GEORGIA INSTITUTE OF TECHNOLOGY RESEARCH REACTOR DECOMMISSIONING PLAN

June, 1998

Prepared by
NES, INC.
DANBURY, CT

Project Application 3027		Copy No.	Assigned To	
APPROVALS				
TITLE / DEPT. - SIGNATURE - DATE				
REV NO	PREPARED BY	TECH. REVIEW	QA REVIEW	VICE PRESIDENT
0				
1				
2				
3	Pat. [illegible] 6/3/98	Eric [illegible] 6-4-98	Gerald F. Towny 6/4/98	[illegible] for ECD 6-4-98
4				
5				
6				
7				
8				
9				
10				

NES, Inc.

REVISION LOG

REV NO.	DATE	PAGE NO.	DESCRIPTION	APPROVAL
1	5/3/98	All	Extensive Revisions, CRA 10032	
2	5/26/98	All	Editorial Corrections, CRA 10034	
3	6/3/98	All	Editorial Corrections, CRA 10045	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
ACM	asbestos containing material
Am	americium
Bq	becquerel
C	carbon
Ca	calcium
CCE	contamination control envelope
CFR	Code of Federal Regulations
Ci	curie
cm	centimeter
Co	cobalt
Cs	cesium
cu	cubic
d	day
DC	decommissioning contractor
D&D	decontamination and decommissioning
DECON	A decommissioning alternative
Dept.	department
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
dpm	disintegrations per minute
ECCS	Emergency Core Cooling System
EPA	Environmental Protection Agency
etc.	etcetera
Eu	europium
Fe	iron
ft.	feet
°F	degrees Fahrenheit
g	gram
Ge	germanium
GM	Geiger-Müller
GT	Georgia Tech
GTRR	Georgia Tech Research Reactor

3

H	hydrogen
h	hour
hr.	hour
HEPA	high-efficiency particulate air
HP	health physics
HVAC	heating, ventilation and air-conditioning
I	interstate
i.e.	that is
in	inch
Inc.	Incorporated
ID	inner diameter
km	kilometer
Kr	krypton
l	liter
Li	lithium
lbs.	pounds
LLRW	low-level radioactive waste
LLD	lower limit of detection
m	meter
min.	minute
MSHA	Mine Safety and Health Administration
ms	millisecond
MW	megawatt
MW-hrs.	megawatt-hours
n	nano
NaI	sodium iodide
NCRP	National Council on Radiation Protection and Measurements
NES, Inc.	NES, Incorporated
NIOSH	National Institute for Occupational Safety and Health
NNRC	Neely Nuclear Research Center
No.	number
NRC/US NRC	U.S. Nuclear Regulatory Commission
OD	outer diameter
OSHA	Occupational Safety and Health Administration

pCi	picocurie
PC	protective clothing
POL	Possession Only License
PPE	personal protective equipment
psia	pounds per square inch absolute
psig	pounds per square inch gauge
Pu	plutonium
QA	quality assurance
QAPP	Quality Assurance Program Plan
QC	quality control
RCT	Radiation Control Technician
RSO	Radiation Safety Officer
RWP	radiation work permit
s	seconds
TEDE	total effective dose equivalent
Th	thorium
TLD	thermoluminescence dosimeter
TSRC	Technical Safety Review Committee
U	uranium
U.S.	United States
μ	micro
y	year
ZnS	zinc sulfide

1.0 SUMMARY OF PLAN

1.1 INTRODUCTION

The purpose of this document is to provide a decommissioning plan for the dismantling of the Georgia Institute of Technology Research Reactor (GTRR) and associated systems. Georgia Tech has been issued a Possession-Only-License (POL). The POL is considered Amendment Number 12 to the Facility License R-97.

The scope of this decommissioning plan is to describe the methods and controls to be implemented during the handling, removal and disposal of radioactive materials and the radiological survey and release of the decommissioned areas and structures by the US NRC for unrestricted use by Georgia Tech. Other licensed activities performed under other Georgia Tech licenses are expected to continue at the site.

1.2 REACTOR FACILITY DESCRIPTION

The GTRR began operation in 1964 as a research facility where engineering students would train to operate commercial nuclear power plants and researchers would explore the frontiers of biology and material sciences. It is located on the 330-acre campus of the Georgia Institute of Technology. The campus is located in a residential and commercial area just north of the center of downtown Atlanta.

More than 13,000 students are enrolled at Georgia Tech. The institute employs approximately 5,000 faculty and staff. The City of Atlanta, according to the 1990 census, has a population of 394,017 and covers 323.4 square km. Today, the metropolitan area has an excess of 3.1 million people. The eastern boundary of the Georgia Tech campus coincides with the combined leg of I-75 and I-85, the major traffic artery that runs north and south through Atlanta. The location of the Georgia Tech campus with respect to major traffic arteries is shown in Figure 1.1. 3

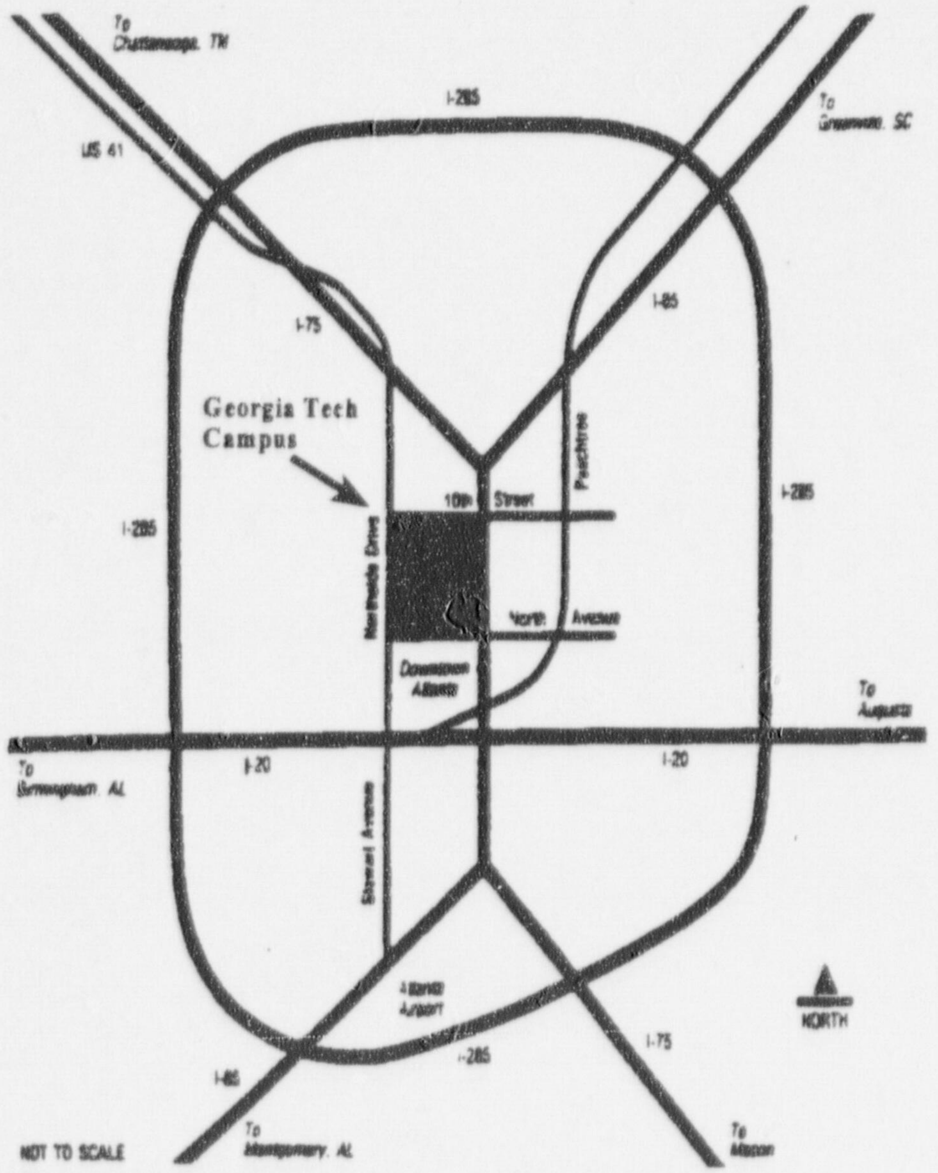


Figure 1.1 Map Indicating the Location of Georgia Tech with Respect to Major Traffic Arteries

The GTRR is a part of the Georgia Institute of Technology - Neely Nuclear Research Center (NNRC) in the city of Atlanta, Georgia. The NNRC is comprised of the GTRR located in the containment building, the hot cell, support laboratories and offices.

Laboratories, office space and a variety of support facilities are housed in the three-story building adjoining the containment building. In the southeast corner of the building is a high bay area including the hot cell, Radiochemistry Laboratory, Decontamination Room and storage facility. This area is controlled from the remainder of the building, with routine access through the change room entrance. Figures 1.2 and 1.3 illustrate the NNRC floor plan.

1.3 CONTAINMENT BUILDING DESCRIPTION

The reactor containment building consists of three floors. The building is a cylindrical steel tank with a diameter of 82 feet and a 12-inch-thick concrete wall on the inside of the steel tank. The roof is a torispherical dome, approximately 50 feet above ground level, that provides a leaktight barrier to the escape of gas from the interior.

1.3.1 Ground Floor

The ground floor of the containment building houses the reactor process equipment, the exhaust ventilation equipment and the electrical load center for the building. Although the ground floor is at the same elevation as the ground level of the laboratory building, there is no direct access between the two areas. The ground floor can only be reached by elevator or stairways from the first floor of the containment building. The reactor process equipment is located within an area surrounded by 2-foot-thick concrete walls. The filter bank and blower for the containment building exhaust are adjacent to this shielded area. A large holdup volume through which this exhaust must pass is cast into the ground floor slab. Another large void in this concrete slab provides an expansion chamber which is connected to the helium/nitrogen space above the reactor core through a rupture disk.

The ground floor also contains the compressor room, two rooms that contain the rabbit support systems and an experimental area, and a cooling system for the bismuth blocks. The ground floor plan is shown in Figure 1.4.

