ENVIRONMENTAL REPORT

PULSTAR NUCLEAR REACTOR
Docket #50-297
North Carolina State University

1. INTRODUCTION

The PULSTAR Reactor located on the North Carolina State University Campus at Raleigh, North Carolina is a 1 MW pool type research reactor. It is used to support undergraduate and graduate education at North Carolina State University (NCSU), various graduate research endeavors, and specialized nuclear services to the industrial community. Typical reactor activities include: experiments associated with nuclear engineering education, basic research, neutron radiography, prompt gamma activation analysis, nuclear power plant operator training, and service irradiations such as neutron activation analysis and isotope production.

The PULSTAR Reactor generally operates 5 days per week with an annual average of approximately 1200 full power hours per year. Reactor staffing is generally limited to one shift with the exception of utility operator training programs where back-shift operations occur. The utility training programs however are generally low power physics measurements and reactor startups, and thus do not significantly influence the full power operation hours. Figure 1 depicts the reactor operation history during the first 15 years of operation covering the period 1973 through 1988.

The PULSTAR Reactor is housed in Burlington Engineering Laboratories located on the north portion of the North Carolina State University (NCSU) campus. Figure 2 depicts the location of Burlington Engineering Laboratories with respect to the NCSU campus. Figure 3 is the general layout of

August 1, 1988

Burlington Engineering Laboratories depicting the location of the PULSTAR Reactor and its associated external cooling system and ventilation stack. Burlington Engineering Laboratories was constructed in the late sixties and was designed to blend with the existing adjacent NCSU campus structures. As designed, Burlington Engineering Laboratories essentially incorporates no conspicuous features that would identify the building as a nuclear reactor site.

2. FACILITY

The PULSTAR Reactor external support facilities in the Burlington Engineering Laboratory complex include the cooling tower for reactor produced heat dissipation, the 100 foot ventilation stack whereby the reactor bay ventilation is exhausted, and underground power and water utilities.

The reactor cooling tower is a typical air conditioning mechanical draft design and is located inside a brick screen cubicle as depicted in Figure 3. In addition to the PULSTAR cooling tower, this cubicle houses a similar but larger mechanical draft tower used in air conditioning the entire Burlington Engineering Laboratories complex. The brick screening improves the aesthetics for the external placement of both cooling towers. Make-up water for the cooling tower is provided through underground connections to the university's raw water system and thus provides no external features affecting the environment.

The 100 foot ventilation stack has existed at the Burlington Engineering Laboratories complex since the construction of NCSU's first reactor in 1952. When the PULSTAR was constructed, the stack was retro-fitted with an internal concentric ventilation duct that handles the PULSTAR ventilation exhaust. Hence, with the exception of painting, the stack has retained the same visual appearance since the early 1950s. The NCSU campus has several high structures in the immediate vicinity of the reactor stack, including a coal fired boiler exhaust stack (approximately 100 feet tall) and several multistory buildings such as the D.H. Hill Library Bookstack with 11 floors.

Radioactive gaseous effluent from the PULSTAR Reactor is primarily argon-41. Radioactive liquid effluents from the facility are predominantly laboratory waste water and primary coolant pump gland leakage. Both effluents are monitored for radioactivity prior to release; gases by the Stack Monitoring system and liquids by the Waste Tank Monitoring system.

Radioactive solid waste is packaged and shipped in accordance with the pertinent NRC and DOT regulations. Appropriate shipping containers and an approved NRC receiving site are used in accordance with federal regulations. Radioactive solid waste shipments are shown in Figures 7 and 8.

Chemical and sanitary wastes are similar to those present in other laboratory equipped buildings at North Carolina State University.

3. ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND FACILITY CONSTRUCTION

Construction of the Burlington Engineering Laboratory complex which houses the PULSTAR Reactor occurred on the north campus of North Carolina State University in the vicinity of several other large university buildings. Therefore, construction did not produce a significant affect on the terrain, vegetation, wildlife or nearby waters, etc. The societal, economic and aesthetic impact of the Burlington Engineering Laboratories complex is no greater than that of any similar university structure.

