DECOMMISSIONING PLAN

MANHATTAN COLLEGE ZERO POWER REACTOR

License No. R-94

Docket No. 50-199

Prepared by Catherine C. Stanton

Rev. 1 - July 1998

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1 SUMMARY OF PLAN

1.1 Introduction

This decommissioning plan is submitted in support of Manhattan College's request to the Nuclear Regulatory Commission (NRC) for authorization to decommission the reactor and terminate its license (No. R-94). The Manhattan College Zero Power Reactor (MCZPR) is a heterogeneous pool type reactor, light water moderated and fueled with 19.75% enriched uranium. It is located on the campus of Manhattan College in the Riverdale section of the Bronx in New York City. The reactor is in a Nuclear Engineering Facility within the Leo Engineering Building at 3825 Corlear Avenue.

The MCZPR is licensed to operate at a maximum power level of 100 milliwatts through March 26, 2005 in accordance with license amendment No. 6, issued March 26, 1985. Manhattan College is requesting a Possession-Only (PO) license followed by decommissioning after the Decommissioning Plan (DP) is approved. Once fuel and the PuBe source are removed and all decommissioning actions are completed we request termination of the reactor license. This decision is based on the lack of current and anticipated academic need for the facility. The intent is to remove all radioactive material and release the area for unrestricted use.

Decommissioning will be performed under the direction of the Dean of Engineering, with consultation with the campus Radiation Safety Committee. Catherine C. Stanton has been retained as a consultant by Manhattan College to prepare this DP. Mrs. Stanton has served as the Chief Reactor Supervisor since June 1993. She has been an adjunct member of the faculty since 1981 and holds a Senior Reactor Operator's license for this facility. She will oversee the actual decommissioning activities, including the final radiological survey, which will be conducted with college maintenance personnel and student assistance. Surveys to date (e.g., in support of the conversion from HEU to LEU fuel) have indicated that virtually all of the material in the facility will meet the release criteria in Regulatory Guide 1.86. Once the decommissioning plan is adopted, an interim radiation survey will be performed to document any changes due to operation with the LEU core. Contractor assistance is expected to be limited to shipment of activated metal for disposal if needed based on the results of the interim radiation survey.

1.2 Background

The MCZPR is located on the Manhattan College campus on the first and second floors of the Leo Engineering Building located at 3825

Corlear Avenue. The Leo Engineering Building provides classrooms, laboratories, library, and computer facilities for an estimated 1800 students at any one time. Faculty, Administration and student activity offices are also located in the building. The Nuclear Engineering Facility is designed for isolation from the rest of the engineering building. The MCZPR has been in the same location since its installation at Manhattan College in 1964.

The campus is in the Riverdale section of the New York City borough of the Bronx. The area is residential and is easily accessible from the Major Deegan Expressway. Figure 1-1 shows the location of the Leo Engineering Building. The shaded areas on Figures 1-2 and 1-3 show the location of the first floor and second floor levels, respectively, of the Nuclear Engineering Facility within the Leo Engineering Building.

Manhattan College also has two subcritical facilities located on the second floor level adjacent to the MCZPR (Room 221 on Figure 1-3). The College plans to decommission these facilities simultaneously with the work on the MCZPR to levels that will permit unrestricted release of the entire area indicated. (New York City licensing authority is in effect for the subcritical facilities.)

Manhattan College was founded in New York City in 1853 and chartered by the Legislature and the Board of Regents in April 1863. It is a private, independent institution that provides both liberal arts education and concentrations in specific disciplines including business, education and engineering. The College moved to its present location in 1923 and has owned the Leo Engineering Building in which the MCZPR is located since 1963.

The MCZPR achieved initial criticality in March 1964. Operating license R-94 was renewed for an additional 20 years in 1985 and conversion from high enriched to low enriched uranium fuel (HEU to LEU) was accomplished in 1991.

1.2.1 Reactor Decommissioning Overview

Manhattan College has selected the DECON method of decommissioning for the MCZPR. Review of surveys previously performed in support of operations, HEU to LEU fuel conversion, and tank remediation indicate that only minimal amounts of activated metal, if any, will require removal and disposal as low level radioactive waste for the facility to meet the criteria for release for unrestricted use. There have been no instances of contamination during the reactor's operating lifetime and therefore no significant decontamination efforts are anticipated.

Manhattan College

NUMERICAL	ALPHABETICAL
1 - Memorial Hall	8 - Alumni Hall
2 - De La Salle Hall	32 - Birches Cottage
3 - Manhattan Hall	43 - Bluff Cottage
4 - Hayden Hall	40 - Broderick Hall
5 - Cardinal Hayes Library	5 - Cardinal Hayes Library
6 - Smith Auditorium/ Chapel of De La Salle and His Brothers	15 - Christian Brothers Center
7 - Chrysostom Hall	24 - Christian Brothers' Residence (1)
8 - Alumni Hall	25 - Christian Brothers' Residence (2)
9 - Draddy Gymnasium	39 - Christian Brothers' Residence (3)
10 - Jasper Hall	7 - Chrysostom Hall
11 - Thomas Hall (Student Center)	2 - De La Salle Hall
12 - Solomon House	44 - Donohue Hall
13 - Lavelle Hall (Alumni & College Relations Offices)	42 - Dowling Hall
14 - Sears Hall (Development Office)	9 - Draddy Gymnasium
15 - Christian Brothers Center	22 - Farrell Hall
20 - Paulian Hall	41 - Galway House
21 - Leo Engineering Building	28 - Granville Hall
22 - Farrell Hall	4 - Hayden Hall
23 - Neumann House	10 - Jasper Hall
24 - Christian Brothers' Residence (1)	13 - Lavelle Hall (Alumni & College Relations Offices)
25 - Christian Brothers' Residence (2)	21 - Leo Engineering Building
28 - Granville Hall	30 - Lloyd Hall
30 - Lloyd Hall	3 - Manhattan Hall
31 - Mundelein Hall	1 - Memorial Hall
32 - Birches Cottage	33 - Mitty Hall
33 - Mitty Hall	31 - Mundelein Hall
37 - St. Joseph's Hall	23 - Neumann House
38 - Rock Ledge	46 - Overlook Manor
39 - Christian Brothers' Residence (3)	20 - Paulian Hall
40 - Broderick Hall	38 - Rock Ledge
41 - Galway House	37 - St. Joseph's Hall
42 - Dowling Hall	14 - Sears Hall (Development Office)
43 - Bluff Cottage	6 - Smith Auditorium/Chapel of De La Salle and His Brothers
44 - Donohue Hall	12 - Solomon House
45 - Sullivan Hall	45 - Sullivan Hall
46 - Overlook Manor	11 - Thomas Hall (Student Center)