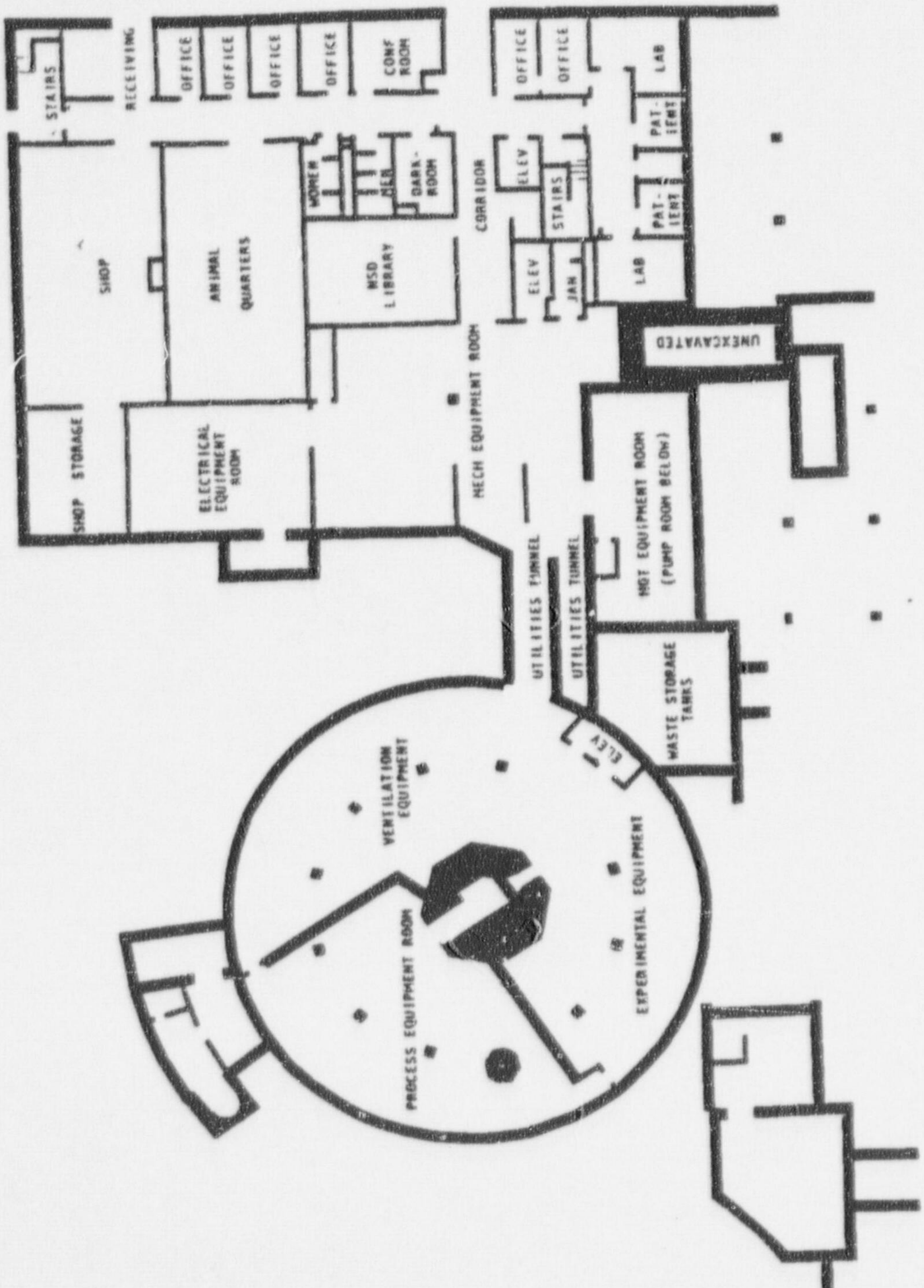


Figure 1.2 Nuclear Research Center Ground Floor Plan

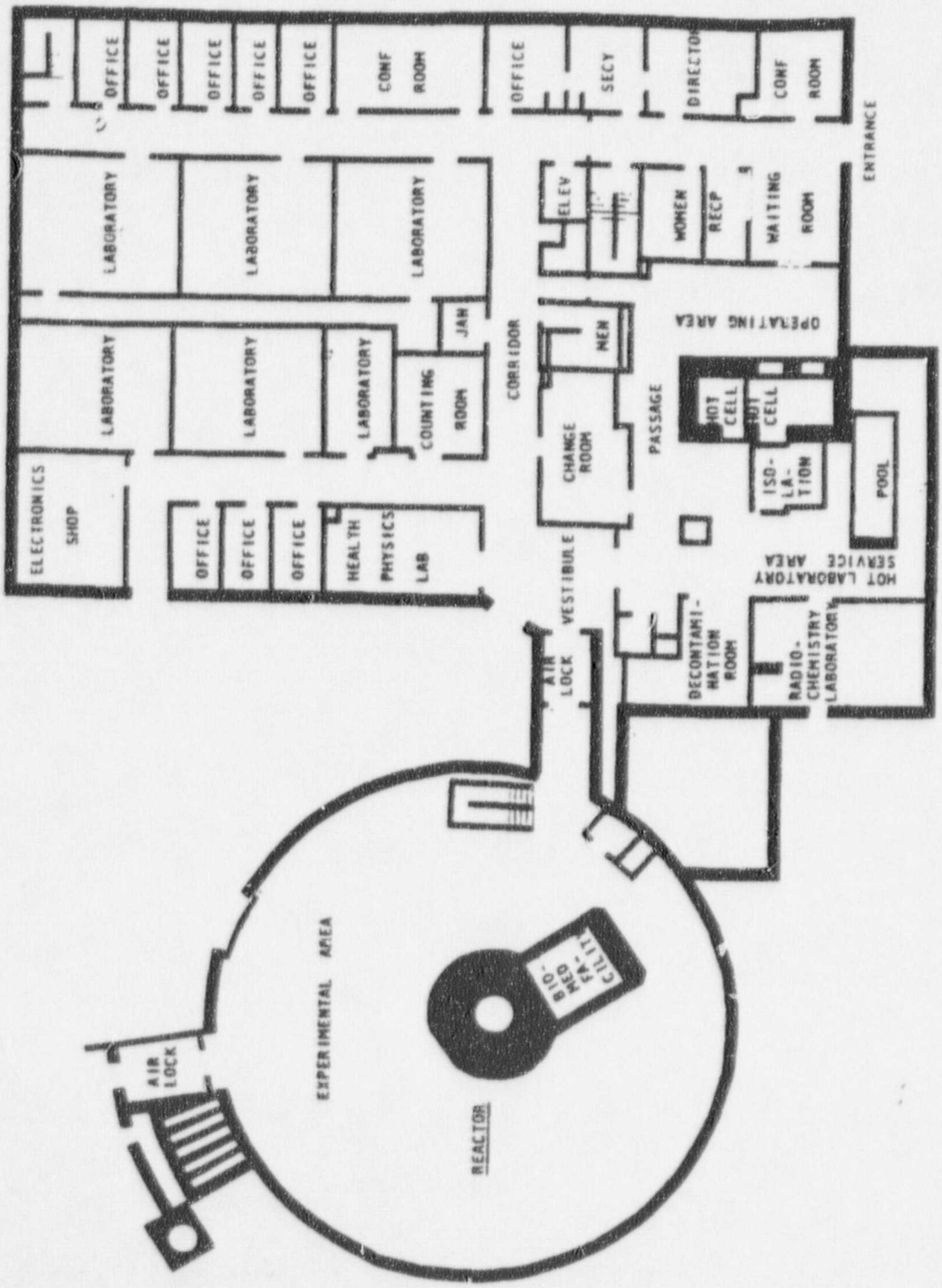


Figure 1.3 Nuclear Research Center First Floor Plan

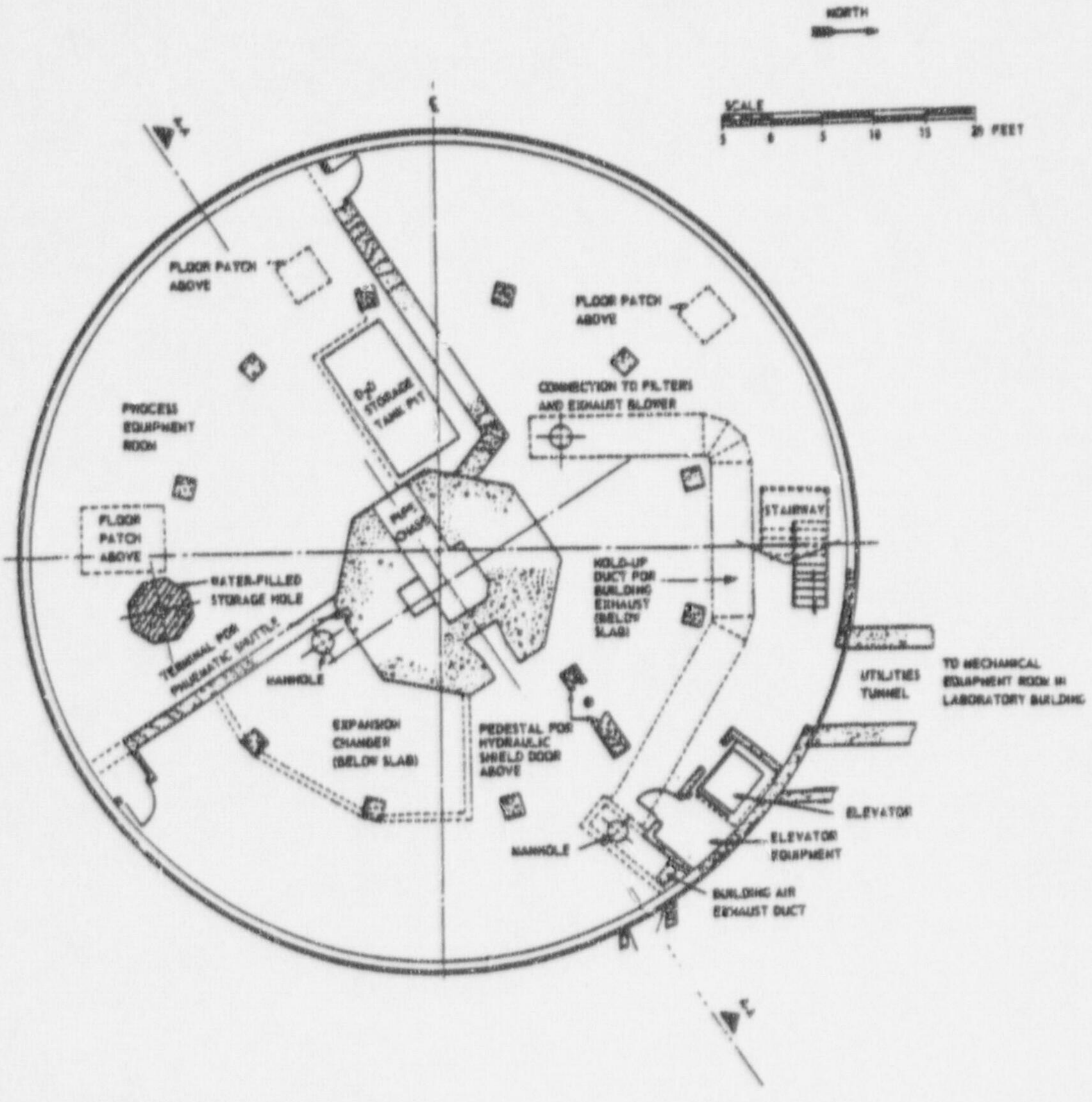


Figure 1.4 Reactor Containment Building Ground Floor Plan

1.3.2 First Floor

The first floor is largely unoccupied except for the reactor near the center. The center of the reactor is displaced, approximately three feet, from the center of the building. This allows for more efficient use of the polar crane when engaged in operations above the reactor. The crane can reach almost every point on the first floor which is not covered by the balcony or walkway. Three removable floor patches permit large and heavy objects to be moved by the cranes between the ground and the first floors.

The first floor contains a vertical water-filled fuel storage hole which is approximately 13 feet long extending to the ground floor. The first floor also contains horizontal plug storage holes of two different types: ten concrete "A" type holes are approximately 1 foot in diameter and 8 feet long; and eight concrete "B" type holes are approximately 9 inches in diameter and 8 feet long.

The containment building is entered at the first floor level by one of three routes: the main air lock leading to the laboratory building; a smaller personnel air lock leading to the outside service court; and a truck door. A shielded irradiation room, the biomedical irradiation facility, is located on the first floor immediately adjacent to the reactor. Figure 1.5 shows the first floor plan.

1.3.3 Second Floor

The top of the reactor is 15 feet above the first floor. At this level, shown in Figure 1.6, there is a walkway which runs completely around the circumference of the building. At one point, this walkway is enlarged to form the second floor which connects with the top of the reactor. The reactor control room occupies much of the second floor. Glass panels in the front wall of the control room provide the reactor operators with a partial view of the main floor. An Emergency Core Cooling System (ECCS) tank is also located on the second floor. Air is supplied to the containment building by an air-conditioning unit which is located on the roof of the control room. The second floor may be reached using the elevator or stairs.

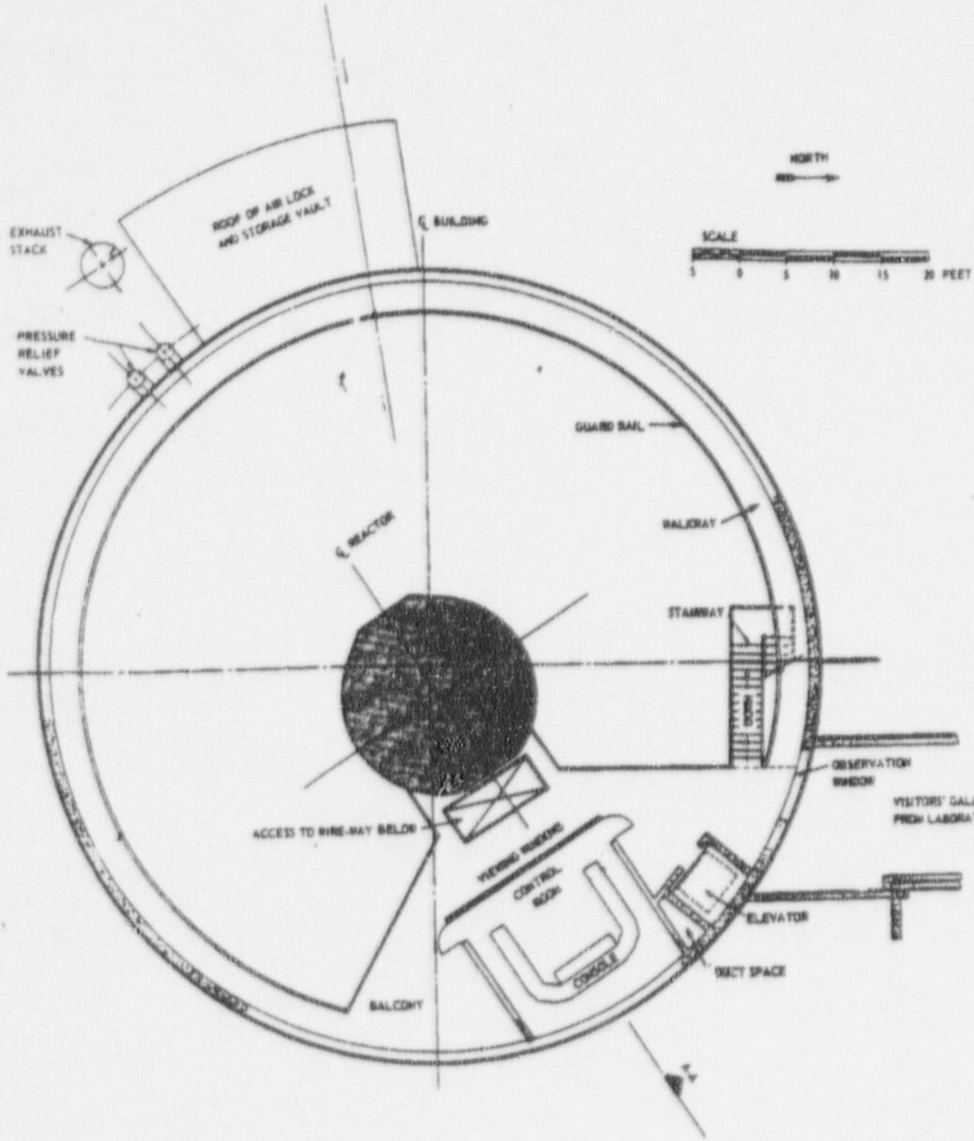


Figure 1.5 Reactor Containment Building First Floor Plan

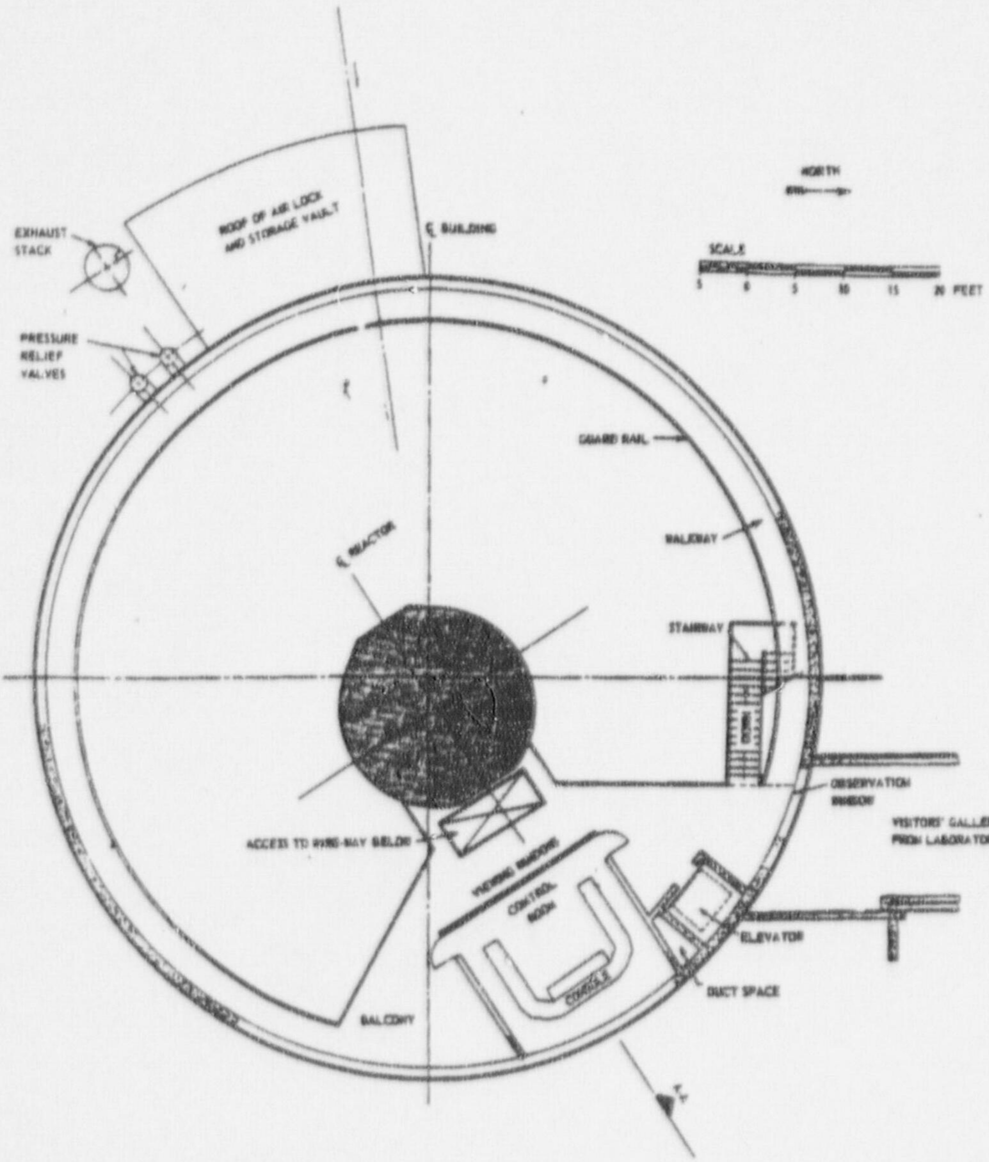


Figure 1.6 Reactor Containment Building Second Floor Plan

1.4 REACTOR DESCRIPTION

1.4.1 Reactor Structure

The GTRR is a 5 MW thermal, heavy-water moderated, cooled and reflected reactor, fueled with curved plates of uranium aluminum alloy. The core contained up to 19 fuel elements. Principal design parameters of the GTRR are indicated in Table 1.1, and the general arrangement of the reactor is shown in Figure 1.7 (Reference 1).

Table 1.1 Key Design Parameters of the GTRR

PARAMETER	DESCRIPTION
Reactor	Heterogenous, D_2O moderated and cooled
Thermal Power	5 MW
Operating Pressure	15 psia
Reactor Outlet Temperature, Moderator	131°F
Reactor Vessel	
Configuration	Cylindrical tank
Overall Dimensions	10.4 ft. high x 6 ft. nominal outside diameter
Approximate Weight	2,000 lbs
Material	Al
Core	
Volume	7.3 $ft.^3$
Length	2 ft.
Equivalent Diameter	2.33 ft.
Containment Building	
Type	Containment
Shape	Cylindrical with torispherical top and flat bottom
Shell Diameter	82.17 ft.
Shell Composition	ASTM-A201 Grade B
Shell Thickness	Bottom and sides - 0.44 in.; top side - 1.75 in.; top center - 0.63 in.
Material	Steel and concrete
Maximum Pressure Expected	2.1 psig

PARAMETER	DESCRIPTION
Design Pressure	2.0 psig
Safety Factor	3
Test Pressure	2.0 psig
Air Locks	2
Truck Door	1
Reflectors	Graphite
Shielding	
Neutron Shielding	0.25 in. boral
Thermal Shielding	3.5 in. lead
Annular Concrete Shield	4.75 ft.
Shim-Safety Blades	
Number and Shape	4, rectangular
Dimensions	5.5 in. x 1 in. X 45.5 in.
Composition	Aluminum-clad cadmium
Regulating Rods	
Number in Core and Shape	1, tubular
Dimensions	1.38 in. I.D. x 1.42 in. O.D. x 24 in. long
Composition	Aluminum-clad cadmium
Fuel Element Design	
Fuel-Moderator Material	U-Al; heavy water
Uranium Content	188g
Length of Fuel Element	23.5 in.
Thickness of Fuel Element	2.854 in.
Cladding Material	Aluminum
Fuel Inventory	None

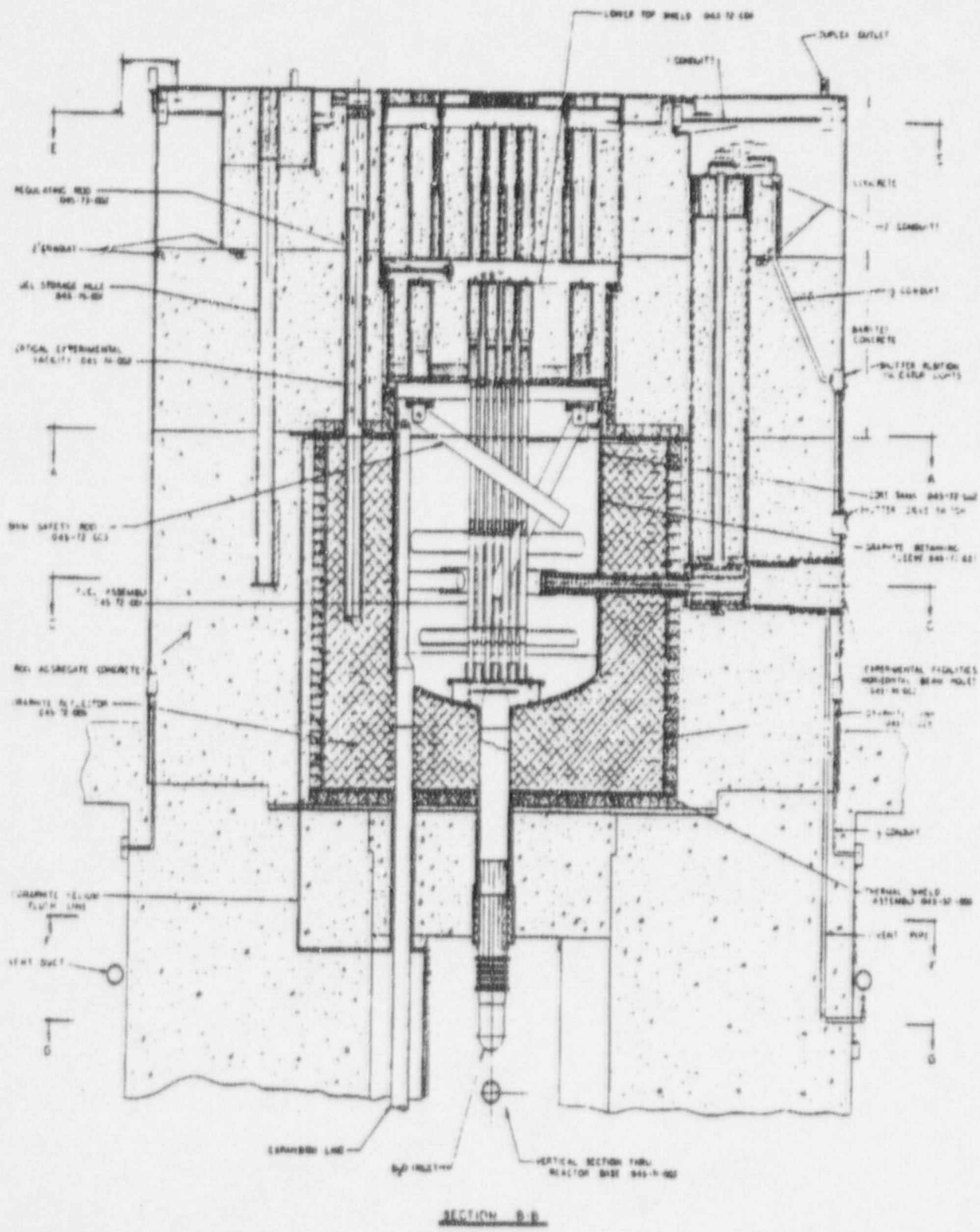


Figure 1.7 Vertical Section through Reactor

1.5 OPERATING HISTORY

The GTRR was used for neutron activation analysis, operator training and material testing. The reactor operated almost daily for an average energy output of 1297 MW-hrs. per year (Reference 2). The reactor is equipped with numerous horizontal and vertical experimental facilities to be used for the extraction of beams of fast and slow neutrons and for the performance of irradiations within the facilities.

The GTRR began operation in 1964 and continued operating through November 17, 1995 at power levels up to 5 MW. During its operating life, the reactor generated 40,204 MW-hrs. of thermal power (Reference 2). The fuel was removed from the NNRC complex on February 15, 1996.

1.6 DECOMMISSIONING PROGRAM ELEMENTS

1.6.1 Selected Method

Georgia Tech intends to remove all licensable radioactive materials from the site, verify the absence of these materials, terminate the POL and release the site for unrestricted use.