4. ENVIRONMENTAL EFFECTS OF FACILITY OPERATION

The thermal plume produced by the cooling tower in support of the PULSTAR Reactor has not produced a noticable effect on the environment. As stated earlier, the PULSTAR cooling tower is sited adjacent to a much larger cooling tower used for Burlington Engineering Laboratories air conditioning. The latter cooling tower releases significantly more waste heat without observable effects on the environment. Excessive drift and/or fog have not occurred with the operation of the PULSTAR cooling tower.

Routine release of radioactive gaseous effluents is primarily argon-41 for the PULSTAR Reactor and is produced by neutron activation of air. In order to minimize the ^{41}Ar production, the pneumatic transfer system (used to shuttle irradiation capsules to the reactor core) is purged with nitrogen when the reactor is expected to operate above 50% power for more than 10 minutes. This administrative procedure related to the nitrogen purge system hardware enables the PULSTAR Facility to keep the ^{41}Ar releases as low as practical. The majority of the remaining ^{41}Ar production continues to occur during the actual use of the pneumatic transfer system, while it is filled with normal air. ^{41}Ar contributions also derives from dissolved air in the pool water and experimental facilities with external neutron beams, however, these contributions are small. Annual releases of radioactive effluents have been and will be at or below established federal limits. Figures 4 and 5 detail the total ^{41}Ar release history that has occurred during the first 14 years of PULSTAR Reactor operation. Figure 4 provides total activity (in curies) and Figure 5 provides the activity (in $\mu Ci/ml$). The data for both graphs were taken from PULSTAR Annual Reports to the Nuclear Regulatory Commission (NRC) and represent the values at the top of the 100 feet ventilation stack.

Radioactive liquid effluents are collected in three underground fiberglass tanks buried outside the Burlington Engineering Laboratories complex. Provisions are available for mixing the tanks prior to sampling and/or transferring the contents from one tank to another. The liquid waste tanks are carefully monitored and release controlled so that pertinent federal regulations are met. These tanks are ultimately released to the sanitary sewer system. Figure 6 depicts the total annual radioactive liquid waste release (in microcuries) during the first 14 years of PULSTAR Reactor operation. Data for Figure 6 were taken from PULSTAR Annual Reports to the NRC.

There are no releases of potentially harmful chemical substances associated with the PULSTAR Reactor operation. However, small amounts of a corrosion inhibiting additive for the cooling tower piping system are released as part of the cooling tower blow-down and evaporative losses. This cooling tower water may also contain dissolved solids which accumulate as a result of the continuing evaporation from the tower.

The use of hazardous chemicals in support of research endeavors is controlled through the North Carolina State University Life Safety organization. Specifically, this organization provides the researcher with a means of disposing hazardous chemicals to avoid using the sanitary sewer system and general guidelines on the handling and hazards associated with various chemicals. With the exception of the trace amounts of cooling tower chemical releases, the PULSTAR Reactor does not generate chemical waste that impacts the environment.

Potential effects from the continued operation of the PULSTAR Reactor on the environment, including esthetics, noise, societal or impact on local flora and fauna are expected to be small.

5. ENVIRONMENTAL EFFECTS OF ACCIDENTS

Accidents ranging from the failure of an experiment to the largest credible core damage with associated fission product release result in doses less than 10 CFR Part 100 guidelines and are considered negligible with respect to the environment.

6. UNAVOIDABLE EFFECTS OF FACILITY CONSTRUCTION AND OPERATION

The unavoidable effects of continued operation of the PULSTAR Reactor involve the materials used in construction that cannot be recovered and the fissionable material used in the reactor. No adverse impact on the environment is expected from either of these unavoidable effects.

7. ALTERNATIVES TO CONSTRUCTION AND OPERATION OF THE FACILITY

There are no suitable alternatives to the capabilities and rewards provided by a nuclear research reactor. The capabilities provided via the reactor facility include the training of nuclear engineering students in reactor operation, production of radioisotopes, and the use of irradiation facilities or neutron beams in support of research.

