DISMANTLING PLAN FOR THE R-3, 10 KW REACTOR

NRC License No. R-63
Docket 50-111

Nuclear Reactor Program
Department of Nuclear Engineering
North Carolina State University at Raleigh
Raleigh, North Carolina 27650

Date: 15 March 1980

FOREWORD

In July, 1976, a "Dismantling Plan, North Carolina State University, 10 Kilowatt Research Reactor" was prepared, reviewed by the NCSU Radiation Protection Council, and submitted to the Nuclear Regulatory Commission. This Plan was prepared to accommodate a specified objective.

Having a totally different objective to achieve, the following "Dismantling Plan for the R-3, 10 KW Reactor" has been prepared. The above cited plan was reviewed and pertinent parts incorporated. New thoughts and ideas have been included to the point there is little, if any, similiarity between these plans, and the July, 1976, submittal should be disregarded.

The reactor to be dismantled and decontaminated is the 10 KW research reactor at North Carolina State University known as the "R-3" - the third reactor on campus. The license for this reactor is NRC R-63.

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REVISIONS

Number	Description	Date

DISMANTLING PLAN
FOR THE R-3, 10 KW REACTOR

INTRODUCTION

The objective of this document is to provide a plan for the disassembly of the North Carolina State University (NCSU) 10 kilowatt research reactor and for the ultimate disposal of unusable components, both contaminated and non-contaminated. The successful dismantling and decommissioning of this reactor will be a prelude to a request for the termination of the NRC Reactor License R-63.

APPLICABLE CRITERIA

NCSU shall use as criteria for determining the success of this dismantling-decommission effort the following documents:

- NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors."
- NCSU Handbook for Protection Against Ionizing Radiation, Fifth Edition, 1978.

At the Conference on Decontamination and Decommissioning of Nuclear Facilities, September 16-19, 1979, Sun Valley, Idaho, it was apparent that other than the above documents there was very little acceptable experience data available on which to base criteria for the release of a research reactor site to unrestricted use. However, it will be the policy of the University to reduce the radiological hazard associated with the R-3 reactor site to as low as reasonably achieveable (ALARA). Toward this objective, all information received, official or private, will be evaluated and, if applicable, used. An individual in the NRC, Directorate for Operating Reactor Projects, has suggested that the residual radiation from any surface needs to be less than .05 mRem/hr before the item can be released for unrestricted use. This suggestion is consistent with 10CFR 20.105.

Therefore, the resulting radiation level from any surface in the R-3 reactor site shall be less than 0.05 mRem/hr., or less than the requirements of the above referenced documents, whichever results in the least hazard to the general public.

DESCRIPTION HISTORY OF THE NCSUR-3 REACTOR

The NCSUR-3 Reactor is a 10 kilowatt graphite reflected tank-type reactor using 18 plate MTR-type fuel elements. The core lattice is a 5 x 5 array of fuel (21) and graphite (4) elements. Figure 1 provides a drawing of the reactor facility. Figure 2 shows the relationship of the R-3 reactor to the Burlington Engineering Laboratories' complex. Figure 3 shows the R-3 reactor and the adjacent offices and laboratories in the original building which was known as the "Burlington Nuclear Laboratory." Figure 4 shows the Reactor Coolant System. Attachment 1 provides a listing of Reactor Components, by suggested "tasks".

The NCSUR-3 Reactor was operated from 1960 to 1973, at which time the NRC Operating License was terminated and a license to "possess but not operate" was issued. In 1973, the reactor core was unloaded, the fuel placed in storage racks within the reactor tank, the control rods removed to storage, and the electrical controls were disconnected to prevent further operation. In February, 1974, the fuel was removed from water storage, examined, and placed in dry storage. The reactor system was drained completely at this time. The beam ports and thermal column were closed and each locked by its own three combination safe-type lock. The top of the reactor tank was covered by a two inch thick steel plate. The electrical circuit breaker box containing the breaker for the overhead crane was locked. Thus, the amendment to our R-63 license "to possess but not operate" had been fulfilled.