1.6.2 Major Tasks and Schedules

The major tasks of this program include:

1. Initial radiation survey of equipment, structures and areas;
2. area and equipment decontamination;
3. removal of beam tubes and gates, safety rods and drives, and shield plugs and plates;
4. removal of reactor vessel;
5. removal of retention tanks;
6. removal of biological shield;
7. packaging, shipping and disposal of irradiated and contaminated material, equipment and rubble at a licensed repository;
8. final radiation survey of the facility; and
9. final report preparation.

Georgia Tech has prepared a technical bid specification and will prepare a contract for a Decommissioning Contractor. It is expected that work will proceed in April, 1999 and that the final radiation survey will occur in June, 2000.

1.6.3 Facility Events

The GTRR began operation in 1964 and was in operation until 1996 when the fuel was removed. The decision to decommission the reactor was made on July 1, 1997. A characterization survey was performed in October 1997 in preparation for decommissioning. Additional information on important facility history is provided in Section 2.2

1.6.4 Estimated Cost

The estimated cost of this program, including disposal of all wastes, is presented in Section 8.0, herein.

1.6.5 Availability of Funds

The State of Georgia is committed to providing the funding for this dismantlement program.

1.7 PROGRAM QUALITY ASSURANCE

The DC will be chartered with the responsibility of performing the preparatory engineering, decommissioning work, waste packaging and disposal and final radiation survey. The DC will be required to implement his own radiological control program and quality assurance program. However, Georgia Tech will conduct its own overcheck of the DC's programs to ensure that the work is performed in a safe and controlled manner.

Georgia Tech's overcheck program will be defined in a Quality Assurance Program Plan (QAPP) which will include:

- Review of contractor's operating personnel health and safety training program.
- Review of DC's radiological control program - including ventilation, instrument usage and calibration, personnel monitoring and area monitoring procedures.
- Review of DC's work procedures with regard to public health and safety and the principles of ALARA.
- Audit of contractor records - including training, radiation surveys, instrument calibration and shipping data.
- Independent check of area radiation levels and surface contamination levels.
- Approval chain of documentation to be submitted to the NRC.

1.8 EXECUTIVE ENGINEER

Georgia Tech intends to utilize an executive engineer who will:

- Coordinate review and approval of the DC documents.
- Monitor the work performance of the DC.
- Prepare periodic progress and schedule reports, field change reports, radiation survey overcheck reports and waste shipment summaries.
- Exercise control of the work via his authority to cease operations if the work is not being performed in accordance with approved procedures.
- Assist the DC where possible to ensure safe and efficient performance of the program.

2.0 DECOMMISSIONING ACTIVITIES

2.1 DECOMMISSIONING ALTERNATIVE

Georgia Tech has selected the DECON alternative of decommissioning the reactor. The definition of this alternative is as follows:

DECON is the removal from the facility site of all fuel assemblies, source material, radioactive fission and corrosion products, and all other radioactive and contaminated materials having activities above unrestricted release levels. The areas included in the decommissioning effort will be decontaminated to unrestricted use levels.

The Decommissioning Plan consists of several activities oriented towards dismantling the remaining reactor vessel, biological shield, and primary systems and structures that may be contaminated or activated above unrestricted release levels, in a safe manner which is in accordance with ALARA principles set forth by Georgia Tech. Refer to NES Document No. 82A9087, "Georgia Institute of Technology Research Reactor Decommissioning Project Report, Radiological Characterization Report," January, 1998 (Reference 3) for the current radiological status of the facility.

In addition to the reactor, the facility also contains laboratories, offices, classrooms and a hot cell, which are not included in this decommissioning project. Therefore, during the dismantlement program, precautions will be taken to preclude unauthorized access to controlled areas, to prevent the spread of airborne contamination and to prevent any direct radiation hazards to personnel.

2.2 FACILITY RADIOLOGICAL STATUS

The GTRR began operations in 1964 as a research facility where engineers would train to operate commercial nuclear power plants and researchers would explore the frontiers of biology and material sciences. Georgia Tech has decided to decommission the reactor and terminate the reactor license.

2.2.1 Facility Operating History

The following is an account of major events that occurred during the life of the reactor that could impact the characterization and decommissioning activities:

2.2.1.1 Reactor Coolant Level Sensing Line Leak Problem

On June 20, 1972, a leak in the D_2O primary coolant system was reported at the GTRR. A small pinhole leak was observed on the primary coolant system. Based on the characterization data, this leak did not result in significant contamination in the area.

2.2.1.2 Upgrade Power Level

The reactor was licensed on December 29, 1964 to operate at one megawatt. In June, 1974, the license was amended and the maximum power of the GTRR was increased from one to five megawatts. In order to allow limits at five megawatts, several modifications had to be made. The cooling system was redesigned by Southern Nuclear Engineering Corporation personnel involved in the original design. A gravity feed emergency cooling system was developed to handle increased decay heat. Emergency lighting and communications systems were installed. The reactor instrumentation was also expanded to include full redundancy and a backup system on reactor safety channels. The Argon-41 release rate was significantly reduced, and was within allowed limits for operation at five megawatts.

2.2.1.3 Leakage of Bismuth Shield Blocks Cooling System

The bismuth shield block cooling system leaked into the area beneath the biomedical irradiation facility on the ground floor during operation. This has contaminated the pedestal walls and floor beneath the reactor. The liquid was diverted to a nearby sump which is also contaminated.

2.2.2 Current Radiological Status of Facility

A characterization survey of the GTRR was performed by a contractor, NES Incorporated, in October, 1997 to determine the nature and extent of radiological activities in order to permit the preparation of the GTRR Decommissioning Plan and Cost Estimate. Results indicate both fixed and loose contamination throughout the facility. The results of the survey are presented in the Characterization Report (Reference 3). Based on the GTRR characterization survey of the areas outside of the containment building, contamination was found in the Radiochemistry Room fume hood, the Decontamination Room and walk-in hood. Removable contamination above release crtieria was not detected outside of the reactor building except for removable α activity of 74 dpm/100 cm^2 on the beaker in the Radiochemistry Room fume hood. Radiation levels throughout the containment building ranged from very low (<20 dpm/100cm^2 for $\beta\gamma$ direct) to very high (>1,400,000 dpm/100cm^2 for $\beta\gamma$ direct) The highest radiation exposures were concentrated on the reactor faces and near the plug storage vaults. The background obtained in certain areas, such as the walk-in hood and Plug Storage Area, was considerably high and may have led to some of the high readings. Appendix A lists a summary of the results of the characterization survey performed. 3

2.2.3 Release Criteria

The radioactive materials unrestricted release criteria limits for surface contamination will be below the limits specified in Table 1, "Acceptable Surface Contamination Levels," of US NRC Regulatory Guide 1.86, "Termination of Operating License for Nuclear Reactors," June, 1974 (Reference 4).

The final survey will be in accordance with NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination," June, 1992 (Reference 5).

2.3 DECOMMISSIONING ACTIVITIES AND TASKS

The release of the reactor containment building will be divided into the following set of activities and tasks which will provide a complete and cost-effective method for decommissioning the GTRR and associated facilities:

2.3.1 Mobilization and Preparation

2.3.1.1 Procedure Development

Prior to performing any decommissioning activities, procedures specific to the decommissioning project will be developed. These procedures will support the specific work plan for decommissioning the GTRR and release the areas included in the effort for unrestricted use. All procedures will be reviewed by the Georgia Tech Technical Safety Review Committee (TSRC) for completeness and compliance with all US NRC, State of Georgia and Georgia Tech rules and regulations. Quality Assurance (QA) documents will be developed to ensure the integrity and consistency of the procedures developed. The QA documents will be reviewed by the TSRC.

2.3.1.2 Site Mobilization and General Employee Training

This task includes the travel of workers to the site, as well as the shipping of equipment and materials required to perform the decommissioning activities. A staging area, field office, counting room, control points and a change area will be established. The workers will also be familiarized with the facility.

All demolition personnel, including subcontractors, will be trained in accordance with the site-specific Radiation Worker Training Program and receive a general safety briefing. All site personnel will attend a one day site-specific training class performed by a Georgia Tech representative. Additional training and testing by the DC will include in-vivo and in-vitro testing, physicals, respirator fit tests and an eight-hour OSHA re-certification class. 3

2.3.1.3 Initial Site Survey

An initial site survey will be performed to confirm the radiological condition of the facility as described in the Characterization Report. This survey will include smear surveys to determine protective clothing requirements; exposure rate surveys to determine representative background exposure rates; and baseline air monitoring to determine respirator requirements. A photographic survey of the facility will be performed for documentation purposes. During the characterization effort, material screening performed identified several locations where hazardous material was present. This included some materials in the Plug Storage Vaults, the lead wall in the Biomedical Irradiation Facility and the lead paint on the stairs and reactor top.

2.3.1.4 Set Up Work Areas/Install CCE

Prior to commencing the decommissioning activities, replacement HEPA filters will be installed in the containment ventilation system. Radiological control area boundaries will be established, including postings, as well as frisking stations and step-off pads. Temporary shielding will also be moved into position during this task. A staging area for decommissioning equipment and materials will be established inside the GTRR building. A contamination control envelope (CCE) with portable HEPA ventilation will be constructed around the reactor vessel and biological shield.

2.3.1.5 Decontaminate Equipment Prior to Removal

Any radiation sources located within the building, other than those associated with decommissioning activities, will be removed. These materials include glassware, cleaning tools and experimental equipment located inside the containment building, decontamination room and radiochemistry room. A preliminary wipe down will be performed to reduce the threat of airborne contamination to the workers. Areas used for staging of equipment and supplies will also be decontaminated.

2.3.1.6 Set Up Packaging and Staging Area

Packaging areas will be established for both clean and contaminated waste. Contaminated waste will be segregated into radiologically contaminated and mixed waste. Some volume reduction segmentation of the waste may occur in the contaminated waste packaging area in order to maximize the packaging efficiency. The contaminated and mixed waste will be packaged for transportation and disposal. If the waste is determined to be radiologically releasable, it will be placed in the clean packaging area, loaded into roll-off containers and onto flatbed trailer trucks.

2.3.2 Reactor Complex

The removal of the reactor complex will proceed in a logical sequence, beginning at the top of the pedestal. All cutting will be performed within the CCE. Abrasive saws will be used as much as possible to minimize the use of torch cutting. The following tasks detail the removal process in order of occurrence:

2.3.2.1 Vertical Beam Ports

The vertical beam ports will be removed - including the thimbles, thimble plugs, sample tubes and liners. The thimble plugs will be opened utilizing an abrasive saw, and all lead will be removed from the plugs and sent to a mixed waste processor. The lower two-thirds of the sample tubes and thimbles will be disposed of as radioactive waste. The remaining concrete and steel will be segmented as necessary, packaged and disposed of as radioactive waste. The steel liner will be core drilled, segmented and disposed of as radioactive waste.

2.3.2.2 Shim Safety Rods and Drives

The four shim safety rods will be disconnected from the drives, removed through the top shield, cut in half and disposed of as mixed waste (due to the cadmium they contain). The shim safety rod drives will be disconnected, removed, segmented and disposed of as radioactive waste. The regulating rod and drive will also be removed, segmented and disposed of as mixed waste.

2.3.2.3 Horizontal Beam Gates

The ten horizontal beam gate drive motors will be disconnected and removed. The drive motors are assumed to be releaseable; therefore, they will be surveyed and disposed of as clean waste. With the drives removed, the gates, gate plugs and drive shaft will be removed using the overhead crane. The gates will be separated from the shafts and cut open. The lead inside will be removed and disposed of as mixed waste, and the remainder disposed of as radioactive waste. The gate plug and shaft will be segmented, as needed, to fit into the waste containers and disposed of as radioactive waste. Core drilling will be utilized to remove the steel liner, and the material removed will be disposed of as radioactive waste.

2.3.2.4 Spent Fuel Storage Holes

The spent fuel storage hole plugs will be removed and disposed of as radioactive waste. The hole liner will be core drilled out and each liner will be cut in half utilizing an abrasive saw. The liners will be packaged and disposed of as radioactive waste. The lead shield around the spent fuel holes will be removed and disposed of as mixed waste. The spent fuel storage hole on the first floor of the containment building will be removed and disposed of as radioactive waste. 3

2.3.2.5 Piping and Instrumentation

This task accounts for the removal of miscellaneous piping and ventilation in and around the reactor complex. The bulk of the systems and reactor ventilation system will be removed during facility decontamination. The materials will be disposed of as radioactive waste.

2.3.2.6 Lead Cover Plate

The lead cover plate will be removed in two distinct pieces - the inner plate and outer plate. The 24 lead and steel port plugs will be removed from the inner plate and cut open with an abrasive saw. The lead will be removed and disposed of as mixed waste, and the steel will be disposed of as radioactive waste. The inner plate will then be removed and cut open, and the lead inside will be disposed of as mixed waste. The steel will be disposed of as radioactive waste. A similar process will be performed for the outer plate. First, the eight lead and steel port plugs will be removed. Then, the outer plate and lead will be removed. All steel will be disposed of as radioactive waste.

2.3.2.7 Upper Top Shield

The upper top shield will also be removed in two distinct pieces - the inner shield plug and outer shield plug. The 24 concrete and steel inner port plugs and eight concrete and steel outer port plugs will be removed and disposed of as radioactive waste. The inner concrete and steel upper top shield will be removed and disposed of as radioactive waste. The outer concrete and steel upper shield plug will be removed and disposed of as radioactive waste. Segmenting of this piece will be required for packaging.

2.3.2.8 Lower Shield Plug

The 31 lead, concrete and steel port plugs will be removed from the lower top shield plug and cut open with an abrasive saw. The lead will be removed and disposed of as mixed waste. The remaining concrete and steel will be disposed of as radioactive waste. The lead, concrete and steel lower top shield will be removed and cut open, and the lead inside will be disposed of as mixed waste. The concrete and steel will be disposed of as radioactive waste.

2.3.2.9 Fuel Spray Manifold

The fuel spray manifold pipe will be cut free within the reactor, utilizing long-handled tools, and transferred to the CCE. The manifold will be further segmented and disposed of as radioactive waste.

2.3.2.10 Reactor Vessel

A remote operated robotic arm will be installed in the reactor vessel to facilitate segmentation. Using an abrasive saw connected to the robotic arm, the horizontal beam ports and through tubes will be cut free and lifted out. The bottom pipes will be core bored and removed. The reactor vessel will be cut into sections using an abrasive saw mounted on the robotic arm. Lifting holes will first be drilled into each section with a drill attached to the robotic arm, and each section rigged. Each section will be lifted out with the overhead crane, transferred to the packaging area and disposed of as radioactive waste.

2.3.2.11 Graphite Retaining Sleeve

The graphite retaining sleeve will be removed in a similar fashion as the vessel. The sleeve will be cut into sections using an abrasive saw mounted on the robotic arm. Lifting holes will be drilled into each section, and each section will be rigged. After cutting, the section will be transferred to the packaging area using the overhead crane. Each section will be disposed of as radioactive waste.

2.3.2.12 Graphite Removal

The 4-inch by 4-inch graphite stringers will be removed using long-handled tools from either the top of the biological shield or through the thermal column. The graphite will be packaged and disposed of as radioactive waste.

2.3.2.13 Horizontal Beam Ports

The beam port and through tube plugs will be removed and disposed as radioactive waste. Lead will first be removed from the through tube plugs by cutting the top off the plugs with an abrasive saw. The lead will be disposed of as mixed waste. The graphite plugs will then be removed from the beam ports and disposed of as radioactive waste. Using an abrasive saw connected to the robotic arm, the horizontal beam ports and through tubes will be cut free from the graphite region and lifted out. The remaining concrete-embedded beam port and through tubes will be core bored out and disposed of as radioactive waste.

2.3.2.14 Boral Removal

The 1/4-inch boral sheet staked to the inside of the steel tank will be removed in a similar fashion as the vessel. The boral will be cut into sections using an abrasive saw mounted on the robotic arm, and the metal screws will be removed. Lifting holes will be drilled into the sections, and each section will be rigged. After cutting, the sections will be transferred to the packaging area using the overhead crane. Each section will be disposed of as radioactive waste.

2.3.2.15 Inner Steel Tank

The inner steel tank will follow a similar removal scenario to that described for the boral removal. The tank will be cut into sections using an abrasive saw mounted on the robotic arm. Lifting holes will first be drilled into each section; and each section will then be rigged. After cutting, the section will be transferred to the packaging area using the overhead crane. The sections may have to be pried free of the lead, as the molten lead was poured into the space between the inner and outer steel tanks. Also of concern are the cooling coils attached to the lead side of the tank. These coils will be removed from the lead side of the tank and disposed with the tank; however, some lead may adhere to the coils requiring their separation. Each section will be disposed of as radioactive waste.

2.3.2.16 Lead Thermal Shield

The lead thermal shield was formed by pouring molten lead into the space between the inner and outer steel tanks. With the inner tank and cooling coils removed, the lead will be pried free of the outer tank in easily handled pieces with long-handled tools. The pieces will be lowered into a basket and transferred to a waste container. The lead will be disposed of as mixed waste.

2.3.2.17 Outer Steel Tank

The outer steel tank will be removed using the same methods as the removal of the inner steel tank. The tank may have to be pried free of the concrete prior to removal. Each section will be disposed of as radioactive waste.

2.3.2.18 Thermal Column Shutter and Shielding

In order to remove the thermal column shutter and shields, the two thermal column door plugs will be removed first, segmented with an abrasive saw and the lead removed. The steel cover plate will then be removed, segmented and packaged. The exposed lead shield will then be removed and packaged for processing. The concrete and steel blocks will also be removed and packaged. Segmenting of these blocks is not required. The concrete, steel and lead doors will be removed, segmented and packaged. Any remaining lead will then be removed and packaged for disposal. The concrete and steel will be disposed of as radioactive waste and the lead as mixed waste.

2.3.2.19 Biomedical Irradiation Facility Shutter and Shielding

In order to remove the biomedical irradiation facility shutter, the aluminum cover plate will be removed first and segmented. The exposed lead bricks will then be removed and packaged. The movable shield plugs and doors will also be removed. The outer bismuth shield, the water tank and the inner bismuth plug will be removed and packaged. Due to the package restrictions, segmenting of these items will have to be performed. The materials will be disposed as radioactive waste.

2.3.2.20 Fission Chambers

The fissions chambers will be removed and packaged for disposal. The remaining U-235 will be packaged and shipped to an appropriate site.

2.3.3 Biological Shield

2.3.3.1 Activated Concrete

Based on information provided in the Characterization Report for the GTRR, activation extends a distance of less than 68 inches from the core midpoint (Reference 3). The inner radius of the concrete biological shield is approximately 64.63 inches from the core centerline; therefore, less than 3.5 inches of activated concrete will be removed from the inner biological shield wall at the centerline. A smaller amount of activated concrete will be removed at the top and bottom of the lower biological shield wall. Due to the relatively small amount of activated concrete and the limited access, the concrete will be removed with a bobcat/ jackhammer. The waste will be packaged and disposed of as radioactive waste.

