shield and complete decontamination of the room, its appurtenances, and the remaining equipment. The facility is to be released for unrestricted use as defined by US NRC Regulatory Guide 1.86. This Phase II Plan follows the format outlined by the US NRC Standardization and Special Projects Branch paper entitled, "Guidance and Discussion of Requirements for an Application to Terminate a Non-Power Reactor Facility Operating License," dated September 15, 1984.

1.1 Summary Description

After approval of this plan by the NRC, UCLA intends to distribute a Request for Proposal to prospective commercial bidders to complete decommissioning of the reactor facility in accordance with the Phase II plan.

This Plan provides a description of the reactor facility, its current radiological status, the decommissioning approach, tasks and schedules, estimated costs, and the radiation protection program to be exercised during Phase II.

1.2 Reactor Facility Description

The UCLA reactor and support facilities are located in the reactor building within Boelter Hall. The facility includes the reactor room (room 104), adjacent first floor work spaces (rooms 102 and 103), and the former control (room 201). Fig 1.1 and 1.2 illustrate these rooms. The transformer vault (room 104) serves as the power distribution center for the entire reactor building. A restroom and a shower are located in the southwest corner of the former control room. Other support areas that were once a part of the facility were cleared for general use prior to initiation of decommissioning.

Besides the concrete biological shield and movable shield blocks, the reactor room houses a balcony at the second floor level, a stairway to the ground floor of the room, a ventilation exhaust system, a 10 ton bridge crane, piping and drains, 30 cylindrical fuel storage pits, a sink usable for low-level decontamination of small tools, a shower, three floor drains and the process pit containing the sump, sump pump, and two 250 gallon holding tanks.

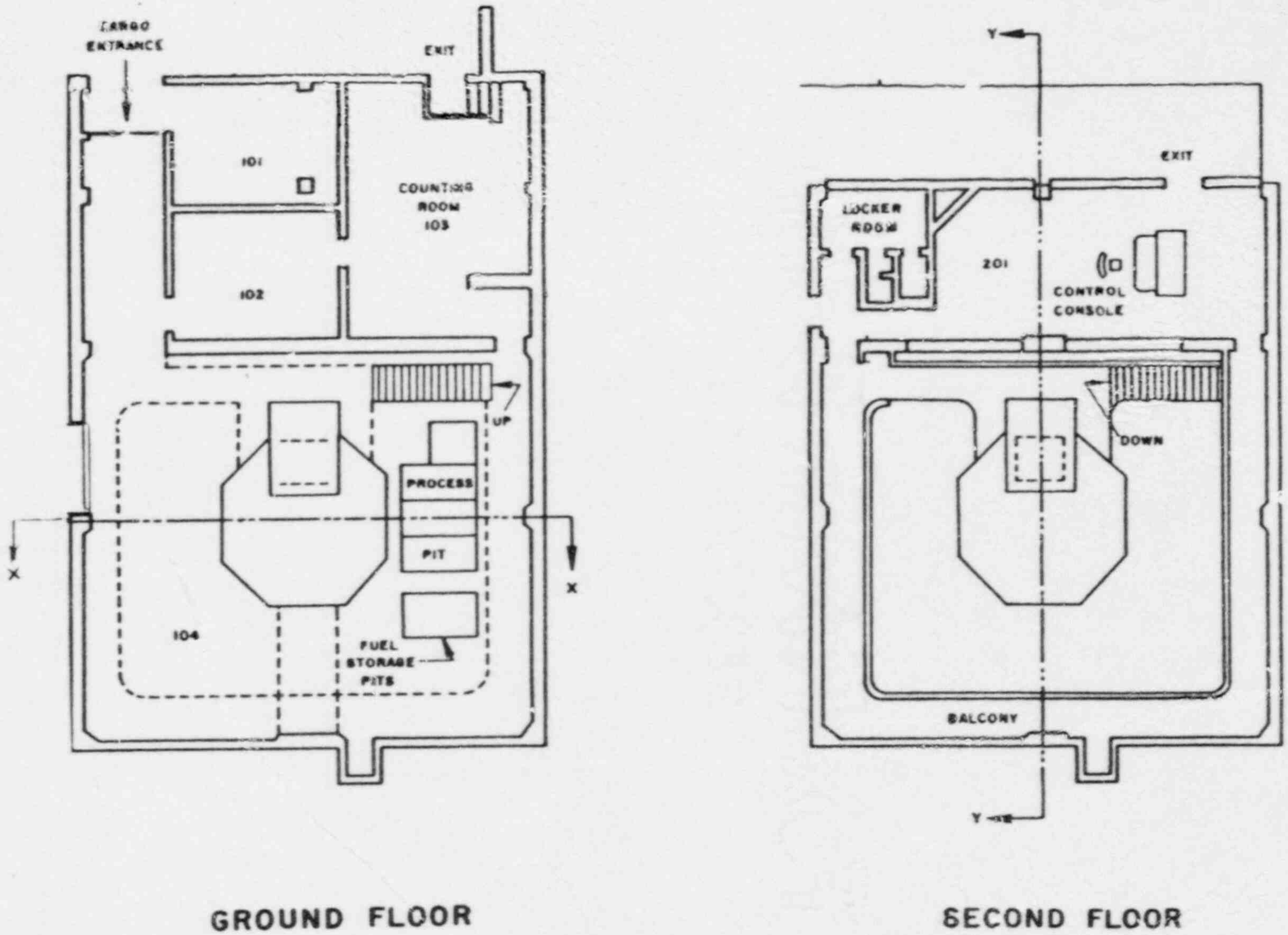
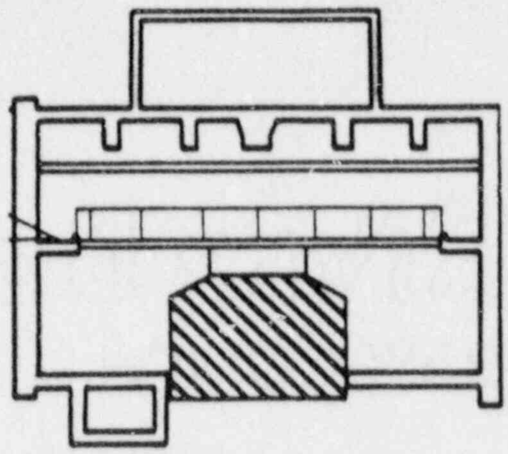