A total of 52.5 megawatt hours of operations were performed over the

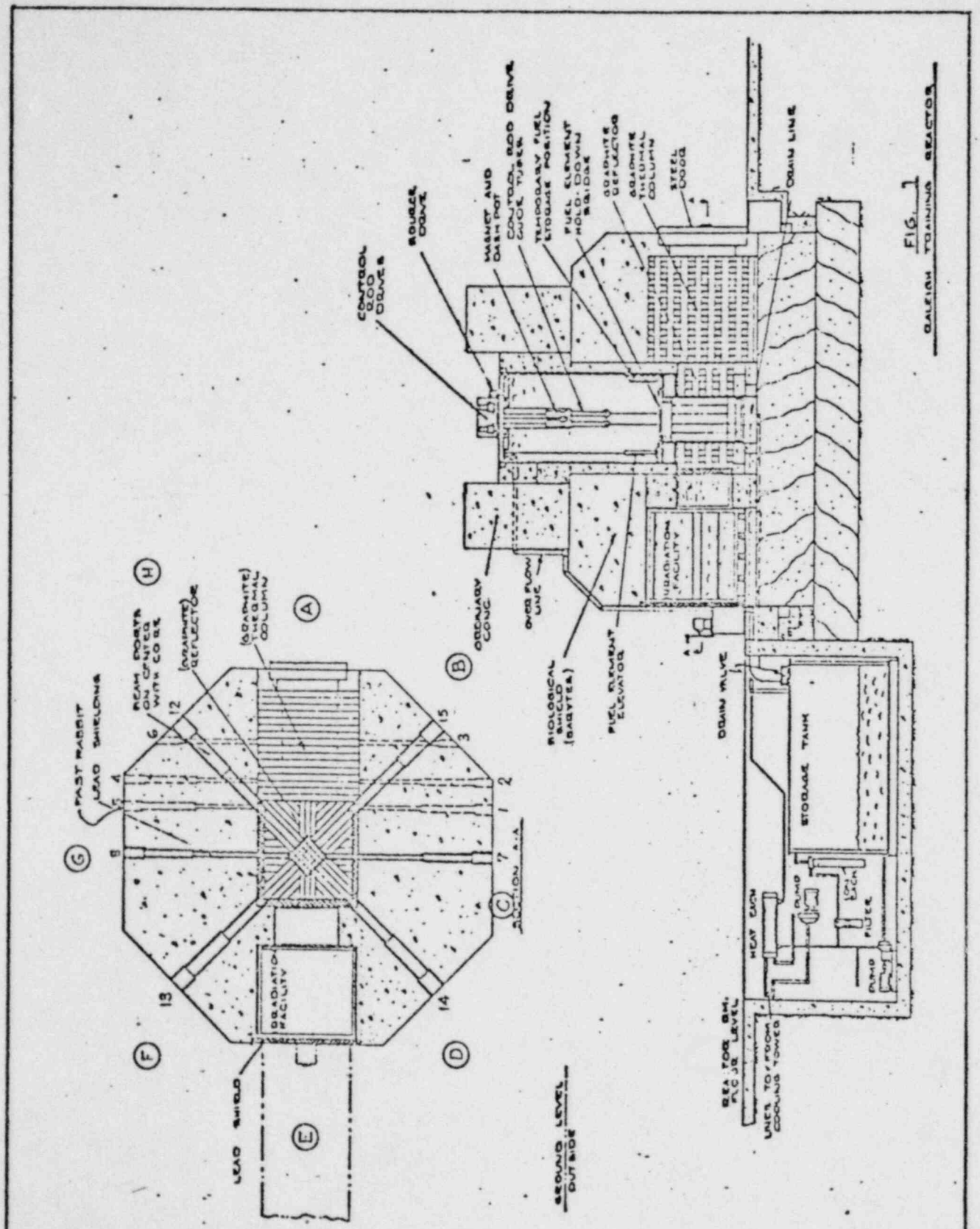
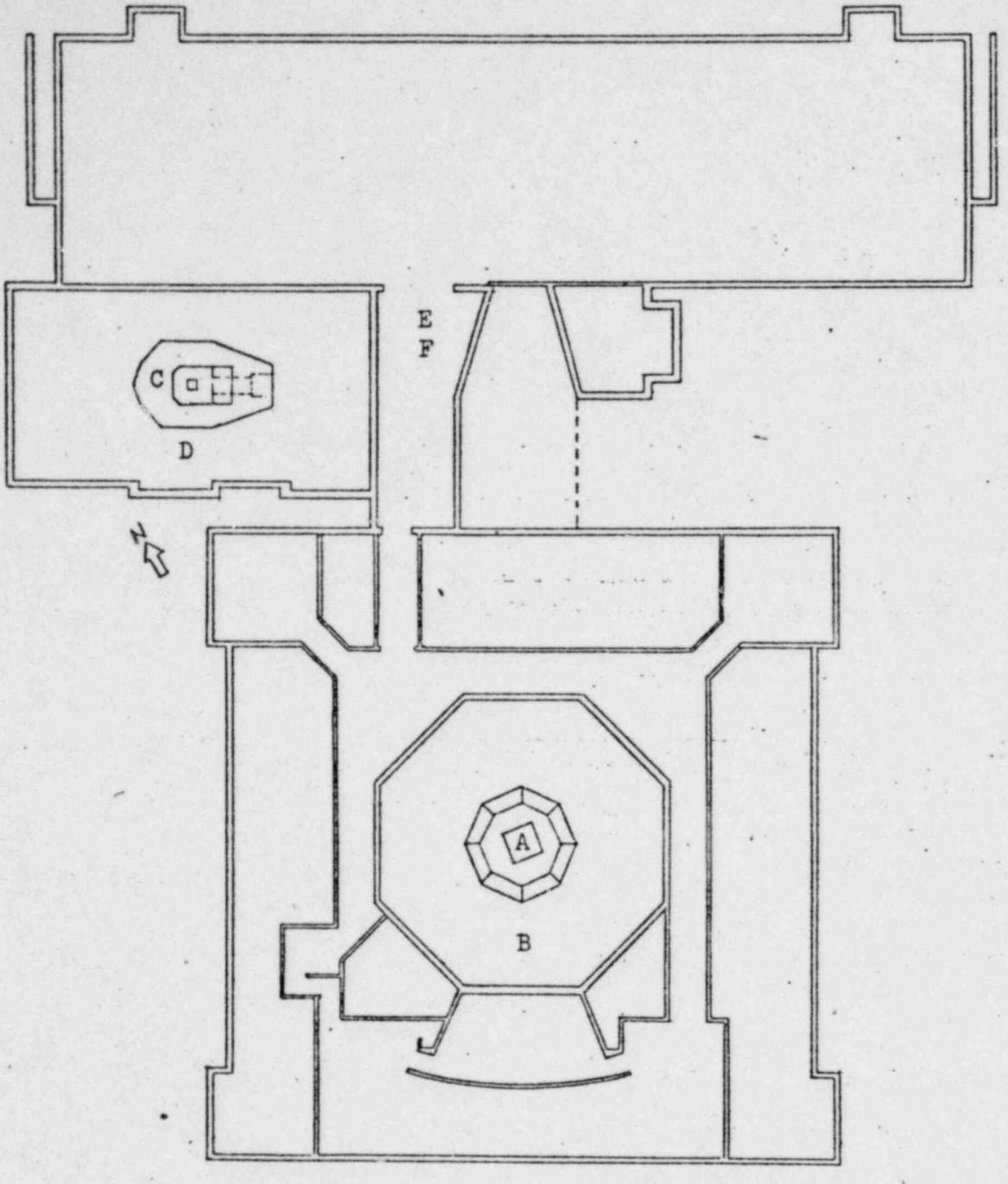