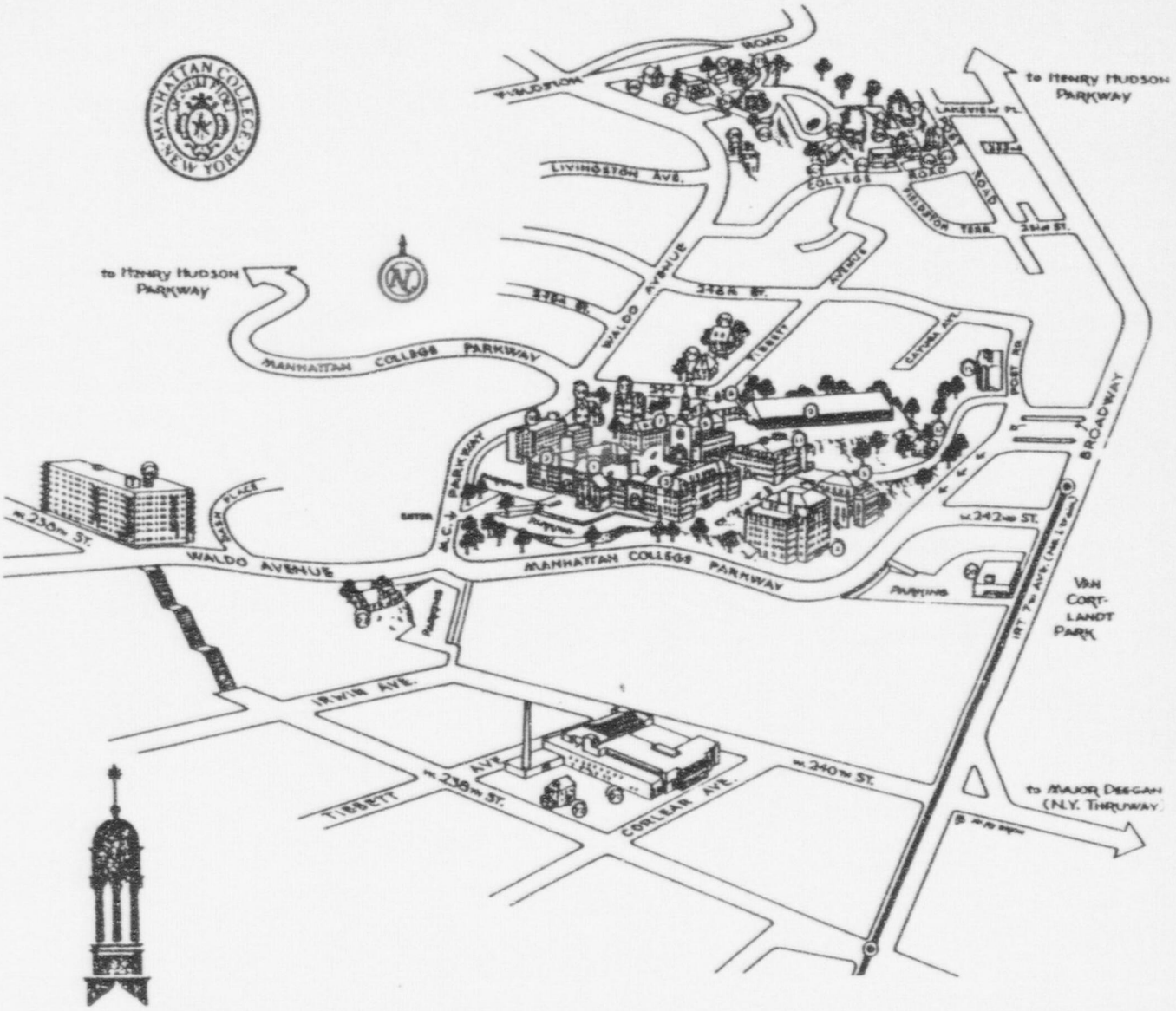


Figure 1-1

Location of Leo Engineering Building

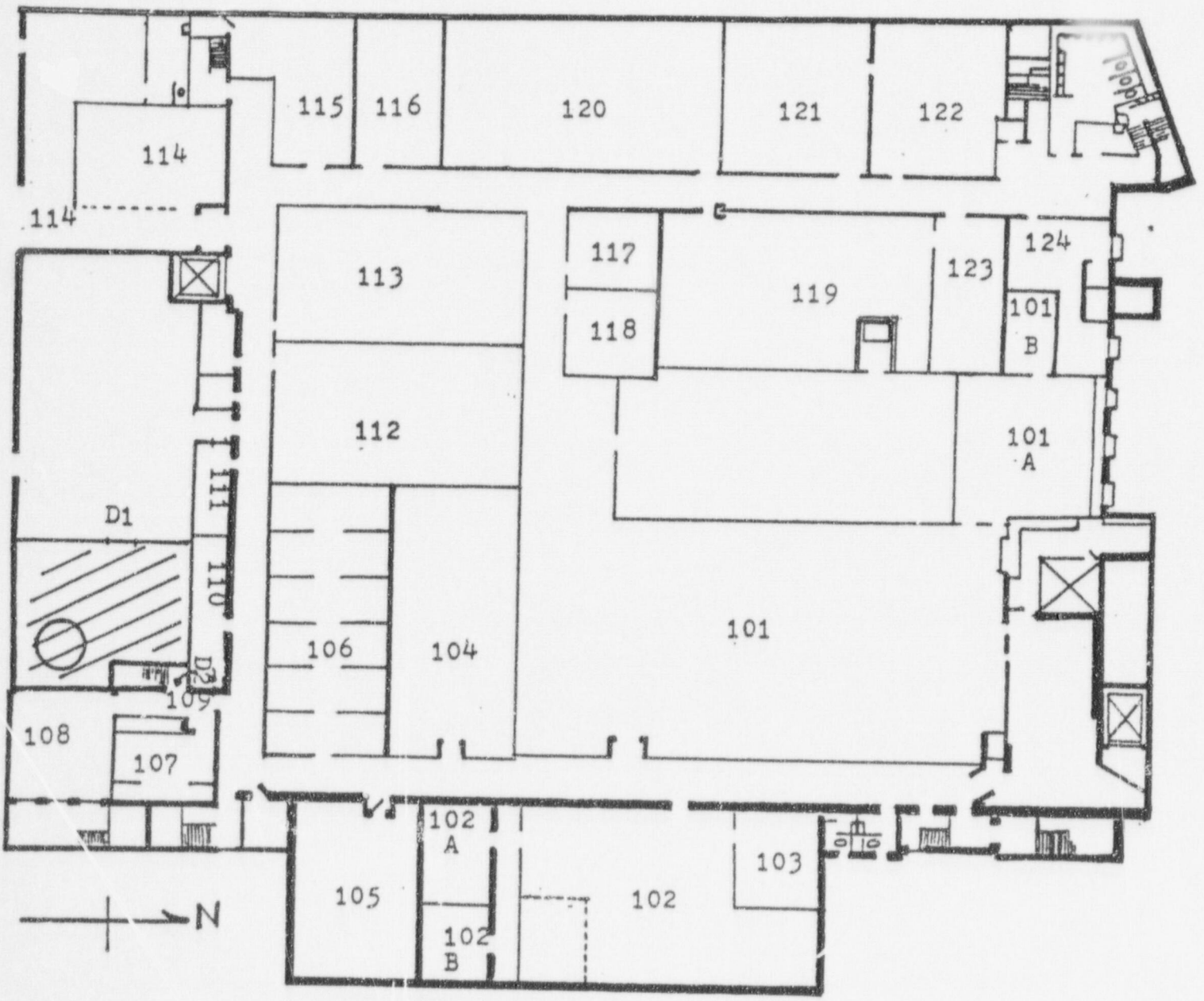


FIGURE 1-2

PLAN OF FIRST FLOOR OF THE LEO ENGINEERING BUILDING

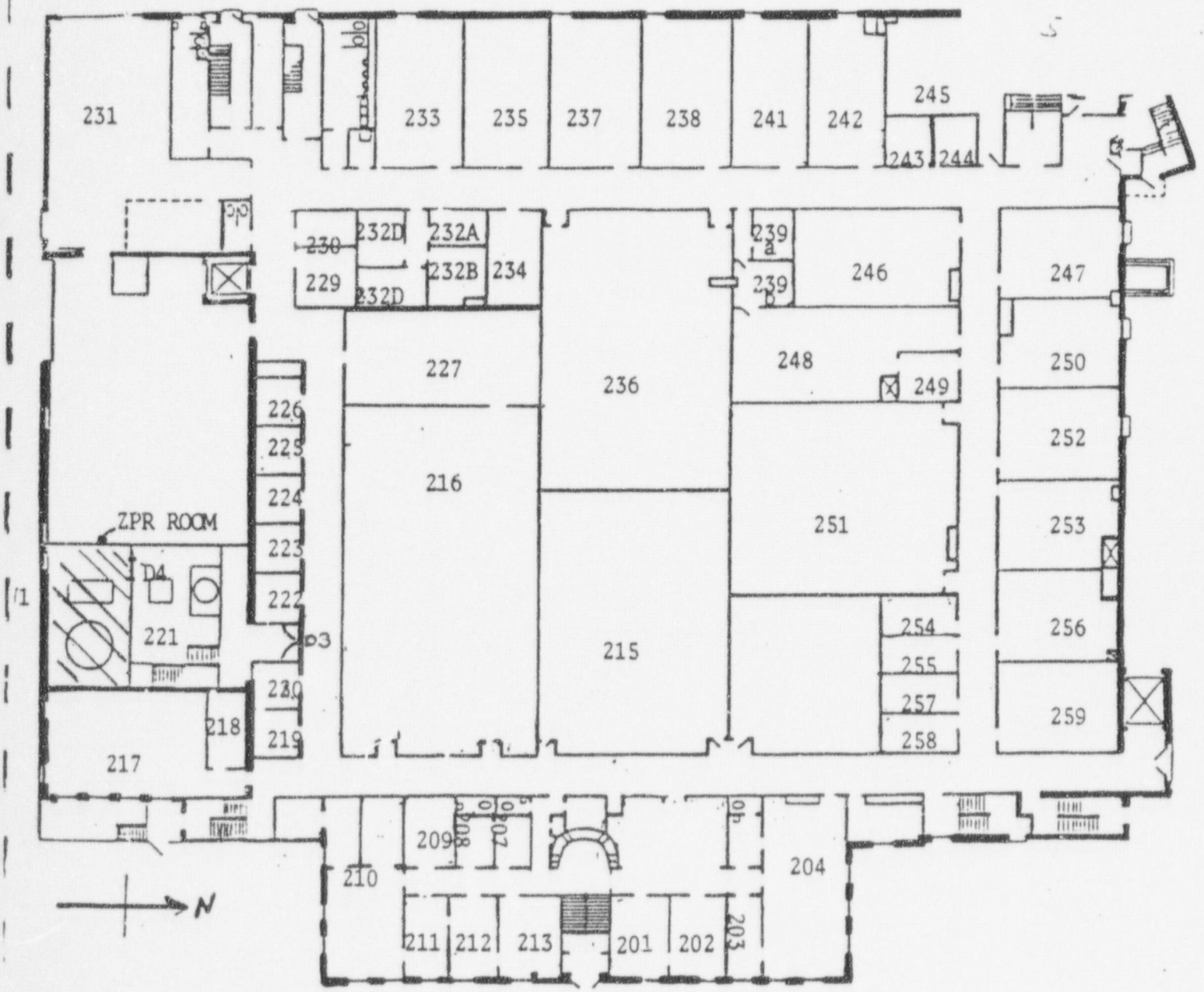


FIGURE 1-3
PLAN OF SECOND FLOOR OF THE LEO ENGINEERING BUILDING

1.2.2 Estimated Cost

It is estimated that the decommissioning process will cost approximately $65,000, including the cost of the final radiation survey, transfer of sources and disposal of related low level radioactive waste.

1.2.3 Availability of Funds

Manhattan College has established an external sinking fund for this purpose. Annual deposits will be made to ensure that funds are available at the anticipated date needed.

1.2.4 Program Quality Assurance

Dr. Robert E. Berlin will provide QA oversight of the planning, dismantlement, radiological surveys and material shipments associated with decommissioning the MCZPR. Dr. Berlin, now retired from Manhattan College, served as Reactor Administrator for eight years. He is a private consultant with a practice in radioactive site decontamination, decommissioning and site remediation. His resume is included in Appendix A.

Planning, dismantling, radiological survey and material shipments will all be performed in accordance with written procedures by trained personnel. Procedures will be reviewed by the Campus Radiation Safety Committee prior to implementation. All procedures will comply with all pertinent regulatory requirements including those for transportation. Each step of the decommissioning program and confirmatory surveys will be documented to develop a stand-alone record of the decommissioning process that will be suitable for internal audit and regulatory review.

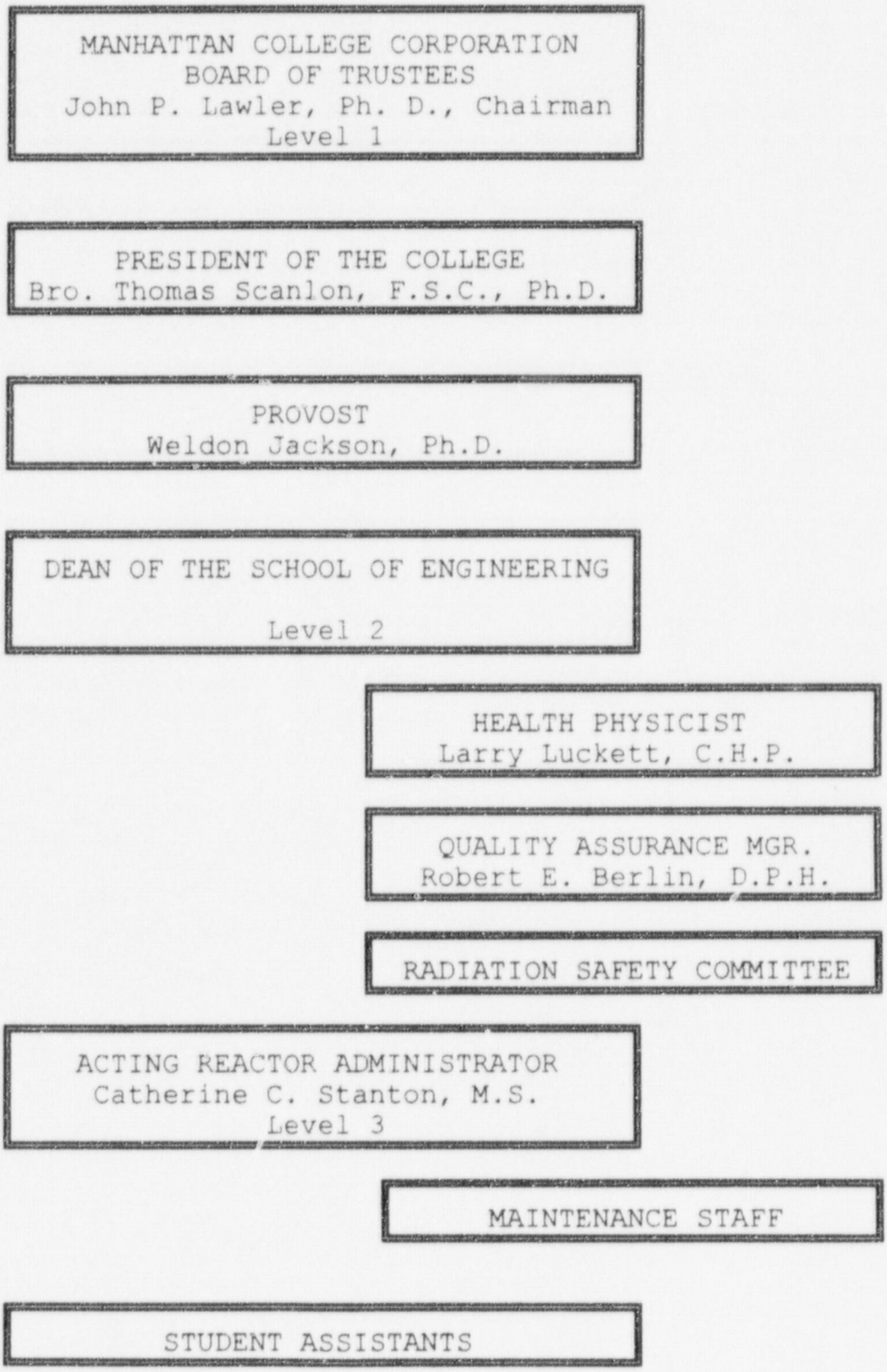
As shown in the organizational chart (Figure 1-4) Dr. Berlin will report directly to the Dean of Engineering who will have overall responsibility for this project on behalf of Manhattan College. The Dean of Engineering will also oversee the contractor(s), maintenance personnel and student assistants performing the actual tasks.

2 DECOMMISSIONING ACTIVITIES

2.1 Decommissioning Alternative

Manhattan College has chosen the DECON option for decommissioning the MCZPR. This approach includes removal of all radioactive material exceeding the levels in RG 1.86 and compliance with the criteria in proposed 10 CFR 20.1402 that the total effective dose

FIGURE 1-4
ORGANIZATIONAL STRUCTURE
MCZPR DECOMMISSIONING



equivalent to the average member of the critical group would not exceed 25 mrem/year. Based on review of the facility operating history, in particular the fact that there has never been contamination of the facility and the very low neutron fluxes achieved, it is anticipated that only minimal amounts of activated metal (if any) will require removal and disposal to achieve these conditions.

The objective of decommissioning the MCZPR is to release the laboratory space for other use by the School of Engineering. No specific use of the space has been identified to date but it is anticipated that some use as a laboratory would be likely with limited occupancy (less than 40 hours per week). Despite the limited occupancy of the laboratory, the calculation of the TEDE release criteria is based on continuous, unrestricted use of the facility.

Transfer of fuel and PuBe sources to DOE are expected to be the pacing factors in completing the decommissioning. Manhattan College is actively working with DOE representatives at INEL to schedule fuel removal. At present the DOE spent fuel management plan provides for acceptance of all Al clad research reactor fuel at Savannah River Laboratory. Because of the extremely low radiation levels of the MCZPR fuel (<2mrem/hr on contact on removal) there is a possibility that this fuel may instead be accepted at the Y-12 plant in Oak Ridge. No firm date for this transfer has yet been established but an estimate of a 1-2 year lead time has been discussed.

Manhattan College has contacted personnel at Los Alamos National Laboratory operating the Pu recovery program and been placed on the list for acceptance of the source. Based on current operating schedules it is estimated that the source could be transferred in the year 2000. It will remain in secure storage until that time.

2.2 Facility Radiological Status

2.2.1 Facility Operating History

Part of the Department of Physics at its installation in 1964, the MCZPR has been operated by the Mechanical Engineering Department since November 1969. The original license was renewed for an additional twenty years in accordance with Amendment No. 6 dated March 26, 1985.

Conversion from High Enriched Uranium Fuel (HEU) to Low Enriched Uranium Fuel (LEU) to comply with 10 CFR 50.64 limiting the use of

HEU in domestic research and test reactors was authorized by Amendment No. 8 dated March 12, 1990. In characterizing the HEU fuel prior to shipment off site, staff estimated that it had generated 8.8 w-hr (0.0004 MWD/element) of energy since startup at Manhattan College. No information was available on the earlier operating history at American Machine and Foundry from 1961-1964.

LEU elements were loaded into the core in February 1991. The reactor was defueled in July 1992 to facilitate extended repair and tank remediation. It was refueled in April 1995 and is conservatively estimated to have produced 0.8 watt-hours prior to defueling in December 1996.

2.2.2 Current Radiological Status of the Facility

The fuel has been removed and placed into secure storage in the first floor level of the facility, as have all other licensed sealed sources (PuBe startup source and Cs-137 source). The fuel and the sources have been placed in their original shipping containers and are stored within the Controlled Access Area (CAA) in accordance with the provisions of the existing MCZPR Security Plan. To maintain doses due to the presence of these sources for an extended period ALARA, it is requested that the requirement for periodic leak testing be amended to conform with the language in SNM License #1892. That is, that leak tests for non-alpha emitting sealed sources will not be required during storage but will be performed when the source is removed from storage and prepared for shipment. The sources will not be stored for a period exceeding 10 years without performing a leak test. All materials were leak tested prior to being placed into storage and determined to be intact. The storage area and measured radiation levels are indicated on Figure 2-1.

The second floor level of the facility, shown on Figure 2-2, includes the reactor tank, platform and operating console. Measured radiation levels as of November 1995 (with fuel and startup source present) are indicated on this Figure. The radiation levels shown in Figure 2-2 are illustrative of the fact that even when fuel and the PuBe source were present the radiation levels in the MCZPR did not differ significantly from background. The only identifiable radiation source other than the fuel and the source is some metal rods (about 4 inches long) which are present in a shielded container. They will be measured for activity as part of the interim survey. Background radiation levels in portions of the building remote from the reactor facility have previously been measured to be 10-12 microR/hr gamma and 0.0-0.02 microR/hr beta. Radiation levels in the building remote from the reactor facility represent "background" levels for purposes of decontamination.

