NUREG/CR-3370

Evaluation of Nuclear Facility Decommissioning Projects

Summary Report

North Carolina State University
Research and Training Reactor

Prepared by B. W. Link, R. L. Miller

UNC Nuclear Industries

Prepared for
U.S. Nuclear Regulatory Commission

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Prepared for
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Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
NRC FIN B7568

EVALUATION OF NUCLEAR FACILITY DECOMMISSIONING PROJECTS

SUMMARY REPORT
NORTH CAROLINA STATE UNIVERSITY
RESEARCH AND TRAINING REACTOR

Reviewed by DOE-RL:

J. D. White, Director, Surplus Facilities Management Program Office — 7/18/83 Date

Approved by UNC:

T. E. Dabrowski, Director, Decommissioning Programs Department — 7/17/83 Date

Approved by NRC:

D. W. Reisenweaver, NRC Program Manager — 7/25/83 Date

ABSTRACT

This document summarizes information from the decommissioning of the NCSUR-3 (R-3), a 10 KWt university research and training reactor. The decommissioning data were placed in a computerized information retrieval/manipulation system which permits future utilization of this information in pre-decommissioning activities with other university reactors of similar design. The information is presented both in some detail in its computer output form and also as a manually assembled summarization which highlights the more significant aspects of the decommissioning project. Decommissioning data from a generic study, NUREG/CR 1756, "Technology, Safety and Costs of Decommissioning Nuclear Research and Test Reactors," and the decommissioning of the Ames Laboratory Research Reactor (ALRR), a 5 MWt research reactor, is also included for comparison.

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1.0 INTRODUCTION

This document summarizes the available information concerning the decommissioning of the NCSUR-3 (R-3) reactor located at North Carolina State University. This small research and training reactor is similar to a number of others presently in use or in a shutdown status throughout the U.S.

The decision was made to decommission the subject reactor in the DECON mode in order to free the occupied space for other university-associated activities.

The decommissioning data were assembled in a form that permitted its input into a computerized data-handling system. The computer program used is a flexible data accumulation, manipulation and retrieval system which can provide:

- Greater accuracy in cost, labor and radiation exposure estimates
- Greater awareness of methods for keeping radiation exposures ALARA
- Guidance in estimating time requirements for decommissioning activites
- Better prediction of radiation and contamination levels
- Identification of special areas of difficulty in the decommissioning process.

As the amount of data from actual decommissioning projects increases, the value of the Decommissioning Data System as a decommissioning aid is enhanced. Some comparison information with reference research and test reactors is included in Section 2.0.

1.1 Acronyms - Abbreviations - Definitions

Definitions of Decommissioning Alternatives

DECON - to immediately remove all radioactive material to permit unrestricted release of the property.

SAFSTOR - to fix and maintain property so that risk to safety is acceptable for period of storage followed by decontamination and/or decay to an unrestricted level.

ENTOMB - to encase and maintain property in a strong and structurally long-lived material (e.g., concrete) to assure retention until radioactivity decays to an unrestricted level.

Acronyms - Abbreviations

A/C	Activated or Contaminated
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
BARN	Barnwell, S. Carolina (waste disposal site)
BIO	Biological
Ci	Curie
CS	Carbon Steel
Cu Ft	Cubic Feet
DDS	Decommissioning Data System
DNA	Data Not Available
DO	Dismantling Operations
DOE	Department of Energy
DOS RED FCT	Dose Reduction Factor
DPM	Disintegrations per Minute
DR	Drawings
EPA	Engineering, Planning, Administration
HP	Health Physics
HP/QA	Health Physics/Quality Assurance
HVAC	Heating, Ventilation, Air Conditioning
HX	Heat Exchanger
KWt	Kilowatts Thermal
Licensee	North Carolina State University
MAPPER	Maintain, Prepare, and Produce Executive Reports
MWd	Megawatt Days
MWdt	Megawatt Days Thermal
N/A	Not Applicable
NCSU	North Carolina State University
NRC	U.S. Nuclear Regulatory Commission
NRP	Nuclear Reactor Program
RICH	Richland U.S. Ecology Disposal Site
SPEC NO	Specification Number
SS	Stainless Steel
SYS/COMP	System Component
TRIP LEN	Trip Length
TYP	Type
UNC	UNC Nuclear Industries, Operations Division
μR	Micro-roentgen

2.0 FACILITY SUMMARY REPORT

The purpose for this section is two-fold: (1) to provide the reader with a condensed overview of the decommissioning of a university-type reactor, similar to several U.S reactors which will eventually be decommissioned, and (2) to present a brief comparison between this decommissioning project and the generic decommissioning study for a reference 1 MWt research reactor (RRR) and the decommissioning experience at the Ames Laboratory Research Reactor (ALRR)[1], a 5 MWt research reactor.

Cost information for RRR and ALRR was in 1981 and 1980 dollars, respectively, while comparative R-3 information is in 1983 dollars. To allow a comparision, all costs are converted to 1983 dollars using the Normalized Cost Escalation table in section 4.0 of this report. The information in this section is a summary of the computer-output information in section 7.0.

2.1 Facility Description

	R-3 NCSU Reactor and Training Reactor	RRR Reference Research Reactor	ALRR Ames Laboratory Research Reactor
Location:	Raleigh, N.C.	Corvallis, OR	Ames, IA
Owner:	State of North Carolina	Oregon St. University	DOE
Operator:	NCSU	OSU	Ames Laboratory
Reactor Type:	Research & Train.	TRIGA (Pool-Type)	Research (D_2O)
Operating Lifetime:	11 years	40 yr. (5% operating)	12 years
Decommissioning Mode:	DECON	DECON	DECON
Power Rating:	10 KWt	1 MWt (Steady State)	5 MWt
Lifetime Power:	2.1892 MWdt	740 MWdt	15,200 MWdt
Reason for Decommissioning:	Need eliminated	End-of-Life	Reduced Funding

2.2 Summary of Costs and Radioactive Waste

	R-3	RRR	ALRR
Total Decommissioning Cost, 1983 Dollars:	233,700	1,033,000	4,816,000
Personnel Exposure, Manrem:	1.78	18.3	69.4
Radwaste Volume, Cu. Ft.:	1,017	5,650	40,830
Radionuclide Inventory, Curies:	2.28	1,500	6,672

[1] NUREG/CR-3336, "Decommissioning Summary Report, Ames Laboratory Research Reactor"

2.3 Comparisons of Cost Items

2.3.1 Dollar Costs

The following listed items are compared to total dollar costs adjusted to 1983 for these decommissioning projects.

	R-3		RRR		ALRR	
Item (Unit)	No. of Units	No. of $ Per Unit	No. of Units	No. of $ Per Unit	No. of Units	No. of $ Per Unit
Radionuclide Inventory (Ci.)	2.28	102,450.	1500	689.	6672	722.
Radwaste (Cu. Ft.)	1017	230.	5650	183.	40830	118.
Lifetime Pwr. Output (MWdt)	2.1892	106,740	740	1396	15200	317.
Monthly Spending Rate	22	10,620.	8.5	121,500	45	107,010

2.3.2 Man-Rem Costs

The following listed items are compared to the total personnel exposure to radiation during the decommissioning program.

	R-3		RRR		ALRR	
Item (Unit)	No. of Units	No. of Units Per Manrem	No. of Units	No. of Units Per Manrem	No. of Units	No. of Units per Manrem
Radionuclide Inventory (Ci.)	2.28	1.28	1500	81.97	6672	96.14
Radwaste Volume (Cu. Ft.)	1017	571.35	5650	308.74	40830	588.33
Decommissioning Costs ($)	233679	131,280	1033000	56450	4816000	69400

3.0 DESCRIPTION OF COMPUTER REPORTS

The reports described below are the basic reports used in the decommissioning data system (DDS). The descriptions, as presented, are intentionally idealized. It should be understood that all report functions will not always be utilized, because the available decommissioning information varies from project to project. In addition to the basic reports, the MAPPER computer program used as the basis for the DDS provides the ability to produce supplementary reports by manipulating the data available in the basic reports.

3.1 General Information

This report is a free format input report designed to accommodate descriptive data of any kind. Entries may be given any title and related to any facility system by a system component number. Data are entered in any format on any subject. The report is used to record information that does not fit into any of the report types organized by column. This includes facility location, description, owners, operators, builders, etc. Summary data may also be included where it is not readily derivable from other reports or for convenient reference.

3.2 Decommissioning Code Table/Index

This report contains a list of unit items, including facility buildings, systems and system components, and budgetary items, with a corresponding identification number for each unit. The identification system is used throughout DDS to relate data to specifically identified units.