2.3.3.2 Bottom Shield

Again, based on information provided in the Characterization Report for the GTRR, activation extends a distance of less than 68 inches from the core midpoint. The bottom shield concrete is approximately 65.25 inches from the core horizontal centerline (Reference 3); therefore, less than 3 inches of activated concrete will be removed from the inner biological shield floor at the centerline. As one moves away from the centerline, the depth of activated concrete decreases. Due to the relatively small amount of activated concrete and the limited access, the concrete will be removed with a bobcat/jackhammer. The waste will be packaged and disposed of as radioactive waste.

2.3.4 Facility Decontamination

With the reactor complex and the activated concrete removed, the rest of the facility can be decontaminated.

2.3.4.1 Outdoor Characterization

In conjunction with the facility decontamination, surface samples will be taken from the yard surrounding the facility. An environmental analysis of these samples will be performed to determine whether any radiological or hazardous contamination exists outside of the containment.

2.3.4.2 Size Reduction Tent Decontamination

The radioactive packaging area tent will be removed, packaged and disposed of as radioactive waste. This task will not be performed until all removal and decontamination has been completed.

2.3.4.3 Remove Contaminated Systems

All contaminated piping and associated tanks, pumps, valves and heat exchangers will be removed, packaged and disposed of as radioactive waste. The following systems are considered contaminated and will be removed:

- Primary Coolant System
- Overflow Return and Purification System
- D_2O Recombiner and Helium Makeup System
- Emergency Cooling System
- Shield Cooling System
- Bismuth Cooling System
- Liquid Waste System
- Rabbit System
- Isotope Facility

2.3.4.4 Remove Sludge from Retention Tanks

An opening of sufficient size to allow sludge removal will be cut into each tank. The sludge will be removed using long-handled tools and transferred to a disposal container. A portable HEPA ventilation system will be installed during this operation. All waste will be disposed of as radioactive waste.

2.3.4.5 Remove Retention Tanks

Due to a limited amount of space in the waste storage tank room, the tanks will be cut into maneuverable pieces, about 100 pounds each. A cutting grid will first be laid out on each tank, and a lifting hole will be burned into each segment. Each segment will be rigged to a chain hoist and cut with a torch. Each segment will be moved outside of the NNRC and packaged for disposal as radioactive waste. As part of the facility restoration, new retention tanks will be installed after removal of the old retention tanks.

2.3.4.6 Remove/Package Material in Plug Storage Vault

It was determined that about half of the storage locations contain miscellaneous contaminated items. These items will be removed and packaged as radioactive waste.

2.3.4.7 Decontaminate Floors and Walls Outside of the Containment Building

Contaminated areas outside of the containment building will be decontaminated using scabblers and shot blasting equipment. Shot blasting equipment will be used on an as-needed basis. These areas include the walk-in hood in the decontamination room. All waste will be disposed of as radioactive waste.

2.3.4.8 Re:ctor Ventilation System and Stack

The reactor ventilation system duct, blowers, stack and filters will be decontaminated where possible or will be removed and packaged as radioactive waste. Removal of the stack and ventilation equipment will be done on an as-needed basis. Scaffolding will be erected as needed, and a portable HEPA ventilation system will be installed. The removal of this system also includes the decontamination of the holdup duct in the ground floor. The floor slab will be removed from above the trench with a concrete saw. The trench will be decontaminated as required.

Scaffolding will be erected around the 76-foot stack. The stack will be torch cut into eleven sections and lowered to the ground. The sections will be segmented and packaged as radioactive waste.

2.3.4.9 Decontamination of Containment Basement Floor

Contaminated areas on the ground floor of the containment building will be decontaminated using scabblers and shot-blasting equipment. Shot blasting equipment will be used on an as-needed basis. These areas include the pump area, the process equipment room and the experimental equipment area. All waste will be disposed of as radioactive waste.

2.3.4.10 Decontamination of Containment First Floor

Contaminated areas on the first floor of the containment building will be decontaminated using scabblers and shot-blasting equipment. Shot blasting equipment will be used on an as-needed basis. These areas include the Biomedical Irradiation Facility. All waste will be disposed of as radioactive waste.

2.3.4.11 Decontamination of Containment Second Floor

Contaminated areas on the second floor of the containment building will be decontaminated using scabblers and shot-blasting equipment. Shot blasting equipment will be used on an as needed basis. These areas include the top of the reactor complex, the outer walls of the control room and the catwalk. All waste will be disposed of as radioactive waste.

2.3.4.12 Decontaminate Plug Storage Vault

All holes that are contaminated above the release limit will be removed with a core boring machine. With the core boring complete, each location will be surveyed to verify that it is releasable. The removed material will be disposed of as radioactive waste.

2.3.4.13 Decontamination of the Air-Conditioning System

The removal of the air-conditioning system will be the last decommissioning activity to occur in the building. Scaffolding and a portable HEPA ventilation system will be installed during the removal of this system. The HVAC units over the Control Room, the three HVAC units in the ground floor and all associated ductwork will be removed, packaged and disposed of as radioactive waste.

2.3.5 Final Radiological Survey

A final release survey of the GTRR building will be performed in accordance with NUREG/CR-5849 (Reference 5). This survey will ensure the release of the building for unrestricted use. See Section 4.0 for the proposed Final Radiation Survey Plan. Decontaminate any areas identified during the final release survey as contaminated above the unrestricted release criteria and document results. Re-survey and document results.

2.3.6 Independent Confirmatory Survey

Once the decommissioning work has been completed, the US NRC will have an independent team perform an independent verification survey to ensure that the unrestricted release criteria has been met. A small DC team will also be present on site during this period to assist the verification team as necessary.

2.3.7 Final Site Cleanup and Demobilization

All contractor equipment used in the decommissioning project will be decontaminated, surveyed and released. Rental equipment will be returned, and clean equipment purchased by Georgia Tech will be packaged and stored on site. A general cleanup of the site will be performed. Dose analysis will be performed on the site workers at this time. All personnel will leave the site after completion of all site activities. General housekeeping will be performed to leave the site in a suitable condition.

2.3.8 Prepare Final Project Report

At the conclusion of the project, a final report will be issued detailing the decommissioning process. The final report will describe the general approach that was used during the decontamination and decommissioning effort. It will include records of all laboratory sample analysis, final survey data, personnel exposure data, calculations of activity shipped to the disposal sites and the actual waste volumes. It will describe the final status of the facility. A draft copy of this report will be provided to Georgia Tech for their review and comment. Comments will be resolved, and a final version of the document will be issued to the US NRC for review and action.

2.3.9 Schedule

Program start is expected to be April 15, 1999. Refer to Figure 2.1 for the anticipated project schedule.

Figure 2.1 Decommissioning Schedule for the GTRR

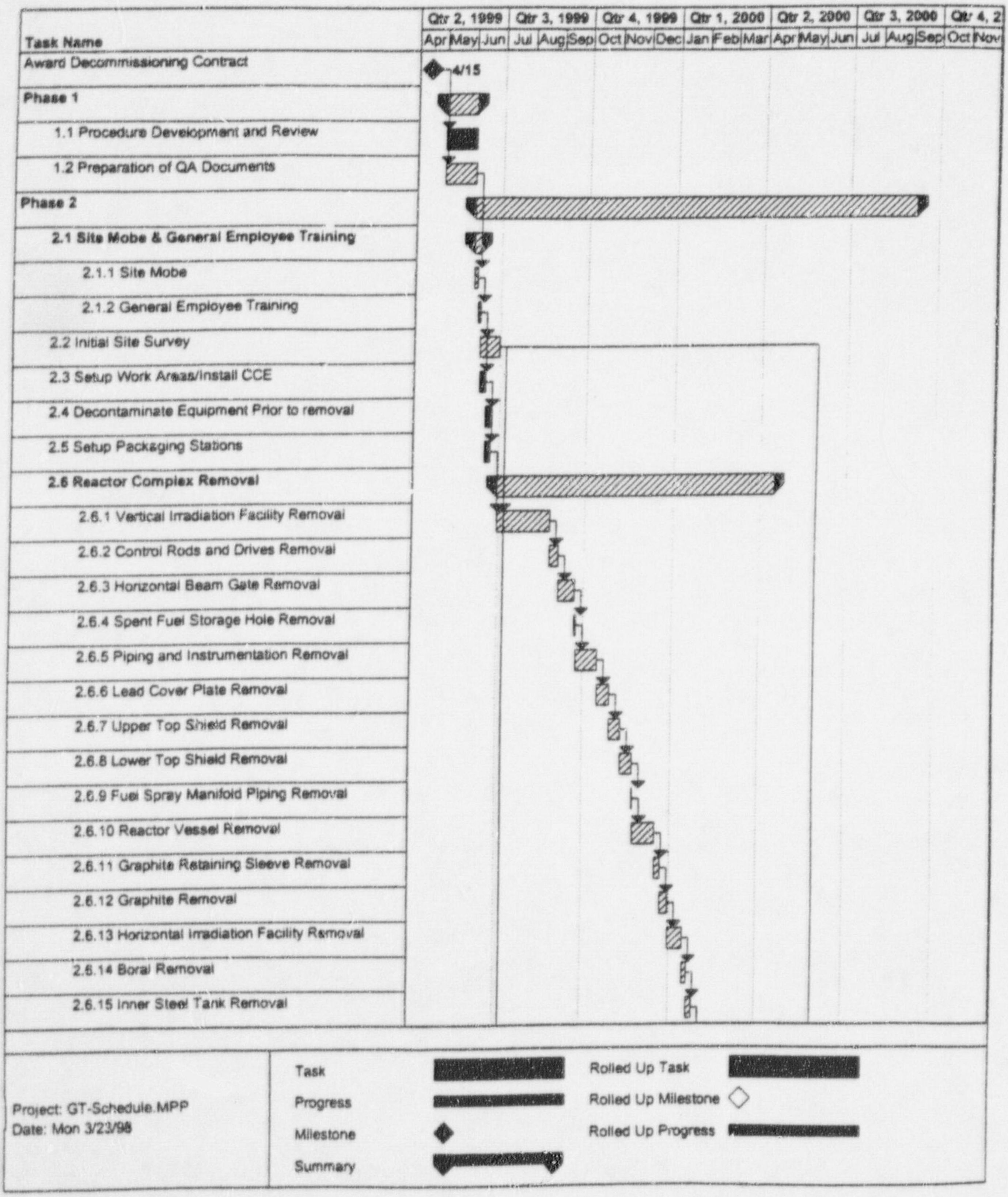
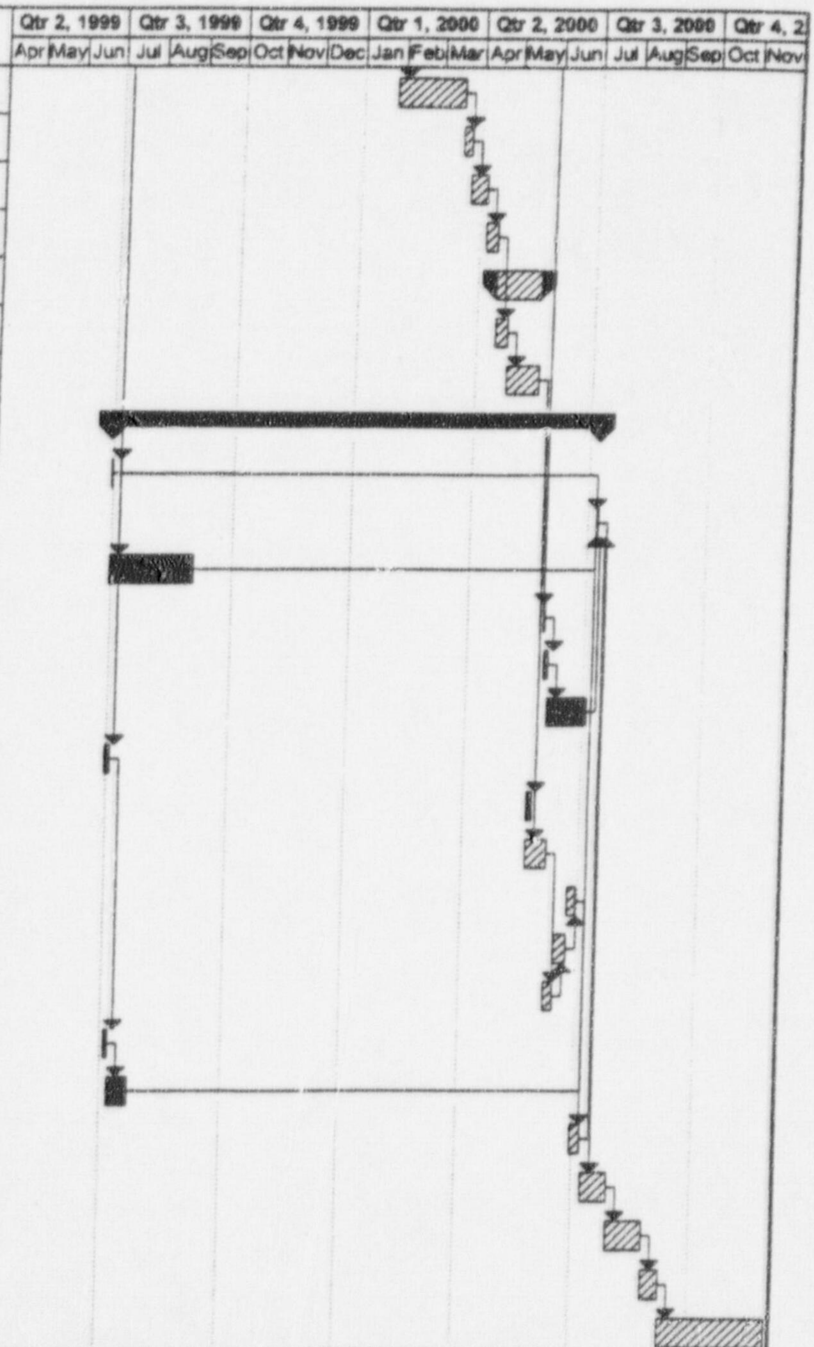


Figure 2.1 Decommissioning Schedule for the GTRR (continued)

Task Name
2.6.16 Lead Thermal Shield Removal
2.6.17 Outer Steel Tank Removal
2.6.18 Thermal Column Door Removal
2.6.19 Medical Facility Shutter Plug Removal
2.7 Decontaminate/Remove Biological Shield
2.7.1 Remove Activated Concrete from Walls
2.7.2 Decontaminate Bottom Shield
2.8 Facility Decontamination
2.8.1 Yard Characterization
2.8.2 Size Reduction Tent Decontamination
2.8.3 Remove Contaminated Systems
2.8.4 Characterize Retention Tank
2.8.5 Remove Sludge from Retention Tanks
2.8.6 Remove Retention Tanks
2.8.7 Remove & Package Material in Storage Hol
2.8.8 Decon Other Area Floors
2.8.9 Remove Reactor Ventilation System
2.8.10 Deconatminate Containment Ground Floor
2.8.11 Decontaminate Containment 1st Floor
2.8.12 Decontaminate Containment 2nd Floor
2.8.13 Characterize Plug Storage Holes
2.8.14 Decontaminate/Remove Plug Storage Hole
2.8.15 Decontaminate Shell Ventilation System
2.9 DGC Confirmatory Survey
2.10 Final Radiological Survey
2.11 Final Site Cleanup and Demobilization
2.12 Prepare Final Decommissioning Report



Project: GT-Schedule.MPP
Date: Mon 3/23/98

Task		Rolled Up Task	
Progress		Rolled Up Milestone	
Milestone		Rolled Up Progress	
Summary			

2.4 DECOMMISSIONING ORGANIZATION AND RESPONSIBILITIES

The organization for the management of the reactor facility during the decommissioning program is shown in Figure 2.2. The organization is consistent with that defined in the proposed, revised technical specifications for the POL.

2.4.1 Radiation Safety Officer

The Radiation Safety Officer (RSO) heads the Georgia Tech Office of Radiation Safety and supervises a professional staff providing health physics support to the Georgia Tech campus. This person is a qualified health physicist who will maintain proficiency in radiation safety over the duration of decommissioning activities. The RSO will advise the TSRC about all matters regarding radiation monitoring and radiation safety during decommissioning activities. This person will review and approve all Radiation Work Permits (RWPs). 3

The RSO will direct his health physics staff to perform independent radiation monitoring audits over the subcontracted health physics staff during decommissioning activities and final release survey. The RSO has the authority and responsibility to interrupt or suspend any activity involving the use of radiation if the methods and/or procedures used are determined to be unsafe and/or contrary to applicable regulations.

2.4.2 Director of the Neely Nuclear Research Center

The Director of the NNRC will have the overall responsibility for direction of the decommissioning plan and activities to ensure radiation safety during decommissioning activities, including safeguarding the general public and facility personnel from radiation exposure. The Director has the authority and responsibility to interrupt or suspend any activity involving the use of radiation if the methods and/or procedures used are determined to be unsafe and/or contrary to applicable regulations. The interruption/suspension will remain in effect until resolved by the TSRC. The Director will review and approve all RWPs.