Fig. 1.1. Reactor Facility Floor Plan



SECTION X-X

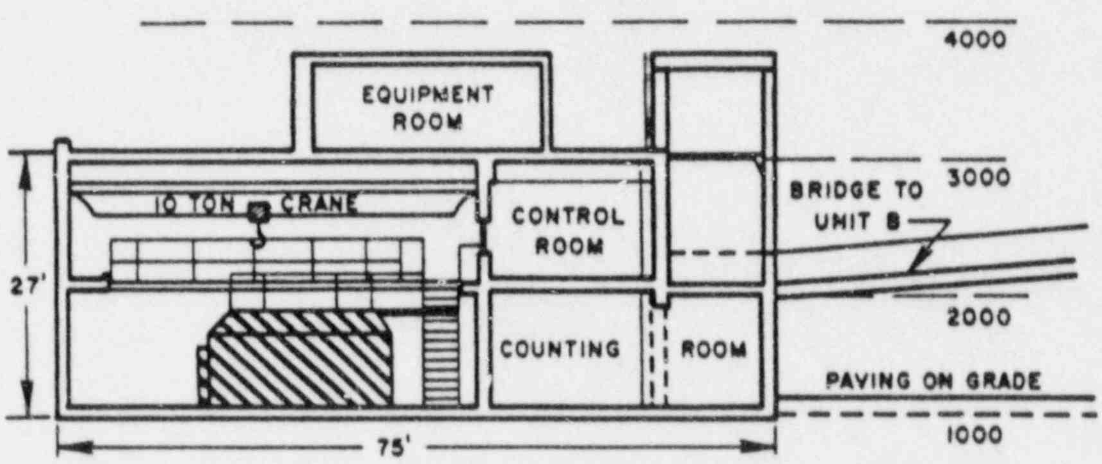


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Fig. 1.2. Reactor Building - Sections

The ventilation exhaust system includes ductwork which extends from the floor of the reactor room to the seventh floor (roof), the exhaust fan and intake plenum on that roof, and the exhaust stack which rises about 20 feet above the roof level.

The reactor building is a two story structure 75 feet long (east-west), 49 feet wide (north-south), and 27 feet high. It is walled off and provides the foundation of a seven story building. It shares common walls with laboratories, shops, and offices on the north, east, and south sides. The reactor room occupies the eastern 43 feet of the building and is 49 feet wide by 27 feet high.

1.3 Current Radiological Status of the Facility

All non-embedded components of the reactor have been removed from the site. These include the core-moderator, the graphite thermal column, shield tank, peripheral equipment, fuel boxes, control blade system components, protruding parts of pipe and structures, and twenty-five of the twenty-nine concrete shield blocks. The remains of the reactor consist of the concrete biological shield which includes the monolithic structure and four removable shield blocks. The principal embedments in the blocks is steel in the form of reinforcing bar, angle iron edging, beam port liners, and plugs. The total radioisotope inventory in the remains is shown in Table 1.1. The radiation levels in the reactor room are present in Fig. 1.3.