This basic report type may be expanded to include tables or indices of other kinds related to facility decommissioning. Candidate tables are labor category wage rates, shipping company rates, shipping company name codes, disposal site name codes and rates, or archived file tape names.

One of the basic values of this report is the fact that, by utilizing an index which can ultimately be made common to all reactor facilities included in the program, the report can become the intercomparison base for the DDS. The full utilization of this base will not be possible until an adequate number of facilities are included in the DDS.

3.3 Significant Event Report

This report is used to record the facility's operating history, which in some cases could impact facility decommissioning. It contains dates, system/component numbers, and event descriptions. Noteworthy events such as construction completion, startup, shutdowns, significant incidents, and accidents are recorded in this report.

3.4 Radionuclide Inventory

An inventory of radionuclides present in each facility system will be made prior to the start of decommissioning. The amount of each radionuclide or its concentration, the measurement date, and a description of each system's material composition is recorded. It is also noted whether a radionuclide present in a system is the result of neutron activation or contamination.

3.5 Project Cost/Exposure Report

Costs, schedules, man-hours, man-rem, both estimated and actual, are listed for each activity specification number. These costs may be broken out on lines having a subactivity specification number. This report is the main respository of cost and exposure information for a decommissioning project.

3.6 Dose Rate and Contamination Report

Dose rates at locations throughout each facility are recorded prior to decommissioning. Locations relative to a reference map, elevation, system/component number, and type of measurement are recorded for each measurement. Both upper and lower limits of dose rates or contamination levels (in disintegrations per minute) are listed.

3.7 Project Labor Report

Decommissioning labor costs, exposure, and man-weeks for each activity specification are recorded at a to-be-determined frequency. This supplements the project cost/exposure report by providing data on how costs and exposures accumulate over the course of a decommissioning project.

3.8 ALARA Report

The ALARA report contains records of ALARA efforts by activity specification number. The affected facility system, date, cost items, exposure information, and a description of the ALARA effort are listed. This report can be used to calculate by activity specification number or for all activities the total estimated man-rem saved as well as total cost incurred through the implementation of the ALARA effort.

3.9 Shipment Report

Volumes, weights, and other physical data are recorded by waste type for material produced by each activity specification. These data are listed for each shipment of material from the decommissioning site. Trip lengths and vehicle dose rates are recorded in order to calculate public exposure.

3.10 Disposal Costs

The costs associated with each waste disposal shipment are recorded in the Disposal Costs Report. Costs are divided into transportation, burial, and container categories. Costs for each container type on the shipment are also listed.

3.11 Surveillance Report

The surveillance report is used to record annual costs and exposures associated with long term surveillance of a decommissioned facility. Under normal conditions a surveillance report would not be included for a facility decommissioned under Mode DECON.

3.12 Public Dose Report

The exposure of the public to radiation which results from the decommissioning of nuclear facilities is one criterion which is to be considered during the pre-decommissioning evaluation phase. This report presents an estimate of such exposure information, based on extrapolations of measurement data and numerous assumptions, including both routine and accident conditions.

4.0 COST ADJUSTMENTS

All cost information included in this document is presented in actual dollars as the charges were paid through the decommissioning program. For adjusting costs listed in the computer reports to year of interest, use the inflation rate table below.

Normalized Cost Escalation Table

Annual Inflation Rate *	Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0.029	1966														
0.029	1967														
0.042	1968														
0.054	1969														
0.059	1970	1.000													
0.043	1971	1.043	1.000												
0.033	1972	1.076	1.033	1.000											
0.062	1973	1.138	1.095	1.062	1.000										
0.110	1974	1.248	1.295	1.172	1.110	1.000									
0.091	1975	1.339	1.296	1.263	1.201	1.091	1.000								
0.058	1976	1.397	1.354	1.321	1.259	1.149	1.058	1.000							
0.065	1977	1.462	1.419	1.386	1.324	1.214	1.123	1.065	1.000						
0.077	1978	1.539	1.496	1.463	1.401	1.291	1.200	1.142	1.077	1.000					
0.113	1979	1.652	1.609	1.576	1.514	1.404	1.313	1.255	1.190	1.113	1.000				
0.135	1980	1.787	1.744	1.711	1.649	1.539	1.448	1.390	1.325	1.248	1.135	1.000			
0.104	1981	1.891	1.848	1.815	1.753	1.643	1.552	1.494	1.429	1.352	1.239	1.104	1.000		
0.061	1982	1.952	1.909	1.876	1.814	1.704	1.613	1.555	1.490	1.413	1.300	1.165	1.161	1.000	
0.050	1983	2.002	1.959	1.926	1.864	1.754	1.663	1.605	1.540	1.463	1.350	1.215	1.111	1.050	1.000

Example: A cost paid in 1971 dollars would increase to a cost of 1.959 times the original, if paid in 1983 dollars.

*Source: Statistical abstract of the United States, 1982 Consumer Price Index.
1983 data are interim estimated.

In planning for large decommissioning projects which cover long time spans or are scheduled to start at some time in the future, cost estimates should consider the "worth" of current money and then adjust cost estimates to reflect this consideration. This exercise, referred to as a "time value cost analysis", considers the year of expenditure, interim surveillance and maintenance costs, major non-routine maintenance costs, and inflation rates. "Worth" of current money is usually based upon an average yield on stable, non-speculative investments such as long and short-term treasury bills. A "time value cost analysis" results in a percentage value, referred to as the discount rate, which is used to discount the cost of a future project to the current "worth" of money. This discount rate includes consideration of financial uncertainties, such as project cost overruns, recovery costs for major accidents, etc.

Example - A discount rate of two percent yields the following table:

Year	Discount Factor	Year	Discount Factor
1	0.9804	6	0.8880
2	0.9612	7	0.8706
3	0.9423	8	0.8513
4	0.9238	9	0.8535
5	0.9057	10	0.8204

If project is estimated to cost $10,000 during a time period six years from today, the amount of money presently required to be invested is ($10,000) (0.8880) or $8,880.

Detailed discussions and suggested assumptions may be found in the following references:

1. "Methodology for Establishing Decommissioning Priorities," U.S. Department of Energy, Richland Operations Office, RLO/SFM-82-7, June, 1982.

2. "The Rate of Discount for Evaluating Public Projects," Mikesell, R. F., 1977

   American Enterprise Institute for Public Policy Research, Washington, D.C.

3. "Navigating through the Interest Rate Morass: Some Basic Principles," Santoni, G. J., and C. C. Stone 1981
   Federal Reserve Bank of St. Louis Review, March 1981

5.0 FINAL SITE CONDITION

5.1 Criteria

The decommissioning contractor left the R-3 Bay in an acceptably clean condition on March 7, 1983. The North Carolina State University Health Physicist then began the final site survey to assure that the dismantling work had resulted in satisfactory decontamination of the R-3 bay. The Nuclear Regulatory Commission had required that the dose rates at one meter due to the activity of Cs-137, Co-60, and Eu-152 be less than 25 μR/hr (5 μR/hr above the 20 μR/hr background). Regulatory Guide 1.86 recommendsthat the removable contamination be less than 100 disintegrations per minute per 100 square centimeters. The philosophy of the NCSU final site survey was to take dose rate surveys and removable contamination swipes of all existing surfaces in the R-3 Bay at ten (10) foot intervals to assure satisfactory decontamination to levels below the Regulatory Guide 1.86 recommendation.

5.2 Final Site Condition

5.2.1 NCSU Final Site Survey

All horizontal surfaces were surveyed and swiped in the survey. These surfaces included the radial trenches, fuel storage bins and the base and foundation of the R-3 as the contractor left it. The beam catchers and storage holes in the walls were also swiped. In practice, the ten (10) foot interval was reduced to eight (8) feet to better fit the geometry of the R-3 Bay. The R-3 Bay walls were also surveyed and swiped up to the level of the crane track.

The dose rate surveys showed that all areas in the R-3 Bay were decontaminated to a level of less than 25 μR/hr except the area directly above the concrete which was below the R-3 core. This location appeared to measure between 26 and 27 μR/hr with a Ludlum μR/hr meter. All of the swipes taken showed removable contamination of less than 85 dpm/100 cm^2. The results of the NCSU HP Final Site Survey were incorporated in a letter to the NRC dated March 29, 1983.