8. LONG TERM EFFECTS OF FACILITY CONSTRUCTION AND OPERATION

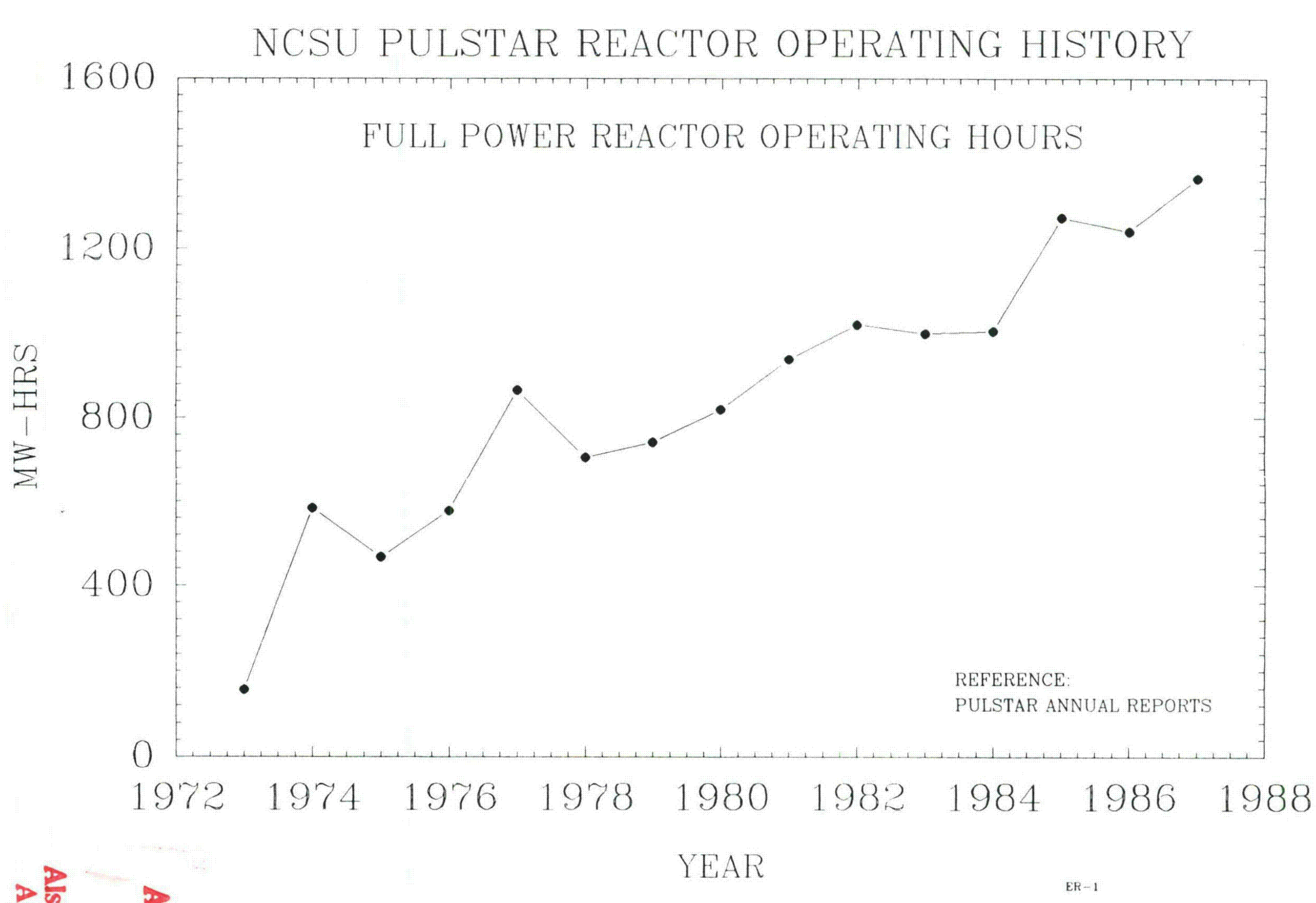
The long-term consequences of the continued operation of the PULSTAR Reactor are considered to be beneficial via the contributions to scientific knowledge and education. Considering the relatively small capital investment associated with the PULSTAR Reactor construction and its resulting small impact on the environment, very little irreversible and irretrievable commitment is associated with the facility.