Table 1.1. Radioisotope Inventory - Fixed Concrete

Isotope	Half-life (years)	Concrete Activity %	Concrete Activity (Ci)	Steel Activity %	Steel Activity (Ci)	Total (Ci)
Mn-54	0.865	0.3	0.04	0.4	0.01	0.05
Co-60	5.27	9.0	1.07	18.1	0.[illegible]	1.25
Cs-134	2.06	0.2	0.02	--	--	0.02
Eu-152	13.6	13.7	1.62	--	--	1.62
Eu-154	8.6	1.0	0.12	--	--	0.12
H-3	12.3	61.8	7.32	--	--	7.32
C-14	5730.0	14.0	1.66	--	--	1.66
Fe-55	2.7	--	--	75.1	0.76	0.76
Tc-99	214000.0	--	--	6.5	0.07	0.07
		100.0	11.85	100.0	1.02	12.87

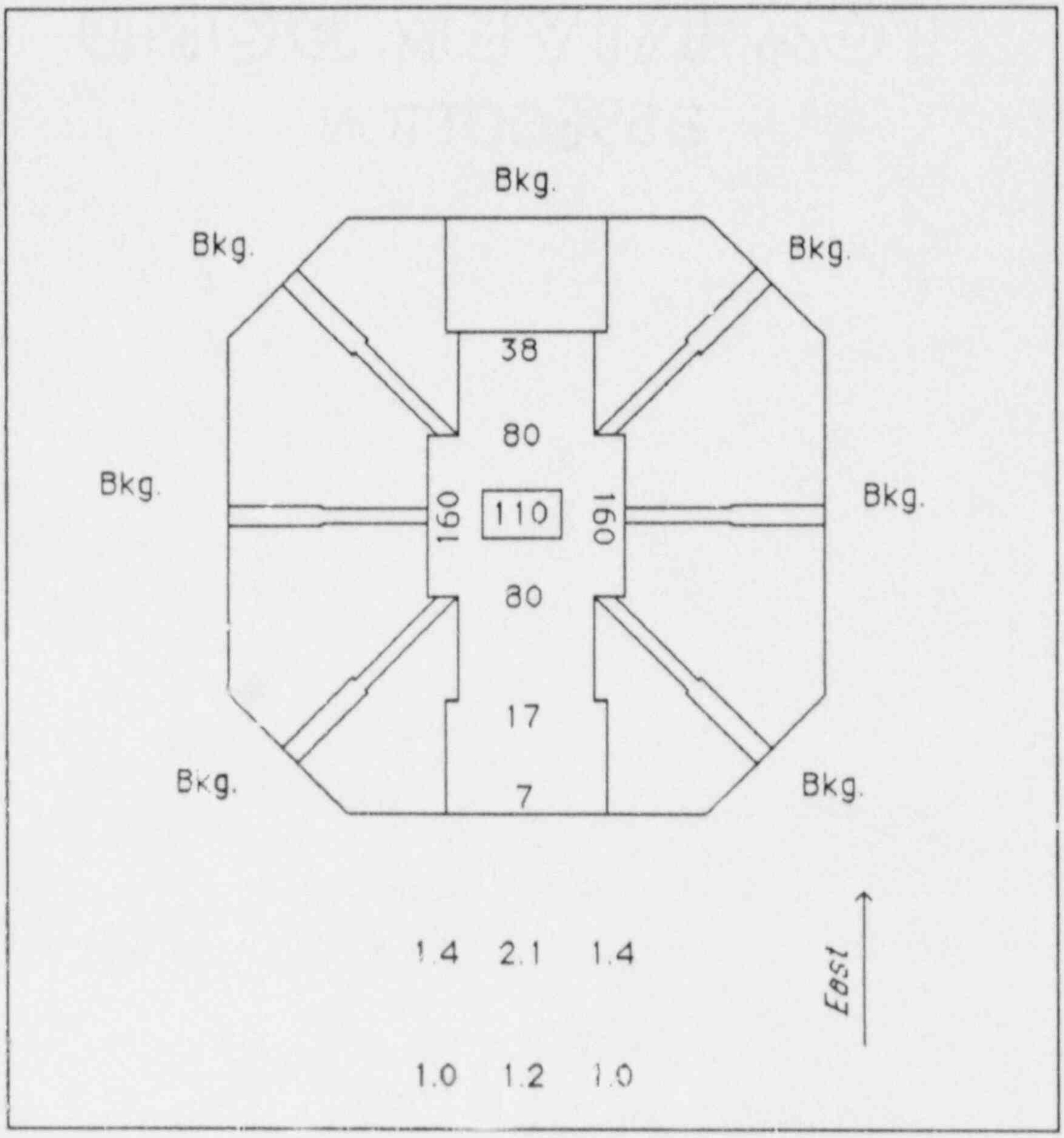


Fig. 1.3. Radiation Levels (mR/h) in the Reactor Room.