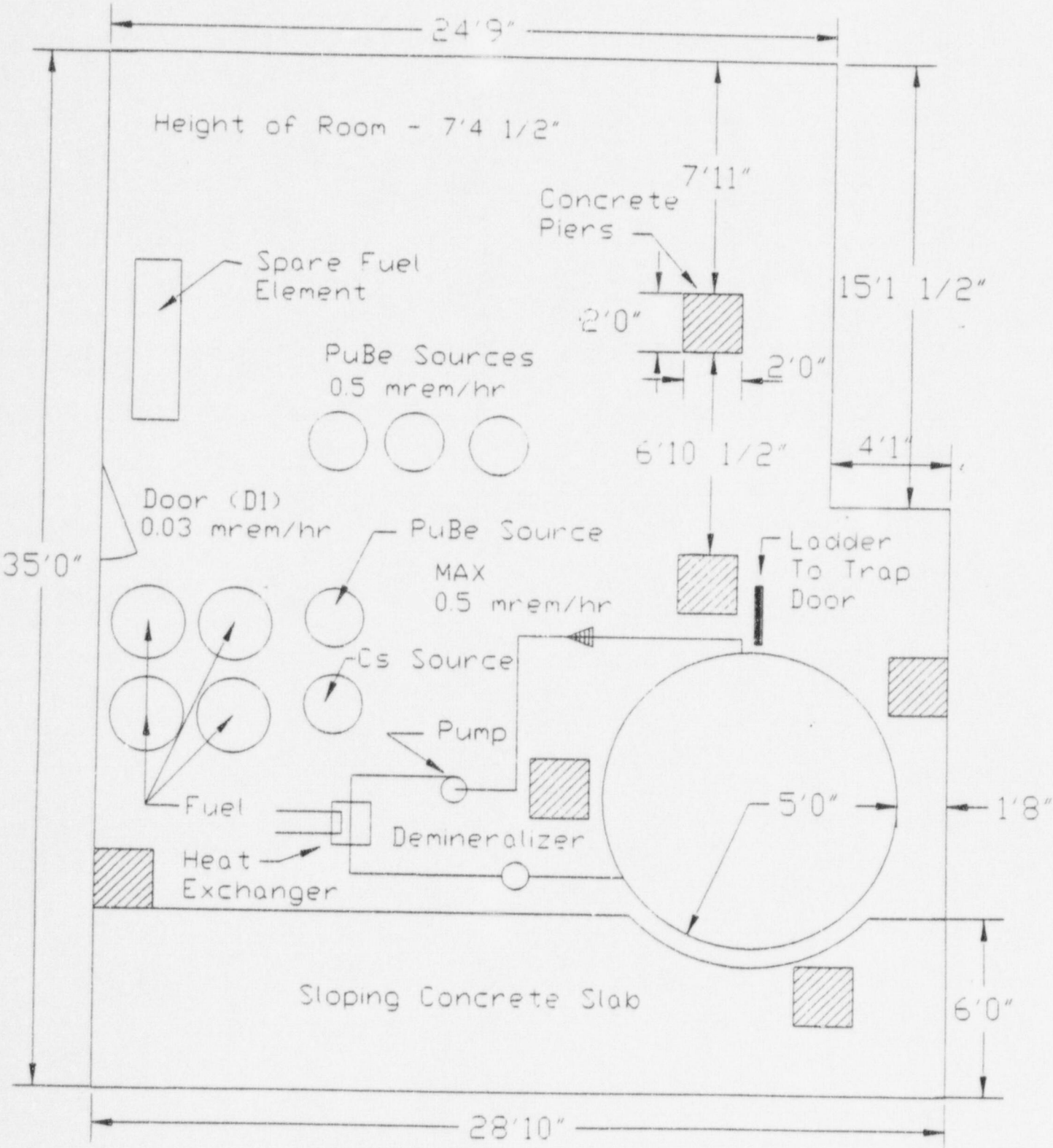


FIGURE 2-1

Measured Radiation Levels in Storage Areas

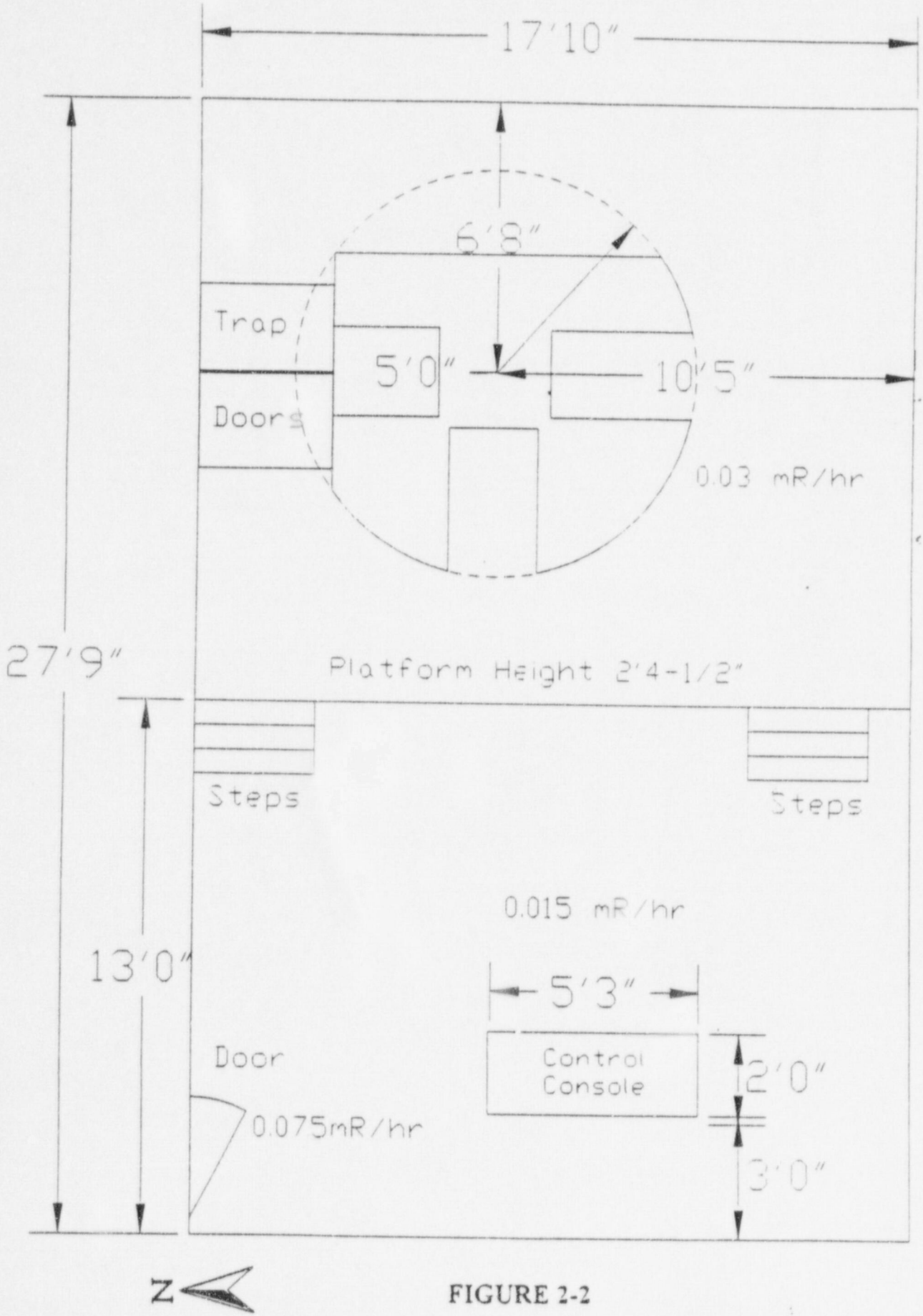


FIGURE 2-2

Measured Radiation Levels in MCZPR Room

The tank moderating water was discharged to the sanitary sewer system following analysis that documented no radioactive material distinguishable from background. After review and concurrence with the Health Physicist for compliance with 10 CFR Part 20 limits, the tank was drained as provided in the Radiation Safety Program.

Radiation levels for the tank and internal components will be measured when the moderator water has been drained. Surveys performed prior to the tank remediation in 1994 indicated that all structures caused area radiation levels less than 5 microRem/hr greater than background at one meter from the surface. Remediation efforts in the tank at the time of the HEU/LEU conversion as well as the subsequent tank coating and refurbishment were performed in direct contact with components and surfaces. The maximum annual exposure incurred for these programs was 160 mrem. Cumulative exposure was less than 1 person rem.

The interim survey to be performed once the tank is drained (see also Section 2.3.1) will document existing radiation levels within the tank and on internal components. It is anticipated that conditions will be essentially the same as those existing prior to operation with the LEU based on the limited number of times criticality was achieved, the short duration of operation at critical and the very low power level.

2.2.3 Release Criteria

The unrestricted release criteria limits for surface contamination shall be below the limits specified in Table 1, "Acceptable Surface Contamination Levels", of USNRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors".

The proposed radiological criteria for unrestricted use in 10 CFR 20.1402 will be met. That is, the total effective dose equivalent to an average member of the critical group will not exceed 25 mrem/year as the result of residual radioactivity at the facility that is distinguishable from background. Residual radioactivity will be reduced to levels that are as low as reasonably achievable.

The final survey will be in accordance with NUREG/CR-5849, "Monitoring for Compliance with Decommissioning Termination Survey Criteria".

2.3 Decommissioning Tasks

2.3.1 Activities and Tasks

The Manhattan College DP includes all tasks whose completion is required in order to remove all radioactive components from the MCZPR facility. Any components remaining in the facility at the time of the final survey will be below the contamination limits of Regulatory Guide 1.86 and will meet the criteria of proposed 10 CFR 20.1402 for unrestricted use.

These tasks are:

1. Dispose of moderating water.

Upon verification that the water meets the limits in 10 CFR 20 for discharge to the sanitary sewer system, it will be disposed. This action is not unique to decommissioning and has been performed previously as authorized under the existing license and Technical Specifications in relation to facility maintenance, remediation and fuel conversion.

2. Perform interim survey.

This survey will determine the extent of material, if any, that exceeds the release criteria and requires removal and disposal as radioactive waste. This survey will be performed as soon as the tank is drained and access is available. It will follow the requirements in NUREG/CR 5849.

3. Remove components exceeding release criteria.

Any components requiring disposal as radioactive waste will be disassembled or sectioned using expendable tools and equipment. Both components and tools will be packaged and disposed as low level radioactive waste. Operating procedures will be prepared and approved for all decommissioning tasks not previously performed. Possible materials that would be so handled include the control rods and guide tubes, in-core instrumentation, startup source guide tube, and the previously identified metal rods in the shielded storage. The only other material expected to exceed release criteria are the fuel and sealed sources which are discussed separately below.

4. Clean floor and walls.

Areas in which component removal was performed will be surveyed subsequently to identify any surface contamination exceeding the limits in Regulatory Guide 1.86. Any such areas will be cleaned using standard techniques and disposable materials. They will be resurveyed to verify compliance with the release criteria and cleaning materials will be added to the low level radioactive waste to be shipped for disposal.

5. Transfer fuel to DOE.

Upon receipt of shipping containers and authorization to transfer fuel from DOE, the elements will be removed from their storage containers, placed in the shipping containers, surveyed, sealed and shipped in accordance with DOT regulations. The old storage containers (the original Sylcor shipping containers) will be surveyed prior to release of the fuel to the transport company for shipment as an additional verification that the fuel is intact

and to verify that they meet the criteria for unrestricted release. Any contamination found exceeding the release limits will be cleaned using standard techniques as described for the floors and walls of the facility. After successful cleaning and resurveying, the storage containers will be released for disposal as non-radioactive trash.

6. Transfer PuBe source to DOE.

Manhattan College will work with DOE representatives at the Los Alamos National Laboratory to accomplish the transfer of the startup source for Pu recovery. The procedures will be similar to those for transfer of spent fuel, involving transfer of the source to the shipping container provided (after leak testing and verification that it is intact), surveying, sealing and shipping in accordance with DOT regulations. The used storage container will also be surveyed prior to release of the source to the transport company for shipment as an additional verification that the source is intact and to verify that it meets release criteria. It will be cleaned if necessary and released for disposal as non-radioactive trash.

7. Transfer sealed source to authorized recipient.

Amendment No. 10 to Facility License R-94 authorizes possession and use of a sealed source up to 5 millicuries for calibration of radiation monitoring channels. It is expected that this source will be transferred to another authorized user, possibly within the College, for use in ongoing projects.

8. Ship Waste for Disposal

Any material identified as exceeding the release criteria will be packaged and shipped for disposal in accordance with all applicable NRC and DOT regulations. A licensed broker/waste transporter will be retained to perform the shipment of materials prepared by decommissioning staff.

9. Perform final radiation survey.

The final radiation survey, following the requirements of NUREG/CR-5849, will be performed following completion of transfer of all radioactive material off site. To the extent feasible, this survey will be performed in stages. That is, areas such as the second floor level of the facility from which radioactive material can be removed early will be surveyed and verified as clean as soon as the material is removed. First floor levels in which fuel and the PuBe source are stored until they can be transferred to DOE will be surveyed following transfer. Previously surveyed areas will not be resurveyed unless radioactive material was introduced subsequent to the prior survey.

10. Submit final report to NRC requesting verification of final survey and license termination.

There are no special health or safety considerations related to the decommissioning tasks described here. With the possible exception of pipe segmentation, the decommissioning actions are

similar to others performed during earlier maintenance and remediation of the facility. None of these actions incurred radiation exposures exceeding the investigative levels defined in the facility Radiation Safety Program for routine operation. Decommissioning actions are expected to incur exposures that are less than or equal to those from these prior projects.

General safe lab practices involving such things as cleaning materials, moving heavy packages and climbing ladders, will be observed at all times. No materials or procedures will be used during decommissioning without appropriate procedures and changes in the fire protection, ventilation and Technical Specifications, if needed.