9. COSTS AND BENEFITS OF FACILITY AND ALTERNATIVES

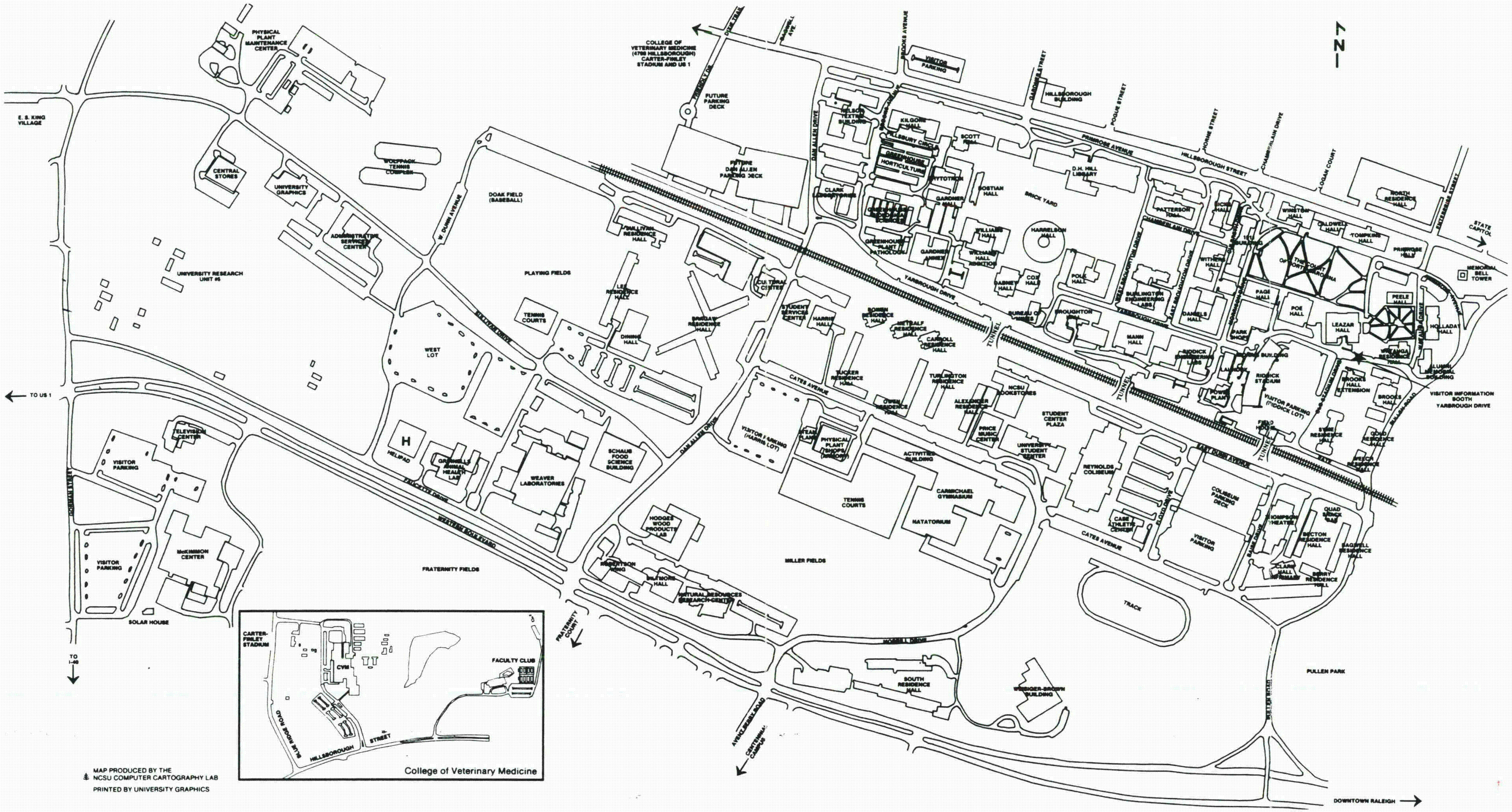
The original cost of the PULSTAR Reactor, excluding the Burlington Laboratory building, was less than one million dollars. The benefits include but are not limited to: neutron activation analysis, prompt gamma activation analysis, neutron radiography, radioisotope production, basic research support, training reactor operating personnel, and student education. There exists no alternative device that can reasonably provide this range of activities.