FIGURE 1 - Raleigh Training Reactor



License R-63

A - NCSU R-3 Reactor

B - R-3 Bay

License R-120

C - NCSU PULSTAR Reactor

D - PULSTAR Bay

E - PULSTAR Control Room, 2nd Floor

F - PULSTAR Mechanical Equipment Room, Bay Floor Level

C, D, E, F - PULSTAR Reactor Bldg.

FIGURE 2 - BEL Complex

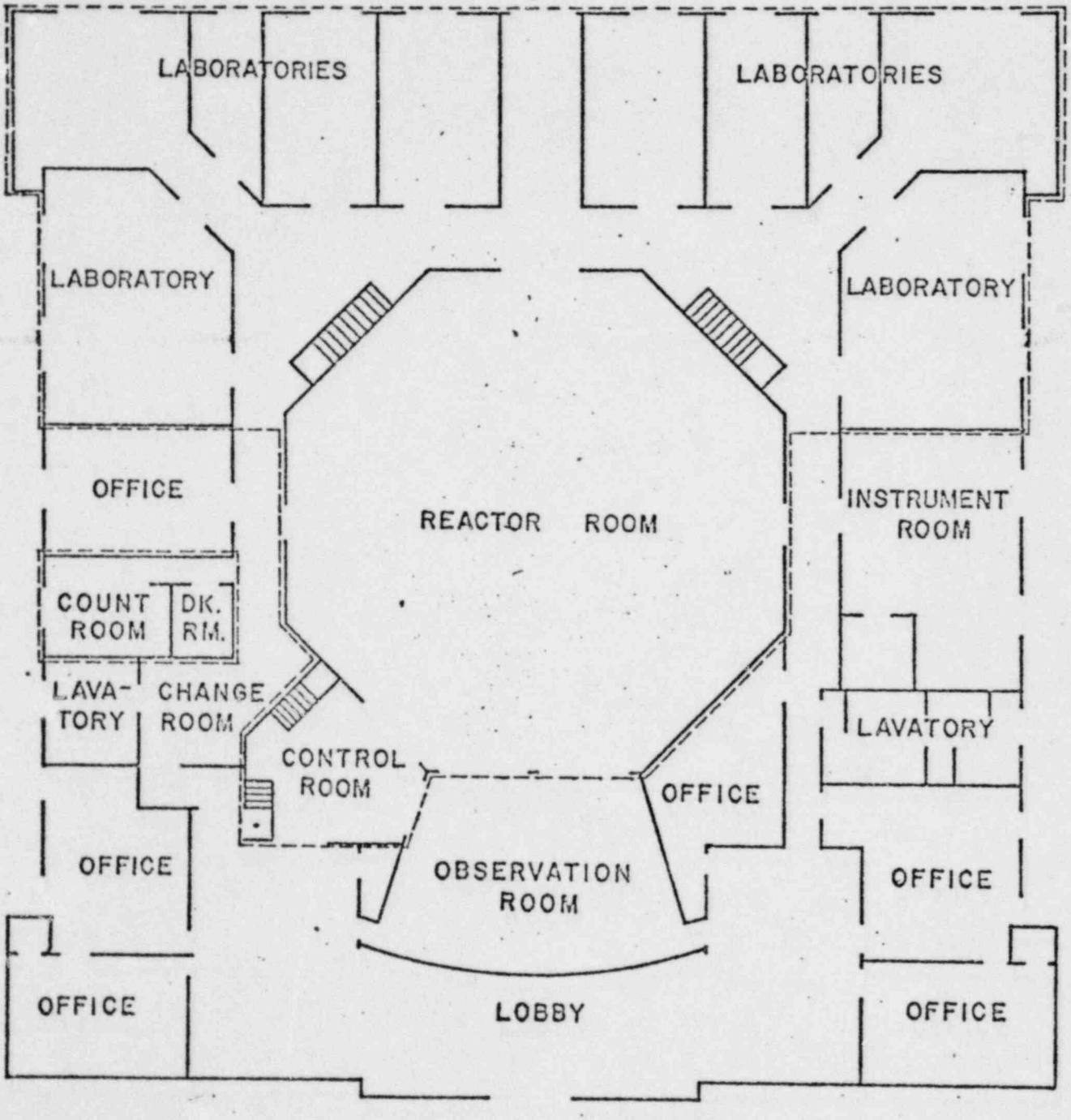


FIGURE 3

REACTOR BUILDING LAYOUT
MAIN FLOOR

SCHEMATIC DIAGRAM OF REACTOR COOLANT SYSTEM