5.2.2 Confirmatory NRC Survey

The licensee (NCSU) submitted their report of the final survey of the R-3 reactor facility for radiation and radioactive material to the Nuclear Regulatory Commission on March 29, 1983. Residual removable contamination levels were far below the limits for release for unrestricted use. The survey report showed that in one area the external radiation levels at one meter above the floor were 7 to 8 μR/hr above a background of 20 μR/hr. This location was one meter above the floor in the center of the facility below the reactor core location after approximately 18 inches of concrete were removed. Surveys of the area in question were made by the NRC

inspector, utilizing 1-1/2 inch thick steel plate to simulate the shielding regained by replacing the removed concrete and to re-establish the floor level. Subsequent measurements, both with and without the steel plate in place, were less than the required 5 μR/hr above a background of 20 μR/hr. The assumption is made that replacement of the removed concrete will reduce the radiation levels to below those permissible for unrestricted use.

Smear surveys by the NRC inspector showed removable contamination levels were well below the release limits for unrestricted use. The smears were counted for both alpha and beta/gamma activity at the licensee's facility. Confirmatory beta measurements were made in the Region II laboratory. Thirty disintegrations per minute (dpm) per 100 square centimeters (100 cm^2) was the highest beta/gamma level. The highest alpha level was 1.9 dpm/100 cm^2.

The inspector had no further questions or comments.

6.0 CONCLUSIONS AND LESSONS LEARNED

Several lessons were learned from the decommissioning of the R-3 reactor which might be helpful to others. These lessons are summarized in the following paragraphs.

6.1 As-Built Drawings

Throughout the life of the facility, a complete set of "as-built" drawings and manuals should be maintained. Such "as-builts" should include embedments in the structure even though they are no longer used. In fact, it would be advisable to maintain a set of drawings that shows every permanently installed fixture that must ultimately be removed even though it is no longer in use.

6.2 Modifications to the Structure

Any modifications to the structure should consider ultimate dismantling. To allow grout or a bonding agent to flow into the crack between otherwise independent concrete structures could make them far more difficult to remove. Also to reduce dismantling costs, buildings containing large steel structures should have large doors or other provisions to allow intact removal of large pieces of equipment.

6.3 Disassembly Tools

Disassembly tools should be maintained in a storage space with controlled access. Special tools may have been designed to install certain parts of the structure and components. If these tools are seldom used, then they may be lost. A good example of this were four (4) eye bolts that were used for removing a several-ton concrete block from the R-3 reactor. Without these eye bolts, it would have been necessary to use a jack hammer to break up the concrete and remove it in pieces. The eye bolts were threaded to match the

threads of an embedment which were non-standard. Fortunately, a piece of one of the old eye bolts was located and from that piece it was possible to remanufacture four (4) eye bolts that would fit the embedments.

6.4 Labor Productivity

Labor productivity should take into account orientation time, high turnover rates among laborers assigned to a job, and the time required to suit up to enter a controlled area. The contractor hired by NCSU to dismantle the concrete structure had no experience working his men under the controlled conditions required in a nuclear facility. Consequently, labor productivity was less than predicted.

6.5 Prepare the Decommissioning Plan and Maintain it Up-to-Date

The Decommissioning Plan should be prepared with assistance from the Operation and Maintenance staff during the early years of plant operation. It should be reviewed prior to major modifications to the facility and revised following the modifications.

6.6 Use Existing Staff

Use existing Operations and Maintenance staff for the initial phase of the dismantling. This will allow the plant staff to compare the condition of the plant at the time of decommissioning with "as-built" drawings. This effort should produce information that would allow a contractor to more intelligently prepare a proposal for the decommissioning work.

6.7 Dust Control

If the concrete structure is to be broken up, dust control must be thoroughly studied. It is recommended that the first concrete to be broken up should be non-radioactive. During the first few days of the demolition of the concrete structure of the R-3 reactor, fine dust was distributed throughout a three-story research building. Decontamination would have been extremely difficult if this fine dust had been radioactive. Awareness of this problem and the possible consequences of the spread of contamination throughout the building, caused the contractor to improve the ventilation system for dust control.

6.8 Keep the Nuclear Regulatory Commission Informed

The Nuclear Regulatory Commission has not yet developed a complete set of guidelines for the decommissioning of nuclear facilities. Where guidelines do exist, they do not refer specifically to research reactors. Discussions with Nuclear Regulatory Commission personnel in Bethesda, Maryland and Atlanta, Georgia were most helpful.

PAGE NO. 1
.R-3-DECON UNC DECOMMISSIONING DATA SYSTEM GENERAL INFORMATION REPORT 72C1104

# SYSTEM/COMPONENT	.SYS/COMP. NUMBER .	ENTRY TITLE

DESCRIPTION

OPERATING HISTORY

. NAME:	NCSUR-3 (R-3)	STARTUP DATE:	MARCH 16, 1960
. LOCATION:	RALEIGH, N.C	SHUTDOWN DATE:	FEBRUARY 19, 1973
. OWNER:	NCSU/STATE OF N.C.	MEGAWATT DAYS:	2.1892 MWDT
. OPERATOR:	NCSU	MAJOR SHUTDOWNS:	25 MONTHS, 27 MONTHS (SEE SIGNIFICANT EVENTS REPORT)
		DECOMMISSIONING MODE:	DECON
. ARCHITECT/ENGINEER:	NCSU/NUCLEDYNE CO.		
. SPECIAL LICENSE:	AMENDMENT OF OPERATING LICENSE TO 'POSSESS BUT NOT OPERATE'.		
. BUILDER:	NCSU/SYLVANIA CORNING NUCLEAR		
. NSSS:	N/A		

.REFERENCES, REPORTS AND PAPERS

. CONSTRUCTION/OPERATION

.1.SUMMARY HAZARDS REPORT FOR THE NORTH CAROLINA STATE UNIVERSITY TRAINING
REACTOR, NCSU AND THE NUCLEDYNE COMPANY, NCSU: RALEIGH, N.C., 1958
.2.NORTH CAROLINA STATE UNIVERSITY REACTOR (NCSUR-3) OPERATIONS MANUAL,
SCHOOL OF ENGINEERING-NCSU: RALEIGH, N.C., 1970.

. DECOMMISSIONING

.1.MONTY PROGRESS REPORTS 1-10, NCSU: RALEIGH, N.C., 1982-1983
.2.PRELIMINARY PROGRESS REPORT ON THE DECOMMISSIONING OF THE NCSU 10KW RESEARCH
AND TRAINING REACTOR, NCSU: RALEIGH, N.C., APRIL, 1982
.3.DISMANTLING PLAN FOR THE R-3 10KW REACTOR, NCSU: RALEIGH, N.C., MARCH, 1980
.4.DECOMMISSIONING OF THE NORTH CAROLINA STATE UNIVERSITY 10KW RESEARCH AND
TRAINING REACTOR, NCSU: RALEIGH, N.C., NOV. 17, 1982
.5.PRELIMINARY REPORT ON THE DECOMMISSIONING OF THE NCSU 10KW RESEARCH AND
TRAINING REACTOR, NCSU: RALEIGH, N.C., SEPTEMBER, 1982
.6.FINAL REPORT ON THE DECOMMISSIONING OF THE NCSU 10KW RESEARCH AND
TRAINING REACTOR, NCSU: RALEIGH, N.C., APRIL, 1983

.DECOMMISSIONING INFORMATION

.PERSONNEL RADIATION EXPOSURE

. NUMBER OF PERSONNEL MONITORED:	40
. AVERAGE DOSE IN MANREM:	0.0371
. TYPICAL DOSE IN MANREM:	0.030
. MAXIMUM DOSE IN MANREM:	
. DURING FUEL REMOVAL:	0.203
. DURING DISMANTLING:	0.070
. DURING ENTIRE PROJECT:	0.208
. TOTAL MANREM USED:	1.784
. DOSE TO PUBLIC:	0

# SYSTEM/COMPONENT	.SYS/COMP. NUMBER .	ENTR. TITLE

. COST SUMMARY

. LABOR, INC. BENEFITS	94,494.83
. EQUIPMENT & MATERIAL:	5,771.90
. WASTE AND FUEL DISPOSAL:	69,372.74
. MAINTENANCE:	[illegible]
. CONTRACTED DISMANTLING	[illegible].06
. TRAVEL:	770.84
. TOTAL DECOMMISSIONING COST	233,878.83

. MANPOWER COSTS, EXCLUSIVE OF SUBCONTRACTS

. PREDECOMMISSIONING ENGINEERING:	1663.73
. ENGINEERING, PLANNING AND ADMINISTRATION (EPA):	53627.92
. HEALTH PHYSICS AND QA:	16708.90
. SECURITY:	N/A
. DECOMMISSIONING WORKERS:	11616.14
. BENEFITS:	10258.27
. MISCELLANEOUS:	619.87
. SUBCONTRACTS FOR DISMANTLING AND FUEL DISPOSAL:	100355.35