10. CONCLUSION

There will be no significant environmental impact associated with the re-licensing of the PULSTAR Reactor and hence no additional environmental impact statement over and above this document is required.


NCSU PULSTAR REACTOR OPERATING HISTORY
FULL POWER REACTOR OPERATING HOURS
MW-HRS
1600
1200
800
400
0
1972
1974
1976
1978
1980
1982
1984
1986
1988
YEAR
REFERENCE:
PULSTAR ANNUAL REPORTS
ER-1

ER FIGURE I



NORTH CAROLINA STATE UNIVERSITY CAMPUS MAP

SAR FIGURE 2-1

ER FIGURE 2

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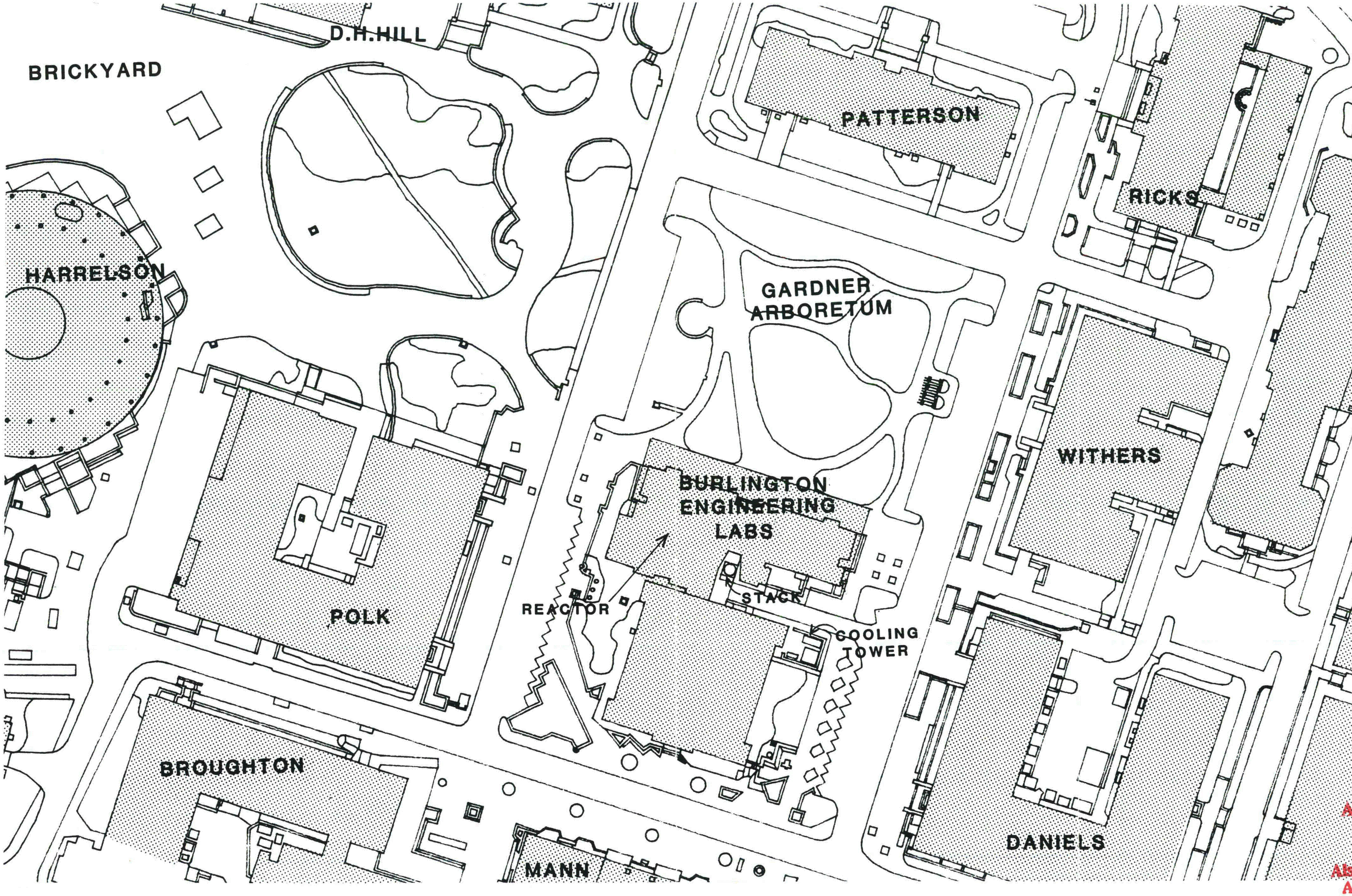