2.4.3 Technical Safety Review Committee

The TSRC will review and approve all plans, policies and procedures to be performed under the GTRR Decommissioning Project. The TSRC will review and audit the D&D project operations and activities. TSRC members will be appointed by the President of Georgia Tech. The TSRC will keep a written record of the meetings and will report directly to the President. 3

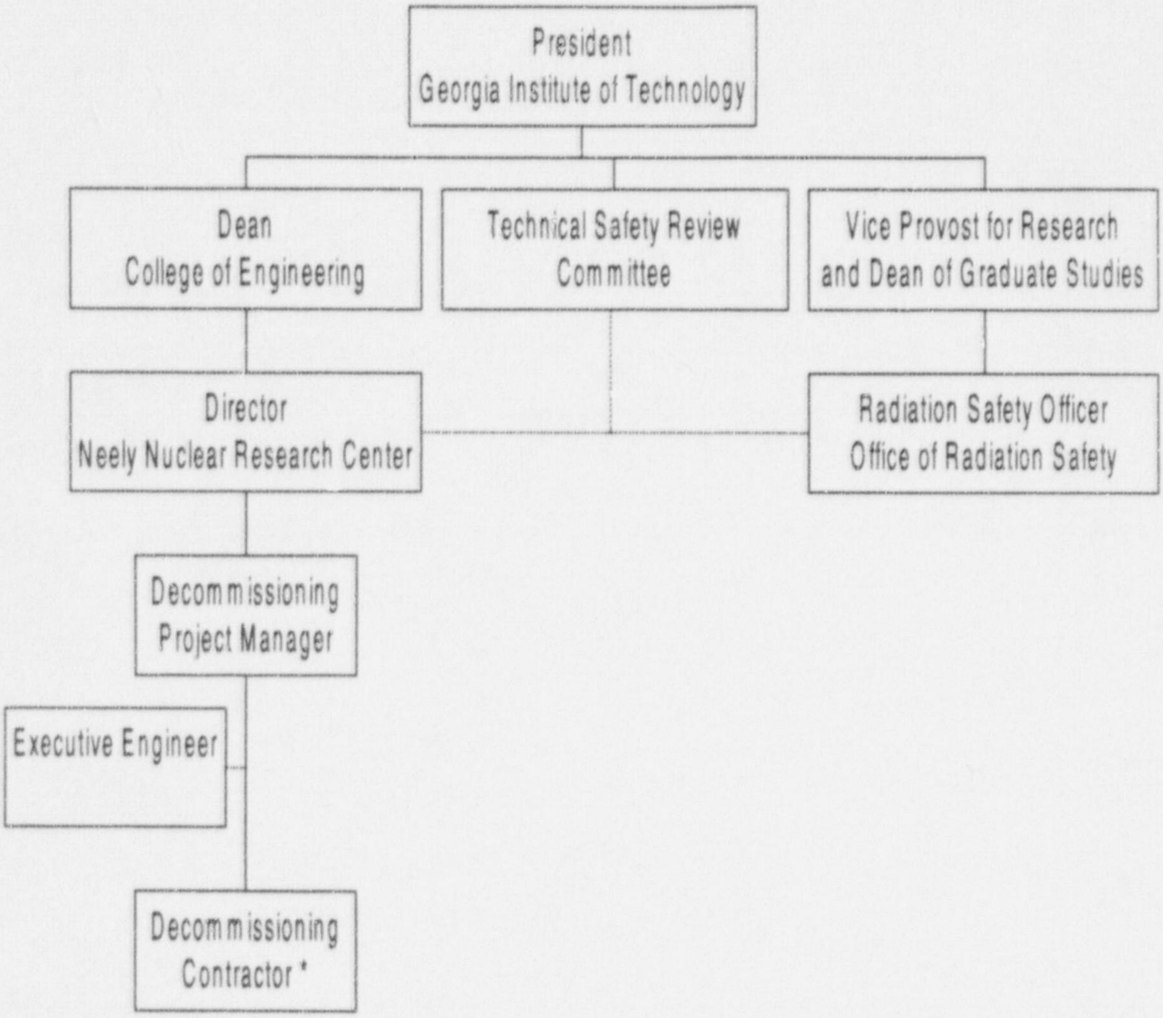
2.4.4 Executive Engineer

The Executive Engineer will serve as the decommissioning consultant for Georgia Tech, providing overall contractual direction to the DC. The Executive Engineer will coordinate Georgia Tech's review of DC documents; continuously monitor the contractor's performance to ensure satisfactory execution of the work; and routinely report on program progress to Georgia Tech. The Executive Engineer has the authority to cease operations if the work is not being performed in accordance with approved procedures.

2.4.5 Decommissioning Contractor

The DC will be an experienced nuclear D&D firm who will be responsible for the actual field performance of the dismantling program. The DC will be chartered with the responsibility of performing engineering, decommissioning work, waste packaging, disposal and the final release survey. The contractor will be responsible for preparation of detailed work plans; radiological monitoring and control of his own work; safe removal of all radioactive materials - including demolition, packaging and shipping; performance of the final radiation survey; and preparation of the final report in support of the license termination application to the US NRC. The DC will implement its own radiological control program and quality assurance program. The DC will provide the required resources, including personnel and equipment, to perform all of the D&D activities. See Section 2.6 for additional duties of the DC.

Figure 2.2 GTRR Decommissioning Organization Structure



* The Decommissioning Contractor's organization and duties will be provided in the Work Plan.

2.5 TRAINING PROGRAM

The training program for all personnel directly involved with accomplishment of the decommissioning program will include:

- General employee training in compliance with 10 CFR 19.12 for all personnel involved with radioactive materials or those in the vicinity of radioactive materials.
- Radiation worker training in compliance with 10 CFR Part 20. The radiation safety training program will include personnel monitoring, radiation surveillance and monitoring, controlled areas and ventilation, access controls, and health physics administrative controls.
- Respiratory protection training in accordance with the requirements of ANSI Z-88.2 (Reference 6), NRC Reg. Guide 8.15 (Reference 7), NUREG-1400(Reference 8) and 29 CFR 1910.134.
- Hearing conservation training to meet the requirements of 29 CFR 1910.25.
- Hazard Communication training to meet the requirements of 29 CFR 1910.1200. Radiological and demolition-induced hazards will be reviewed together with precautionary measures.
- Technical training, including mockup simulation or pre-performance briefings, to ensure proper equipment usage and achievement of ALARA. Topics will include decontamination, material segmentation and demolition, and packaging and shipping.

All training will be conducted by DC personnel qualified in the program contents. Section 3.1.1 summarizes the types of training necessary to implement the ALARA concept.

2.6 CONTRACTOR ASSISTANCE

Georgia Tech intends to use the DC to perform the actual decommissioning activities as indicated in Section 2.4.5. Oversight will be maintained by Georgia Tech throughout the decommissioning program by assignment of an Executive Engineer and periodic audits of program performance to assure satisfactory experience on the part of the DC.

2.7 DOCUMENTS AND GUIDES

All guides, standards and reports used to develop this Decommissioning Plan are listed in Section 9.0.

3.0 PROTECTION OF THE HEALTH AND SAFETY OF RADIATION WORKER AND THE PUBLIC

3.1 RADIATION PROTECTION

3.1.1 Ensuring As Low As Reasonably Achievable Radiation Exposures

A site-specific ALARA plan for maintaining worker radiation exposure will be developed by the DC and used for the decommissioning of the GTRR. The ALARA plan will demonstrate knowledge of the source of radiation during dismantling, pre-planned mitigation of the source impact, pre-planned minimization of the duration of personnel exposure to the source and the protection of personnel during their exposure.

The TSRC will approve the ALARA Plan following review and approval by the Executive Engineer and the Georgia Tech RSO. Routine audits will be conducted to ensure that the items identified in the task reviews are implemented. All individuals associated with this decommissioning project are responsible for implementing the ALARA plan. 3

In planning the details of the decommissioning program and following the guidance of the ALARA Plan, the general sequence to be followed will be the removal of the most activated material first. This serves two important ALARA purposes:

1. Retains the inherent shielding of the biological shield during removal of the activated material; and
2. Minimizes the period of exposure of the work force to the largest segment of the radioactive inventory.

The decommissioning contractor will be encouraged to utilize local shielding where appropriate to reduce exposure fields. A separate HEPA exhaust system will be maintained at the point of demolition to further minimize the potential spread of contamination.

All demolition activities involving the potential for airborne contamination will be accomplished with workers using appropriate respiratory protection equipment.

The decommissioning contractor has the responsibility for reflecting ALARA concepts in the detailed planning of the program and for day-to-day implementation of ALARA principles in the accomplishment of the work. The Georgia Tech RSO will reflect Georgia Tech's responsibility for ensuring the achievement of ALARA via their approval of program documents including RWPs.

Training is an important ALARA component. Properly trained personnel work safely and efficiently and receive less radiation exposure. All personnel working on the decommissioning of the GTRR and in the vicinity of the containment building will be given instructions in radiation safety prior to the commencement of their work activities. There will be three levels of training performed by the DC:

1. **Non-radiation worker training** (information for clerical, administrative, vendors, etc.).
2. **Radiation worker training** (for workers directly involved in handling activated or contaminated materials and entering radiation areas).
3. **Supervisor training** (for persons directing the activities of radiation workers).

OSHA hazardous environment protection training will also be provided with emphasis on dust ingestion prevention, noise mitigation and handling of heavy loads. Additional briefings and practical training will be performed as required to review work procedures, equipment usage, radiation control requirements and specific hazards associated with certain procedural steps. Records of each individual training session will be maintained on the job site.

The three major areas of radiological control to be implemented during the decommissioning project are:

- Personnel radiation exposure limits,
- radiation work permits, and
- surface contamination area isolation.

The specific ALARA techniques that will be used for a particular task will be included in the work plan and will be based on the ALARA review.

3.1.2 Health Physics Program

3.1.2.1 Implementing the Health Physics Program

The implementation of the Health Physics Program during the decommissioning project will be the responsibility of the DC. Approval and audit monitoring of the contractor's program will be performed by the Georgia Tech RSO. The contractor will be responsible for: 3

- Preparation of the GTRR Site Health and Safety Plan.
- Provisions of a full-time health physics staff to perform all survey, monitoring and radiological control functions.

- Selection of appropriate instrumentation for radiation and contamination surveys and for personnel monitoring.
- Calibration, testing and maintenance of instrumentation.
- Monitoring of effluent discharges from contamination control envelopes.

3.1.2.2 Plans and Procedures

3.1.2.2.1 Site Health and Safety Plan

The Site Health and Safety Plan prepared by the DC will include a description of the controls to be exercised to minimize personnel exposure - including stipulation of radiation exposure limits to workers and non-radiation worker personnel; personnel dosimetry - including film badges or TLDs, self-reading pocket dosimeters, extremity TLDs and tracking of radiation exposures; internal radiological monitoring - including bioassays and/or excretion analysis; identification and monitoring of controlled areas - including radiation areas, controlled surface contamination areas, airborne radioactivity areas and radioactive materials areas; radiological survey techniques and frequencies - respiratory protection, including engineering controls and respirator use; air monitoring and dust control; contamination control; and satisfaction of OSHA requirements. 3

3.1.2.2.2 Instrument Calibration and Maintenance Procedure

A written procedure for calibration and maintenance of survey instruments will be prepared by the DC. It will identify the staff responsibilities for instrument control and records. The procedure will also define pre-use instrument check requirements, protection and storage of instruments, and calibration requirements. All instruments used for surveys will be calibrated at no greater an interval than twelve months and after every instrument repair.

3.1.2.2.3 Airborne Radioactivity Control Procedure

An airborne radioactivity control procedure which will define how compliance will be attained with the provisions of 10 CFR 20, Appendix B, Table II, "Respiratory Protection and Use," will be prepared. The procedure will define air sampling techniques and frequencies; the calculation of beta-gamma and alpha concentration in the air samples; the use of portable and continuous air monitors; air sampling of the outside environment; and maintenance of air sampling records. The procedure will also define the limits and conditions under which full-face respirators or hoods will be worn; airborne limits for alpha and beta-gamma activity beyond which personnel will not be allowed into the area; respirator maintenance and decontamination; and the operation of HEPA-protected CCEs. All demolition activities which have the potential for creating airborne radioactivity will be performed within a CCE. Whenever work activities are occurring inside a CCE, a HEPA exhaust system, sized for at least three CCE volume air changes per hour, will be in continuous operation exhausting from the CCE. In addition, HEPA exhaust systems will also be utilized to control known airborne generating activities - such as grinding or scabbling contaminated materials. A separate exhaust can be taken at the point of generation within a CCE.

3.1.2.2.4 Environmental Program Plan

With the location of the site in the center of a populated area, environmental concerns are high. Therefore, an environmental monitoring program will be established to ensure that no releases exceeding regulatory limits occur during the decommissioning project. The DC will prepare this document and additional plans and procedures which will be used during the decommissioning project. These include, but are not limited to, employee training, radiation safety, effluent monitoring, personnel monitoring, access control to work areas, sampling and laboratory analysis of samples, specific operational procedures, preparation of RWPs, radioactive waste shipment, emergency planning and the QAPP. All plans and procedures will be reviewed by the TSRC. 3

3.1.2.2.5 Emergency Plan

The Emergency Plan will be prepared by the DC to detail the actions taken in the event of an emergency and the responsibility and immediate response of the DC, Georgia Tech personnel and local agencies. The responsibilities of all parties are specified in the appropriate event description. Emergency events that should be included are accidental spillage of hazardous liquids, airborne radioactivity alarm or release, fire, radiation alarm or exposure, and other events specific to the decommissioning project. A step-by-step procedure will be included for each event. The NNRC emergency plan calls for the use of city services, should events requiring their assistance arise during the decommissioning activities. The plan should include information of the responsible parties and their phone numbers. The Emergency Plan will be approved by the TSRC.

3.1.2.3 Facilities

Supporting facilities which will be provided by Georgia Tech for implementation of a comprehensive Radiation Protection Program will include the following:

- Control stations for entrance or exit of personnel into radiation or contaminated areas; for movement of radioactive waste material; and for movement of potentially contaminated equipment and instruments.

The DC will provide the following:

- An area to clean, repair and decontaminate equipment, monitor instruments, tools and other material,
- Office space to store the DC's materials and equipment,
- Changing room(s) with emergency showers which allow for the segregation of contaminated from non-contaminated clothing,
- Equipment to facilitate communication between workers and supervisory personnel between radiological and non-radiological areas.

3.1.2.4 Radiation Protection Equipment

Radiation protection equipment will be available for use as needed. Equipment that will be supplied by the DC and made available throughout the decommissioning project are listed below:

- Protective clothing;
- respiratory protection devices;
- dosimeters;
- contamination control equipment (barricade rope, sheet plastic, plastic bags, plastic containers);

- HEPA ventilation units, vacuum cleaners;
- signs, labels, tags and rope;
- survey equipment; and
- mobile or temporary shielding.

3.1.2.5 Occupational Radiation Exposure Limits

Radiation exposure limits are used for controlling personnel exposure to radiation (excluding medical and dental exposures) to levels which are believed to cause no ill-effects even if the employee was exposed to these levels throughout his/her entire working life. These limits are found in 10 CFR 20.1201, "Regulation Standards for Protection Against Radiation," (Reference 9).

Decommissioning operations will be controlled so that no employee exceeds any 10 CFR 20 occupational exposure limits, and that the total of all employees' exposures is limited to the lowest levels reasonably achievable. The decommissioning project goal is to limit total radiation exposures to less than Georgia Tech's ALARA objective of 20 percent of the regulatory limits.

The US NRC annual occupational radiation exposure limits are summarized in Table 3.1. The personnel radiation exposure limits for the GTRR Decommissioning project are summarized in Table 3.2.

Table 3.1 NRC Annual Occupational Exposure Limits

Type of Exposure	10 CFR 20 Limits
Whole Body (Internal + External) TEDE	**5 Rem**
Lens of the Eye	**15 Rem**
Extremities	**50 Rem**
Any Organ or Tissue and Skin (Sum of the deep dose equivalent and the committed dose equivalent)	**50 Rem**
Declared Pregnant Worker: (Embryo/Fetus)	**0.5 Rem** **9 Months**
Minors and Students (Internal+External) (under age 18)	**0.1 Rem**
Members of the Public/Visitors	**0.1 Rem**

Because of the nature of the work and the methods used during the decommissioning effort, it is anticipated that the work can be accomplished with low average radiation exposures to the workers. Therefore, the administrative limits shown below in Table 3.2 will be adhered to throughout this program.

Table 3.2 Administrative Limits for Whole Body Exposure

Period of Exposure	Radiation Exposure Limit
Daily	**100 mRem**
Weekly	**250 mRem**

Although negligible public exposure is expected as a result of the decommissioning program for the GTRR, the DC will ensure that the limits for public exposure specified in 10 CFR 20.1301, "Dose Limits for Individual Members of the Public," are not exceeded.

3.1.3 Radiation Work Permits

Radiation Work Permits (RWPs) will be prepared to ensure that the radiological and other hazardous work conditions associated with a specific activity or group of activities are well defined; that all necessary preparations and plant conditions have been established; and that all required personnel protective measures are clearly specified. The RSO, the Director of the NNRC or their designees will approve all RWPs. Work within a controlled area cannot commence without an approved RWP. Should radiological or hazardous conditions change significantly during the performance of an activity under a RWP, then it is incumbent upon the site supervisor to stop the work and initiate the new RWP which reflects the changed condition.

As a minimum, all RWPs will contain the following information:

- Radiation and contamination mapping based upon current radiological surveys, analytical results and calculations (e.g., contaminated area, "clean" working areas, examination areas, low dose waiting areas, hot spots, etc).
- Access requirements to control the spread of contamination from contaminated to "clean" working area and methods employed to minimize exposure to all personnel.
- Listing of work area monitoring requirements necessary to detect changes in the radiological conditions.
- Listing of required personnel dosimetry and protective devices.
- Requirements for RCT coverage (continual, intermittent, on-call, or not required).
- Description of the work to be performed, including estimates of time required.
- Requirements for additional information (pre-job briefings, additional training and ALARA briefings).
- As an addendum to the RWP, personnel entry logs will be maintained to document entry and egress from areas governed by the RWP and to track accumulated exposure for ongoing work.

3.1.4 Contamination Control Envelopes

Work involving the demolition of contaminated material which could cause airborne radioactivity levels to exceed the established limits will be performed within a CCE. The CCE will be maintained at a negative pressure relative to the environment outside the CCE during the time that physical demolition or handling of the contaminated material is occurring within the CCE. The exhaust from the CCE will be through a HEPA ventilation unit to ensure retention of potential contamination.

All personnel entries into and exits from a CCE will be made at a contamination control point which will include a step-off pad, replaceable floor covering (paper or plastic) for contamination control, personnel radiation monitoring equipment, and repository for used protective clothing.

All equipment or materials to be removed from a CCE and intended for unrestricted use will be surveyed and verified to ensure that the limits of Table 1 in US NRC Regulatory Guide 1.86 are met before being released from the control point (Reference 4). If the limits are exceeded, the material or equipment will be decontaminated or contained and identified before being released from the area.

3.1.5 Preliminary Collective Dose Estimates

The activities involving personnel radiation exposure are listed in Table 3.3, together with the estimated occupational exposures. Based on the GTRR Radiological Characterization Report and on past NES project experience, the total effective dose equivalent (TEDE) should be below 8.0 person-rem (Reference 3).