. LABOR RATES ($/HR)

. DECOMMISSIONING OPERATIONS CONTRACTOR	DNA
. MANAGERS:	15-20
. PROJECT ENGINEER:	7-10
. SUPERVISORS:	12-15
. CLERICAL:	5-7
. REACTOR OPERATIONS:	10-13
. DECON TECH:	10-12
. GUARDS:	5-7
. HP TECH:	15
. ELECTRICIANS:	8-10
. LABORERS:	4-7
. JANITORS:	4-7
. CONTRACTOR MANAGER:	12-15
. FOREMEN:	10-12
. HEAVY EQUIP. OPERATORS:	7-9
. LABORERS:	6-8
. SENIOR HEALTH PHYSICIST:	25
. ASST. HEALTH PHYSICISTS:	20-22
. SUBCONTRACTOR EMPLOYEES	DNA

.R-3-DECON UNC DECOMMISSIONING DATA SYSTEM GENERAL INFORMATION REPORT 72C1104

SYSTEM/COMPONENT	SYS/COMP. NUMBER	ENTRY TITLE

WASTE DISPOSAL COSTS

BURIAL CHARGES:	$11445.17
TRANSPORT CHARGES:	15611.95
CONTAINER COSTS:	3754.64
TAXES:	789.69
FUEL DISPOSAL COSTS:	28791.29
TOTAL	$60392.74

WASTE DISPOSAL RATES

BURIAL RATES:		$10.15/CU.FT.
		12.31/CU.FT.
		11.40/CU.FT.
CASK RENTAL RATES:		N/A
TRANSPORTATION RATES:		
SHIPMENT NO. 1		$6.42/CU.FT.
SHIPMENT NO. 2		12.31/CU.FT.
SHIPMENT NO. 3		14.97/CU.FT.
SHIPMENT NO. 4		18.30/CU.FT.
TAX RATES:	APPROX.	$0.30/CU.FT. SHIPMENTS NO. 1-3
	APPROX.	$2.27/CU.FT. SHIPMENT NO. 4

SURCHARGES: NONE

OTHER COSTS

UTILITIES:	DNA
MISC. SUPPLIES:	DNA
NUCLEAR INS.:	DNA
LICENSE FEES:	DNA
FINAL SITE SURVEY:	DNA
TAXES:	N/A
REAL ESTATE SALE VALUE:	N/A

WASTE DISPOSAL DATA

		RADIOACTIVE WASTE	NON-RADIOACTIVE WASTE
NUMBER OF SHIPMENTS:		4	31
TOTAL VOLUME-RADWASTE:	(CU FT)	1017	N/A
TOTAL VOLUME-CLEAN:	(CU FT)	N/A	2250
TOTAL MASS -RADWASTE:	(TONS)	36.81	N/A
TOTAL MASS -CLEAN:	(TONS)	N/A	142.9
NUMBER OF CONTAINERS:		133	N/A
TOTAL RADWASTE INVENTORY:	(CI)	2.280825	N/A

.FINAL SITE SURVEY SUMMARY

BASIS FOR CRITERIA: REG GUIDE 1.86/ CORRESPONDENCE

CRITERIA SUMMARY: ALL EXISTING SURFACES MUST HAVE A DOSE RATE AT ONE METER DUE TO EU-152, CO-60, AND CS-137 OF LESS THAN 5 MICRO-R/HR. ABOVE NATURAL BACKGROUND, DETERMINED TO BE 20 MICRO-R/HR. ALL SURFACES MUST HAVE REMOVABLE CONTAMINATION OF LESS THAN 100DPM/100CM2.

INSTRUMENTS USED: NUCLEAR DATA MODEL 66 MULTICHANNEL ANALYZER COUPLED TO NAI DETECTOR LUDLUM MODEL 19 MICRO-R/HR METER

SURVEY RESULT SUMMARY: ALL SURFACES HAD DOSE RATES AT OR BELOW 25 MICRO-R/HR (THE ESTABLISHED LIMIT) AND REMOVABLE CONTAMINATION LEVELS OF LESS THAN

.R-3-DECON UNC DECOMMISSIONING DATA SYSTEM GENERAL INFORMATION REPORT 72C1104

$ SYSTEM/COMPONENT	.SYS/COMP. NUMBER .	ENTRY TITLE
$	85	DPM/100 CM2

COMPARISON ITEMS

TOTAL COST OF DECOMMISSIONING
---------- = COST/UNIT
NO. OF UNITS COMPARISON ITEMS

ITEMS	NO. OF UNITS	COMPARISON COSTS	
CURIES	2.280825	102454	DOLLARS/CURIE
RAD WASTE (CU FT)	1017	229.77	DOLLARS/CU FT
SPENDING RATE (MONTHS)	22	10622	DOLLARS/MONTH
POWER RATING (MWE)	N/A	N/A	DOLLARS/MWE
LIFETIME MWDT	2.1892	106742	DOLLARS/MWDT

NO. OF UNITS COMPARISON ITEMS
---------- = UNITS/MANREM
TOTAL MANREM USED

ITEMS	NO. OF UNITS	COMPARISON COSTS	
CURIES	2.280825	1.28	CI/MANREM
RAD WASTE (CU FT)	1017	571.4	CU FT/MANREM
TOTAL COST ($)	233678.83	131280	$/MANREM
LIFETIME MWDT	2.1892	1.23	MWDT/MANREM
POWER RATING (MWE)	N/A	N/A	MWE/MANREM

.ASSUMPTIONS

. BECAUSE OF THE VERY LOW LEVELS OF RADIATION EXPERIENCED THROUGHOUT THIS
. DECOMMISSIONING PROJECT, PUBLIC DOSE LEVEL IS ASSUMED TO BE ZERO.

.R-3-DECON .N.C. DECOMMISSIONING DATA SYSTEM - DECOMM CODE TABLE/INDEX 19283002

* FACILITY .SYS/COMP.		
* SYSTEM/COMPONENT . NUMBER .		
	01	HEALTH PHYSICS, QUALITY ASSURANCE (HP/QA) ALL COSTS INCURRED DUE TO HEALTH PHYSICS OR QUALITY ASSURANCE ACTIVITIES WERE PLACED IN THIS CATEGORY.
	01.01	LABOR, HP/QA
	01.02	EQUIPMENT HP/QA
	01.03	MATERIAL HP/QA
	01.04	TRANSPORTATION HP/QA
	01.05	DISPOSAL HP/QA
	01.06	MAINTENANCE HP/QA
	01.07	PACKAGING HP/QA
	01.00.01	HP/QA INTERNAL (WITHIN NCSU)
	01.00.02	HP/QA EXTERNAL (CONTRACTOR)
	02	ENGINEERING, PLANNING, ADMINISTRATION (EPA) ALL ENGINEERING, PLANNING, AND ADMINISTRATIVE ACTIVITIES (INCLUDING DOCUMENT PREPARATION, RESEARCH, AND ORGANIZATIONAL AND PLANNING MEETINGS) ARE INCLUDED IN THIS CATEGORY.
	02.01	LABOR (EPA)
	02.02	EQUIPMENT (EPA)
	02.03	MATERIAL (EPA)
	02.04	TRANSPORTATION (EPA)
	02.05	DISPOSAL (EPA)
	02.06	MAINTENANCE (EPA)
	02.07	PACKAGING (EPA)
	02.00.01	EPA, INTERNAL
	02.00.02	EPA, EXTERNAL
	03.	DISMANTLING OPERATIONS (DO) ALL ACTIVITIES INVOLVING THE DISMANTLEMENT, REMOVAL, OR DISPOSAL OF MATERIAL FROM THE R-3 FACILITY WERE PLACED UNDER THIS DISCIPLINE
	03.01	LABOR, (DO)
	03.02	EQUIPMENT, (DO)
	03.03	MATERIAL, (DO)
	03.04	TRANSPORTATION, (DO)
	03.05	DISPOSAL, (DO)
	03.06	MAINTENANCE, (DO)
	03.07	PACKAGING, (DO)
	03.00.01	DO, INTERNAL
	03.00.02	DO, EXTERNAL
	04.	DRAWINGS (DR) ALL INFORMATION CONCERNING THE PREPARATION OF DECOMMISSIONING PROJECT RELATED DRAWINGS ARE INCLUDED IN THIS CATEGORY.