Note: All measurements acquired with ion chamber survey instrument at 1.0 meter above floor surface.

Background Levels (Bkg.) are less than 0.1 mR/h.

1.3.1 Pipes, Drainlines, and Ductwork

The primary water system has also been removed and the residual equipment in the process pit consists of a sump, a sump pump and two 250 gallon holding tanks. The sink and shower drainlines merge with three other floor drains to empty into the sump. A separate drain from the reactor core also passes to the sump. Swipes of inlets and outlets of these drainpipes and the accessible points of the exhaust system ductwork when counted on a beta counter, revealed all surface contamination levels below the limits prescribed in Table 1 of USNRC Regulatory Guide 1.86. However, it is possible that the pipes and drainlines may have been activated from neutron streaming. Further surveys will be performed during Phase II as increase access is gained.

The sump is a reservoir 24 inches wide, 24 inches long and 61 inches deep. At the bottom there is about an inch and a half of sludge covered by approximately 24 inches of water. Samples of the water and the sludge were individually counted on a high resolution Ge(Li) spectrometry system and a liquid scintillation spectrometer for possible contamination. The results are reported in Table 1.2.

Table 1.2. Activity of Radioisotopes in the Sump

Isotopes	Half-Life (years)	Water %	Activity* (μCi)	Concrete Sediment %	Activity** (μCi)	Total (μCi)
Cs-60	5.27	---	---	10.3	50.0	50.0
Eu-152	13.6	---	---	26.0	127.0	127.0
H-3	12.3	100	18.3	52.1	253.8	272.1
C-14	5730.0	---	---	11.6	56.7	56.7
		100	18.3	100.0	487.5	505.8

* Volume of Sump water is approximately equal to 7.83 ft^3

** Volume of the sediment is approximately equal to 0.5 ft^3. Density of the sediment is taken to be that of concrete, i.e., 200 lbm/ft^3.

1.4 The Decommissioning Approach

For Phase II, UCLA intends to complete decommissioning of the facility for "unrestricted" use by availing the services of an outside contractor. "SAFSTOR" is no longer under consideration. The selected decommissioning alternative is "DECON". After the approval of this plan by the NRC, UCLA will soon distribute a Request for Proposal to potential commercial bidders.

1.5 Decommissioning Organization and Responsibilities

An organizational line has been developed to overview the decommissioning program. Since most of the demolition and decommissioning work will be performed by the outside contractor, the organizational line as detailed in Fig 1.4 will only be peripherally involved. UCLA will provide a Health Physicist at the site whenever work is in progress.

1.6 Regulation, Regulatory Guides, and Standards

Demolition, decontamination, and decommissioning will be governed by all applicable State and Federal regulations and requirements. Table 1.3 provides a list of the major regulations; regulatory guides, standards and the pertaining subject matters.

1.7 Training and Qualifications

UCLA would require the outside contractor to do the following:

a. Demonstrate the qualification and experience of all the personnel (subcontractors included) involved in decontamination, decommissioning activities, health physics, and use and maintenance of monitoring and safety equipment.

b. Provide a detailed account of the training program used for workers concerning radiation hazards and work with radioactive material.

c. Provide a complete description of the methods proposed by the firm to bring the project to completion.

These items are expected to be in the quotation submitted by the bidder. UCLA will review these items to ensure ALARA procedures, health and safety compliance with all State and Federal guidelines and regulations, and the UCLA license. UCLA will reserve the right to interrupt operations which are seen as unnecessarily compromising to the health and safety of the students, faculty or staff or leading to unacceptable environmental contamination, until the problem is rectified.