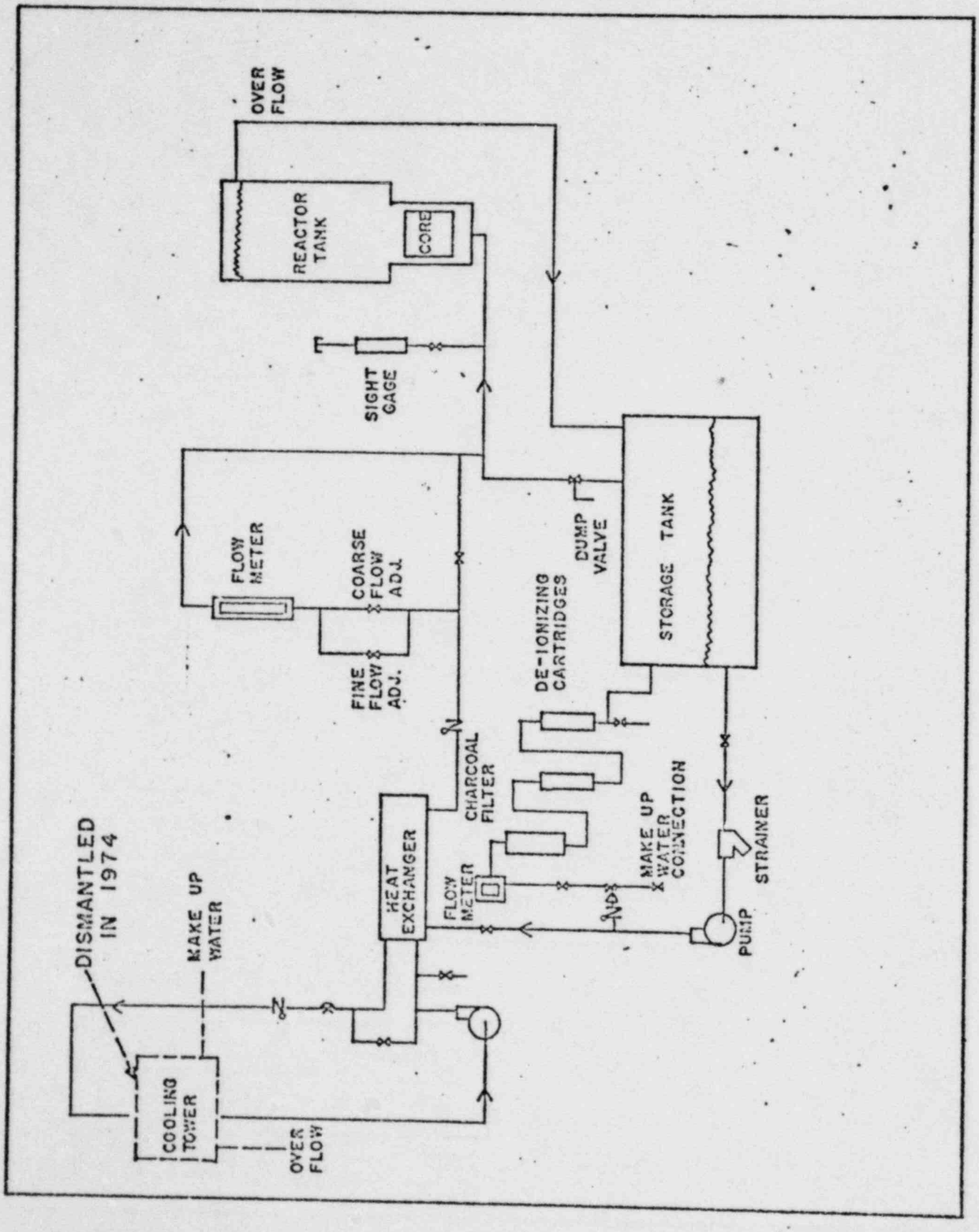


FIGURE - 4

operating period of the reactor. Table 1 and Figure 5 provide data on the year-by-year operating history. The NCSUR-3 Reactor operations were terminated after the completion of the new 1 megawatt PULSTAR research reactor in 1972. This new facility provided all reactor services required at NCSU, and it was not economically feasible to continue operation of the R-3 reactor.