FACILITY SYSTEM/COMPONENT	SYS/COMP. NUMBER	
	04.01	LABOR, (DR)
	04.02	EQUIPMENT, (DR)
	04.03	MATERIAL, (DR)
	04.04	TRANSPORTATION, (DR)
	04.05	DISPOSAL, (DR)
	04.06	MAINTENANCE (DR)
	04.07	PACKAGING (DR)
	04.00.01	DR, INTERNAL
	04.00.02	DR, EXTERNAL
	05.00.01	BENEFITS, INTERNAL
	05.00.02	BENEFITS, EXTERNAL

.R-3-DECON UNC DECOMMISSIONING DATA SYSTEM - SIGNIFICANT EVENT REPORT 19203006

#EVENT .SYS/COMP. # DATE	.NUMBER .	SIGNIFICANT EVENT DESCRIPTION
501101		CONSTRUCTION STARTED ON INITIAL REACTOR R-1,HOMOGENEOUS WATER BOILER, 1 KW
530901		R-1 CONSTRUCTION COMPLETED
550501		R-1 SHUTDOWN DUE TO CORROSION LEAK
570501		CONSTRUCTION COMPLETED, R-2 REACTOR, 200 WATTS, HOMOGENEOUS WATER BOILER
581201		R-2 DISMANTLED AND MODIFICATION TO R-3 INITIATED
601101		R-3 CONSTRUCTION COMPLETED
610301		R-3 OPERATION INITIATED
.721212		NCSU REQUESTS THE AEC TO AMEND OPERATING LICENSE TO A 'POSSESSION ONLY' LICENSE.
.730219		R-3 SHUTDOWN; FUEL STORED IN BASKETS UNDER WATER INSIDE REACTOR TANK; CONTROL RODS REMOVED TO STORAGE; ELECTRIC CONTROLS DISMANTLED; SAFE STORAGE BEGINS.
.740219		FUEL REMOVED FROM REACTOR TANK AND STORED IN FUEL STORAGE PIT IN FLOOR OF R-3 BAY; SYSTEM DRAINED OF WATER; SAFE STORAGE CONTINUES.
.740318		NRC AMENDS LICENSE NO. R-63 TO 'POSSESSION ONLY' LICENSE; SAFE STORAGE CONTINUES.
.760701		NCSU PREPARES FIRST DISMANTLING PLAN FOR NRC APPROVAL EIS/ENVIRONMENTAL ASSESSMENT REQUIREMENT WAIVED BY NRC
.791114		FUEL REMOVED FROM FUEL STORAGE PIT AND SHIPPED TO SAVANNAH RIVER LABORATORY; SAFE STORAGE CONTINUES.
.800301		NCSU PREPARES REVISED DISMANTLING PLAN FOR NRC APPROVAL; SAFE STORAGE CONTINUES.
.810515		NCSU BEGINS DOCUMENT AND DRAWING REVIEW AND BEGINS PRE-DISMANTLING RADIATION SURVEYS; SAFE STORAGE CONTINUES.
.810601		NRC ISSUES DISMANTLING ORDER; NRC REQUIRES NO ENVIRONMENTAL IMPACT STATEMENT; SAFE STORAGE CONTINUES.
.811014		NCSU BEGINS DISMANTLING ACTIVITIES WITH THE REMOVAL OF THE THERMAL COLUMN.
.811215		FIRST RADIOACTIVE WASTE FROM R-3 SHIPPED TO BURIAL GROUND-CONSISTS OF GRAPHITE FROM THERMAL COLUMN AND ALL THREE

#EVENT .SYS/COMP. # DATE	.NUMBER .	SIGNIFICANT EVENT DESCRIPTION
.		CONTROL RODS.
.820101		NCSU BEGINS PREPARATION OF REQUEST FOR PROPOSAL FOR THE DEMOLITION OF THE R-3 CONCRETE BIOLOGICAL SHIELD; NCSU REMOVES THE REACTOR TANK, THE REMAINING THERMAL COLUMN, AND AND THE BULK IRRADIATION FACILITY.
.820315		UNC-NUCLEAR INDUSTRIES CONTRACT FOR R-3 DECOMMISSIONING DATA COLLECTION AND DOCUMENTATION AWARDED.
.820601		REQUEST FOR PROPOSAL (RFP) FOR DEMOLITION CONTRACT FINALIZED, INCLUDING UP-TO-DATE DRAWINGS.
.820709		DECOMMISSIONING FUNDING APPROVED; RFP MAILED TO PROSPECTIVE BIDDERS.
.820715		BIDDERS' CONFERENCE HELD AT NCSU.
.820722		SECOND SHIPMENT OF RADIOACTIVE WASTE CONSISTING OF REACTOR TANK, BEAM TUBE SHIELD PLUGS, AND GRAPHITE SHIPPED TO BURIAL GROUND.
.820817		RFP BIDS OPENED.
.821013		CONTRACT AWARDED TO LOW BIDDER.
.821015		DEMOLITION OF R-3 CONCRETE BIOLOGICAL SHIELD BEGINS.
.830216		THIRD SHIPMENT OF RADIOACTIVE WASTE CONSISTING OF BIOLOGICAL SHIELD CONCRETE AND REINFORCING BAR COMPLETED.
.830307		DEMOLITION CONTRACT COMPLETED.
.830309		FOURTH AND FINAL SHIPMENT OF RADIOACTIVE WASTE CONSISTING OF BIOLOGICAL SHIELD CONCRETE AND REINFORCING BAR COMPLETED.
.83^316		NCSU FINAL SITE SURVEY COMPLETED.
.830406		NRC FINAL SITE SURVEY COMPLETED.
.830422		NRC FINAL SITE SURVEY REPORT ISSUED.

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.R-3-DECON U.N.C. DECOMMISSIONING DATA SYSTEM - RADIONUCLIDE INVENTORY H30'\

#SYS/COMP. # NUMBER	SOURCE MATERIAL DESCRIPTION	MEASUR./ EMENT C.	DATE	RADIONUCLIDE NAME	CURIES	CURIES. DPM/ FT**3	DPM/ 100CM2.
	THERMAL COLUMN GRAPHITE	A	DNA	EU 152	0.02677	1.2E-4	DNA
	CONTROL RODS	A	DNA	CD 113	0.0.14	1.9E-2	DNA
		A	DNA	CD 109	0.007	9.3E-3	DNA
		A	DNA	NI 63	0.674	9.0E-2	DNA
	BIOSHIELD CONCRETE	A	DNA	BA 133	0.04314	6.4E-5	DNA
		A	DNA	CO 60	0.13372	2.0E-4	DNA
		A	DNA	EU 152	1.37756	2.0E-3	DNA
	REACTOR TANK	A	DNA	CO 60	0.0022	7.2E-5	DNA

RADIONUCLIDE	% OF TOTAL
EU-152	61.6
NI-63	29.6
CO-60	6.1
BA-133	1.9
CD-113	0.6
CD-109	0.3
FE-55	0.01

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.R-3-DECON UNC DECOMMISSIONING DATA SYSTEM - PROJECT COST/EXPOSURE 19AB3022

#	ACTIVITY/SPEC NO	COST ITEM/ACTIVITY	SYS/COMP NUMBER	A.C.	START DATE	SCHED COMPL DATE	MAN HOURS	ESTIMTD COST $	MAN REM	START DATE	ACTUAL COMPL DATE	MAN HOURS	ACTUAL COST $	MAN REM
		HP/QA LABOR	01.01									2003	16708.9	
		HP/QA EQUIPMENT	01.02										336.7	
		HP/QA MATERIALS	01.03										27.0	
	NOTE 1	HP/QA INTERNAL	01.00.01										15708.9	
	NOTE 1	HP/QA EXTERNAL	01.00.02										363.8	
		EPA LABOR	02.01									5390	53894.3	
		EPA EQUIPMENT	02.02										28.9	
		EPA MATERIALS	02.03										3538.4	
		EPA TRANSPORTATION	02.04										770.8	
		EPA DISPOSAL	02.05										14.8	
		EPA MAINTENANCE	02.06										14.8	
	NOTE 1	EPA INTERNAL	02.00.01										50268.2	
	NOTE 1	EPA EXTERNAL	02.00.01										1993.9	
	NOTE 2	DO LABOR	03.01									1388	11969.6	
		DO EQUIPMENT	03.02										829.3	
		DO MATERIALS	03.03										794.6	
		DO TRANSPORTATION	03.04										15597.2	
		DO DISPOSAL	03.05										12234.9	
		DO MAINTENANCE	03.06										669.7	
		DO PACKAGING	03.07										3754.6	
	NOTE 1	DO INTERNAL	03.00.01										12687.0	
	NOTE 1	DO EXTERNAL	03.00.02										133508	
		DR LABOR	04.01									386	1663.7	
		DR MATERIALS	04.03										216.9	
	NOTE 1	DR INTERNAL	04.00.01										1784.4	
	NOTE 1	DR EXTERNAL	04.00.01										96.2	
	NOTE 3	BENEFITS	05.00.01										10258.3	
#												9167	355733.8	
#														