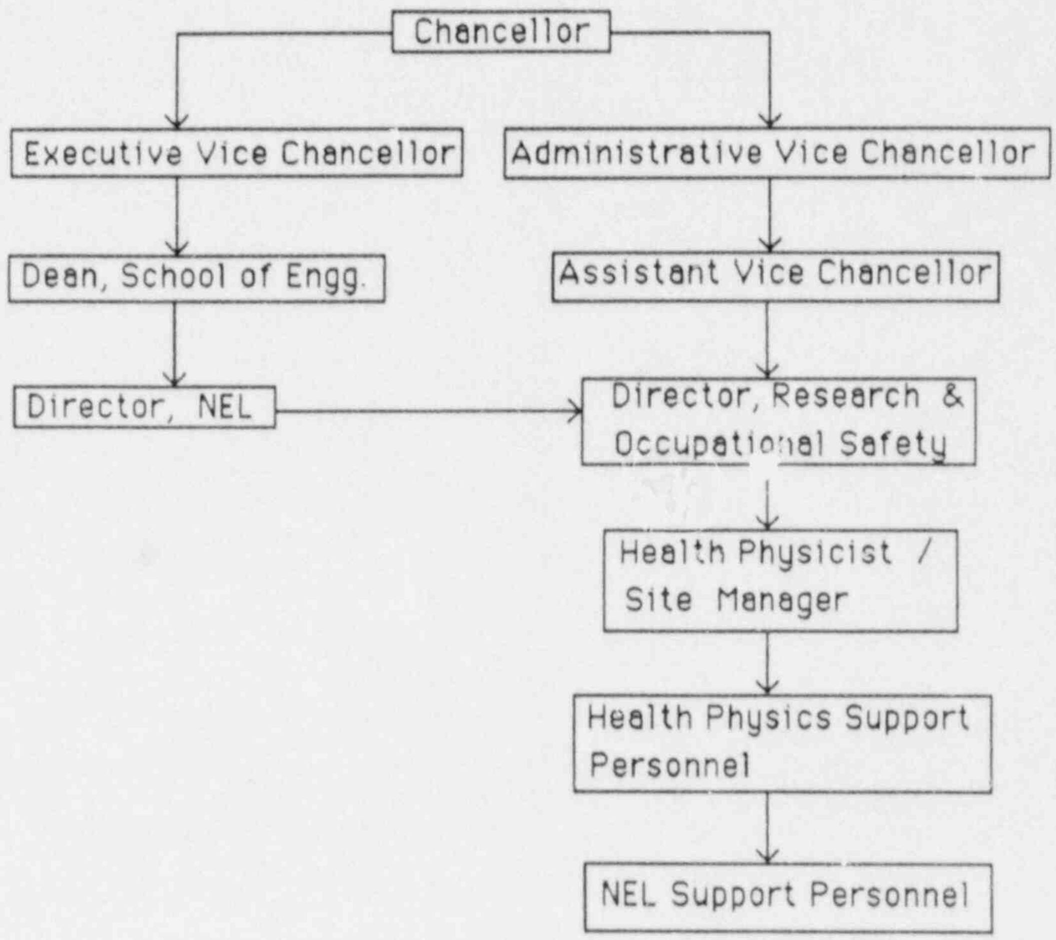


Fig. 1.4. Organizational Line during Decommissioning.

Table 1.3. Regulations, Guidelines, and Standards

Subject	Title
Radiation Protection and Surveys	* Title 10 Code of Federal Regulations Part 20 * NRC Regulatory Guide 1.86 * NUREG/CR 2082, "Monitoring for Compliance with Decommissioning Termination Survey Criteria"
Worker Safety	* California Broad Scope License, 1335-70 * Title 8 California Administrative Code (Cal OSHA)
Environment	* Title 40 Code of Federal Regulations (EPA - NEPA) * Title 14 CAC, Chapter 3, "Guidelines for Implementation of the California Environmental Act" * NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities"
Transport of Radioactive Materials	* Title 10 Code of Federal Regulations Part 71, "Packaging of Radioactive Materials for Transport and Transportation of Radioactive Material under Certain Conditions" * Title 49 Code of Federal Regulation, Department of Transportation Hazardous Material Regulations
Decommissioning	* NRC's, "Guidance and Discussion of Requirements for an Application to Terminate a Non-Power Reactor Facility Operating License" * ANSI/ANS-15.10-1981, "Decommissioning of Research Reactors"

2.0 OCCUPATIONAL AND RADIATION PROTECTION PROGRAMS

2.1 Radiation Protection Program

The Radiation Safety Office will exercise a supervisory role during the dismantling and decommissioning through an assigned technologist (health physicist). Policies, procedures, and practices will be those specified in the UCLA Radiation Protection Manual and other applicable regulations and guides (see Table 1.3). Its Radiation Protection Program for decommissioning involves requirements to monitor, control, and adequately limit surface contamination, radiation field, and personnel exposure. All techniques and practices will be designed to keep radiation exposure levels ALARA and within 10CFR20 requirements.

2.1.1 Personnel Dosimetry

For external exposure assessment, all workers will be required to wear personnel dosimeter film badges and calibrated pocket ionization chambers. The ionization chambers will provide a daily record of personnel doses. Extremity dosimeters will be kept at hand and provided to personnel if required.

For assessment of internal contamination, the Radiation Safety Office has counting facilities for bioassays such as thyroid, urine, and total body count. TBCs will be employed on workers before and after the Phase II work. The estimated collective dose-equivalents during Phase II is shown in Table 2.1.