Table 3.3 Estimated Occupational Exposures

Decommissioning Activity	Estimated Collective Dose (Person-rem)
Initial Site Survey	1.06e-01
Setup Work Areas/Install CCE	1.19e-02
Decontamination of Equipment Prior to Removal	2.06e-03
Setup Packaging and Staging Area	9.47e-03
Reactor Complex Removai	4.90e+00
Removal of Vertical Beam Ports	1.09e+00
Removal of Shim Safety Rods and Drives	2.09e-01

Removal of Horizontal Beam Gates	2.78e-01
Removal of Spent Fuel Storage Holes	3.94e-02
Removal of Piping and Instrumentation	2.43e-02
Removal of Lead Cover Plate	2.57e-01
Removal of Upper Top Shield	2.27e-01
Removal of Lower Shield Plug	2.07e-01
Removal of Fuel Spray Manifold	1.85e-02
Removal of Reactor Vessel	3.63e-01
Removal of Graphite Retaining Sleeve	1.04e-01
Removal of Graphite	1.04e-01
Removal of Horizontal Beam Ports	2.64e-01
Removal of Boral	7.72e-02
Removal of Inner Steel Tank	9.95e-02
Removal of Lead Thermal Shield	9.67e-01
Removal of Outer Steel Tank Removal	1.20e-01
Removal of Thermal Column Shutter and Shielding	2.57e-01
Removal of Biomedical Irradiation Facility Shutter and Shielding	1.97e-01
Decontamination and Removal of Biological Shield	6.95e-01
Removal of Activated Concrete	1.74e-01
Decontamination of Bottom Shield	5.21e-01
Facility Decontamination	2.03e+00
Outdoor Characterization	6.01e-05
Decontamination of Size Reduction Tent	3.61e-04
Removal of Contaminated Systems	1.23e+00
Removal of Sludge from Retention Tanks	6.98e-03

Removal of Retention Tanks	6.11e-02
Removal and Packaging of Material in Plug Storage Vault	2.25e-02
Decontamination of Floors and Walls Outside of the Reactor Containment Building	1.74e-02
Removal of Reactor Ventilation System and Stack	3.34e-02
Decontamination of Containment Ground Floor	2.17e-02
Decontamination of Containment First Floor	3.05e-01
Decontamination of Containment Second Floor	2.22e-01
Characterization of Plug Storage Vault	4.86e-03
Decontamination and Removal of Plug Storage Holes	8.56e-03
Decontamination of Air-Conditioning System	7.94e-04
PROJECT ESTIMATED TOTAL	**7.74e+00**

Utilizing contamination control enclosures in conjunction with HEPA filtration and ventilation units will minimize the potential for internal uptakes. This widely used engineering control will result in minimizing personnel radiation exposure in keeping with ALARA principles and objectives.

3.1.6 Respiratory Protection Program

A site-specific Respiratory Protection Program will be implemented by the DC in compliance with ANSI Z-88.2 (Reference 6) US NRC Regulatory Guide 8.15 (Reference 7), 10 CFR 20.1701 through 20.1704 (Reference 10) and OSHA requirements. The guidelines governing the Respiratory Protection Program will include the following components:

- Written procedures governing the use of respirators;
- assignment of responsibilities;
- types of records;
- training of employees and supervisors;
- quantitative and qualitative fit testing;
- work area surveillance;

- medical surveillance;
- special respirator-use problems and limitations; and
- maintenance and repair of respirators.

All respirator protection equipment utilized will meet the requirements of the MSHA and/or NIOSH approved respiratory protection equipment.

All respiratory protection equipment will be stored and maintained so that it is protected from outside contamination and damage and routinely inspected by respirator users prior to each use.

3.2 RADIOACTIVE WASTE MANAGEMENT

3.2.1 Fuel Removal

All nuclear fuel was removed from the site on February 15, 1996. The irradiated fuel was transported to the U.S. Department of Energy (DOE) Savannah River site for storage.

3.2.2 Radioactive Waste Processing

During the decommissioning activities, radioactive materials in liquid, solid and airborne forms are expected to be generated. Management of these wastes is an integral part of the decommissioning plan and includes provisions for minimizing the amount of waste generated, as well as waste collection, treatment, packaging and shipment off site for disposal.

Since the majority of the systems at GTRR are dry, the major source term during decommissioning will be the solid waste associated with the activated concrete and the activated and contaminated metallic structure of the reactor and associated reactor support equipment. There is radioactive contamination present in the sump.

Radioactive contamination generated during GTRR decommissioning will be present in two forms:

1. solids, and
2. liquids from the primary coolant system and cutting operations.

The solid radioactive waste will be comprised of parts of the shield tank, the beam ports, activated/contaminated reactor structural materials, graphite blocks and stringers, shield blocks and the biological shield. To the extent possible, contaminated/activated cadmium control rod blades, an activated antimony-beryllium source, lead bricks and the lead shield curtain will be decontaminated. Waste will be packaged and shipped to the designated disposal site.

The expected volume of solid radioactive wastes is shown in Table 3.4. NES Document No. 82A9088, "Decommissioning Cost Estimate for the Georgia Institute of Technology Research Reactor," March, 1998 (Reference 11).

Table 3.4 Expected Volume or Weight of Solid Radioactive Waste

Radioactive Waste Description	Estimated Volume or Weight
Radioactive Waste	9,625 cu ft.
Mixed Waste (mostly lead)	133,447 lbs.

Because of the small work areas available, the demolition materials will require removal as the demolition proceeds. An area in the containment building will be kept clear during demolition to allow the staging of a waste container. A protective plastic cover will be placed on the outside of the container to prevent contamination. After the container is filled, it will be surveyed, manifested and placed in temporary storage until shipment.

Liquid waste generated during decommissioning activities will be collected and assayed to determine if release to the sanitary sewer is permissible. Liquid waste that cannot be released to the sewer will be solidified prior to shipment to an approved disposal site. Expected and possible sources of liquid radioactive waste are:

- decontamination of parts,
- concrete cutting and coring operations,
- personnel decontamination, and
- residual water in dismantled systems.

Efforts will be made throughout the decommissioning project to minimize the generation of liquid radioactive waste.

3.2.3 Radioactive Waste Disposal

A procedure will be prepared for the handling, storage and shipment of radioactive materials in accordance with 10 CFR 20.2006, "Transfer for Disposal and Manifests," (Reference 9); 49 CFR Parts 100-177, "Transportation of Hazardous Materials," (Reference 12); 10 CFR Part 61, "Licensing Requirements for Land

Disposal of Radioactive Waste," (Reference 13); and applicable disposal site license conditions for processing and disposal of low-level radioactive wastes.

3.2.3.1 The Radioactive Material Shipment Manifest

Each shipment of radioactive waste must be accompanied by a shipment manifest as specified in Section I of Appendix F, "Requirements for Low-Level Waste Transfer for Disposal at Land Facilities and Manifests to 10 CFR 20.1001 through 20.2401," (Reference 10). Barnwell and Envirocare are possible radioactive waste disposal sites.

3.2.3.2 Waste Classification (Provisions of 10 CFR 61)

The criteria for waste classification for low-level waste disposal is contained in 10 CFR Part 61 (Reference 13). The significant radionuclides generated as a result of neutron activation are shown in Table 3.5 (References 2 and 3). In addition, the reactor contains a very small quantity of stainless steel present in components such as grid support plate bolts. The bottom of the lower top shield is stainless steel with 1 wt% boron. It is concluded that the wastes from the GTRR can be classified as radioactive waste. Radioactive wastes do not need to be segregated for disposal, provided they meet the stability criteria described in Paragraph 61.56 of 10 CFR Part 61 (i.e. wastes do not structurally degrade and affect the overall stability of the disposal site through lumping, collapse, etc.). The type of waste containers for packaging and shipping radioactive materials will be 4' x 4' x 6' (~90 cu. ft. net) B-25 boxes, or equivalent. 3

Radioactive waste generated from the GTRR decommissioning is expected to meet the stability criteria. To further comply with regulations, the containers will be filled so that voids will be kept to a minimum, ensuring structural stability when overburdened or when other packages are placed over them.

Table 3.5 Isotopes Potentially Present and Principal Decay Characteristics

Isotope	Half Life	Principle Decay Modes	Locations Where Isotopes Were Present
H-3	12.32 y	β^-	Horizontal Beam Ports Vertical Beam Ports
Fe-55	2.73 y	ϵ	Biological Shield
Co-60	5.271 y	β^-, γ	Biological Shield Plug Storage Area Reactor Vessel Pipe Chase Tunnel Chemical Addition Tank No. 2 Retention Tanks Bismuth Shield Block Coolant Liquid Water-filled Storage Hole Process Equipment Room Tanks
Eu-152	13.54 y	$\beta^-, \beta^+ \epsilon, \gamma$	Reactor Vessel
Cs-137	30.07 y	β^-, γ	Retention Tanks Water-filled Storage Hole
C-14	5,715 y	β^-	Reactor Vessel Plug Storage Area

3.2.3.3 **Mixed Waste**

Mixed (radioactive and hazardous) waste, as defined in the Low-Level Waste Policy Amendments Act of 1985, is LLRW which also contains hazardous waste that either (1) is listed as a hazardous waste in Subpart D of 40 CFR Part 261, or (2) cause the LLW to exhibit any hazardous waste characteristics identified in Subpart C of 40 CFR Part 261 (Reference 14).

Contaminated/activated cadmium control rod blades, an activated antimony-beryllium source, lead bricks and lead shield curtains are considered mixed waste and will be decontaminated to the maximum extent possible. Mixed waste will be packaged and shipped to the designated disposal site.

3.2.3.4 **Waste Minimization**

Waste minimization refers to any measure, procedure or technique that will reduce the overall amount of waste generated during decommissioning operations. Waste minimization can be divided into three general categories: techniques which control the generation of waste; techniques which clean, decontaminate or otherwise remove material from the waste stream; and techniques which reduce the volume of space that the generated waste occupies. The following are specific waste minimization techniques that will be used during the project:

- Take only that material absolutely required to perform the task into the radiologically-controlled area.
- Minimize the use of consumable objects - such as wrapping plastic, bags, rags and paper. Use only the amount needed for the job, conserve and reuse whenever possible.
- Do not knowingly mix hazardous materials with radioactively - contaminated materials.
- Observe waste packaging procedures.
- Minimize the use of liquids and activities that will generate liquid which is potentially contaminated.
- When packaging waste, minimize empty space inside the container; fill voids whenever possible.
- Use engineering controls to minimize the spread of contamination and reduce the amount of decontamination materials required.

3

- When possible, wrap equipment and tools being used in the decommissioning process in protective material (plastic sleeving, etc.) to prevent the equipment from becoming contaminated.
- Use signs and posters to stress radioactive waste reduction.
- Limit the number of access points to radiologically-controlled areas.
- Ensure housekeeping is conducted in radiologically-controlled areas to minimize the collection of trash.
- Minimize excessive use of protective clothing.
- Remove liquids from rags and mops prior to disposal.
- A contaminated tool crib program will be used to store reusable contaminated equipment.
- Use material that can be easily decontaminated - such as fiberglass ladders and aluminum scaffolding.

Waste minimization methods are to be observed whenever possible, provided that they do not compromise overall safety or have a potential environmental impact.

3.3 RADIOLOGICAL ACCIDENT ANALYSES

Since all nuclear fuel has previously been shipped off site and since the residual radioactive inventory is very small, there is zero probability for a criticality accident to occur that could significantly affect occupational or public health and safety during decommissioning activities.

Other potential accidents - such as spillage and minor spreads - may be possible. Such minor incidents are typical of decontamination and decommissioning projects and do not pose a serious threat. The DC's Emergency Plan will be implemented if such accidents arise.

4.0 PROPOSED FINAL RADIATION SURVEY PLAN

4.1 INTRODUCTION

A final radiation survey of the facility will be conducted in order to ensure that the area satisfies the unrestricted release criteria for radioactive material according to NUREG/CR-5849 (Reference 5).

The final radiation survey will be conducted after all other decommissioning activities have been completed. A final radiation survey plan will be prepared to support this effort. The detailed plan for the final radiation survey will depend on:

- The radiological history of the GTRR;
- results of the characterization survey; and
- identification of potential contaminants.

4.2 FINAL SURVEY PROCEDURES

A final survey procedure specific to this project will be developed. It will include, but is not limited to, the following information:

4.2.1 Building Survey

As stated in NUREG/CR-5849, the areas included in this project will be divided into two types: affected and unaffected. The affected areas are rooms that have known radioactive contamination in excess of site specific guidelines as defined in NUREG/CR-5849, Appendix A. These areas include the reactor containment building, radiochemistry room fume hood and decontamination room, which includes the walk-in hood. The unaffected areas are the rooms that have no known residual radioactivity based on historical and current information. 3

The walls, ceilings and floors in the affected areas will be gridded to:

- Facilitate systematic selection of measuring/sampling locations;
- provide a mechanism for referencing a survey or sample back to a specific location so that the same survey point can be readily relocated; and
- provide a convenient means for determining average activity levels as stated in NUREG/CR-5849. The area may be divided into survey units which have common history or radiological characteristics.

4.2.1.1 Affected Areas

For the final radiation survey of affected areas, the survey units will be divided into two subunits:

1. Floors and lower (up to 2 m height) walls; and
2. Upper wall and ceiling surfaces, and all other surfaces not described in (1) above.

Affected areas will be gridded as follows:

1. For floors and lower surfaces, survey grid blocks should be at intervals of 2 meters or less.
2. For upper wall and ceiling surfaces survey grid blocks should be at intervals of 4 meters or less.

Affected areas will be surveyed as follows:

1. The floors and lower surfaces of affected areas receive a 100 percent scan as directed in NUREG/CR-5849.
2. The coverage for the upper wall and ceiling surfaces will be dependent on the potential for these surfaces to be radioactively contaminated.
3. Vertical and horizontal surfaces, e.g., air exhaust vents or horizontal surfaces where dust would settle will be surveyed. To assure reasonable coverage of these surfaces, an average of at least one measurement per specific site location or per 4 m^2 of the surface area, whichever is the greatest should be selected.

4.2.1.2 Unaffected Areas

Unaffected areas will be gridded as follows:

1. Unaffected areas will be gridded at intervals of 4 meters or less.
2. Unaffected areas will be surveyed by performing at least 30 selected assessments at a frequency of at least one systematic measurement per 4 m^2, i.e., at least one per grid square.
3. The unaffected area surveys should ensure that a minimum of 10 percent of the surface area is scanned as directed in NUREG/CR-5849.

4.2.1.3 Exposure Rate Measurements

3

Exposure rate measurements should be performed at 1 meter from the floor and lower wall surfaces at a frequency of not less than once every 4 m^2 or once per grid block, whichever is greater.

4.2.1.4 Minimum Data Required

The following minimum data should be recorded:

- A list of the types and locations of measurements and samples to be obtained.
- Survey grid block numbers, identifiable on a scale drawing, and the building floor number.
- Name of surveyor taking measurements, date of survey and location data relative to the grid coordinates.
- Surface smears, plaster chips, etc., and the indoor block number from which they were taken, the container number and information pertaining to any matching air readings.
- Type, model number, calibration data and any other information needed regarding the portable survey instruments to interpret the data obtained with these instruments and to ensure quality control of the data.
- When the block surveyed is below the sensitivity of the instrument, the fact that such a measurement was made will be included as significant data.
- Quality control procedures for ensuring the validity of the data.

4.2.2 Instrumentation and Survey Methods for Contaminated Surface Surveys

To determine the instrumentation to be used in the decommissioning activities, isotopes of concern have been identified. Those isotopes present are listed in Table 3.5 in Section 3.2.3.2. The instruments to be used in the radiation surveys will be selected on the basis of type and level of radiation results of reviewing GTRR historical information and the results of the characterization survey.

Both direct and indirect (wipe) monitoring methods will be used to obtain a complete assessment of the surfaces being examined during the termination survey. For direct methods of surface monitoring, the detector is kept as close as possible to the surface and moved at a slow speed to ensure a source detection. The scan speed should not exceed one detector width per second. This speed should be reduced to as low as one-third detector width per second for those situations when relatively low count rates may be indicative of residual activity exceeding guideline values. The probe will be held stationary for a quantitative measurement, and the instrument reading will be averaged over 100 cm^2 and compared to Table 1 of the US NRC Reg. Guide 1.86, (Reference 4) for final disposition of the area being surveyed.

Following the direction of NUREG/CR-5849, smears for removable surface activity will be obtained by wiping the representative portions of approximately 100 cm^2 using a dry filter paper and applying uniform moderate pressure (Reference 5). As much as practical, efforts should be made to standardize, the procedure for taking the wipe.

The instruments used for direct and indirect monitoring of surface contamination will be capable of measuring surface activity at the guide levels specified in Table 1 of US NRC's Reg. Guide 1.86. Instruments will be tested and calibrated in accordance with the specifications contained in the ANSI Standard, "Radiation Protection Instrumentation Test and Calibration," ANSI N323-1978, or the most recent revision.

Table 4.1 lists the detection capabilities of the various types of survey instruments that could possibly be used to support decommissioning activities. The work plan will specify which instruments will be used in the D&D activities.

Table 4.1 Typical Sensitivity Capabilities for Various Survey Methods

METHOD	APPLICATIONS	NUCLIDE	SENSITIVITY
GM Thin Walled Probe	Surveyed by Hand or Walking Stick	Gross Beta/Gamma	2000-3000 dpm/100 cm^2
GM End Window of Pancake	Hand Surveyed for Beta Contamination	Gross Beta/Gamma	1500 dpm/100cm^2
GM Floor Monitor	Surveying Smooth Surfaces	Gross Beta/Gamma	2000 dpm/100 cm^2
Gas Flow Proportional Floor and Wall Monitors	Surveying Smooth Surfaces	Gross Beta or Alpha	<100 dpm/100 cm^2
Gas Flow Proportional Automatic Counter	Smear Samples	Gross Alpha-Beta-Gamma	<20 dpm/100 cm^2 α <100 dpm/100 cm^2 β
ZnS	Hand Surveying for Contamination	Gross Alpha	<100 dpm/100 cm^2

METHOD	APPLICATIONS	NUCLIDE	SENSITIVITY
ZnS Integrating Mode	Smears/Air Samples	Gross Alpha	<20 dpm/100 cm^2
NaI or Plastic Scintillation	μR Exposure rates or μrem Dose Rates	Gamma Emitters	<0.1 μR/hr <0.1 μrem/hr
Phoswich	Special Phoswich for Sr-90	Beta	1 nCi/g <200 dpm/100 cm^2
Intrinsic Germanium	Soil/Material Sampling	Gamma Emitters	<1 pCi/g-15 pCi/g
NaI or Ge(Li)	Soil/Material Sampling	Gamma Emitters	<1 pCi/g-100 pCi/g
GM Integrating Counter	Counting Smears/Air Samples	Gross Beta	<1000 dpm/100 cm^2
Liquid Scintillation	Counting H-3, C-14	Low Energy Beta	<100 dpm/100 cm^2
Radio chemistry	Measurements at Low Levels for Specific Nuclides	Beta-Gamma-Alpha Emitters	Variable
Eniwetok Proportional	Soil Integrated Mode (5-10 min.)	Gross Alpha	5 pCi/g

4.2.3 Documentation

As stated in NUREG/CR-5849, proper documentation of every aspect of the final survey is necessary for future reference to the decommissioning survey. An accurate mapping of the reactor containment building and surrounding areas within this decommissioning project will be maintained for future review and verification by a regulatory inspector.