2.3.2 Schedule

1.	Dispose of moderating water	January 1998
2.	Perform interim survey	Within 3 months of decommissioning approval
3.	Remove components exceeding release criteria	Within 4 months of decommissioning approval
4.	Clean floor and walls	Within 5 months of decommissioning approval
5.	Transfer fuel to DOE	TBD (1999?)
6.	Transfer PuBe source to DOE	TBD (2000?)
7.	Transfer sealed source to authorized recipient	Spring 1998
8.	Ship Waste for Disposal	Within 30 days of transfer of fuel and sources
9.	Perform final radiation survey	30 days after fuel and source transfer
10.	Submit final report to NRC	90 days after fuel transfer

As outlined in the table above, the pacing items in accomplishing the decommissioning of the MCZPR are the transfer of fuel and startup source to the DOE designee. Initial contacts have been made with the INEL personnel responsible for scheduling fuel transfer and with both the Chicago Operations Office and the LANL personnel responsible for PuBe source return. No definitive date for transfer has yet been identified by either organization. It appears that some extended storage under a Possession Only License may be necessary for this material.

Actions within Manhattan College's control will be performed in a

timely manner subsequent to receipt of the Decommissioning Order from the NRC. All actions will be performed with the objective of progressiyely reducing the restricted and controlled area as quickly as possible and minimizing the possibility of subsequent contamination. Manhattan College is committed to achieving and documenting a facility eligible for release for unrestricted use and the surveys performed will support this commitment. When possible, material and equipment (such as electronics and instrumentation) will be transferred for reuse at another educational facility to minimize waste generation. Most of this material is non-radioactive. When necessary (e.g., for the Cs-137 source), Manhattan College will verify that the recipient is licensed to receive the material transferred.

2.4 Decommissioning Organization and Responsibilities

The organization for the management of the MCZPR during the decommissioning phase is shown in Figure 1-4. The organization builds to the fullest extent possible on the organization authorized for facility operation as defined in Section 6 of the Technical Specifications for Facility License R-94.

Three levels of authority are provided for, as follows:

Level 1: Responsible for the facility license and site administration.
Level 2: Responsible for safe accomplishment of the reactor decommissioning program.
Level 3: Responsible for carrying out decommissioning actions.

Overall continued responsibility for public and facility personnel safety rests with the Board of Trustees of the College and top management. Management has requested the Dean of the School of Engineering to assume direct responsibility for the safe completion of the decommissioning program. The Dean will be the point of contact for the College for all communications with regulatory authorities for this program.

Manhattan College has contracted for the assistance of Catherine C. Stanton to serve as Acting Reactor Administrator during the decommissioning program. In this capacity, Mrs. Stanton will serve as the facility Radiation Safety Officer as provided in the Technical Specifications. She will be assisted by building maintenance personnel and student assistants with training in radiation measurement.

All decommissioning actions will be taken with the concurrence of the campus Radiation Safety Committee. This change from the former

Reactor Operations Committee reflects the change from an operating to a possession and storage status for the radioactive material on site at the MCZPR. The Radiation Safety Committee will provide continuing institutional oversight of the material if extended storage is required prior to transfer to DOE. The current membership and expertise in radiological protection of the Radiation Safety Committee is shown in Appendix A.

2.5 Training Program

As stated previously, the actions taken during the decommissioning phase will be similar to previous efforts during tank remediation and HEU to LEU fuel conversion. As such, no separate training program is planned for personnel participating in decommissioning. The expertise required includes knowledge of radiation and its biological effects, monitoring and instrumentation, regulatory limits on radiation exposure (and related site administrative limits provided in the Technical Specifications), and measures for maintaining radiation exposure as low as reasonably achievable.

Decommissioning staff have expertise in each of these areas as the result of prior operating experience at the MCZPR, through academic training, and job experience. The reactor RSO will provide basic radiation protection and general safety instruction to any decommissioning staff (e.g., maintenance staff and student assistants) who need it using existing training materials and procedures.

2.6 Contractor Assistance

Manhattan College has contracted with Catherine C. Stanton to provide oversight of the decommissioning activities. Mrs. Stanton, a licensed Senior Reactor Operator and Chief Reactor Supervisor for the MCZPR, will serve as the Acting Reactor Administrator and radiation safety officer. Her status as a contract employee is analogous to her long standing status as an adjunct member of the faculty since she was retained on a semester to semester basis to fill a specific need of the College. Previously that need was an academic one. At present, it is to decommission the MCZPR.

Dr. Berlin and Mr. Luckett are independently retained by Manhattan College to provide Quality Assurance and Health Physics support, respectively. They will be responsible to the Dean of Engineering as will Mrs. Stanton and will perform their tasks in consultation with the campus Radiation Safety Committee. The only other

contractor assistance that may be required is a waste transporter/broker who would transfer low level radioactive waste for disposal should that be necessary based on the results of the interim survey. Because that requirement has not yet been established, this contractor has not yet been selected. Contractor selection will consider prior experience with similar tasks, including compliance with all applicable NRC, Agreement State and DOT requirements. Decommissioning staff will prepare and package the material to be shipped, if any.

All contractors will be directly responsible to the Dean of the School of Engineering who will have authority to oversee the quality and timeliness of the work.

2.7 Decontamination and Decommissioning Documents and Guides

Decommissioning-related operations will be governed by pertinent sections of relevant federal, state and local regulations, regulatory guides, and standards associated with nuclear research reactor dismantling, safety, radiological and environmental health, and industrial hygiene. Those believed applicable are:

American National Standards Institute/American Nuclear Society, ANSI/ANS 15.10, "Decommissioning of Research Reactors", ANS, LaGrange Park, Illinois, 1981.

American National Standards Institute/American Nuclear Society, ANSI/ANS 15.19, "Shipment and Receipt of Special Nuclear Material from Nuclear Research Reactors", 1991.

Code of Federal Regulations, Title 10, "Energy" and Title 49, "Transportation". In particular, 10 CFR Parts 20, 30, 50, 71 and 73 and 49 CFR Parts 170-189.

US Nuclear Regulatory Commission, Draft Regulatory Guide DG-1006, "Records Important for Decommissioning of Nuclear Reactors", September 1989.

US Nuclear Regulatory Commission, IE Circular 81-07, "Control of Radioactively Contaminated Material", May 14, 1981.

US Nuclear Regulatory Commission, IE Information Notice 83-05, "Obtaining Approval for Disposing of Very Low-Level Radioactive Waste", February 24, 1983.

US Nuclear Regulatory Commission, IE Information Notice 85-92, "Survey of Wastes Before Disposal from Nuclear Reactor Facilities", December 2, 1985.

US Nuclear Regulatory Commission, NUREG/CR 5849, "Monitoring for Compliance with Decommissioning Termination Survey Criteria", June 1992.

US Nuclear Regulatory Commission, Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", 1974.

Other information will be referenced as needed. For example, specific shipment instructions from DOE or its designees for transfer of spent fuel and PuBe source(s) will be followed.

3 PROTECTION OF THE HEALTH AND SAFETY OF RADIATION WORKERS AND THE PUBLIC

3.1 Radiation Protection

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

Manhattan College has developed and implemented a program to maintain radiation exposures at the Nuclear Engineering Facility ALARA. As specified in the Radiation Safety Program for the MCZPR, a copy of which is included as Appendix B to this Plan, College administration has delegated the responsibility for maintaining radiation exposures ALARA at the MCZPR to the reactor Radiation Safety Officer (RSO). The reactor RSO will work in consultation with the campus RSO and the Radiation Safety Committee. Implementation involves a combination of training of workers and students, periodic review and evaluation of occupational exposures and records of radiation level surveys, and modification of equipment and procedures if warranted to reduce exposures.

All decommissioning activities will be conducted in accordance with the existing ALARA program to minimize radiation exposure of decommissioning staff. This will involve training, personnel monitoring, surveys and use of procedures reviewed and approved by the RSO. It is expected that refresher training in preparing material for shipment will be the primary deviation from the general training program. Procedures used for the HEU/LEU fuel conversion will form the basis for the shipment

Instrumentation available for survey samples includes a Ludlum 1000 with 43-10 probe for alpha and two Eberline ESP-2s with an HP-260 probe for beta-gamma and an Eberline SPA-1A for alpha. A Bicron microR meter is available for area radiation surveys.

No significant personnel exposures are anticipated based on prior experience and the fact that no contamination or activation has been found in surveys performed during fuel conversion and tank remediation. Personnel exposure will be monitored with portable radiation detectors, and individual film badges with both beta-gamma and neutron sensitivity.

Radiation protection during decommissioning will be the responsibility of the campus RSO. The principles and procedures in the existing radiation safety program for the MCZPR (Appendix B to the SAR and this DP) will be used to supplement general requirements applicable to other radioactive material uses at Manhattan College. Day to day responsibility for personnel radiation safety will rest with the reactor RSO. Periodic review and oversight will be provided by the campus RSO who will have authority to stop or modify work if necessary to ensure that radiation exposures remain ALARA. Policies and procedures will be reviewed and approved by the Radiation Safety Committee before implementation. The campus RSO is a member of the Radiation Safety Committee and will report directly to the Dean of the School of Engineering. The Health Physicist will continue to be available for consultation as needed. Health Physicist concurrence on regulatory compliance is required prior to release of radioactive material from the facility.

3.1.2 Health Physics Program

The health physics program in place for the operation of the facility will be continued through the end of decommissioning. There are no differences expected that would increase potential radiation exposures from existing conditions or procedures.

Portable radiation detectors will be used to verify area dose rates during decommissioning and shipping procedures. The health physicist will verify that all material transferred from the facility meets regulatory requirements.

3.1.3 Dose Estimates

Fuel and source shipment, interim radiation survey and removal of activated metal, if any, are the tasks that could entail personnel radiation exposure. Several similar tasks have been performed previously (e.g., HEU/LEU conversion and fuel shipment) with radiation exposures below detectable levels. Dose estimates for the decommissioning program are estimated to be similar to those from the previous operations. Individual exposures are expected to be below Investigational Level I, the level at which no further actions

are required to maintain exposures As Low As Reasonably Achievable according to the MCZPR Radiation Protection Program. Investigational Level I corresponds to a whole body exposure of 125 mrem/calendar quarter. Cumulative exposures are expected to be less than one person rem for the entire decommissioning program.

All exposures will be external because only solid material will be handled - and no cases of contamination have occurred in the facility. The bulk of the exposures are expected to result from leak testing the fuel and sealed sources prior to shipment. Prior to shipment, fuel will be removed from the storage container. Each element will be wipe tested to determine the level of removable contamination. The wipes will be counted for alpha and beta/gamma activity. Similar measurements will be made of the storage containers to document that no radioactive material exceeding the limits for unrestricted release is present. Surveys to date - of facility and fuel sources and reactor water - have indicated no radioactive material distinguishable from background. Portable radiation monitors will be used to verify expected exposure rates - or identify differences which could require procedures to be modified to ensure compliance with 10 CFR Part 20 and the ALARA program. Prior experience at this facility indicates that total exposures will be a fraction of the regulatory limit.

3.2 Radioactive Waste Management

3.2.1 Fuel Removal

Based on current DOE schedules it is anticipated that all other decommissioning tasks will precede fuel and PuBe source transfer. As previously stated, the fuel and source will be maintained in secure storage in the first floor area currently authorized for temporary storage. It is within the controlled area and the existing emergency plan and physical security provisions will be maintained until the fuel and source are removed from the site. No radioactive waste is expected to be generated as a result of fuel removal.

3.2.2 Radioactive Waste Processing

To date no radioactive waste has been generated from operation of the MCZPR and therefore no processing has been required. Existing practices for screening materials prior to release will be continued. This involves wiping potentially contaminated materials according to approved procedures and counting the wipes to verify that removable contamination (alpha and beta/gamma) is below release levels. microRem meter readings will also be used to verify that the exposure rate at one meter is less than 5 microRem/hr above

background. All measurements will be reviewed by the health physicist prior to release of the material or equipment, as provided in the Radiation Safety Program.

Should any equipment exceeding the release criteria be identified, it is expected that it will result from activation of metal and that the exposure rates will be close to those acceptable for release. For planning purposes, approximately one cubic foot of such material has been estimated to require disposal. No liquid or gaseous wastes are expected to be generated from decommissioning.

3.2.3 Radioactive Waste Disposal

If the interim survey described in Section 2.3.1 indicates that operation with the LEU core has not significantly changed the radiological status of the facility from what was determined in the early 1990's, there will be no need for radioactive waste disposal. For planning purposes, it has been estimated that approximately one cubic foot of activated metal might exceed the release criteria and require disposal.

If disposal is required, a licensed broker/waste transporter will be retained to transfer the material to the Barnwell facility, assuming it remains available to low level radioactive waste generators from New York State. All packaging, monitoring and shipping will be in accordance with DOT regulations and the disposal site acceptance criteria. As stated previously, any material which does not meet the release criteria for unrestricted use (as verified by the Health Physicist) will be disposed of as radioactive waste.

3.2.4 General Industry Safety Program

The decommissioning program will be performed in accordance with the College's general safety procedures. As described previously, anticipated decommissioning actions do not include any hazards different from those present during operation and routine maintenance. No non-radioactive airborne hazardous materials will be used and dust masks and eye protection will be used when indicated.

Access to the reactor vessel for surveying and dismantlement of internal structures will be via ladder from the reactor platform. All work will be performed in teams with support in the event of falls, etc. Decommissioning staff will be in contact with on campus and off campus medical support personnel if needed.

3.3 Radiological Accident Analysis

This section discusses the likelihood and consequences of accidents occurring during and after the decommissioning process, resulting from human error, equipment malfunction, or external natural phenomena.

The decommissioning will be conducted under the supervision of the Acting Reactor Administrator. Safety-related activities will be monitored by the Health Physicist and reviewed and approved by the Radiation Safety Committee.

During fuel shipment the only possible scenarios that could result in damaged fuel are handling accidents involving dropping of a fuel element. This could occur during transfer of the fuel from the storage containers to the shipping containers. One accident scenario evaluated during the core conversion process considered a maximum drop of the fuel element from the second to the first floor of the reactor room (about eight feet). Such a drop, in terms of the fuel weight (about 5.5 kilograms per element), will yield approximately 37 Kilojoules potential energy to the outer 1/8" thick aluminum cylinder.