Table 2.1. Estimated Collective Dose-Equivalent of Personnel during Phase II

Task Activity	Person-Rem
1. Contractor Move-in & Initial Radiation Survey	0
2. Concrete Demolition and Removal	1.5
3. Package Materials for Transport & Burial	0.5
4. Final Release Survey	0.0
	2.0

2.1.2 Instrumentation

A wide range of radiation monitoring instruments are currently available at the reactor. These include portable and non-portable instruments for radiation field surveys, radioactive contamination surveys, area monitoring, particulate monitoring, personnel monitoring, and sample analysis. Table 2.2 lists the type of these instruments. These instruments are routinely calibrated by the Radiation Safety Office. Only "NBS traceable" standards are used in calibration of these instruments.

The contractor will supplement the list with his/her own equipment. He/She will be required to furnish detailed documentation of appropriate calibrations for all radiation survey and measuring instruments to be used on the project.

Table 2.2. Types of Radiation Monitoring Instruments Available for Reactor Decommissioning

* Portable GM Survey Meters
* Portable Ion Chamber Rate Meters
* Single Channel Analyzers with Scintillation and GM Probes
* Micro R Meter
* Liquid Scintillation Counter System
* Gamma Spectroscopy System
* Pressurized Ion Chamber System
* Hand and Foot Monitor
* Pocket Ion Chamber Dosimeters
* High Volume Air Sampler
* Stack Effluent Monitor

2.2 Industrial Safety and Hygiene Program

The Office of Research and Occupational Safety (OROS) will oversee the industrial safety and hygiene program. OROS has specialists in the areas of toxic materials, electrical safety, machine safety, and fire protection. All personnel protective equipment such as half-face dust respirators, anticontamination clothing, safety shoes, safety glasses, temporary shield, etc. provided by the contractor will be used under the guidance and direction of the OROS.

2.3 Contractor Assistance

The selected contractor will be required to provide all labor, equipment, materials, shipping, routine health and safety monitoring, and any other requisite factor to complete the project. This will include the packaging, removal, and transportation of radioactive and non radioactive material from the site in accordance with all governing regulations. However, UCLA shall oversee and review all tasks during the decommissioning project. UCLA will retain overall responsibility for health and safety considerations during decommissioning.

2.4 Cost Estimate and Funding

The cost of Phase II decommissioning is estimated to be \$200,000 exclusive of internal personnel costs. This includes the estimated cost of the termination survey. The School of Engineering and Applied Sciences (SEAS) has approved this cost.

3.0 DISMANTLING AND DECONTAMINATION TASKS AND SCHEDULES

3.1 Tasks

The Contractor's tasks in Phase II will include the following:

a. raising the concrete monolith and pedestal to floor level,
b. excavation of the approximately 52 ft^3 of concrete down to about 22 inches below floor level,
c. removal of four large concrete blocks,
d. packaging materials for appropriate land burial,
e. transfer of such material to burial site,
f. decontamination of the reactor room and nearby areas, and
g. final release survey of the facility.

3.2 Schedule

The schedule for the decommissioning project after approval of this plan by the NRC is shown in Table 3.1

Table 3.1. Estimated Schedule of Phase II Decommissioning of the UCLA Argonaut Reactor Facility

Task/Activity	Time Period
1. Selection of Contractor	30 days
2. Contractor Move-in and Initial Radiation Survey	30 days
3. Concrete Demolition and Removal	60 days
4. Packaging and transfer of materials to burial site	20 days
5. Clean up and final release survey	30 days
Total duration after NRC plan approval	170 days

Of course, the schedule is subject to unforseeable delays and/or events beyond the control of UCLA.

3.3 Tasks Analysis

3.3.1 Contractor Move-in and Initial Radiation Survey

This initial task would involve setting up a temporary office for the Contractor, planning of future tasks, demarcation of work areas, health and safety training of all employees, and an initial radiation survey by the Contractor. This survey would be based on the existing data supplied by UCLA indicating the current radiological status of the facility.

Room 201 (see Fig. 1.1) which was formerly the control room is cleaned and can be used as an office. It houses reactor records, health physics supplies, and a garment change room for donning protective clothing. It will be used as a control point of entry to the reactor room during decommissioning.

3.3.2 Concrete Demolition and Removal

The concrete to be removed by the Contractor can be classified in several ways: composition, structural geometry, and neutron induced radioactivity level. The latter is detailed in Table 1.1. A brief description of the other two classification follows:

3.3.2.1 Composition: Three different concrete mixes were used in forming the biological shield. These are:

Type	Density (lbm/ft^3)
Mix No. 1: Heavy Concrete	197 (207)
Mix No. 2: Extra Heavy Concrete	235 (247)
Mix No. 3: Conventional Concrete	147 (150)

For each mix, the first density is the builder's specification of minimum density. The density enclosed in parenthesis is the number used by UCLA in estimating weights as built. No further description of the mixtures has been found. Physical examination of core samples show a grayish continuum with both lighter and very dark aggregates. The dark aggregate, with typical dimensions of a few centimeters, is magnetite. It is assumed that the concrete consists of a conventional concrete with magnetite substituted for some of the more commonly used aggregates.