SAR FIGURE 2-3
ER FIGURE 3
DETAILED CAMPUS LAYOUT WITHIN PROXIMITY OF
BURLINGTON ENGINEERING LABORATORIES

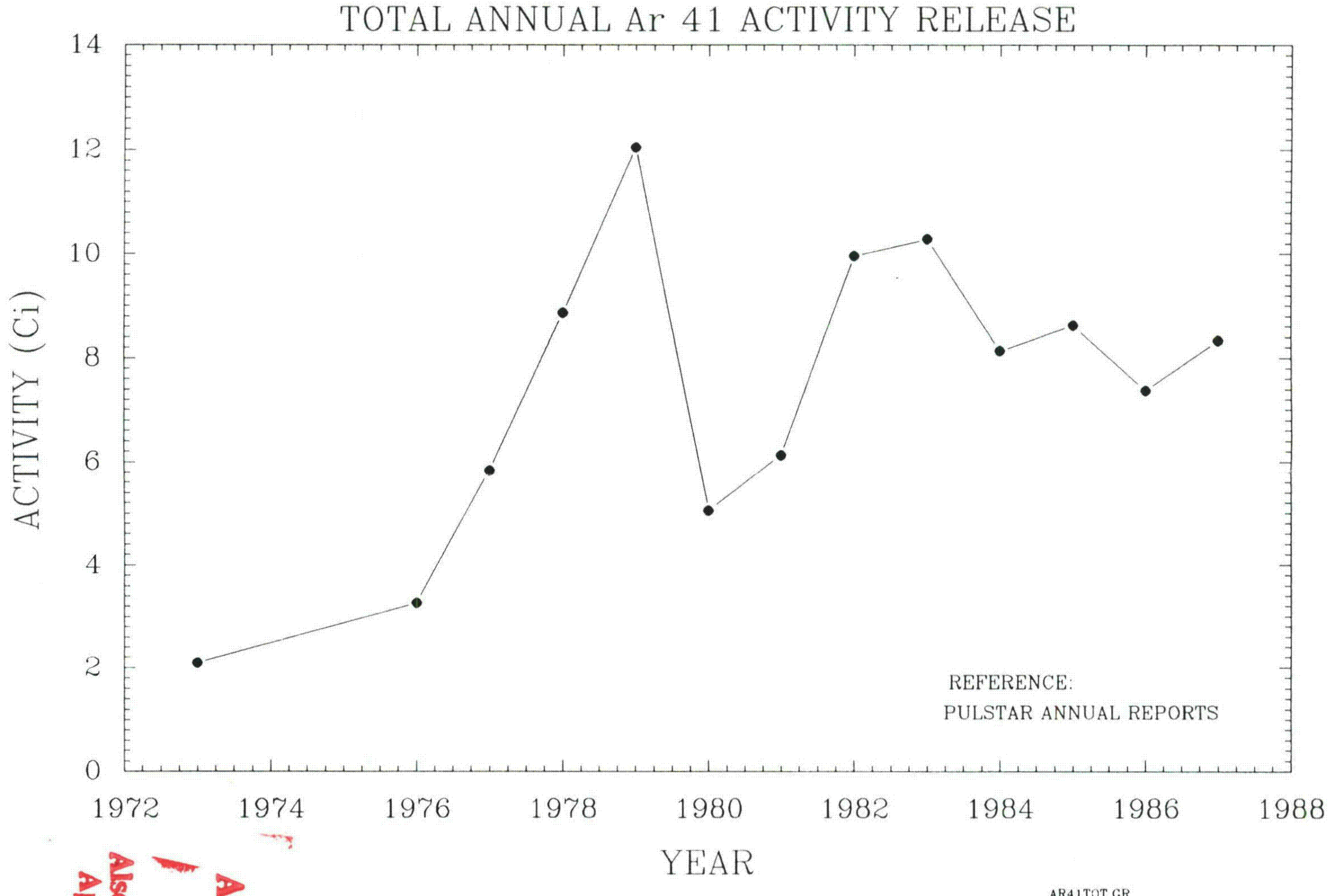