Instrument measurements and analytical results will include the following data:

- Location of the measurement or sample;
- date(s) of measurement or sample collection;
- measured concentration of the specific nuclides in pCi/m^3 or mBq/m^3 for air samples; pCi/g or mBq/g for soil samples;
- analytical error at 95 percent confidence level should be reported for all analyses;

- name of surveyor, sampler and/or analyst;
- analysis date;
- instrument specifications and calibration data;
- confidence level and standard error attached to analytical results; and
- name of person verifying results.

The actual net measured values and their associated errors will be reported for purposes of calculating averages. For values lower than the LLD, the LLD will be provided. However, when calculating averages, the actual net measured values (including negative numbers) will be used. The use of LLDs would bias the results on the high side.

The following supplemental information will be included with the radiation measurements and analytical results for inclusion in the final report:

- Description of the survey and sampling equipment;
- survey and sampling procedures - including sampling times, rates and volumes;
- analytical procedures;
- calculation methods;
- calculation of the lower limit of detection;
- calibration procedures; and
- discussion of the program for ensuring the quality of results.

The data will be presented so that the radiological condition of the site is completely and accurately depicted and the radiological condition of the site can be ascertained without further analysis and manipulation of the data.

A DC written report will be submitted to the US NRC on the final radiation survey, as required by the US NRC Regulatory Guide 1.86. The report will include a description of the survey methods, instruments, analysis and an evaluation of the results. 3

5.0 TECHNICAL AND ENVIRONMENTAL SPECIFICATIONS

A POL was issued by the US NRC on April 2, 1998. All decommissioning activities will be performed under 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of By-product Material," (Reference 15). The current Technical Specifications will be adhered to during the decommissioning process. 3

6.0 PHYSICAL SECURITY PLAN PROVISIONS

Physical security of the building is based on the building being secured at all times. Key cards will be issued on a need-to-possess basis only and are regularly audited and recorded.

Visitors and non-radiation workers must be escorted by a trained radiation worker whenever they are in a controlled area.

During decommissioning activities, all access to the reactor containment building will be limited to those personnel required to perform work. During off hours, all entrances to the reactor containment building will be secured.

In addition, each entrance will be posted to keep inadvertent access of personnel from entering the decommissioning work area.

7.0 QUALITY ASSURANCE PROVISIONS

7.1 ORGANIZATION

The DC is responsible for implementation of the QA and Radiological Control Programs. The DC will ensure that all personnel adhere to the written procedures. The DC will stop the work activities that are not in compliance with all applicable plans and procedures. The Project Manager or designee will conduct oversight of the DC's QA and Radiological Control Programs to ensure that work is performed in a safe and controlled manner.

The procedures for the GTRR decommissioning plan activities will be written by the DC and will be reviewed and approved by the TSRC. Responsibility and authority for the decommissioning activities is illustrated in the organization chart in Figure 2.2 in Section 2.4.

7.2 QUALITY ASSURANCE PROGRAM

7.2.1 Scope

The DC will be responsible for preparing and implementing the GTRR decommissioning project QAPP for the QA Program applicable to the DC's work scope for controlling the decontamination and decommissioning of the GTRR.

7.2.2 Quality Assurance Program Plan

The QAPP describes the organization, document approval and QA aspects for the GTRR decommissioning project. The DC will include the following information in the decommissioning project QAPP:

- Quality assurance actions to be implemented during the GTRR decommissioning project.
- A list of project plans, procedures and forms.
- The policies and practices that will be employed by the DC in meeting the requirements for the project.
- The project organization responsible for the implementation of the decommissioning plan at the facility delineating the authorities and responsibilities of key personnel involved in the project.
- Communication and authority guidelines.
- Review of all program records is performed as specified in the GTRR Decommissioning Plan. This material will be provided to the client's representative upon work completion and is available for review at all times.

- Specific program requirements.

- Review of all data for consistency and accuracy as outlined in the GTRR Decommissioning Plan. Unreasonable or inconsistent data will be investigated and reported in writing as part of the data package, including any specific actions taken and conclusions reached.

- Program documents - This section sets forth the measures in effect at the facility to ensure the complete and correct implementation of the radiological safety program requirements. Enactment of these documents and their requirements are the responsibility of the DC. These documents will be controlled and maintained in accordance with the requirements of an approved document control procedure.

- Records - This section sets forth the measures required to assure that complete and sufficient records are maintained to furnish evidence of activities required to implement the decommissioning plan. Complete turnover of records to the client upon project completion. Collection of these records is the responsibility of the DC. All records and procedures will be maintained at the site of the GTRR project. However, review of documents and procedures will be granted upon request by the Georgia Tech personnel.

- Checklist for the investigation and analysis phase - This section provides the general overview of items that will be investigated during the decommissioning of the GTRR.

- Exception to project requirement list - Maintenance of an "Exception to Project Requirements List" will be performed by the DC. This list will include all items that are at a variance with the project program, including the Georgia Tech Facility Design Information Manual and other written project requirements.

- Document Control Program - Tracking and documenting all changes to the project program will be performed to an approved procedure. This decommissioning plan describes the responsibilities and procedures that are met to control the documents -- such as drawings, specifications, reports, procedures, program plan and the QAPP.

- Audits (see Section 7.2.5).

7.2.3 Applicability

The QA program is applicable during the performance of any decontamination and decommissioning activity through the completion of the DC's work scope and the project.

7.2.4 Records and Reports

Accurate and complete records and reports will be maintained by the DC of the performance and completion of all activities which may result in exposure of workers or the public to radiation or other hazardous/toxic materials. Originals will be given to Georgia Tech upon completion of the project.

7.2.5 Decommissioning Contractor's Internal Audit Program

Upon issuance of decommissioning activity procedures, the DC QA personnel will perform periodic internal audits prior to, during and after decommissioning activities to ensure compliance with the requirements of this plan. The Executive Engineer or NNRC Director designee will perform an independent audit as an over-check of the DC. The respective audit programs will include but not be limited to:

7.2.5.1 The Decommissioning Contractor's Audit Program

1. Review of DC's operating personnel health and safety training program.
2. Review of DC's radiological control program -- including ventilation, instrument usage and calibration, personnel monitoring, and area monitoring procedures.
3. Review of DC's work procedures with regard to public health and safety and the principles of ALARA.
4. Audit of DC's records -- including training, radiation surveys, instrument calibration and shipping data.

7.2.5.2 Georgia Tech Audit program

1. Review of DC's operating personnel health and safety training program.
2. Review of DC's radiological control program - including ventilation, instrument usage and calibration, personnel monitoring, and area monitoring procedures.
3. Review of DC's work procedures with regard to public health and safety and the principles of ALARA.
4. Audits of DC's records - including training, radiation surveys, instrument calibration and shipping data.
5. Independent check of area radiation levels and surface contamination levels.

6. Approval chain of documentation, developed by the DC, to be submitted to NRC.

8.0 COST ESTIMATE

8.1 COST ESTIMATE SUMMARY, INCLUDING ASSUMPTIONS

A detailed cost estimate of the decontamination and decommissioning of the GTRR was performed in conjunction with this report, NES Document No. 82A9088, "Decommissioning Cost Estimate for the Georgia Institute of Technology Research Reactor," March, 1998 (Reference 11). It contains the derivation of the anticipated costs, in 1998 dollars, required to remove the GTRR and associated process system component. The cost estimate includes manpower requirements cost of labor and waste volume and disposal for each work activity.

A detailed listing of the labor, equipment and waste disposal cost components is presented in the cost estimate. A summary of the decommissioning cost estimate is presented in Table 8.1.

NOTE: **Table 8.1 contains proprietary or confidential information only for the NRC's review purpose. This information should not be released to third parties without a written consent approval by the Georgia Institute of Technology.**

Table 8.1 Summary Table for the Decommissioning Cost Estimate

Decommissioning Activity	Decommissioning Cost in 1998 Dollars
1.1 Procedure Development	25,520.00
1.2 Preparation of QA Documents	25,520
2.1 Site Mobilization and General Employee Training	
2.1.1 Site Mobilization	26,015
2.1.2 General Employee Training	48,672
2.2 Initial Site Survey	29,491
2.3 Set Up Work Areas/Install CCE	12,058
2.4 Decontaminate Equipment Prior to Removal	10,925
2.5 Set Up Packaging Stations	4,439
2.6 Reactor Complex	
2.6.1 Vertical Beam Ports	180,754
2.6.2 Control Rods and Drives	17,233
2.6.3 Horizontal Beam Gates	174,632
2.6.4 Spent Fuel Storage Holes	13,685
2.6.5 Piping and Instrumentation	70,115
2.6.6 Lead Cover Plate	34,845
2.6.7 Upper Top Shield	66,976
2.6.8 Lower Shield Plug	66,911
2.6.9 Fuel Spray Manifold	1,452
2.6.10 Reactor Vessel	258,146
2.6.11 Graphite Retaining Sleeve	13,073

2.6.12 Graphite Removal	423,512
2.6.13 Horizontal Irradiation Facilities	64,493
2.6.14 Boral Removal	12,236
2.6.15 Inner Steel Tank	14,088
2.6.16 Lead Thermal Shield	248,367
2.6.17 Outer Steel Tank	15,812
2.6.18 Thermal Column Shutter and Shielding	73,095
2.6.19 Biomedical Irradiation Facility Shutter Plug	246,141
2.7 Biological Shield	
2.7.1 Activated Concrete	11,813
2.7.2 Bottom Shield	89,987
2.8 Facility Decontamination	
2.8.1 Outdoor Characterization	2,247
2.8.2 Size Reduction Tent Decontamination	2,488
2.8.3 Remove Contaminated Systems	171,996
2.8.4 Characterize Retention Tanks	7,813
2.8.5 Remove Sludge from Tanks	14,881
2.8.6 Remove Retention Tanks	68,724
2.8.7 Remove/Package Material in Storage Holes	13,531
2.8.8 Decontaminate Other Area Floors/Walls	53,332
2.8.9 Reactor Ventilation System	274,630
2.8.10 Decontaminate Containment Ground Floor	27,899
2.8.11 Decontaminate Containment First Floor	44,662
2.8.12 Decontaminate Containment Second Floor	35,106
2.8.13 Characterize Plug Storage Vault	1,369

2.8.14 Decontaminate Plug Storage Holes	43,909
2.8.15 Decontaminate Air-Conditicning System	14,511
2.9 DC Confirmatory Survey	54,512
2.10 Final Radiological Survey	54,512
2.11 Final Site Cleanup	8,570
2.12 Prepare Final Report	21,401
2.13 Undistributed Costs	2,048,486
SUBTOTAL	5,244,588
DGC OH&P on Equipment & Materials	147,121
TOTAL	5,391,710
CONTINGENCY (15%)	808,756
TOTAL DECOMMISSIONING COSTS	**6,200,466**

8.2 AVAILABILITY OF FUNDS

The State of Georgia is committed to providing the funding for this dismantlement.

9.0 REFERENCES

1. "Safety Analysis Report for the 5 MW Georgia Tech Research Reactor," January 1995.

2. Blaylock, D.P. ,"Activation Products in the Biological Shield of the Georgia Tech Research Reactor," June 1997.

3. NES Document 82A9087, "Georgia Institute of Technology Research Reactor Decommissioning Project Report, Radiological Characterization Report," January, 1998.

4. US Nuclear Regulatory Guide 1.86, "Termination of Operating License for Nuclear Reactors," June, 1974.

5. NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination," June, 1992.

6. ANSI Z88.2, "Practices for Respiratory Protection," 1980.

7. US NRC's Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," October, 1976.

8. NUREG 1400, "Air Sampling in the Workplace," October, 1991.

9. US NRC's ,"Regulation Standards for Protection Against Radiation," Title 10, Part 20.2006, "Transfer for Disposal and Manifests."

10. US NRC's, "Regulation Standards for Protection Against Radiation," Title 10, Parts 20.1001 to 20.2401.

11. NES Document No. 82A9088, "Decommissioning Cost Estimate for the Georgia Institute of Technology Research Reactor," March, 1998.

12. US DOT's, "Transportation of Hazardous Materials," Title 49, Parts 100-177.

13. US NRC's, "Licensing Requirements for Land Disposal of Radioactive Waste," Title 10, Part 61.

14. Title 40, Code of Federal Regulations, Part 261, "Identification and Listing of Hazardous Waste."

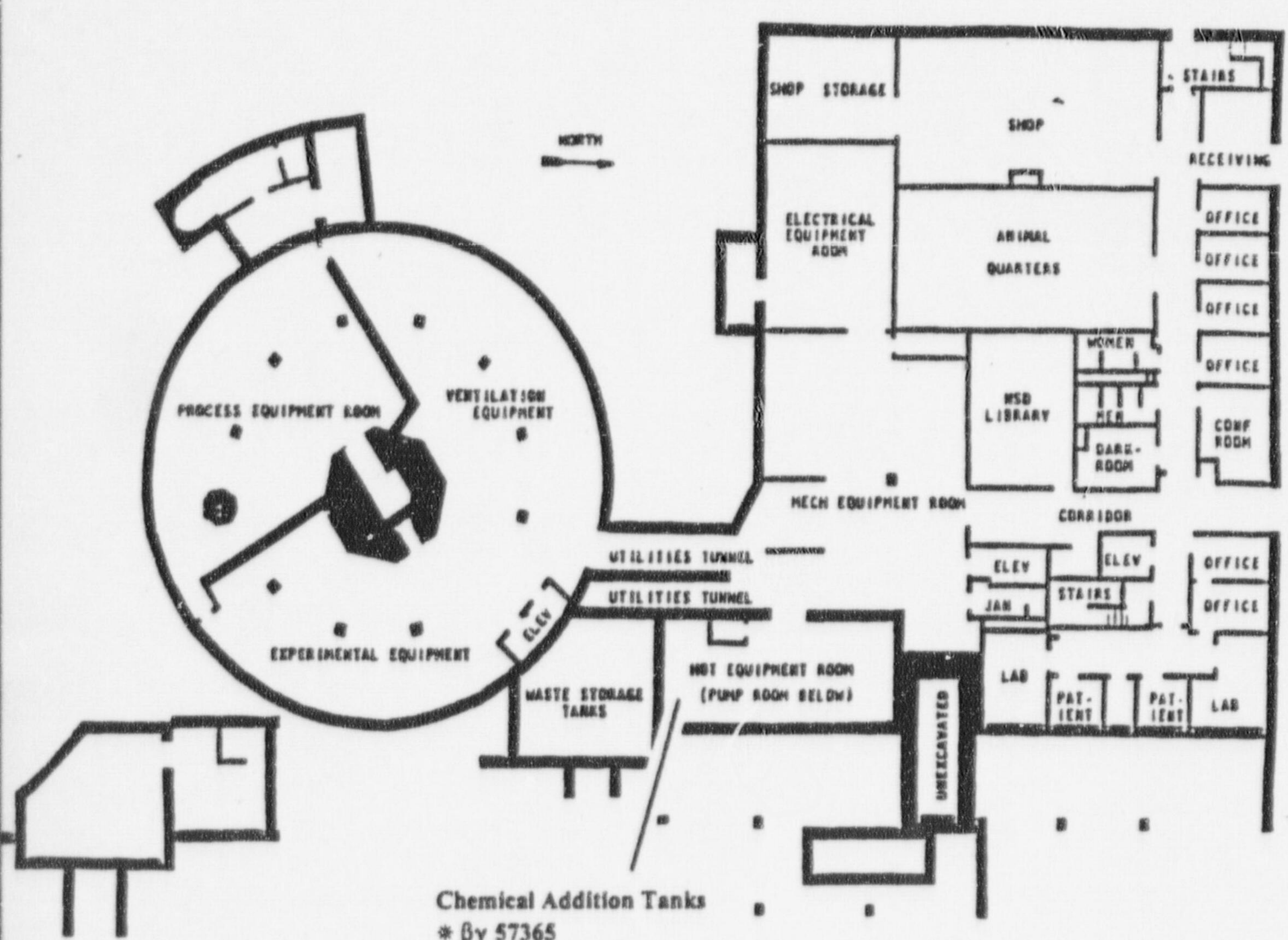
15. Title 10, Code of Federal Regulations, Part 30, "Rules of General Applicability to Domestic Licensing of By-product Material."

16. Section 17.2, "NRC Review of Decommissioning Plan for Non-Power Reactors," of NUREG-1537, "Guidelines for Preparing and Reviewing Applications for te Licensing of Non-Power Reactors," February, 1996.

Appendix A

Activity Data Summary of the NNRC Characterization Project

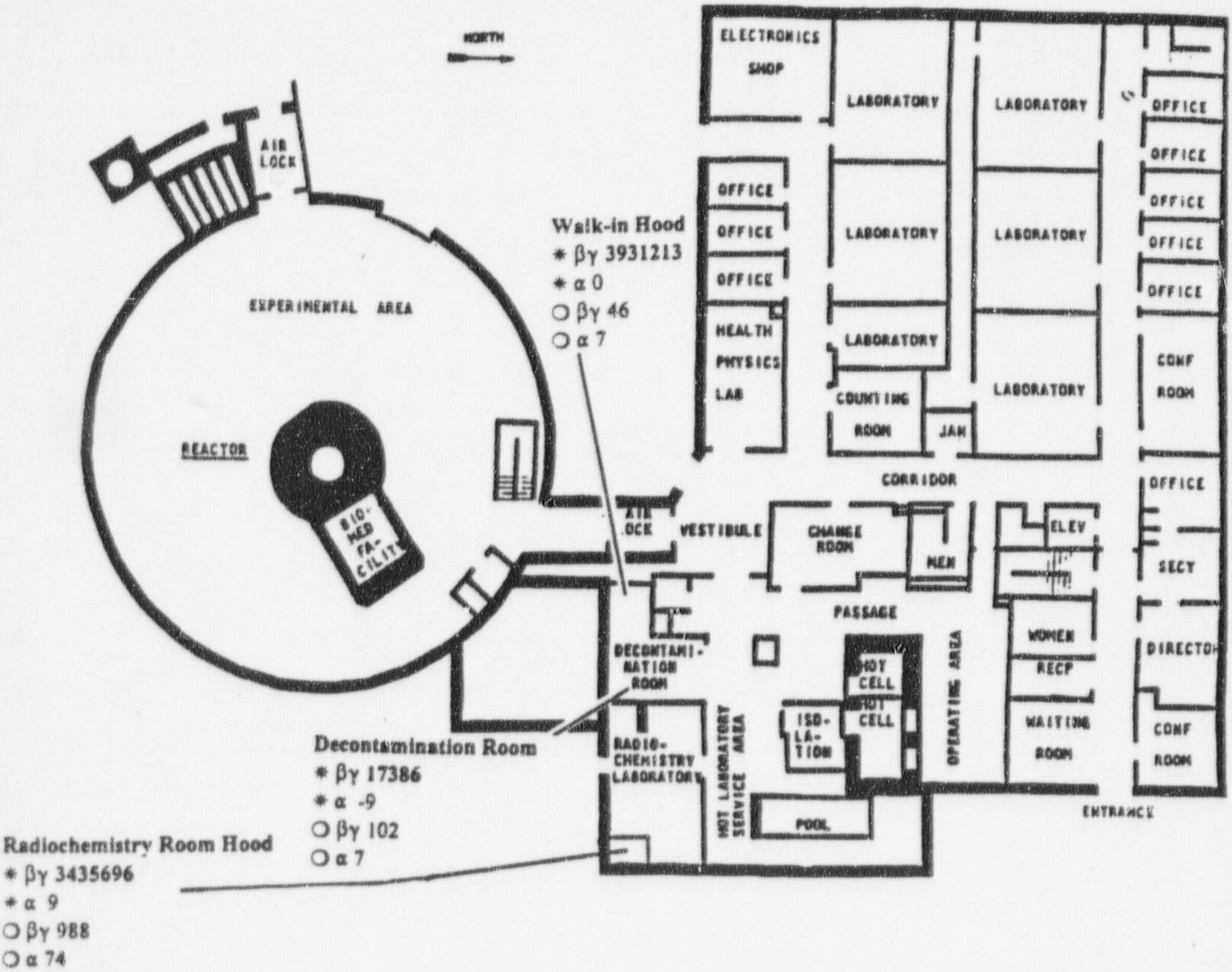
* Direct measurements in dpm/100 cm²
○ Removable measurements in dpm/100 cm²
Bold numbers represent activities **above** U.S. NRC Regulatory Guide 1.86 limits.
All measurements were taken **INSIDE** the facility.