3.3.2.2 Structural Geometry: The extra heavy concrete is found only in some of the removable blocks. The pedestal and subfloor are assumed to be constructed of conventional concrete.

The following estimates of volume and weight of on-site concrete are based upon gross volume of the prismatic structure less the sum of voids (core, thermal column, and shield tank) and removable blocks plus a subfloor excavation.

Table 3.2. Summary of Volume and Weight of Structures

Types of Structures	Volume (ft^3)	Density (lbm/ft^3)	Mass (tons)
Monolithic Structures	1196	150	89.7
	1139	207	117.9
Pedestal	140	150	10.5
Removable Blocks	288	(see Table 3.3)	32.7
Excavation	52	150	3.9
Total	2815		254.7

Further details of these structures are described in the following paragraphs.

3.3.2.3 Monolithic Structures: The vendor drawings indicate that the upper 30 inches and west most 76 inches of the monolith are constructed of conventional concrete, the remainder is heavy concrete. The monolithic structures contain reinforcing bar, electrical conduit, three steel beam port liners (each wing), and a steel plate in the western, conventional concrete, region of each wing. The single drawing that refers to the plate specifies only a 24 inch width. The thickness sealer to 1/2 inch, the height is not specified.

3.3.2.4 The Pedestal: The pedestal runs the entire east-west length of the shield at a width of approximately 5 feet and rises 14 to 16 inches above the floor level. The height and width change in discrete steps to reduce neutron streaming paths.

The pedestal contains the embedded part of the reactor "framework" which supported the control blade system within the core. It is rectangular in outline consisting of two parallel 5 inch 5.7 no. channels, each about 76 inches long with 24 inches long end pieces of the same stock. The 21 inches inside distance between the long channels is further fixed by two angles 5 inches x 5 inches x 5/16 inches perpendicular and welded to the channels. One flange of each channel and one leg of each of the angles is visibly flush with the top surface of the pedestal. Because of mass and close proximity to the core center, this entity is likely to be the single most radioactive object to be encountered in the demolition work.

The pedestal contains some abandoned aluminum pipe and manifolding, and a centered floor drain which empties to the sump.

3.3.2.5 Removable Blocks: All of the removable blocks are fitted with lifting lugs and are manageable with the 10 ton crane and 4 chain sling. These blocks are described in Table 3.3.

Table 3.3. Removable Blocks

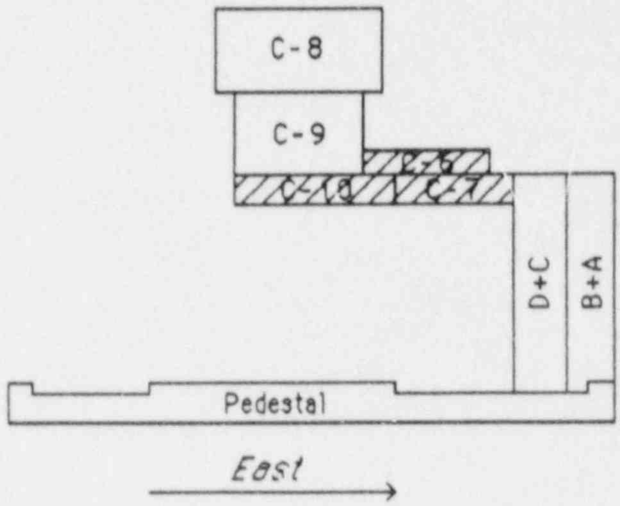
Type[+]	Dimension L x W x H (inches)	Volume (ft^3)	Density (lbm/ft^3)	Mass (tons)
C8	90 x 50 x 30	92.25	207	9.55
Embedded Steel		1.50	480	0.36
C9	84 x 48 x 30	68.79	247	8.50
Embedded Steel		1.21	480	0.29
A + B	66 x 20 x 69	37.93	247	4.68
Void (15 ports)		11.38	0	0.00
Embedded Steel		2.13	480	0.51
A + B				
Port Plugs		10.32	247	1.27
Steel		1.56	480	0.38
C + D	66 x 10 x 69	42.03	247	5.19
Void (15 ports)		7.46	0	0.00
Embedded Steel		3.21	480	0.77
C + D				
Port Plugs		6.18	247	0.76
Steel		1.28	480	0.31

[+] The location of these blocks are shown in Fig. 3.1.