.1.INTERNAL COSTS ARE THOSE INCURRED WITHIN THE NCSU SYSTEM
EXTERNAL COSTS ARE THOSE INCURRED OUTSIDE THE NCSU SYSTEM
.2.DISMANTLING FIGURES INCLUDE FUEL SHIPMENT AND REMOVAL, AND
CONTRACTED DISMANTLING
.3.BENEFITS APPLY TO ALL COST ITEM/ACTIVITIES, DEPENDING ON THE AMOUNT OF
MAN-HOURS EXPENDED WITHIN EACH COST ITEM/ACTIVITY

.R-3-DECON U.N.C. DECOMMISSIONING DATA SYSTEM - DOSE RATE 19283014

MAP REFERENCE	BUILDING	ELEV FEET	MAP COORD.	SYS/COMP. NUMBER	TYP	MR/HR LOWER	MR/HR UPPER	100CM2 LOWER	100CM2 UPPER	EMENT DATE	COMMENT
.NOTE - THREE ANNULI OF READING SURFACES ESTENDING FROM REACTOR CENTER OUTWARD #ARE REPORTED. (A) INNER ANNULUS, SURFACE OF REACTOR BIOLOGICAL SHIELD, (B) #MIDDLE ANNULUS, OUTER WALLS OF REACTOR ROOM PROPER, AND (C) OUTER ANNULUS, #OUTER WALLS OF SERIES OF SMALL ROOMS SURROUNDING THE REACTOR ROOM, BASEMENT #LEVEL. EACH DOSE RATE POINT WILL BE IDENTIFIED, WITH A LETTER. SEE FIGURES #1 & 2 FOR ADDITIONAL DETAIL.											
FIGURE 1	REACTOR	BASE-MENT LEVEL	A	N/A	CON	.010	0.013	DNA	DNA		
FIGURE 1			B		CON	.016	.022				
FIGURE 1		GAMMA FACIL	B		CON		0.140				
FIGURE 1			C		CON		0.014				RM B204
FIGURE 1			C		CON		0.016				RM B203
FIGURE 1			C		CON		0.017				RM B202
FIGURE 1			C		CON		0.017				RM B202
FIGURE 1			C		CON		0.022				RM B208
FIGURE 1			C		CON		0.024				RM B207
FIGURE 1			C		CON		0.016				RM B207
FIGURE 1			C		CON		0.015				RM B206
FIGURE 1			C		CON		0.018				RM B206
.NOTE - THE FOLLOWING DOSE RATE READINGS WERE TAKEN IN ROOMS PERIPHERAL AND #ADJACENT TO THE REACTOR ROOM ONE LEVEL ABOVE THE REACTOR ROOM FLOOR #(BASEMENT LEVEL).											
FIGURE 2	BURLINGTON NUCLEAR LABS	FIRST FLOOR	N/A		CON		0.017				LOBBY, RIGHT
FIGURE 2					CON		0.015				LOBBY, CENTER
FIGURE 2					CON		0.016				LOBBY, LEFT
FIGURE 2					CON		0.016				RM 1202, RIGHT
FIGURE 2					CON		0.017				RM 1202, CENTER
FIGURE 2					CON		0.014				RM 1235
FIGURE 2					CON		0.015				RM 1233
FIGURE 2					CON		0.018				RM 1230, FRONT
FIGURE 2					CON		0.016				RM 1230, REAR
FIGURE 2					CON		0.014				RM 1228
FIGURE 2					CON		0.013				RM 1228 A
FIGURE 2					CON		0.014				RM 1226
FIGURE 2					CON		0.014				RM 1224, RIGHT
FIGURE 2					CON		0.015				RM 1224, LEFT
FIGURE 2					CON		0.015				RM 1223
FIGURE 2					CON		0.017				RM 1222
FIGURE 2					CON		0.014				HALLWAY RM 1201
FIGURE 2					CON		0.015				RM 1220

R-3-DECON U.W.C. DECOMMISSIONING DATA SYSTEM - DOSE RATE 92G3014

MAP REFERENCE	BUILDING	ELEV FEET	MAP COORD.	SYS/COMP. NUMBER	TYP.	MR/HR LOWER	MR/HR UPPER	DPM 100CM2 LOWER	DPM 100CM2 UPPER	MEASUREMENT DATE	COMMENT
FIGURE 2					CON	0.014					RM 1201
FIGURE 2					CON	0.016					RM 1218
FIGURE 2					CON	0.017					RM 1217
FIGURE 2					CON	0.017					RM 1216, FRONT
FIGURE 2					CON	0.022					RM 1216, BACK
FIGURE 2					CON	0.022					RM 1215, FRONT
FIGURE 2					CON	0.035					RM 1215, BACK
FIGURE 2					CON	0.014					RM 1214, RIGHT
FIGURE 2					CON	0.011					RM 1211, CENTER
FIGURE 2					CON	0.010					RM 1210, RIGHT
FIGURE 2					CON	0.019					RM 1207, FRONT
FIGURE 2					CON	0.016					RM 1207, BACK
FIGURE 2					CON	0.016					RM 1205, LEFT
FIGURE 2					CON	0.015					RM 1204, LEFT