SI APERTURE CARD

Also Available On Aperture Card

8809010228-03

NCSU PULSTAR REACTOR OPERATING HISTORY

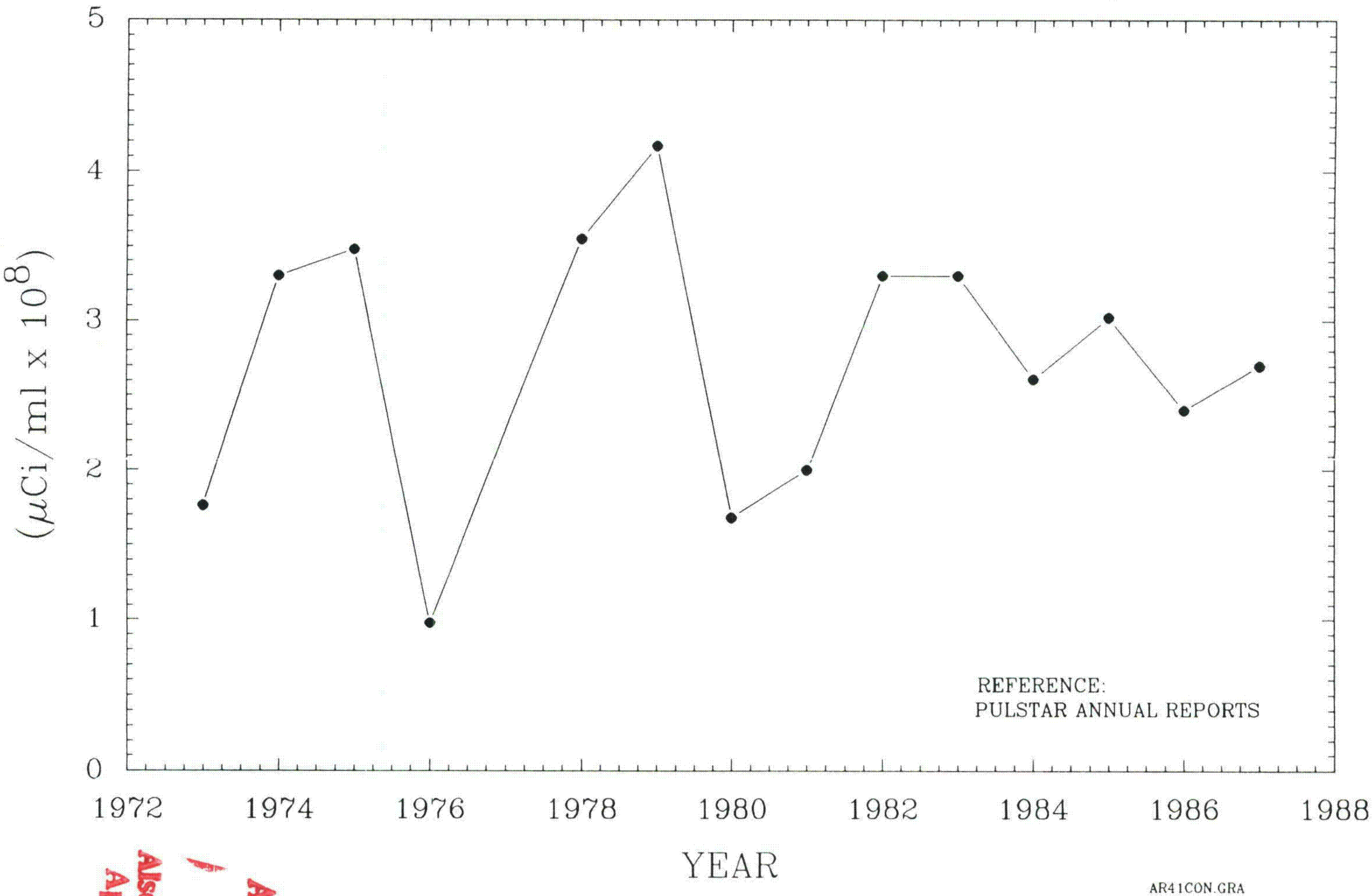