CURRENT SITE STATUS

The NCSUR-3 facility is being maintained in a shutdown status with those radiation detection systems (area and radiation monitors) specified in Amendment No. 6 to the R-63 license kept in an operational status. A license modification to remove these detection systems and periodic surveillance from the license has been requested. However, the status quo shall be maintained until formal relief is received.

The R-3 irradiated fuel assemblies have been shipped to SROO, Aiken, S. C., and the unused (4) fuel assemblies have been moved to the PULSTAR Bay for dry storage. The reactor electrical controls are disconnected. The reactor coolant systems are dry, having been drained in February, 1974.

Daily (working day) high volume air sampling and weekly contamination surveys have been conducted since February, 1973. Neither of these actions have evidenced any radioactivity in the R-3 Bay. A Victoreen Area Monitor Portable, set to alarm at 1 mR/hr., has been on the R-3 shield or over the Gamma Facility for over seven years. This instrument continuously reads in order of 0.1 mR/hr. or less.

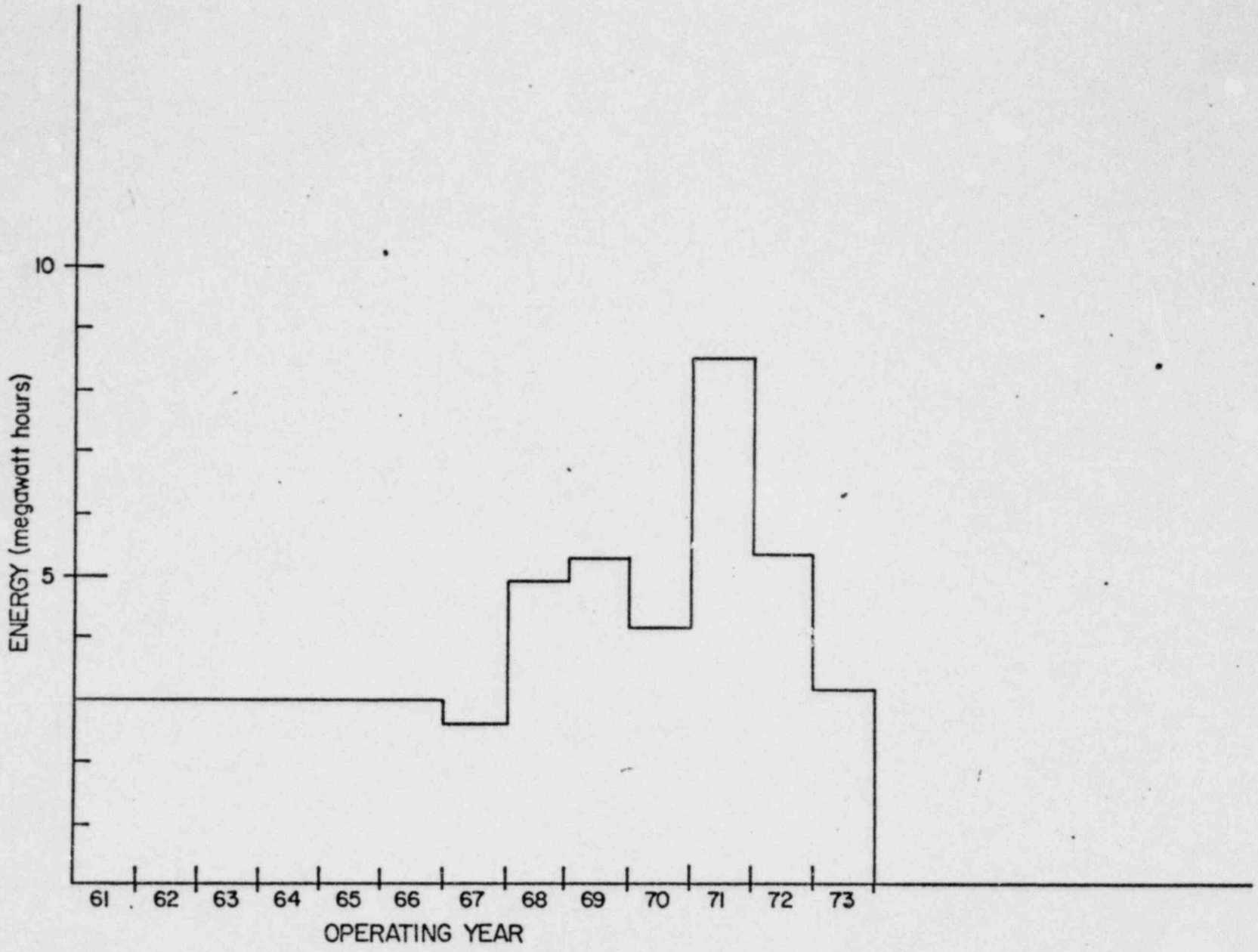
On the basis of the preceding paragraph, there is a good indication that any radiation, contamination or airborne hazard in the R-3 Bay has been and is very low.