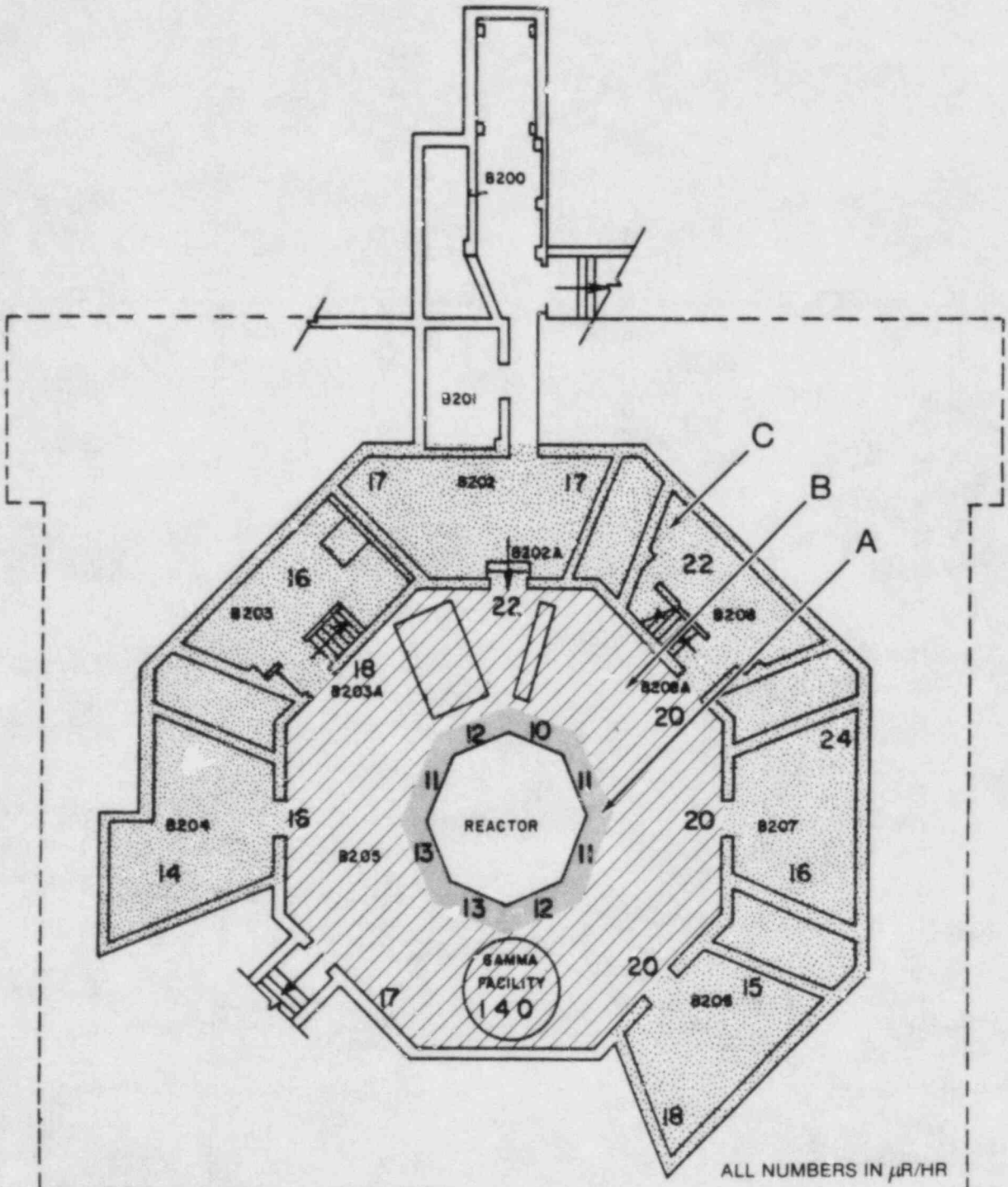

FIGURE 1

BURLINGTON NUCLEAR LAB (SOUTH WING)
BEL DOSE RATES
BASEMENT FLOOR

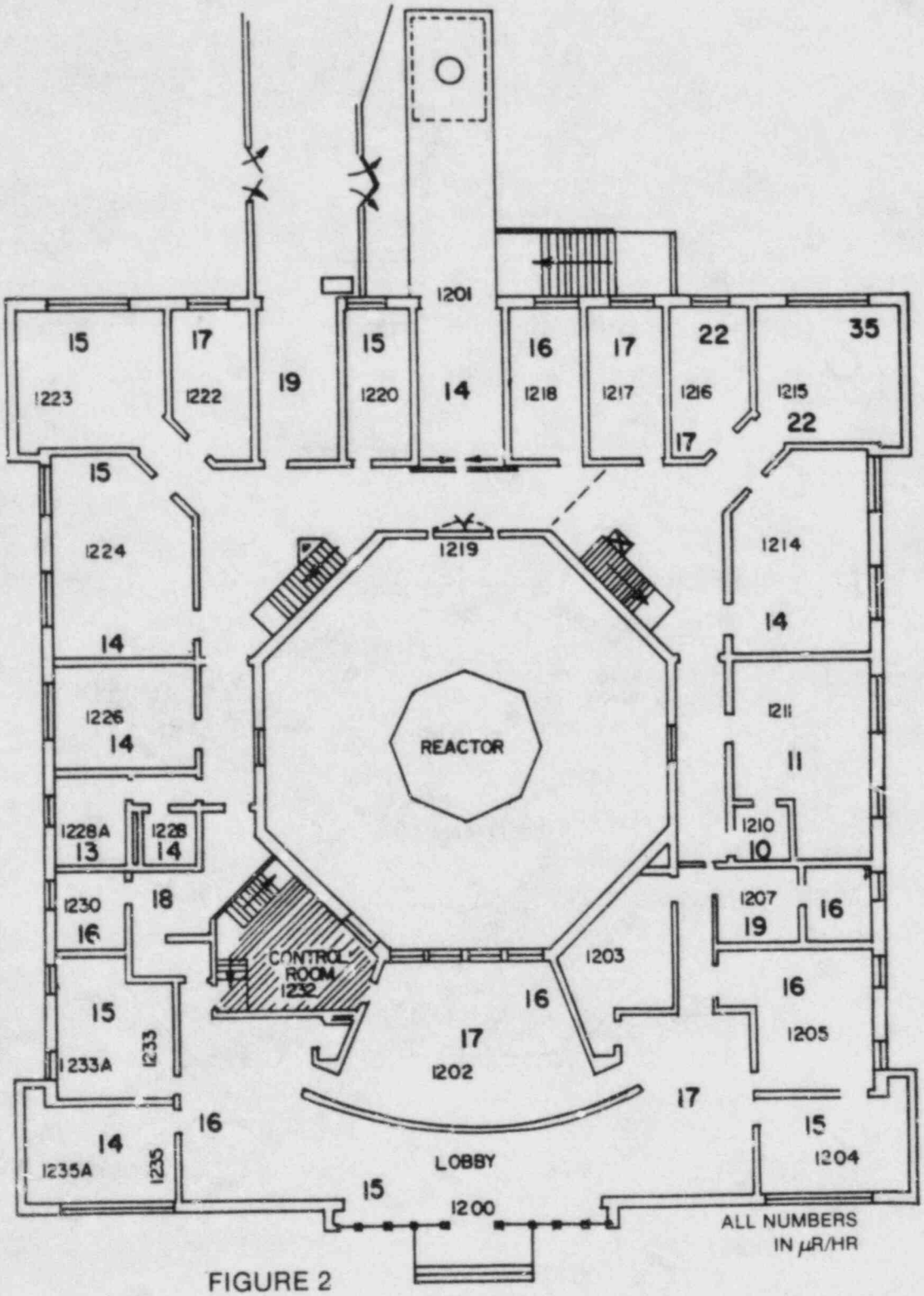

FIGURE 2

BURLINGTON NUCLEAR LABS FIRST FLOOR DOSE RATES

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.R-3-DECOM U.N.C. DECOMMISSIONING DATA SYSTEM - PROJECT LABOR 194F3032

*ACTIVITY. *SPEC NO	DATE	LABOR CATEGORY	MAN WEEKS	LABOR COST $	MAN-REM
		HEALTH PHYSICS, QA	50.69	16709	NOTE 1
		DISMANTLING (NOTE 2)	34.69	11816	
*		DRAWINGS, DEVELOPMENT AND PREPARATION	9.65	1664	
*		ENGINEERING, PLANNING ADMINISTRATION	134.76	53627	
		TOTAL	229.19	83616	

.1. MAN-REM INFORMATION IS NOT AVAILABLE BY LABOR CATEGORY
.2. DISMANTLING FIGURES INCLUDE FUEL REMOVAL AND SHIPMENT, AND CONTRACTED
* DISMANTLING

.R-3-DECON U.N.C. DECOMMISSIONING DATA SYSTEM - ALARA REPORT 192E3010

#					MAN-		DOS.	
#ACTIVITY.SYS/COMP.				ALARA.	REM	INITIAL.	FINAL	RED.	
#SPEC NO	NUMBER	DATE	ALARA COST ITEM	COST $.SAVED.	MR/HR	MR/HR	FCT.	ALARA EFFORT DESCRIPTION

. THE FOLLOWING ITEMS CONCERNING APPLICATION OF THE ALARA PRINCIPAL WERE TAKEN
. FROM DECOMMISSIONING REPORT 67, IDENTIFIED IN THE GENERAL INFORMATION REPORT
. UNDER 'REFERENCES'.
.
. 1. DECOMMISSIONING INSTRUCTIONS
. A TOTAL OF FIVE DISTINCT DECOMMISSIONING INSTRUCTIONS WERE CONSTRUCTED
. TO PROVIDE THE NECESSARY GUIDANCE AND REQUIREMENTS TO ALL EMPLOYEES.
. THE FOLLOWING THREE INSTRUCTIONS WERE SPECIFICALLY APPLIED TOWARD THE
. ALARA COMMITMENT.

. A. INSTRUCTION 2
. 'ENTERING, OCCUPYING AND EXITING THE R-3 BAY DURING DECOMMISSIONING
. OF THE R-3 REACTOR'.
. THE PURPOSE OF THESE SPECIAL INSTRUCTIONS IS TO MAINTAIN THE TOTAL
. EXCESS RADIATION DOSES (I.E. ABOVE BACKGROUND) RECEIVED DURING THE
. DECOMMISSIONING OF THE R-3 REACTOR AS LOW AS REASONABLY ACHIEVABLE.
. IMPLEMENTATION OF THESE INSTRUCTIONS WILL LIMIT THE ENTRANCE OF DECOMMISS-
. IONING PERSONNEL INTO THE R-3 BAY TO ONLY: THOSE PRESONS DIRECTLY INVOLVED
. IN REMOVAL OF REACTOR COMPONENTS AND MATERIALS AND SPECIAL VISITORS WHO
. NEED TO MAKE AN INSPECTION OF THE FACILITIES (E.G. NRC INSPECTORS OR OUT-
. SIDE CONTRACTORS ENGAGED IN OR PROPOSING TO BE ENGAGED IN THE DECOMMISSION-
. ING).