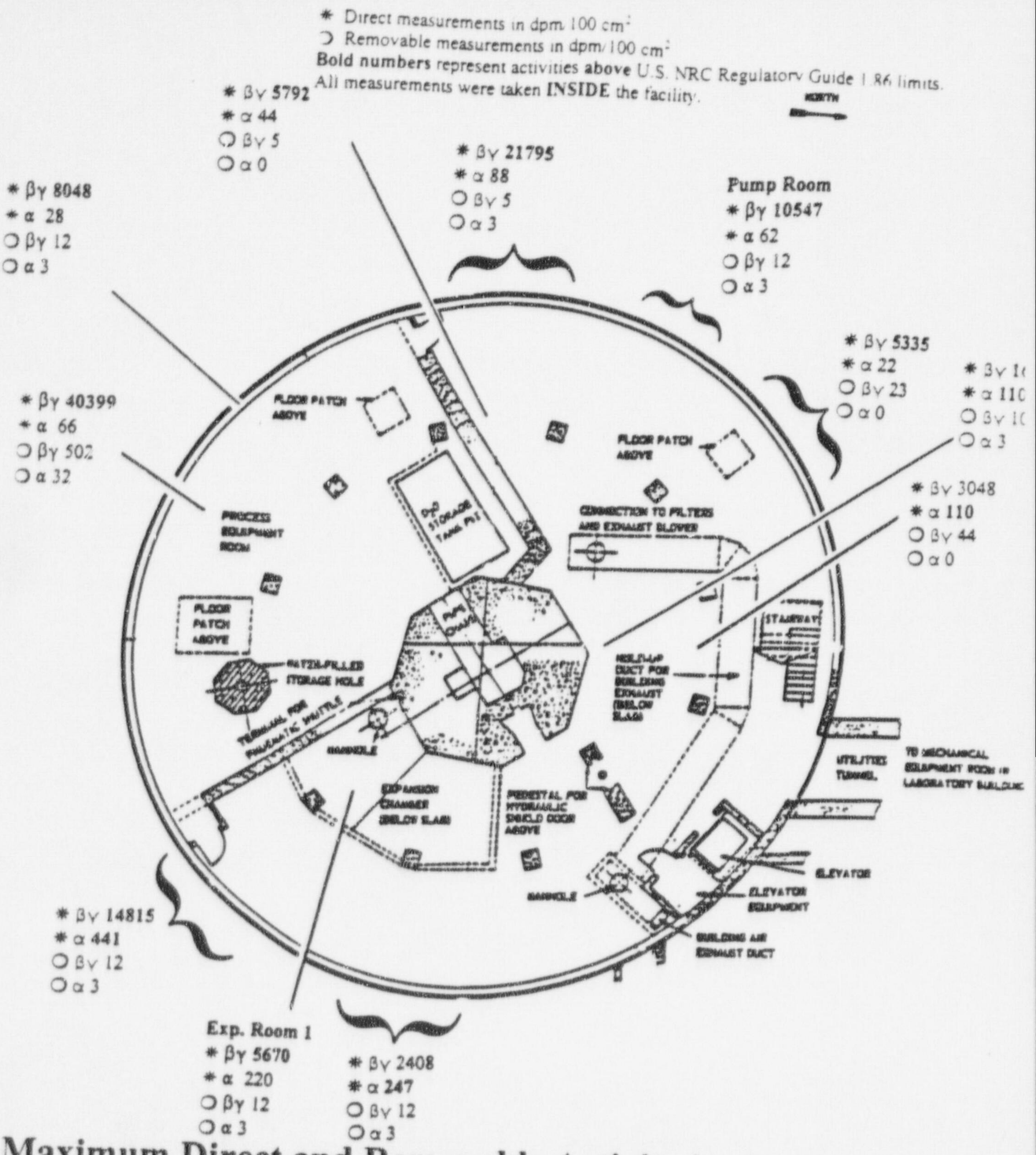
Chemical Addition Tanks
* **βγ 57365**
* α -9
○ βγ 10
○ α 3

Maximum Direct and Removable Activity in the Neely Nuclear Research Center Ground Floor

✱ Direct measurements in dpm/100 cm²
❍ Removable measurements in dpm/100 cm²
Bold numbers represent activities **above** U.S. NRC Regulatory Guide 1.86 limits.
All measurements were taken **INSIDE** the facility.

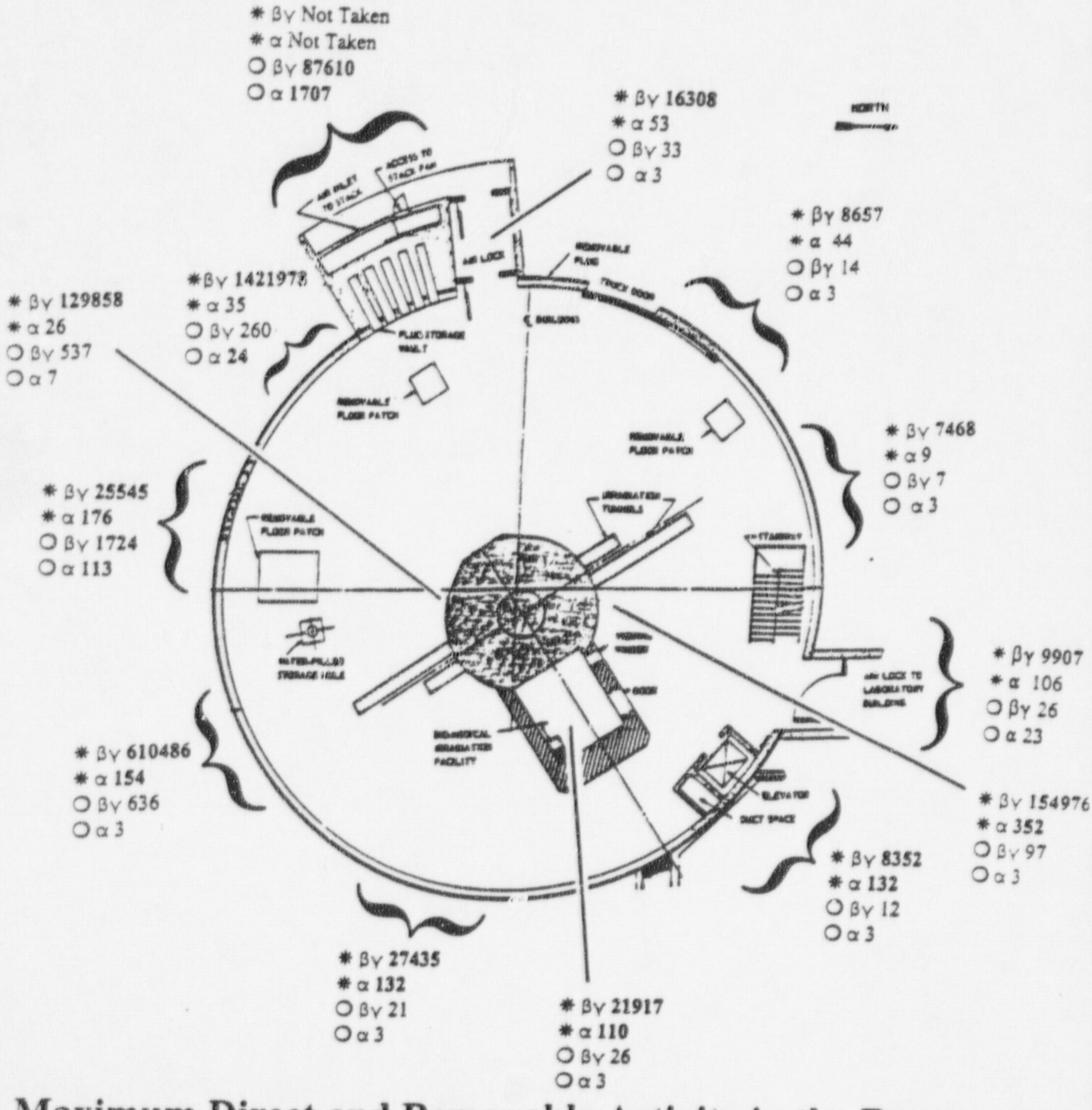


Maximum Direct and Removable Activity in the Neely Nuclear Research Center First Floor



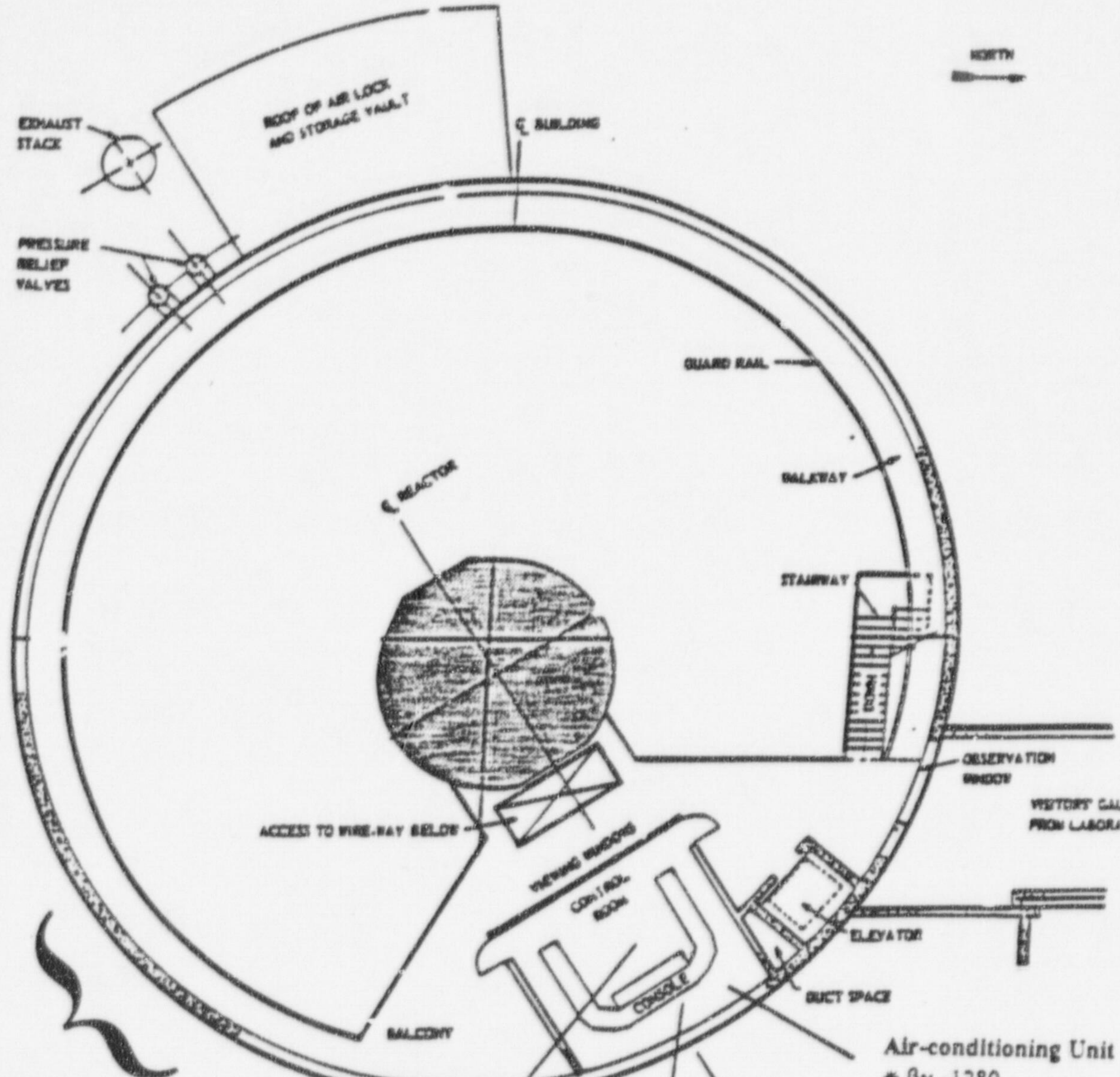
Maximum Direct and Removable Activity in the Reactor Containment Building Ground Floor

* Direct measurements in dpm/100 cm^2
○ Removable measurements in dpm/100 cm^2
Bold numbers represent activities **above** U.S. NRC Regulatory Guide 1.86 limits.
All measurements were taken **INSIDE** the facility.



Maximum Direct and Removable Activity in the Reactor Containment Building First Floor

* Direct measurements in dpm/100 cm^2
❍ Removable measurements in dpm/100 cm^2
Bold numbers represent activities **above** U.S. NRC Regulatory Guide 1.86 limits.
All measurements were taken **INSIDE** the facility.



Catwalk
* βγ **6462**
* α 220
❍ βγ 21
❍ α 7

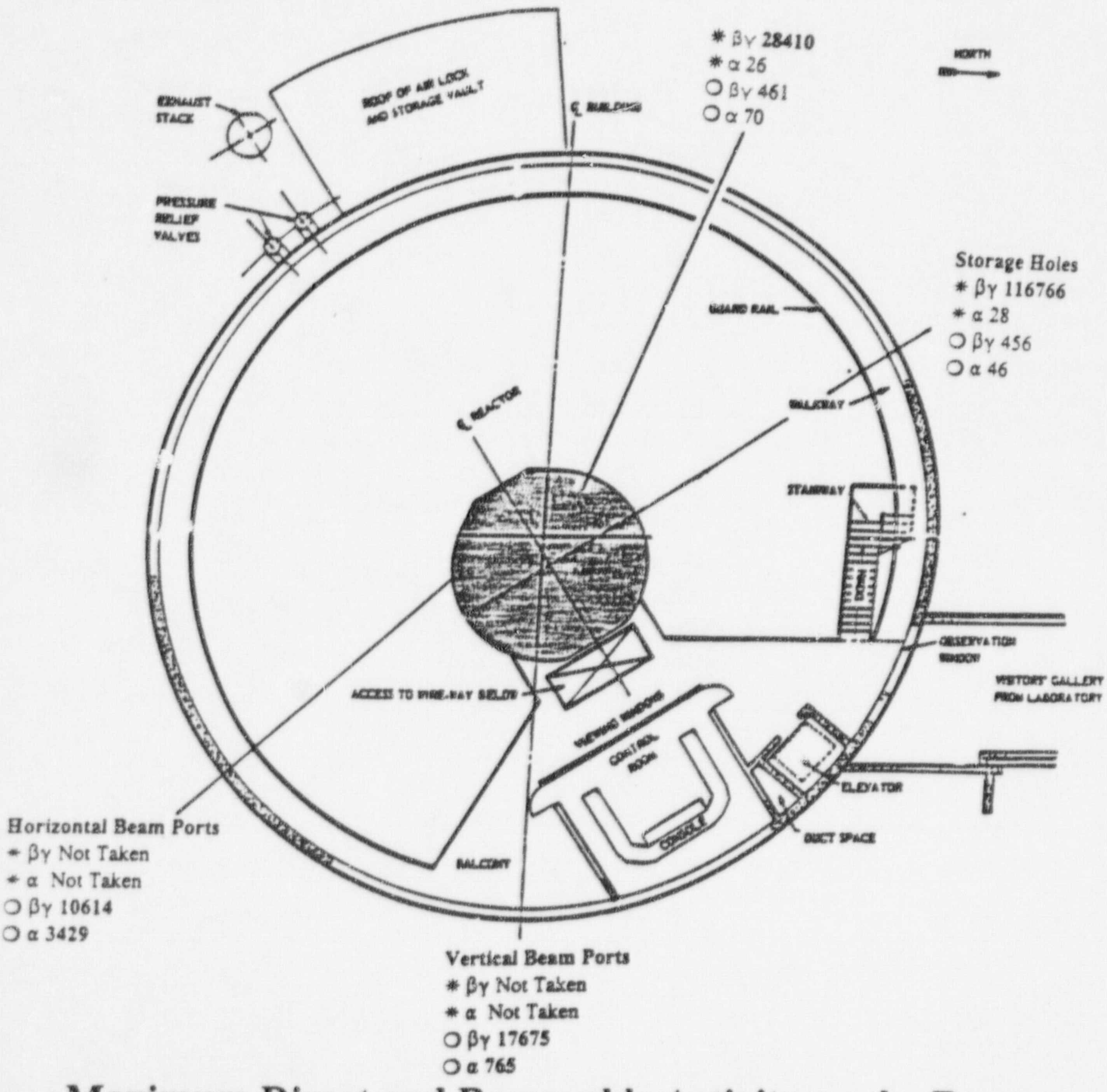
Inner Area
* βγ 2134
* α **286**
❍ βγ 12
❍ α 3

Outer Area
* βγ **5914**
* α **286**
❍ βγ 14
❍ α 3

Air-conditioning Unit
* βγ -1280
* α **638**
❍ βγ 10
❍ α 3

Maximum Direct and Removable Activity in the Reactor Containment Building Second Floor

* Direct measurements in dpm/100 cm^2
❍ Removable measurements in dpm/100 cm^2
Bold numbers represent activities **above** U.S. NRC Regulatory Guide 1.86 limits.
All measurements were taken **INSIDE** the facility.



Maximum Direct and Removable Activity on the Reactor