In June, 1978, the radiation level in the nose grid of the R-3 core was measured by TLD chips, pocket dosimeters and a 2.5 R chamber of a Condenser R-meter. The location of each and the results of a two-hour exposure are given

TABLE 1 - OPERATING HISTORY

N. C. STATE 10 KILOWATT REACTOR

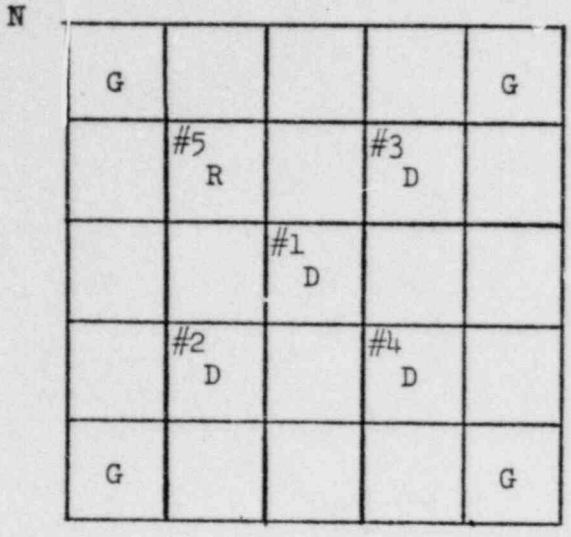
PERIOD	ENERGY (Megawatt Hours)
1960-1965	18.1
1966	2.65
1967	5.0
1968	5.4
1969	4.2
1970	8.6
1971	5.3
1972	3.2
Total	52.54



NCSUR·3 OPERATING HISTORY

FIGURE·5

below:



G - Graphite Stringers

R - 2.5R Chamber

D - Pocket Dosimeters

1, 2, etc. - Pairs of TLD Chips

	mrem		
Position	TLD	Pocket Dosimeter	2.5R Chamber
N	100	-	101
E	106	109	-
S	122	108	-
W	99.5	100	-
Center	83	79	

Exposure Time - 2 Hours

In June, 1976, a radiation measurement and swipes were taken in several beam ports. For the radiation measurement, a thin wall GM was attached to a board that was inserted into tl. beam ports to a point close to the core reflector. In a similar manner, the swipes were taken. The largest dose rate found was 20 mR/hr and the swipe results were less than 120 dpm.

The R-3 reactor had been operated for a total of 52.54 megawatt-hour

over its life span (see Figure 5 and Table 1).

The components of the R-3 reactor in which the greatest amount of activation products are expected to be found are: Core Grid, bottom section of the reactor tank, and in the concrete under the reactor core. These components, each, may contain up to 100 mCi of activation products. This estimate is consistent with that experienced in the dismantling of the UTRI 75 Kw Research Reactor and the 50 Kw Walter Reed Research Reactor. (Note: The fuel has been returned to DOE.)

The activation products in the Core Grid and the reactor tank will be removed from the biological shield and will be a factor in their disposal. The amount of activity in the concrete under the core will be determined prior to any decontamination of the biological shield.

DISMANTLING OPERATION

The dismantling operation as described in this plan will be supervised by the Nuclear Reactor Program (NRP). The principle concerns will be:

a. Personnel safety, both radiological and industrial.

b. The identification and separation of contaminated and non-contaminated items.

c. The proper disposal of both classes of items (see b. above) and compliance with pertinent regulations.

d. The maintenance of complete records.

e. The conduct of the final survey and preparation of completion report.

f. The complete fulfillment of criteria to merit the release of this facility to unrestricted use.

This dismantling plan will be organized in so far as possible into logical tasks such that work on one given task will not be dependent upon

partial or the completion of another task. The work on each task will be carried to completion - disposal and record keeping - before initiating work on the next task. "Disposal" as used in the previous sentence means: placing the item in the proper shipping package or, if the shipping package is filled, the temporary storage of the package pending actual shipment.

Upon the completion of all the tasks, a final radiological survey shall be made to verify compliance with and fulfillment of the criteria established for the release of this facility to unrestricted use. A final report on the effort and the results of this survey will be prepared to accompany our request to terminated the R-63 license.

SAFETY ASPECTS OF THE DISMANTLING OPERATION

Each task will be reviewed prior to initiating work to identify points of possible hazard either radiological or industrial. This information will be given to the workers so they may be alert to cope with and minimize the hazard.

Before the initiation of work on the next task, a radiological survey, both radiation and contamination, will be made. The results will be given to the workmen and to the supervisor so that proper procedures and cautions may be exercised. This type survey may be conducted on a daily basis or more frequently if necessary.

Although the R-3 reactor has been shut down for seven years, and has been dry for six years, the NRP will be prepared to monitor the air in the working areas as well as have radiation detectors available. A hazardous radiation level or an airborne contaminant is not expected; however, every precaution will be taken until it is proven the work can be safely undertaken.