This small amount of energy will neither bend the outer supporting cylinder nor crack the inner concentric fuel plates, based on the results of the previously performed impact test on a dummy fuel element. Transfer to shipping containers on the first floor level of the facility would involve at most a six foot drop which would similarly not result in damage to the fuel element. Once the fuel elements are in place in the containers and they are closed, the containers will protect the fuel from impact resulting from any on site handling accidents.

There are no postulated natural phenomena (e.g., seismic event, severe weather, etc.) that would result in effects more severe than those from the fuel drop postulated above.

Transportation of the fuel elements to the designated receipt point will be in casks specified and provided by DOE and in conformance with all regulatory requirements and approved procedures. The casks are designed to maintain their integrity under any postulated severe accident conditions that could occur during transportation. In the highly unlikely event that an accident occurs that breaches a shipping cask and exposes the fuel element, no elevated personnel exposures would occur based on measured dose rates at the fuel surface. Similarly, a rupture of a fuel element would not result in any appreciable release of fission products or personnel exposure because of the very low fuel burn up.

4 PROPOSED FINAL RADIATION SURVEY PLAN

The final verification radiation survey will include both the first and second floor levels of the MCZPR facility and all components, material and equipment used during operation and decommissioning. No material will be released until it has been surveyed. Background radiation conditions will be attained in the MCZPR facility upon completion of decommissioning.

Details of the final radiation survey will depend upon the results of the interim survey to be performed as one of the first tasks under the decommissioning plan. All floor (and walls up to 2 meters) surface areas larger than one square meter will be marked off in a grid of one meter square blocks. The entire interior of the reactor vessel will be divided into one square meter blocks for surveying. The survey will include a wipe sample of 100 square centimeters (nominal) within each block to identify removable contamination. Wipes for each grid unit will be counted for alpha and beta contamination. Total alpha and beta levels will be measured at the same locations. Limits for fixed and removable contamination will be those in Regulatory Guide 1.86, Table 1.

A beta-gamma survey will be performed at the center of each block at a distance of one meter from the surface. Residual activity will be sufficiently low to comply with the proposed unrestricted use criterion of 10 CFR 20.1402. External radiation will be the only potential exposure pathway. The reference background will be the highest of corresponding measurements in the Leo Engineering Building remote from the MCZPR. Prior measurements indicate a background level of 10-12 microR/hr gamma and 0.0-0.02 microR/hr beta. Results of the survey and the procedures used to obtain and analyze data will be audited by the RSO and by Dr. Robert Berlin, the Quality Assurance Manager, to ensure the accuracy and completeness of the data. Ten percent of all samples will be subject to QA verification.

Small objects, for which a one meter grid is inapplicable will be wipe tested and surveyed in a manner which is consistent with the procedure used for leak testing sealed sources. Limits for removable contamination and residual radioactivity will be those described in the preceding paragraph.

Available instrumentation for survey sample analysis and area radiation surveys was described in Section 3.1.1. If indicated, additional instrumentation would be acquired for the final survey. Instruments used for the surveys will be currently-calibrated in accordance with applicable ANSI standards. All equipment will be operating indoors at room temperature and pressure and measurements will be made manually, not automated. Final data analysis will

follow the methods prescribed in NUREG-5849, "Monitoring for Compliance with Decommissioning Termination Survey Criteria".

A final report documenting the results of the survey will be prepared and submitted to the Nuclear Regulatory Commission (NRC). The NRC or its designee will perform a validation survey prior to terminating the license.

5 TECHNICAL SPECIFICATIONS

Proposed amended technical specifications, applicable to possession only status, are included as Appendix C to this decommissioning plan.

6 PHYSICAL SECURITY PLAN

All SNM of low strategic significance held under license R-94 (fuel and PuBe startup source) is stored in the authorized temporary storage area within the Controlled Access Area (CAA). It will remain there until it is packaged for transfer to DOE's designee. The approved operational physical security plan and safeguards and security procedures will remain effective while this material remains on site.

The physical security plan and safeguards and security procedures have been amended to conform to administrative changes applicable during decommissioning rather than operation. These documents, provided under separate cover, are proprietary information and not for public disclosure as provided in 10 CFR 73.21.

7 EMERGENCY PLAN

Because transfer of the fuel is likely to be the pacing item in decommissioning the MCZPR, the existing Emergency Plan (Appendix D) will remain in effect. Should fuel transfer be accomplished before other portions of the decommissioning operation, Manhattan College will consider whether to revise the Emergency Plan at that time.

8 ENVIRONMENTAL REPORT

This section discusses the anticipated environmental impact of decommissioning the MCZPR and terminating license R-94 as required by 10 CFR 51.

8.1 Proposed Action

Decommissioning the MCZPR under the DECON alternative will include transfer of all licensed radioactive material from the site (e.g., fuel and sources). Reactor internals (control rod blades, guide tubes, startup source guide tube) and instrumentation (uncompensated ion chamber, area radiation monitors and neutron monitor) will be removed from the reactor vessel and monitored. Equipment and surfaces will be monitored to verify compliance with release criteria for unrestricted use as specified in Regulatory Guide 1.86 and proposed 10 CFR 20.1402. Equipment meeting the release criteria for unrestricted use will be transferred for reuse rather than disposal whenever possible to minimize waste generation.

Any surfaces or equipment exceeding the removable activity criteria for unrestricted release will be physically washed until those levels are reached. If such decontamination is not feasible, this material will be disposed as low level radioactive waste. Any surfaces or equipment with residual radioactivity distinguishable from background that would cause an average member of the critical group to receive exposures exceeding the criteria in proposed 10 CFR 20.1402 will be removed and disposed as low level radioactive waste. Whenever possible, licensed materials will be transferred to another licensee for reuse to minimize low level radioactive waste generation.

8.2 Environmental Impact

The only anticipated adverse environmental impact of the proposed action will be that due to transport of the material from the site. Radiological transportation effects will be minimal because the radiation levels of the fuel are very low (< 2 mrem/hr on contact at removal from the core) due to low burnup. All shipments are of sealed solid material unlikely to be dispersed under accident conditions. Shipments will be in compliance with all applicable NRC and DOT regulations and subject to physical security and safeguards oversight. The general accident risk is much lower than that for a truck shipment of nonradioactive material because of the required driver training, truck inspection, routing and notification requirements for such transfers.

No gaseous radioactive wastes will be generated as a result of the proposed action and there are no postulated accident scenarios that could release radioactive material outside the facility. Therefore, no exposure of the public or the environment will result from decommissioning the MCZPR.

As noted in Section 3.1.3 the collective dose to all on site

workers for the entire decommissioning program is estimated to be less than one person rem. There is no estimated exposure to the public from actions on site. Occupational and public exposure may result from transportation of the fuel to Oak Ridge and the source to Los Alamos. The occupational transportation radiological impact is estimated to be 2.4 person-rem. The general public is estimated to receive 1.8 person-rem from transportation. over 90% of this exposure is due to the estimated shipment of the PuBe source to Los Alamos. After license termination public radiation exposure at the laboratory meet the requirements of 10 CFR Part 20 for unrestricted use.

8.3 Alternatives

There do not appear to be any feasible alternatives to the proposed action. Manhattan College has determined that there is no further academic need for the facility at this institution and has therefore placed it into a storage rather than an operating mode. The No Action alternative would require that the material remain on site until the license expiration date in 2005. This would entail continued surveillance and physical security by College personnel and the inability to use three rooms for other academic purposes. It is not an acceptable condition based on ALARA, economic or resource utilization considerations.

9 CHANGES TO THE DECOMMISSIONING PLAN

Changes to the Decommissi ıing Plan necessary to respond to unanticipated conditions may be authorized by the Radiation Safety Committee at the request of the Acting Reactor Administrator. Such changes must comply with regulatory requirements of the NRC and DOT and the Radiation Safety Program. Any changes in the DP which involve unreviewed safety questions or TS changes will be submitted to the Nuclear Regulatory Commission for review before implementation.

10 REFERENCES

American National Standards Institute/American Nuclear Society, ANSI/ANS 15.10, "Decommissioning of Research Reactors", ANS, LaGrange Park, Illinois, 1981.

American National Standards Institute/American Nuclear Society, ANSI/ANS 15.19, "Shipment and Receipt of Special Nuclear Material from Nuclear Research Reactors", 1991.

Code of Federal Regulations, Title 10, "Energy" and Title 49, "Transportation". In particular, 10 CFR Parts 20, 30, 50, 71 and 73 and 49 CFR Parts 170-189.

Decommissioning Plan for The Catholic University Of America, License No. R-31.

Decommissioning Plan for the University of Kansas Training Reactor, License No. R-78.

US Nuclear Regulatory Commission, Draft Regulatory Guide DG 1006, "Records Important for Decommissioning of Nuclear Reactors", September 1989.

US Nuclear Regulatory Commission, IE Circular 81-07, "Control of Radioactively Contaminated Material", May 14, 1981.

US Nuclear Regulatory Commission, IE Information Notice 83-05, "Obtaining Approval for Disposing of Very Low-Level Radioactive Waste", February 24, 1983.

US Nuclear Regulatory Commission, IE Information Notice 85-92, "Survey of Wastes Before Disposal from Nuclear Reactor Facilities", December 2, 1985.

US Nuclear Regulatory Commission, NUREG/CR 5849, "Monitoring for Compliance with Decommissioning Termination Survey Criteria", June 1992.

US Nuclear Regulatory Commission, Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", 1974.

APPENDIX A

QUALIFICATIONS OF DECOMMISSIONING ORGANIZATION PERSONNEL

CATHERINE C. STANTON

Position: Acting Reactor Administrator,
Radiation Safety Officer

Experience: 27 Years

Experience Summary:

Mrs. Stanton has been a member of the Manhattan College adjunct faculty since 1981, teaching in the Departments of Radiological and Health Sciences, and Mechanical Engineering. She has experience in Agreement State licensing as a staff member of the NYS Committee on Licensing; has served as the Chief Reactor Supervisor for the MCZPR since 1993 and is a licensed Senior Reactor Operator; has taught Health Physics and Health and Safety for Remedial Site Workers in the graduate program in Waste Management and Facility Restoration; through independent consulting has provided technical support for licensing efforts by utility, government, industrial and institutional clients especially on radioactive waste management and transportation matters.

Education:

AEC Program in Licensing Procedures, Bethesda, 1970.
M.S., Nuclear Engineering, Ohio State University, 1970
(AEC Fellow in Nuclear Engineering)
B.A., Mathematics, St. Joseph's College, Brooklyn, New York, 1968.

LARRY W. LUCKETT

Position: Health Physicist

Experience: 24 Years

Experience Summary:

Mr. Luckett has extensive experience in radioactive waste characterization and cleanup of contaminated sites in accordance with NRC regulations and DOE Orders; was commissioned as a Health Physics officer in the US Army Medical Corps 1971-1993 (retired at rank of Lieutenant Colonel); was an Associate Professor of Physics at the US Military Academy at West Point responsible for the operation and safety of a subcritical assembly, a Van de Graff particle accelerator and radioactive sources.

Certifications and Training:

Comprehensive Health Physics, American Board of Health Physics
DOE Radiological Worker Training (I and II)
OSHA Hazardous Materials Worker Training (40 hours)
Hazardous Waste Site Supervisor Training (8 hour)
Update to Revised DOT/NRC Transportation Regulations 1997

Education:

Ph.D. (Candidate), Nuclear Engineering, Rennselaer Polytechnic Institute
M.S., Nuclear Engineering/Health Physics, Texas A&M University, 1973.
B.S., Physics, Cum Laude, Trinity University, Texas, 1971.

ROBERT E. BERLIN

Position: Manager of Quality Assurance

Experience: 38 Years

Experience Summary:

Dr. Berlin extensive experience in radioactive waste characterization and cleanup of contaminated sites in accordance with NRC regulations and DOE Orders; participated in development of 10 CFR Part 61; was a faculty member in the Manhattan College Mechanical Engineering Department responsible for the nuclear program and served as the Reactor Administrator for eight years.

Certifications and Training:

Professional Engineer, New York.

Education:

Dr. P.H., Industrial Health/Environmental Science Concentration, Columbia University, School of Public Health, 1985.

M.S., Industrial Engineering, New York University, 1970.

M.S., Engineering Science, Rensselaer Polytechnic Institute, 1959.

B.S., Mechanical Engineering, City College of New York, 1956.