All blocks are edged with 2 inches x 2 inches x 1/4 inches angle (3.19 lbm/ft^3) and contain varying amounts of reinforcing bar. The rebar is sometimes terminated by welds to the center of edge strips. Blocks C-8 and C-9 each contain three cylindrical, vertical steel beam part liners, 3.5 inches x 3.125 inches x 30 inches in C-8 and 2.5 inches x 2.125 inches x 30 inches in C-9.

Blocks A + B and C + D were cast as four separate entities each 10 inches thick and subsequently welded in pairs along adjacent edge strips to form two blocks each 20 inches thick. Block A + B and block C + D each contain 15 rectangular beam ports with matching plugs. The void volumes indicated in the table above are the volumes of the plugs, consequently if the plugs are regarded as a portion of the block, they do not contribute incremental volume to the amount of concrete to be removed.

3.3.2.6 Excavation: The volume is that of a spherical segment of base radius 49 inches extending to a depth of 22 inches below floor level.



Blocks removed during Phase I

Blocks to be removed during Phase II

Fig. 3.1. Location of Removable Blocks

3.3.2.7 The Bridge Crane: The bridge crane is nominally of 10 ton capacity. The bridge runs north-south, the trolley east-west. Balconies limit crane travel in the east-west direction to within about 4 feet of the walls. Bridge carriage width limits crane travel to about 6 feet of the north wall and about 8 feet of the south wall.

3.3.2.8 Balconies and Stairways: There is a reinforced concrete perimeteral balcony at the second floor level on the north, east, and south sides of the reactor room. It continues around the northeast and southeast corners, then drops to the elevation of the reactor top via a steel grid ramp. The steel grid structure continues across the west wall of the room, and supports a steel stairway to the first floor of the reactor room. This steel structure on the west wall is supported by steel beams partially supported by the monolith. Removal of the monolith will require the installation of two columns to replace the two support points.

3.3.2.9 Access: A ramp of 10% slope leads upward from the reactor room floor to the cargo door and the exterior. The door width is about 92 inches and the useful height is limited to about 104 inches by essential plumbing across the ramp ceiling. Because of the height limit, the largest capacity fork-lift that UCLA has found to be capable of entry is a five-ton unit.

3.3.3 Package and Transfer of Materials to Burial Site

All the activated metal components, concrete rubble, any radioactive waste generated during demolition would be securely packaged, surveyed, and shipped to a burial site in conformance with all the governing regulations.

3.3.4 Clean-up and Final Release Survey

Upon completion of the above tasks, a thorough decontamination will be done of the reactor room and nearby areas and a final radiation survey will be performed for release of the facility.

3.3.5 Final Report

At the time of the request for NRC termination survey, UCLA will submit a final report detailing the results of its Final release survey.

3.4 Safe Storage

SAFSTOR is no longer under consideration.

4.0 SAFEGUARD AND PHYSICAL SECURITY

There is no fuel on the site. Normal industrial and physical security measures such as locked doors, limited access to work areas, etc. will be undertaken to prevent inadvertent or unauthorized entry.

5.0 RADIOLOGICAL ACCIDENT ANALYSIS

Since no fuel is no site, this section is not applicable.

6.0 RADIOACTIVE MATERIALS AND WASTE MANAGEMENT

6.1 Fuel Disposal

Not applicable.

6.2 Radioactive Waste Processing

Decontamination of structures, equipment, and floors may generate some liquid radwaste. This will be collected, monitored, and then released to the sanitary sewer, if under the limits of 10CFR20. Whenever possible efforts will be made to absorb or solidify any liquid waste during concrete demolition. The major bulk of radwaste would be solid radwaste from demolition. These would include concrete rubble, activated metallic embedments, equipment and tools, and other auxiliary materials. All these would be packaged on site, surveyed, appropriately classified in a waste class, and shipped to licensed disposal site.

7.0 TECHNICAL AND ENVIRONMENTAL SPECIFICATIONS

UCLA's radiation protection program, its health and safety limits, its adherence to federal and state regulations, its experience in Phase I decommissioning demonstrate its capability to accomplish Phase II decommissioning without any significant impact to the environment or health and safety of the public. Besides, as shown in Table 1.1, about 75% of the total radioactivity in the concrete is due to non-penetrating beta emitters. Hence, radiation field hazards are minimal.

8.0 TERMINATION RADIATION SURVEY PLAN

The details of this termination survey plan would depend on the procedures employed during decommissioning and the interim results of the radiation surveys. A thorough survey under the guidance of the document NUREG/CR 2082 of the reactor and its adjacent rooms is planned.