The R-3 bay floor will be arranged to provide separate areas for receipt and examination of articles removed from the facility; e.g. a contaminated area; holding areas prior to disposal; a working area, and a place of

transition between the contaminatea area and the "clean" area. Standard health physics safety procedures will be observed during the entire operation.

Contaminated solid wastes will be packaged in appropriate containers prescribed by NRC and DOT regulations. Records will be established and maintained throughout this operation. These records will include waste shipments to insure compliance with appropriate regulations.

During dismantling, the R-3 bay will be "off-limits" to all personnel not directly involved with this work. The only exception will be those individuals using the gamma facility which is in the R-3 bay. These personnel will oe admitted only for the duration of their work at the gamma facility. If necessary, the dismantling work will be temporarily interrupted while the gamma facility is being used.

The disposal of non-contaminated solid waste will be handled locally. The early removal of non-contaminated items from the R-3 bay will facilitate operations as it is expected that the available space will be needed to hold contaminated items prior to shipment to a burial site.

DESCRIPTION OF THE FACILITY AFTER DISMANTLING

After successful completion of the dismantling operation, the R-3 bay will be "clean" - free of any radiological contamimation. The R-3 reactor biological shield, from the outside, will appear unchanged. If it is proven that the shield on the inside is contaminated, this surface would show the marks of decontamimation action. The beam tubes will be locked with their three combination safe lock as has been their status since 1973.

Briefly, all surfaces of the biological shield will comply with the criteria that was intially established as necessary for its release to unrestricted use status.

The Nuclear Engineering Department is considering several options for the use of this bay area after its release. Among these are:

1) Dividing the area into laboratories. The gamma facility would be isolated and retained as a "Restricted Area."

2) Partial removal of the upper part of the biological shield to permit the installation of a second floor. This would extend the utilization of the bay. The gamma facility will be isolated. The biological shield would be used to support the second floor.

3) The biological shield could be renovated to use as a "dry irradiation facility."

4) The thick steel plate could be placed on top of the shield and the entire structure, remain standing in the "released conditon."

A firm plan has not as yet evolved. However, the ultimate use of the area will include adequate provisions for the gamma facility.

NCSU RADIOLOGICAL PROTECTION OFFICE (RPO)

The Nuclear Engineering Department, by virtue of the PULSTAR reactor, has a Reactor Health Physics Section which is responsible for the day-to-day radiological safety program related to reactor operations and utilization. The NCSU Radiological Protection Office has campus-wide responsibilities for all utilization of radioactive materials and radiation producing devices and the safety programs related thereto.

The Department RHP will supervise the day-to-day dismantling work and will conduct the various radiation surveys as required. The RHP shall supervise the final survey on which our request to terminate our license will be based.

The NCSU-RPO will over see this operation, conduct "spot" radiological surveys as they deem necessary. They will provide the guidance and supervision of the packaging, labeling and shipping of contaminated articles; a

function they perform for the entire campus.

In short, this dismantling operation will have close supervision on a day-to-day bases by the Reactor Health Physics Section in the Nuclear Engineering Department and NCSU Radiological Protection Office will monitor this operation and confirm the radiological condition of the facility by spot checks.

DISMANTLING PLAN

Attachment 1

This attachment identifies the tasks associated with the dismantling of the R-3 reactor and the decontamination of the R-3 bay and reactor biological shield. Each task lists the major items of equipment to be removed or, in the case of Task VII - R-3 Bay, lists the places of particular interest for contamination survey and subsequent decontamination.

TASK I - Control Room

1. Cut and remove cables from the biological shield top back to the Control Room to isolate the Control Room.
2. Equipment to be removed:

   2 Linear Power Channels
   High Voltage Power Supplies
   Amplifiers
   Difference Amplifier
   Recorders
   Meters
   Scram Circuits
   Alarm Circuits
   Log Power Channel
   Log Amplifier
   Period Circuit
   Period Recorder
   Log N Period Meter
   Log N Power Meter
   Log Gamma Channel
   Preamplifier
   CRM
   Automatic Control and Override System
   Annunciator Panel
   - Alarm Relay System
   - Warning Lights Relay System

TASK I - Control Room (continued)

Console
Area Monitor
Windjammer Panel, Meters, and Power Supply

TASK II - Pipe Pit

The equipment below floor level under the Bulk Irradiation Tank. (Figure 6, Figure 1, page 3.)