Item 12 Radiation Safety Program

Item 12.1 Radiation Safety Committee

Dr. Lance Evans, Radiation Safety Officer
Dr. Louis Uffer
Dr. John Mahoney
Dr. Edward Brown - Dean of the School of Science Representing Management

See Supplement III for each individual on the Committee. (Pages 12-2-->12-6)

CITY OF NEW YORK
DEPARTMENT OF HEALTH
Bureau of Radiological Health

APPLICATION FOR RADIOACTIVE MATERIALS LICENSE

Supplement III

TRAINING AND EXPERIENCE FOR AUTHORIZED USER (NON HUMAN USE)

1. NAME and EDUCATION

Proposed authorized user: Dr. Lance S. Evans, Radiation Safety Officer Manhattan College

Highest degree and field in which awarded: Ph.D. Plant Physiology

2. TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

Field of Training	*Location and Dates of Training*	*Type and Length of Training*	
		Clock hours in lecture or laboratory	Clock hours of supervised on-the-job experience
Characteristics of ionizing radiation	Univ. of California 1967-1970 Brookhaven Nat. Lab.	50 hr 11 hr	6mos/40 hr 10 hr
Units of radiation dose and quantities	University of California Brookhaven Nat. Lab.	10 hr 15 hr	12 hr 5 hr
Radiation detection instrumentation	University of California Brookhaven National Lab. 1972-1975	12 hr 10 hr	-0- -0-
Biological hazards of exposure to radiation	Brookhaven National Lab.	I performed research in this area for three years	

4. EXPERIENCE WITH RADIATION (Actual use of radioisotopes)

Isotope	Bq (mCi) used at one time	Location	Clock hours	Use
3H	10 m Ci	Univ. of Calif.	≈ 150	
14C	7 m Ci	Univ. of Calif.	≈ 150	
3H, 14C	10m Ci each	Brookhaven N.L.	Years of research	
32p, 63NI, other radioisotopes	5 m Ci	Manhattan College & Brookhaven N.L	Years of research	

5. PREVIOUS/CURRENT LICENSE AFFILIATIONS

Licensing Agency	License Number and Date Issued

Bureau of Radiological Health

APPLICATION FOR RADIOACTIVE MATERIALS LICENSE

Supplement III

TRAINING AND EXPERIENCE FOR AUTHORIZED USER (NON HUMAN USE)

1. NAME and EDUCATION

Proposed authorized user:

John D. Mahoney

Highest degree and field in which awarded:

Ph.D., Univ. of Calif. at Berkeley. Nuclear Chemistry

2. TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

Field of Training	*Location and Dates of Training*	*Type and Length of Training*	
		Clock hours in lecture or laboratory	*Clock hours of supervised on-the-job experience*
Characteristics of ionizing radiation	Univ. of Calif. Berkeley Laurence Radiation Lab. 1/61-12/62	95 covering all aspects as in column 1	~~50~~ covering all aspects as in column
Units of radiation dose and quantities	" "		
Radiation detection instrumentation	" "		
Biological hazards of exposure to radiation	" "		

4. EXPERIENCE WITH RADIATION (Actual use of radioisotopes)

Isotope	Qc (mCi) used at one time	Location	Clock hours	Use
238 U	.1	Manhattan College	At Least 50 with each	Primarily Research some Teaching
234Th	.1			
115Cd	2			
63Ni	5			
65Zn	5			
24Na	2			
54Nu	2			
51Cn	2			
60 Co	1			
14C	5			
3H	5			
204Tl	1			
18F	1	Univ. of Calif. Berkeley	100	Research
11C	1		50	
14N	1		50	

Bureau of Radiological Health

APPLICATION FOR RADIOACTIVE MATERIALS LICENSE

Supplement III

TRAINING AND EXPERIENCE FOR AUTHORIZED USER (NON HUMAN USE)

1 - NAME and EDUCATION

Proposed authorized user:

Louis Uffer

Highest degree and field in which awarded: Ph.D. Physics

2 - TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

Field of Training	*Location and Dates of Training*	*Type and Length of Training*	
		Clock hours in lecture or laboratory	Clock hours of supervised radioisotope experience
Characteristics of ionizing radiation	Manhattan College Physics Dept. 1981-1983	20	40
Units of radiation dose and quantities	" "	10	30
Radiation detection instrumentation	" "	50	50
Biological hazards of exposure to radiation	" "	15	10

4 - EXPERIENCE WITH RADIATION (Active use of radioisotopes)

Isotope	Bq (mCi) used at one time	Location	Clock hours	Use
Cobalt 57	2 mCi	Hayden 304	50	Mossbauer Spectroscopy
Cs 137-Na22	0.005 mCi	Hayden 304	40	Beta Spectroscopy
Americium 241	1.5 mCi	Hayden 304	25	Alpha Detector cm Detection

5 - PREVIOUS/CURRENT LICENSE AFFILIATIONS

Licensing Agency	License Number and Date Issued

DEPARTMENT OF HEALTH

Bureau of Radiological Health

APPLICATION FOR RADIOACTIVE MATERIALS LICENSE

Supplement III

TRAINING AND EXPERIENCE FOR AUTHORIZED USER (NON HUMAN USE)

1. NAME and EDUCATION

Proposed authorized user:

Edward Brown

Highest degree and field in which awarded:

Ph.D. Physics

2. TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

Field of Training	*Location and Dates of Training*	*Type and Length of Training*	
		Clock hours in lecture or laboratory	Clock hours of supervised on-the-job experience
Characteristics of ionizing radiation	Standard Undergraduate		
Units of radiation dose and quantities	Physics Training		
Radiation detection instrumentation	" "		
Biological hazards of exposure to radiation	None		

3. EXPERIENCE WITH RADIATION (Actual use of radioisotopes)

Isotope	Bq (mCi) used at one time	Location	Clock hours	Use

4. PREVIOUS/CURRENT LICENSE APPLICATIONS

Licensing Agency	License Number and Date Issued

APPENDIX B

RADIATION SAFETY PROGRAM

6.0 RADIATION SAFETY AND PERIODIC TEST REQUIREMENTS

This section clearly identifies the radiation safety policy in MCZPR. This section also discusses a number of tests performed regularly on the MCZPR components.

6.1 RADIATION SAFETY MANUAL

6.1.1 POLICY

The radiation safety manual has been prepared to guide the activities of faculty members and students using the reactor, the radiation facilities, and radioactive materials in the Manhattan College Nuclear Engineering Facility. It will also be used to ensure radiation protection during decommissioning. A number of general rules and procedures have been adopted, intended to safeguard all personnel. These rules are intended to further the educational mission of Manhattan College and the Zero Power Reactor facility. To that end they may exceed the regulatory requirements applicable under the terms of the reactor license from the Nuclear Regulatory Commission. They are used to instill good radiation safety practice in the faculty and students that is applicable regardless of the facility in which they eventually function. The Reactor Administrator will approve significant changes after review by the Radiation Safety Committee. The rules and procedures are designed to protect all individuals with a minimum of interference in their activities, consistent with the applicable rules and regulations of the Nuclear Regulatory Commission (NRC), with the terms and conditions of Manhattan College's License for Special Nuclear Material, with the Manhattan College Reactor Facility License (and Decommissioning Plan, when approved) and with applicable regulations of the State and City of New York. The radiation safety manual is based on the following assumptions:

- the moral obligation to maintain personnel health and safety with respect to all radiological ordinances can never be compromised;
- the low power and inherent safety of the Manhattan College Zero Power Reactor (MCZPR);
- the need to include reasonable and proper Health Physics procedures by requiring students to know and follow these regulations;
- personnel safety must be the first consideration at all times, and no requirements will be allowed to override safety considerations; and
- an obligation to initiate an ALARA (As Low As Reasonably Achievable) program in keeping with federal (NRC) guidelines.

6.1.2 RESPONSIBILITIES AND AUTHORITY

No set of rules is expected to cover all situations. Administration of and adequate provision for radiation protection and contamination control are the prime responsibilities of the reactor radiation safety officer (reactor RSO) to assure that all radiation protection and contamination control regulations are observed and that the procedures set in the Radiation Safety manual are followed. The reactor RSO is responsible for recommending changes in any operation believed not to be evaluated realistically, for bringing the situation to the attention of personnel concerned, and to the Reactor Administrator for correction. The reactor RSO will work in consultation with the campus RSO.

The reactor RSO staff is available to advise and make recommendations regarding radiological protection. The reactor RSO will initiate radiation surveys, wipe tests, air sampling, Zero Power Reactor water sampling, and such other sampling and environmental analysis as may be requested by the Chief Reactor Supervisor, Reactor Administrator, or by the NRC, either as a directive or as part of revised procedures.

6.1.3 RADIATION SAFETY COMMITTEE

6.1.3.1 FUNCTION

The Radiation Safety Committee shall administer the Manhattan College Zero Power Reactor and isotope program. All proposed procedures for non-routine or unusual operations (including decommissioning) shall be reviewed from the point of radiation safety. All radioactive waste disposal procedures shall be determined by this committee.

6.1.3.2 FREQUENCY OF MEETINGS

The Radiation Safety Committee will routinely meet once a semester or as necessary.

6.1.3.3 QUALIFICATIONS OF LICENSED ISOTOPE USERS

Persons proposing to work with radioactive materials must prepare an outline of qualifications and experiences in the handling and use of radioactive materials. The information submitted will be reviewed by the Radiation Safety Committee. Committee members will be available as consultants to users, and will directly supervise or arrange for supervision of the use of radioisotopes where considered necessary or advisable. Personnel who are approved to work with radiation shall be placed in one of two categories: 1) certified to work with radioactive materials without supervision; and 2) certified to work with radioactive materials only with supervision. Faculty members and research collaborators who use by-product materials, in exempt or non-exempt quantities, as defined in Article 175 of the New York City Health Code, Must submit and file this information. Students taking courses where radiation is used in the laboratory are exempt from this regulation. Students shall be under the control of qualified faculty when

working in the reactor area or with radioactive isotopes.

6.1.3.4 PROCUREMENT AND INVENTORY OF RADIOISOTOPES

The Reactor Administrator will authenticate the inventories of licensed radioisotopes in the reactor facility. This will be accomplished through comparison of written records of the persons in possession of radioisotopes with those of the Radiation Safety Committee. Confirmation of the records by physical inventory of the licensed radioisotopes in the Reactor Facility will be requested at least annually by committee.

6.1.3.5 RECORDS OF COMMITTEE MEETINGS

The committee secretary will prepare permanent written record of committee proceedings for committee approval, such written record to be maintained and presented at the following meeting for approval.

6.1.4 EXTERNAL RADIATION

6.1.4.1 PERMISSIBLE DOSES

The Maximum Permissible Dose (MPD) of radiation, as established by the NRC in regulations appearing in the Federal Register, Title 10, Chapter 1, Part 20, "Standards for Protection Against Radiation" (herein-after referred to as 10CFR20) will govern at Manhattan College. Exposures are stated in rems for the present; future dose values will be presented in sieverts (Sv). Occupational dose limits are given in 10CFR20.1201. Students are covered under the dose limits for individual members of the public in 10CFR20.1301.

6.1.4.2 PERSONNEL MONITORING

Personnel monitoring devices are required. Body type film badges, as supplied by a commercial vendor, shall be issued to those individuals working with radiation. Records indicating absorbed doses from radiation received on the site will be maintained in the reactor area for review by the Chief Reactor Supervisor, the Health Physicist and by the Radiation Safety Committee. A record of personnel exposures, similar to that provided by NRC Form 5, will be maintained or incorporated in the film badge record sheets.

6.1.4.2.1 BETA-GAMMA FILM BADGES

These badges contain beta-gamma film only and are developed regularly. They are worn by student personnel who normally enter the reactor rooms.

6.1.4.2.2 BETA-GAMMA-NEUTRON FILM BADGES

These badges contain both beta-gamma and neutron film and are developed regularly. They are worn by all reactor operator personnel normally working in the reactor rooms.

6.1.4.2.3 VISITOR FILM BADGES

Each group of visitors will be accompanied by an escort. The escort shall wear a special film badge to be worn only while escorting visitors.

6.1.4.3 SPECIAL PROTECTION PROCEDURES

Normally no special precautions are necessary for personal safety in radiation fields where the total body dose is less than 1 mRem/hr. However, it must be remembered that the field at a short distance from a radioactive source will be much greater than the field at normal working distances. Some sources must be handled with tongs or other remote handling equipment. It is also recommended that no person should plan to work for extended periods of time in a field where total body dose rate is greater than 1 mRem/hr. Any field of 2 mRem/hr must be clearly defined and posted with signs containing the radiation symbol and the words, "CAUTION - RADIATION AREA." The Health Physicist shall be notified of any changed circumstances which may be expected to alter the radiation field.

6.1.4.4 MAINTENANCE AND ALTERATIONS

When maintenance and alteration is planned, the Health Physicist will be notified in advance, so that radiation and contamination surveys can be made, and planning for necessary film badges, monitoring, tool decontamination, protective clothing, etc., can be carried out.

Special work permits may be required when a person is working in an area where actual or potential radiation or contamination hazard exists. Such permits will be issued only for outside contractor personnel.

6.1.5 INTERNAL RADIATION

6.1.5.1 PERMISSIBLE DOSE

The permissible annual occupational dose is the lesser of either 1) a total effective dose equivalent of 5,000 mrem or the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye of 50,000 mrem. The dose from internal exposures will be considered additive to dose received from external radiation when calculating total effective whole body dose equivalent as provided in 10CFR20.1202.

6.1.5.2 CONTROL OF INTERNAL RADIATION HAZARDS - CONDITIONS

The list of radioisotopes given in Appendix B to Sections 20.1001-20.2401 of 10CFR20 show a wide variety of substances and range of tolerance levels involved in the control of internal radiation. Toxicity is only indirectly related to measured activity since it varies with the degree of absorption into the body, e.g., ingestion, inhalation, contamination of wounds, or absorption through skin (especially when solvents are involved). For these reasons, it is not possible to set up general rules to cover all situations and Health Physics must be consulted whenever the possibility of the intake of more than 1/10 the applicable annual limit on intake (ALI) in Table 1, Columns 1 and 2, of Appendix B to Sections 20.1001-20.2401 of any isotope exists or is anticipated. The following regulations must be observed as a basic minimum for the control of internal radiation hazards.

6.1.5.2.1 USE AND STORAGE OF RADIOACTIVE MATERIALS

Each area or room in which radioactive material is used or stored and which contains an amount exceeding ten times the quantity of such material as specified in Appendix C to Sections 20-1001-20.2401 of 10CFR20 shall be posted with a sign or signs bearing the radiation symbol and the words "CAUTION - RADIOACTIVE MATERIALS."

6.1.5.2.2 FOOD STUFFS

No beverages, foodstuffs, or application of cosmetics are allowed in the ZPR, graphite or counting areas.

6.1.5.2.3 SMOKING

Smoking is not allowed per college regulations.

6.1.5.2.4 PIPETTING

No radioactive liquid is to be pipetted by mouth.

6.1.5.2.5 SPECIAL HANDLING EQUIPMENT

Some special portable equipment, such as long-handled tongs, remote pipetters, lead carriers, etc., are available for general use in the Counting Room.

6.1.5.2.6 CONTACT WITH HANDS

Rubber gloves are to be worn in cases where radioactive material or solutions of radioactive material may come in contact with hands unless their use introduces a greater hazard or extreme inconvenience. Persons with breaks in the skin must not attempt to work with radioactive

substances without consulting with the Health Physicist for suitable protective measures.