. B. INSTRUCTION 4
. 'PACKAGING OF WASTE'.
. THE CAREFUL SEPARATION AND PACKAGING OF RADIOACTIVE WASTE REMOVED FROM
. THE R-3 BAY IS NECESSARY FOR THE ULTIMATE HEALTH AND SAFETY OF DECOMMISS-
. IONING WORKERS AND THE PUBLIC. IN ADDITION, DOCUMENTATION IS REQUIRED TO
. ASSURE THAT THE ABOVE ACTIONS ARE CARRIED OUT PROPERLY AND IN ACCORDANCE
. WITH ALL PERTINENT REGULATIONS.
. THE PURPOSE OF THIS PROCEDURE IS TO PROVIDE THE GENERAL REQUIREMENTS
. AND GUIDANCE NECESSARY TO DETERMINE THE STATUS OF POTENTIALLY RADIOACTIVE
. MATERIAL AND TO PACKAGE AND DISPOSE OF SUCH WASTE.

. C. INSTRUCTION 5
. 'REMOVAL OF NON-CONTAMINATED MATERIAL FROM THE R-3 BAY'.
. THE PROCEDURES INCLUDED IN THIS INSTRUCTION ENSURE THAT SEGREGATION
. OF RADIOACTIVE FROM NON-RADIOACTIVE MATERIAL IS COMPLETE. THE INSTRUC-
. TION CONSISTS OF STEP-BY-STEP PROCEDURES TO BE FOLLOWED IN THE REMOVAL
. AND DISPOSAL OF NON-RADIOACTIVE MATERIAL AFTER ITS SEGREGATION IS COM-
. PLETED.
.
. 2. ALARA INDOCTRINATION PROGRAM
. ALL CONTRACTOR AND NCSU DECOMMISSIONING WORKERS WERE REQUIRED TO PARTIC-
. IPATE IN AN INDOCTRINATION PROGRAM CONCERNED WITH THE ALARA CONCEPT AND
. RADIOLOGICAL SAFETY. THE PROGRAM INCLUDED LECTURE AND VIDEOTAPE PRESEN-
. TATIONS, AND SUCCESSFUL PASSAGE OF A WRITTEN TEST BASED ON THOSE PRESEN-
. TATIONS.

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.R-3-DECON U.N.C. DECOMMISSIONING DATA SYSTEM - SHIPMENT REPORT 194C3024

SHIP DATE	SHIP NUM	TRIP LEN MILES	MR/HR CONTCT	MR/HR 6 FEET	MR/HR CAB	RADIONUCLIDE NAME	ACTIVITY CURIES	WASTE SPEC NO	WASTE DESCRPTION	TY. P.	PHYS FORM	CHEMICAL FORM	DOT SHIP CLASS	<-- WASTE --> CUBIC FEET	POUNDS
811215	1	2761	20	0	0	EU 152	0.0725		GRAPHITE BLOCKS	A	SOLID	DNA	LSA	187.5	13706
						FE 55	9.7E-5		CARB. STEEL RODS	A	ALL		LSA	GROSS	NET
						NI 63	0.674		CONTROL RODS	A			LSA		
						CD 114	0.014			A			LSA		
						CD 109	0.007			A			LSA		
820720	2	2761	2.5	0.25	0.1	CO 60	2.71E-3		REAC. TANK	A	SOLID	DNA	LSA	94.5	5032
						CA 133	1.92E-3		STEEL BAR	A	ALL		LSA	GROSS	NET
						FE 5.5	1.0E-4		CONCRETE	A			LSA		
						EU 152	5.9E-3			A			LSA		
830216	3	2761	20	0	0.07	CO 60	0.06459		CONCRETE	C	SOLID	DNA	LSA	495	37355
						BA 133	0.02915		REBAR	C	ALL		LSA	GROSS	NET
						EU 152	0.9848		MISC.	C			LSA		
830309	4	2761	5	0.3	0.02	CO 60	0.0712		CONCRETE	C	SOLID	DNA	LSA	240	17529
						BA 133	0.0121		REBAR	C	ALL		LSA	GROSS	NET
						EU 152	0.3908		MISC.	C					

****

RADIOACTIVE QUANTITIES SHIPPED, % OF TOTAL

MATERIAL	WEIGHT	VOLUME	RADIOACTIVITY
CONCRETE	70.7	66.3	64.4
GRAPHITE	22.4	22.5	1.2
CARBON STEEL	3.9	0.6	3.8
ALUMINUM	1.4	2.7	0.1
STAINLESS STEEL	0.06	0.1	29.6
CADMIUM CONTROL RODS	0.02	0.1	0.9
MISCELLANEOUS	1.6	7.7	0.02

NOTE- TOTALS DO NOT ADD UP TO 100% AT ALL TIMES, DUE TO 'ROUNDING OFF'.

****

NON-RADIOACTIVE SHIPMENT DATA

MATERIAL	WEIGHT %
CONCRETE	92.8
STEEL PLATE	2.8
STEEL RE-BAR	1.0
MISCELLANEOUS	3.4

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# SHIP DATE	#SHIP NUM	DISP SITE	BURIAL CHARGES $ BASIC	CURIE	SP/HND	OTHER	TOTAL	SHIPPING COMPANY	TRANSPORTATION CHARGES $ BASIC	PERMIT	OTHER	TOTAL	CONTAINER TYPE	NO CONT	CONT COST	CONT RENT
811215	1	RICH	1902.7				1902.7	TRI-STATE	1202.9		65.61	1268.5	17H DRUMS	25	476.3	N/A
820720	2	RICH	1163.5				1163.5	TRI-STATE	1585.2		30.62	1615.8	17H DRUMS	9	171.5	N/A
													BOX, WOOD	1	408.8	N/A
830216	3	RICH	5643.0				5643.0	TRI-STATE	7408.5		148.5	7557.0	17H DRUMS	66	1078	N/A
830309	4	RICH	2736.0				2736.0	TRI-STATE	4392.0		544.96	4937.0	17H DRUMS	32	533.6	N/A

.1)A TOTAL OF COSTS FOR WASTE SHIPMENT AND CONTAINER PROCUREMENT IN THIS REPORT
*DO NOT EQUAL THE TOTALS IN THE GENERAL INFORMATION REPORT WHICH WAS TAKEN FROM
*NCSU RECORDS. PRESUMABLY OTHER CHARGES NOT REFLECTED IN THIS REPORT
*CONTRIBUTE TO WASTE SHIPMENT AND CONTAINER PROCUREMENT COSTS.

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.R-3-DECOM U.N.C. DECOMMISSIONING DATA - SURVEILLANCE REPORT 194E3030

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#          .S.          .          .<------ ANNUAL ------>.
#    . DECOM ./.EXPENDITUR.     . MAN- .MAN-  .  COST .                                                                    .
#YEAR. MODE  .M.   ITEM   .FREQ. REM  .HOURS .    $   .    EXPENDITURE ITEM DESCRIPTION                                    .
$****.*******.*.**********.****.******.*******.********.*************************************************************.
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.NOTE - INFORMATION WHICH WOULD LOGICALLY BE INCLUDED IN THIS REPORT WAS NOT
#SEPARATELY DOCUMENTED. A MINIMAL QUARTERLY AIR SAMPLING PROGRAM WAS CARRIED
#ON AFTER FINAL SHUTDOWN AND ASSOCIATED COSTS AND PERSONNEL EXPOSURE WERE
#INCLUDED IN ONGOING PROGRAMS ASSOCIATED WITH THE NUCLEAR ENGINEERING LABORATORY

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PAGE NO.    1
.R-3-DECON        UNC DECOMMISSIONING STUDY - PUBLIC DOSE REPORT          F3012
*
*
*-----------------------------------------------------------------------------------------------------------------------------------------------.

.BECAUSE OF THE VERY LOW LEVELS OF RADIATION EXPERIENCED THROUGHOUT THIS
.DECOMMISSIONING PROJECT, PUBLIC DOSE LEVEL IS ASSUMED TO BE ZERO.
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16. ABSTRACT (200 words or less)

This document summarizes information from the decommissioning of the NCSUR-3 (R-3), a 10 KWt university research and training reactor. The decommissioning data were placed in a computerized information retrieval/manipulation system which permits future utilization of this information in pre-decommissioning activities with other university reactors of similar design. The information is presented both in some detail in its computer output form and also as a manually assembled summarization which highlights the more significant aspects of the decommissioning project. Generic decommissioning data extracted from NUREG/CR 1756, "Technology, Safety and Costs of Decommissioning Nuclear Research and Test Reactors," and data from the decommissioning of the Ames Laboratory Research Reactor (ALRR), a 5 MWt research reactor, is also included for comparison.

17. KEY WORDS AND DOCUMENT ANALYSIS

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Cost, Comparison Studies

17b. IDENTIFIERS/OPEN-ENDED TERMS

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