Equipment to be removed:

Storage Tank
Ion Exchange
Pumps
Heat Exchanger
Pipes
Valves
Electrical Lines

NOTE:

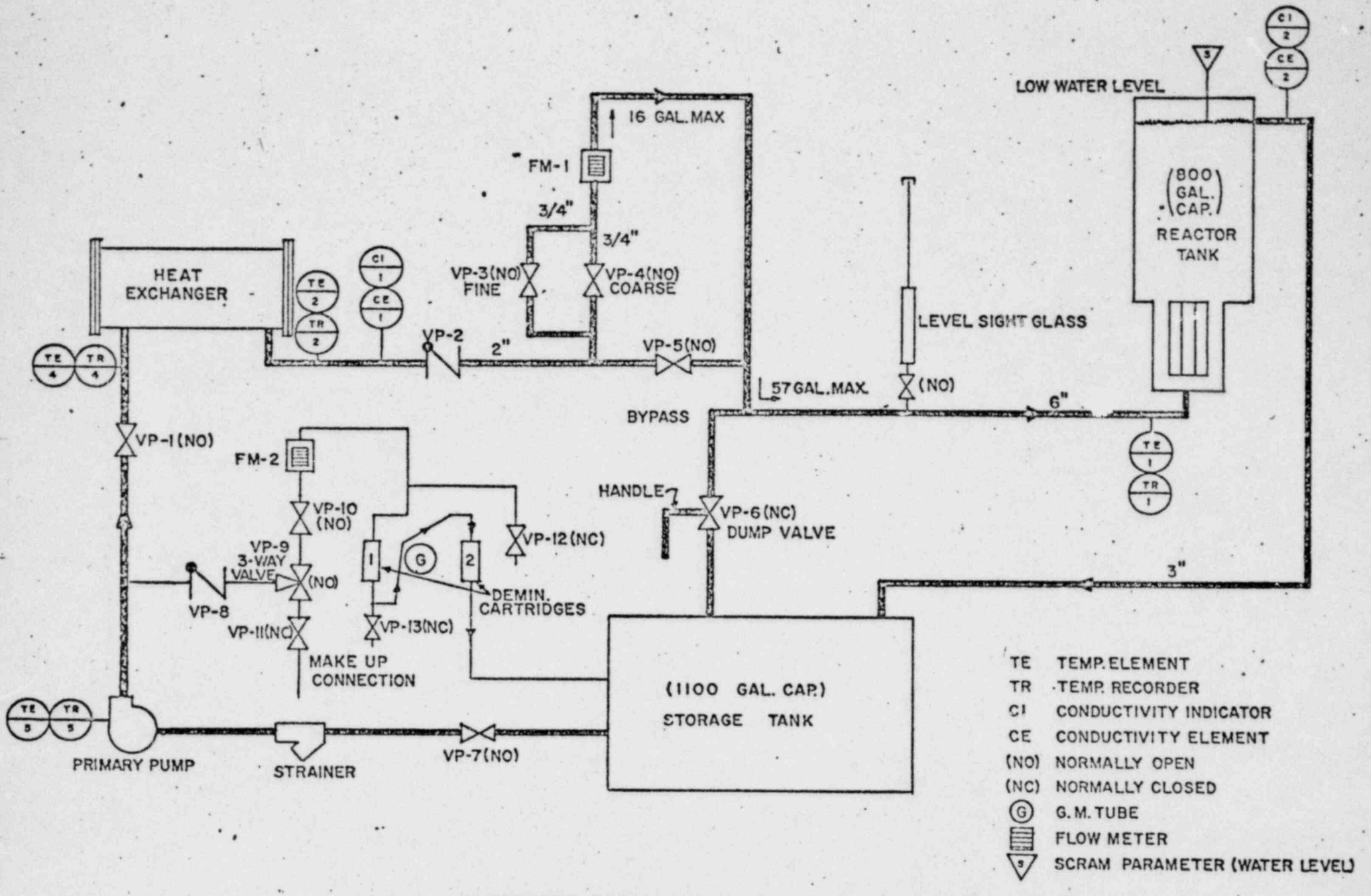
There are two pipes to this storage tank from outside this pit. One pipe is the drain line from the pool tank; and the other, the pool tank over-flow. Although these lines are included in "External Piping to Shield", it may be necessary, in fact, to remove these pipes with Task II.

TASK III - External Piping to Shield

See Note, Task II.

Equipment to be removed:

Drain Line from Pool Tank
Over-flow Line from Pool Tank
Level Site Glass
Bulk Irradiation Facility
Pipe



PRIMARY COOLING SYSTEM

FIGURE 6

TASK IV - Remove Pool Tank

Equipment to be removed:

Control Rod Drive Motors on Top of Pool Tank
Fuel Element Elevator
Graphite "Elements" in Grid Corners
Pool Tank

TASK V - Graphite and Lead Bricks

Equipment to be removed:

4 Instrumentation Cans and Associated Cabling
Graphite - Thermal Column and Reflector
Bricks - Pb around Reflector

TASK VI - Decontaminated Biological Shield

The inside of the biological shield and the beam ports must be surveyed to determine the extent of activation. This survey will determine the extent of the decontamination and the depth of concrete to be removed from the shield and the inside ends of the beam ports.

TASK VII - R-3 Bay

The following areas are to be surveyed and, if necessary, decontaminated:

Trenches
Beam Catchers in the Bay Walls
Storage Tubes in the Bay Walls
Remove the Bay Wall Power Level Indicator
Remove Two Bay Area Monitors
Change Filter in Filter Room

TASK VIII - Final Radiation Survey

The process of decontamination and survey will be continued until all surfaces are acceptable for release to unrestricted usage.