6.1.5.2.7 AIR CONTAMINATION

Any room, enclosure, or operating area in which radioactive materials exist in concentrations in excess of the Derived Air Concentrations (DACs) specified in Appendix B, Table I, Column 3 to Sections 20.1001-20.2401 of 10CFR20 or in which they exist in concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the ALI or 12 DAC-hrs, shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words, "CAUTION - AIRBORNE RADIOACTIVE AREA." No person is to enter a room or area where it is known or suspected that the permissible limit for airborne activity is exceeded. No operation is to be performed which might cause radioactivity to become airborne in excess of permissible levels.

6.1.5.2.8 MOVEMENT OF RADIOACTIVE MATERIALS

No radioactive material is to be moved from the Engineering Building in such a manner that it is possible for the material to escape from the container. Liquids, gases, and dispersible solids must be transported in suitable vessels with a protective sheath of shatterproof material. Surface contamination on articles for decontamination or waste disposal can usually be contained by wrappings of polyethylene sealed with adhesive tape. The outside surface of packages which are to be transported must be free from removable contamination so as to smear below 10 alpha dpm and 100 beta dpm on a standard smear. Materials and equipment to be transferred from a designated shoe cover area must carry HP-2 "Approved if surface contamination is below 100 dpm beta and 10 dpm alpha" for standard wipe smear and if object has no activity detectable with a survey meter.

6.1.5.2.9 ACCIDENTAL CONTAMINATION

Any person believing that radioactive materials may have been absorbed into their body should immediately consult the Health Physicist, who will initiate appropriate bioassay samples and summon medical aid, if these procedures are deemed necessary. Absorption through the unbroken skin is possible when large amounts of active material are involved.

6.1.5.2.10 BIOASSAYS

Reactor personnel other than students may be required to submit urine samples for radioactive analysis. Such samples will be requested at discretion of the Health Physicist or Reactor Operator when any significant internal exposure of radioisotopes is suspected to have occurred. If the sample or samples indicate an overexposure to internal radiation, the Health Physicist will investigate and a report of findings will be prepared. This report will also include recommendations to remedy the situation. The report is to be submitted to the Radiation Safety

Committee for review of Implementation.

6.1.5.2.11 BLOOD COUNTS

Personnel, described in part 6.1.5.2.9 above, may be required to provide a blood sample. The results of the blood count will be received by the Health Physicist and included in the documented report mentioned in part 6.1.5.2.10 above.

6.1.5.2.12 STUDENT LIMITATIONS

Student irradiation of samples will be restricted to solids. This regulation may be modified to include gas or liquid samples. Such modifications are provided by the Radiation Safety Committee, which will review the reasons for the modification and shall demonstrate the radiological safety of the procedures.

6.1.5.3 ALARA

The NRC has introduced the ALARA program as a further measure for reducing radiation exposure to radiological workers. The ALARA program is a commitment on the part of each radiological facility to closely monitor all dosimetry values and seek methods or techniques to further reduce the radiation levels that their staff may receive. The Manhattan College Nuclear Engineering Facility subscribes to this program. Section 6.2 presents the ALARA program as it relates to the Manhattan College Nuclear Engineering Facility.

6.2 ADMINISTRATION COMMITMENT TO ALARA

The administration of Manhattan College and the Manhattan College Nuclear Engineering Facility are committed to the program described in the following sections for keeping exposures (individual and collective) as low as reasonably achievable (ALARA). In accordance with this commitment, an administrative organization for radiation safety has been established and will develop the necessary written policy, procedures and instructions to foster the ALARA concept within Manhattan College. This organization includes the Radiation Safety Committee (RSC) and an appointed Campus Radiation Safety Officer (Campus RSO). Day to day oversight of the radiation protection program (including ALARA) will be performed by the reactor RSO. Annual review will be provided by the Campus RSO.

A formal annual review of the radiation safety program including ALARA considerations will be performed. This shall include reviews of operating procedures and past exposure records, inspections, etc., and consultations with the radiation protection staff or outside consultants.

Modification to operating and maintenance procedures and to equipment and facilities will be made where they will reduce exposures unless the cost, in the judgement of the committee, is considered to be unjustified. The Committee will be able to demonstrate, if necessary, that

improvements have been sought, that modifications have been considered, and that they have been implemented where reasonable. Where modifications have been recommended but not implemented, the committee will be prepared to describe the reasons for not implementing them.

In addition to maintaining doses to individuals as far below the limits as is reasonably achievable, the sum of the doses received by all exposed individuals will also be maintained at the lowest practicable level. It would not be desirable, for example, to hold the highest doses to individuals to some fraction of the applicable limit if this involved exposing additional people and significantly increasing the sum of radiation doses received by all involved individuals.

6.2.1 RADIATION SAFETY COMMITTEE

6.2.1.1 REVIEW OF PROPOSED USERS AND USES

The RSC will thoroughly review the qualifications of each applicant with respect to the types and quantities of materials and uses for which he has applied to assure that the applicant will be able to take appropriate measures to maintain exposure ALARA.

The RSC will ensure that the decommissioning procedures are appropriated and justified and that dose will be ALARA (individual and collective).

6.2.1.2 DELEGATION OF AUTHORITY

The RSC will delegate authority to the RSO for enforcement of the ALARA concept.

The RSC will support the RSO in those instances where it is necessary for the RSO to assert his authority. Where the RSO has been overruled, the Committee will record the basis for its action in the minutes of the Committee's semi-annual meeting.

6.2.1.3 REVIEW OF ALARA PROGRAM

The RSO will encourage all users to review current procedures and develop new procedures as appropriate to implement the ALARA concept.

The RSO will perform a quarterly review of occupational radiation exposure with particular attention to instances where Investigational Levels in Table 6-1 are exceeded. The principal purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is warranted when Investigational Levels are exceeded (see Section 6.2.6).

The RSO will evaluate our Nuclear Engineering Facility's overall efforts for maintaining exposures ALARA on an annual basis. This review will include the efforts of the RSO, authorized users, and workers as well as those of the Administration of Manhattan College and

the Nuclear Engineering Facility.

6.2.2 RADIATION SAFETY OFFICER (RSO)

6.2.2.1 ANNUAL AND QUARTERLY REVIEW

Annual Review of the Radiation Safety Program. The RSO will perform an annual review of the Radiation Safety Program for adherence to ALARA concepts. Reviews of specific procedures may be conducted on a more frequent basis.

Quarterly review of Occupational Exposures. The RSO will review at least quarterly the external radiation exposures of authorized users and workers to determine that their exposures are ALARA in accordance with the provisions stated in Section 6.2.6.

Quarterly review of records of Radiation Level Surveys. The RSO will review radiation levels in unrestricted and restricted areas to determine that they were at ALARA levels during the previous quarter.

6.2.2.2 EDUCATIONAL RESPONSIBILITIES FOR AN ALARA PROGRAM

The RSO will schedule briefings and educational sessions as needed to inform worker of ALARA program efforts.

The RSO will assure that authorized users, workers and ancillary personnel who may be exposed to radiation will be instructed in the ALARA philosophy and informed that administration, the RSC and the RSO are committed to implementing the ALARA concept.

6.2.2.3 COOPERATIVE EFFORTS FOR DEVELOPMENT OF ALARA PROCEDURES

Radiation workers will be given opportunities to participate in formulation of the procedures that they will be required to follow.

The RSO will be in close contact with all users and workers in order to develop ALARA procedures for working with radioactive materials.

The RSO will establish procedures for receiving and evaluating the suggestions of individual workers for improving health physics practices and encourage the use of those procedures.

6.2.2.4 REVIEWING INSTANCES OF DEVIATION FROM GOOD ALARA PRACTICES

The RSO will investigate all known instances of deviation from good ALARA practices; and, if

possible, determine the causes. When the cause is known, the RSO will require changes in the program to maintain exposures ALARA.

6.2.3 AUTHORIZED USERS

6.2.3.1 NEW PROCEDURES INVOLVING POTENTIAL RADIATION EXPOSURE

The Chief Reactor Supervisor will consult with, and receive the approval of, the RSO and the RSC during the planning stage for decommissioning. The Chief Reactor Supervisor will evaluate all procedures before using radioactive materials to ensure that exposures will be kept ALARA.

6.2.3.2 RESPONSIBILITY OF THE AUTHORIZED USER TO THE INDIVIDUALS SUPERVISED

The authorized user will explain the ALARA concept and his commitment to maintain exposures ALARA to all of those supervised.

The authorized user will ensure that the individuals subject to occupational radiation exposure are trained and educated in good health physics practices and in maintaining exposures ALARA.

6.2.4 PERSONS WHO RECEIVE OCCUPATIONAL RADIATION EXPOSURE

The worker will be instructed in the ALARA concept and its relationship to working procedures and work conditions.

The worker will know what recourses are available if it is believed that ALARA is not being promoted on the job.

6.2.5 PRENATAL RADIATION EXPOSURE

This is a set of special instructions to females, their supervisors, and co-workers regarding prenatal radiation exposure including a brief description of the most vulnerable time for exposure to occur and the possible consequences. It states the federal allowable limits and the Investigational Levels adopted by Manhattan College. These special instructions must be given both orally and in print. The individuals receiving this instruction must acknowledge their understanding by signature. Retaining this document is discussed in detail in Section 9.2.2.1.

6.2.5.1 BACKGROUND INFORMATION

It is known that sensitivity of cells to radiation damage is related to their reproductive activity and inversely related to their degree of differentiation. It follows that children could be expected to

be more radiosensitive than adults, fetuses more radiosensitive than children, and embryos even more radiosensitive.

This principle has long been a factor in the development of radiation exposure standards. 10CFR20.1207 places different limits on minors than on adult workers. 10CFR20.1208 relates to embryos or fetuses.

A special situation arises when an occupationally exposed woman is pregnant. Exposure of the abdomen of such a worker to penetrating radiation from either external or internal sources would also involve exposure of the embryo or fetus. Because a number of studies have indicated that the embryo or fetus is more sensitive than an adult, particularly during the first three months after conception, when a woman may not be aware that she is pregnant, the National Council on Radiation Protection and Measurements (NCRP) recommended in its Report No. 39 that special precautions be taken to limit exposure when an occupationally exposed woman could be pregnant.

6.2.5.2 REGULATORY POSITION ON PRENATAL EXPOSURE

Instruction to workers performed under 10CFR19.12 should be given prior to assignment to work in a restricted area. In providing instruction about health protection problems associated with radiation exposure, female workers and those who may supervise or work with them should be given specific instruction about prenatal exposure risks to the developing embryo and fetus.

The instruction should ensure that the employees understand:

1. That 10CFR20.1208 requires that, during the entire pregnancy, the maximum permissible dose equivalent to the fetus from occupational exposure of the declared pregnant woman should not exceed 0.5 rem. This dose is the sum of the deep-dose equivalent to the declared pregnant woman and the dose to the embryo/fetus from radionuclides in the embryo/fetus and in the mother.
2. The reasons for this recommendation.

The instruction should include the information provided in the Appendix to U.S. Nuclear Regulatory Commission Regulatory Guide 8.13 titled "Instruction Concerning Prenatal Radiation Exposure." It should be presented to the employee, her supervisors, and her co-workers both orally and in written form. Each individual should be given an opportunity to ask questions, and each individual should be asked to acknowledge in writing that the instruction has been received.

6.2.5.3 POTENTIAL HEALTH RISKS DUE TO PRENATAL EXPOSURE

Some recent studies have shown that the risk of leukemia and other cancers in children increases if the mother is exposed to a significant amount of radiation during pregnancy. According to a report by the National Academy of Sciences, the incidence of leukemia among children from birth to 10 years of age in the United States could rise from 3.7 cases in 10,000 children to 5.6 cases

in 10,000 children if the children were exposed to 1 rem of radiation before birth (a "rem" is a measure of radiation). The Academy has also estimated that an equal number of other types of cancers could result from this level of radiation. Although other scientific studies have shown a much smaller effect from radiation, the Nuclear Regulatory Commission (NRC) wants women employees of its licensees to be aware of any possible risk so that the women can take steps they think appropriate to protect their offspring.

As an employee of a NRC licensee, you may be exposed to more radiation than the general public. However, the NRC has established a basic exposure limit for all occupationally exposed adults of 1.25 rems per calendar quarter, or 5 rems per year. No clinical evidence of harm would be expected in an adult working within these levels for a lifetime.

The NCRP has recommended that because fetuses may be more sensitive to radiation than adults, their radiation dose as a result of occupational exposure of the mother should not exceed 0.5 rem. The International Council on Radiation Protection (ICRP) has also stressed the need to keep radiation doses to the fetus as low as reasonably achievable (ALARA).

All NRC licensees are now required by 10CFR19 to inform all individuals who work in a restricted area of the health protection problems associated with radiation exposure. This instruction must include information on the possible risks to unborn babies. It is also stated in 10CFR20 that licensees should keep radiation exposures as low as reasonably achievable. Therefore, it is the responsibility of the employer to take all practicable steps to reduce the individual's radiation exposure. 10CFR20.1208 requires that the dose to the embryo/fetus from occupational exposure of the declared pregnant woman not exceed 0.5 rem during the entire pregnancy. When dealing with the protection of a fetus, the alternatives which may be considered by a woman are:

1. If the woman is currently pregnant or is expecting to be soon, she may decide not to accept or continue assignments in restricted areas.

2. The woman may reduce her exposure, where possible, by decreasing the amount of time spent in the radiation area, increasing the distance from the radiation source, and using shielding.

3. If a woman does become pregnant, she could ask her employer to reassign her to areas involving less exposure to radiation. If this is not possible, then she may consider leaving her job. If this decision is made then it should be done without delay. The fetus is most sensitive to radiation during the first three months of pregnancy.

4. The woman could delay having children until she is no longer working in an area where the radiation dose to the fetus could exceed 0.5 rem.

5. The woman may continue working in the higher radiation areas, but with full awareness

that she is doing so at some small increased risk to the fetus.

The following facts are presented to help a woman with this decision.

1. The first three months of pregnancy are the most important, so the decision must be made quickly.

2. In most cases of occupational exposure, the actual dose received by the fetus is less than the dose received by the mother because some the dose is absorbed by the mother's body.

3. At the present occupational exposure limit, the actual risk to the fetus is small, but experts disagree on the exact amount of risk.

4. There is no need for a woman to be concerned about sterility or loss of the ability to bear children. The radiation dose required to produce such effects is more than 100 times larger than the NRC's dose limits for adults.

5. Even if a woman works in an area where she receives only 0.5 rem per three-month period, in 9 months she could receive 1.5 rems and therefore the fetus could receive more than 0.5 rem which is more than the full-term limit required by the NRC.

6.2.5.4 EXPOSURE AT MANHATTAN COLLEGE ZERO POWER REACTOR

Occupational exposures at the Manhattan College Zero Power Reactor are well below the federal limits. Within the ALARA program at the Manhattan College Nuclear Engineering Facility, a set of investigational levels have been developed for occupational external radiation exposure. The Radiation Safety Officer will review exposure records on a quarterly basis and the actions described in Section 6.2 will be taken at the Investigational Levels stated in Table 6-1.

The levels adopted by the Manhattan College ALARA program are well below the recommended limit of 0.5 rem during the gestation period. At investigational level I, a female will receive 0.125 rem/quarter which would total to 0.375 rem for the 9 month gestation period. Anything above this level will cause a review and a report to the RSC where appropriate measures will be taken.

6.2.6 ESTABLISHMENT OF INVESTIGATIONAL LEVELS IN ORDER TO MONITOR INDIVIDUAL OCCUPATIONAL EXTERNAL RADIATION EXPOSURES

The Manhattan College Nuclear Engineering Facility has established Investigational Levels for Occupational external radiation exposure which, when exceeded, will initiate review or investigation by the Radiation Safety Committee and/or the Radiation Safety Officer. The Investigational Levels adopted by Manhattan College are listed in Table 6-1 below. These levels

apply to the exposure of individuals.

TABLE 6-1

Investigational Levels (mRems per calendar quarter)		
	Level I	**Level II**
Whole Body; head and trunk; active blood-forming organs; lens of eyes; or gonads	125	375
Female during gestation period	125	175
Hands and forearms; feet and ankles	1250	3750
Skin of whole body	1250	3750

The Radiation Safety Office will review and record on Form NRC-5, Current Occupational External Radiation Exposures, or an equivalent form (e.g. dosimeter processor's report), results of personnel monitoring, not less than once in any calendar quarter. The following actions will be taken at the Investigational Levels as stated in Table 6-1.

6.2.6.1 QUARTERLY EXPOSURE OF INDIVIDUALS TO LESS THAN INVESTIGATIONAL LEVEL I

Except when deemed appropriate by the RSO, no further action will be taken in those cases where an individual's exposure is less than Table 6-1 values for the Investigational Level I.

6.2.6.2 PERSONNEL EXPOSURES EQUAL TO OR GREATER THAN INVESTIGATIONAL LEVEL I BUT LESS THAN INVESTIGATIONAL LEVEL II

The RSO will review the exposure of each individual whose quarterly exposures equal or exceed investigational Level I. He will report the results of his reviews at the first RSC meeting following the quarter when the exposure was recorded. If the exposure does not equal or exceed Investigational Level II, no action related specifically to the exposure is required unless deemed appropriate by the Committee. The Committee will, however, consider each such exposure in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the Committee minutes.

6.2.6.3 EXPOSURE EQUAL TO OR GREATER THAN INVESTIGATIONAL LEVEL II

The RSO will investigate in a timely manner the causes of all personnel exposures equaling or exceeding Investigational Level II, and if warranted, take action. A report of the investigation, actions taken, if any, and a copy of the individual's Form NRC-5 or its equivalent will be presented to the RSC at the first RSC meeting following completion of the investigation. The details of these reports will be recorded in the minutes. Committee minutes will be sent to the administration of this institution for review. The minutes, containing details of the investigation, will be made available for review.

6.2.6.4 RE-ESTABLISHMENT OF AN INDIVIDUALS OCCUPATIONAL WORKER'S INVESTIGATIONAL LEVEL II ABOVE THAT LISTED IN TABLE 6-1

In cases where a worker's or a group of workers' exposures need to exceed investigational Level II, a new, higher Investigational Level II may be established on the basis that it is consistent with good ALARA practices for that individual or group. Justification for new Investigation Level II will be documented.

The Radiation Safety Committee will review the justification for, and will approve, all revisions of Investigational Levels II. In such cases, when the exposure equals or exceeds the newly established Investigational Level II, those actions listed in section 6.2.5.3 above will be followed.

6.3 CONTAINMENT

All radioactive material must be contained in an appropriate vessel, when not in use and in such condition is known as a source of radiation.

Each container in which there is transported, stored, or used a quantity of radioactive material greater than the quantity shown in Appendix C to 10CFR20.1001-20.2401 shall bear a durable, clearly visible label bearing the radiation caution symbol and the words, "Caution - Radioactive Material."

However, such a label shall not be required:

- If the concentration of the material in the container does not exceed that specified in Table I, Column 2, of Appendix B to 10CFR20.1-20.601.
- For laboratory containers such as beakers, flasks and test tubes used transiently in laboratory procedures, when the user is present.

When containers are used for storage, a "Caution, Radioactive Material" tag or equivalent shall

state also the quantities and kinds of radioactive materials in the container and the date of the measurement of the quantities. In addition to the above requirements, encapsulated sources and any other vessels inside such a container will also be labeled whenever practicable and whenever there is any reasonable possibility of the source or vessel being left outside its container or being separated from it in transit.

The label of sources in transit for use outside the laboratory shall also certify that there is no contamination on the outside of the container. The person dispatching a source is responsible for planning a safe method of transport and for ensuring that adequate warnings are given to all personnel likely to come in contact with the source until it reaches its destination and is turned over to the custody of the recipient.

Sources not in current use should be shielded so that the radiation field at one foot anywhere outside the shield does not exceed 2.5 mrem/hr.

The Manhattan College Reactor Operations Committee shall provide properly controlled and labelled storage for sources larger than those which can be stored in the laboratories. The radiation field at any accessible point outside the storage area shall not exceed 2 mrem/hr. All containers containing radioactive sources shall be labeled with the source strength, and type of source in accordance with 10CFR20.203.

6.3.1 RADIATION AREAS

The Manhattan College Radiation Safety Committee is responsible for requesting the RSO for surveys so that properly marked radiation signs and tags are prominently displayed in all radiation areas. The necessity and extent of isolation and type of radiation sign will be determined by the Health Physicist in accordance with 10CFR20.203.

6.3.2 LABORATORY CONTROL

The Chief Reactor Supervisor or other persons approved by the RSC shall be responsible for the control of contamination in the facility. Working surfaces, walls, and floors must be "clean on wipe" i.e., there must not be removable contamination in excess of 100 dpm beta or 10 dpm alpha per standard smear. Fixed contamination must not exceed 2.5 mR/hr on contact. Since fixed contamination will be gradually liberated by wear of surfaces, the following should be considered for general laboratory conditions:

6.3.2.1 CONTAINERS

Containers of active material and all possible equipment shall be placed in auxiliary containers such as pans or trays, lined with absorbent materials.

6.3.2.2 CONTAMINATED GLASSWARE

Contaminated articles such as used pipettes or stirring rods shall not be laid on a table. They shall be placed in a stainless steel or enamel tray or other suitable container, lined with absorbent material.

6.3.2.3 CLEANLINESS

Good general laboratory and plant house keeping shall be maintained. Practices which are undesirable in any ordinary laboratory shall not be tolerated in laboratory containing radioactive material.

6.3.2.4 SPILLS

In the event of a spill, place, do not drop absorbent material on the spill. Advise others in the area to leave the immediate area. Use a survey meter (Geiger Mueller type) to determine areas of contamination and undertake personnel decontamination action if necessary. The spread of contamination will be arrested and then decontamination procedures effected. The area will not be opened until wipes indicate no contamination.

6.3.3 EQUIPMENT

Equipment that has been surveyed, wipe tested and found to be contaminated shall not (mandatory) be used until decontamination procedures are performed. The specific decontamination procedure will depend on the type of equipment and extent of contamination. All equipment, apparatus or tools that are contaminated shall be placed in plastic bags and sealed. Other articles too large for bags shall have plastic sheeting applied about each item and all running edges shall be sealed with tape. Personnel performing decontamination are to wear gloves and other protective apparel as recommended by the Health Physicist. The Health Physicist shall review and verify surveys and wipe tests to determine the level of radioactivity and several decontamination procedures may have to be performed before equipment is released for use. All materials and water or detergents used in the decontamination procedures shall be retained until verified by the Health Physicist and appropriate disposal modes approved.

In all cases the Health Physicist shall decide upon either a suitable method of decontamination or disposal. Decontamination of all contaminated materials that are not disposed of shall be performed by personnel responsible for the articles.

6.3.4 HANDS AND OTHER BODY PARTS

Survey meters located in the ZPR room shall be used for monitoring of hands and clothing of individuals suspected of being contaminated.

If hands or face are contaminated: then carry out thorough washing with water and a mild detergent. This may have to be repeated a number of times. Each time (after washing) survey the areas that were contaminated.

If clothing only has been contaminated remove the item in question and wash down the material. When washing, use plastic gloves and take care not to splash any of the rinsing water onto the body. This may have to be repeated a number of times. After each washing, survey the contaminated area.

6.4 WASTE DISPOSAL

The chief cause of radiation exposure to the public is contamination of air and water and great care must be taken in the disposal of radioactive waste. Appendix B to 10CFR20.1001-20.2401 lists the maximum permissible concentrations of radioisotopes in air and water for discharge to the environment. No effluent shall be released at any concentration and no waste shall be disposed of except as authorized by the Radiation Safety Committee. In any event, only concentration at or below maximum permissible levels listed in Appendix B in air and water will be allowed to escape continuously to the local environment.

6.4.1 ACCUMULATION OF ACTIVE WASTES

6.4.1.1 DRY WASTE

Cans marked CONTAMINATED WASTE, COLD WASTE and CONTAMINATED GLASSWARE will be provided as needed. These cans shall be polyethylene-lined and shall not be filled so as to prevent closure of the polyethylene bag liner. They should be floor-operated in order to reduce the possibility of spread of contamination by handling the lid. Extreme care should be exercised in keeping contaminated waste out of the cold waste cans, and vice versa. The cans will be monitored regularly by the Health Physicist and shall be marked with the normal radiation sign if the radiation field is greater than 2.5 mR/hr at any point outside the can. Persons placing material in the can which has sufficient activity to produce such a field must notify the Health Physicist.

6.4.1.2 LIQUID WASTE

Five-gallon polyethylene bottles marked CONTAMINATED WASTE shall be provided as needed. Liquid waste should be kept in these containers and not mixed with other waste. A detailed record of the nature of the liquid and the amount and type of activity in the container must be kept by the appropriate supervisor. Physical inventories will be requested

6.4.2 WASTE TRANSFER

Health Physicist will supervise the transfer and disposal of all radioactive wastes in accordance

with policies adopted by the Radiation Safety Committee. Transfer and disposal of such wastes must not be made without the knowledge and approval of the Health Physicist. The Health Physicist will monitor all such wastes and will decide on the appropriate method of disposal. Solid wastes found in contaminated waste cans will be packaged for off-site disposal. Liquid waste will be transferred to 55-gallon drums for storage, concentration and subsequent off-site disposal by a licensed waste disposal contractor.

The RSO will keep complete records of the condition and location of all radioactive waste in storage and of final disposition thereof.

6.5 MANUALS AND CODES

Each person, student or faculty, certified to work with radioactivity shall acquire a copy of the radiation safety manual.

Copies of 10CFR20, 10CFR50, and the codes of the State and City of New York, as well as copies of this manual, will be available for inspection at all times upon request. This material will be maintained in the office of the Reactor Administrator or in the Nuclear Facility files.

6.6 HEALTH PHYSICS SURVEYS

6.6.1 SURVEY INSTRUMENTATION

Survey instrumentation shall be maintained in operating conditions at all times in the counting room and/or in the zero power reactor room (ZPR room). The equipment shall be capable of measuring:

- gamma radiation fields in excess of 10 microR/hr;
- alpha and beta/gamma surface contamination ; and
- one portable neutron survey meter for both facilities

6.6.2 WIPE SURVEYS

Wipe samples of the floor and such other areas as selected by the Health Physicist and/or the Chief Reactor Supervisor shall be performed. The floor areas include the ZPR, graphite, counting and lecture rooms as well as connecting corridors and upper level desk areas. Normally this is performed at six month intervals.

6.6.3 AIR SURVEYS

Air sampling shall be taken of the areas considered in 6.6.2 above. Samples shall be taken at a rate of at least 2.5 cubic feet per minute for 1/2 to 1 hour at each location. Normally this is performed at six month intervals.

6.6.4 DISPOSAL OF POOL WATER AND DEMINERALIZER RESIN

The pool shall not be drained until the water has been assayed and shown to be at or below tolerance as specified in 10 CFR 20. The Health Physicist must be notified in advance as to this action.

The demineralizer is a concentrator of radioactivity, notably short-lived Na-24 and Mg-27. Used resin can never be replaced without Health Physicist coverage and notification. If assay of the resin shows it to be radioactive it will be disposed of in accordance with 10 CFR 20.2001.

6.6.5 LOG BOOKS

For the time period prior to April 1990, the Health Physicist will maintain a bound log book. All entries will be in ink. No erasures are ever to be made. Incorrect entries are to be crossed out, (they must still be legible), and the corrections noted above. These logs will be maintained:

- radiation surveys
- wipe records
- air and water tests

After April 1990, the Health Physics log book will maintain a book with removable sheets. All Health Physics surveys will be recorded on standard forms, numbered, and retained in a binder. All entries will be in ink. No erasures are ever to be made. Incorrect entries will be crossed out and the correction noted and initialed.

6.6.6 SURVEY INSTRUMENTS SERVICING AND CALIBRATION

All of the portable survey equipments in the ZPR room are checked and calibrated on an annual basis.