TOTAL ANNUAL Ar 41 ACTIVITY RELEASE



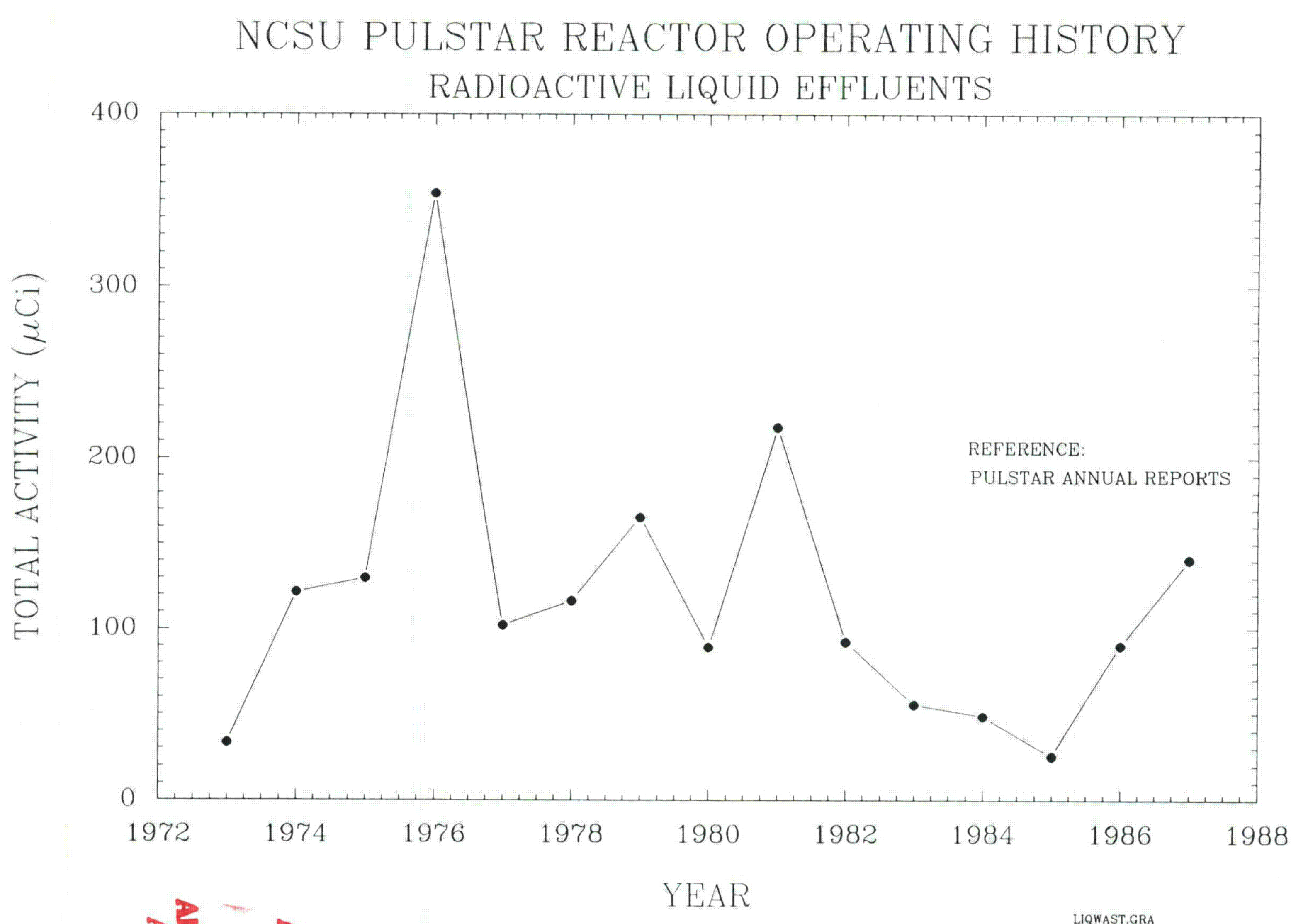
ER FIGURE 4

NCSU PULSTAR REACTOR OPERATING HISTORY

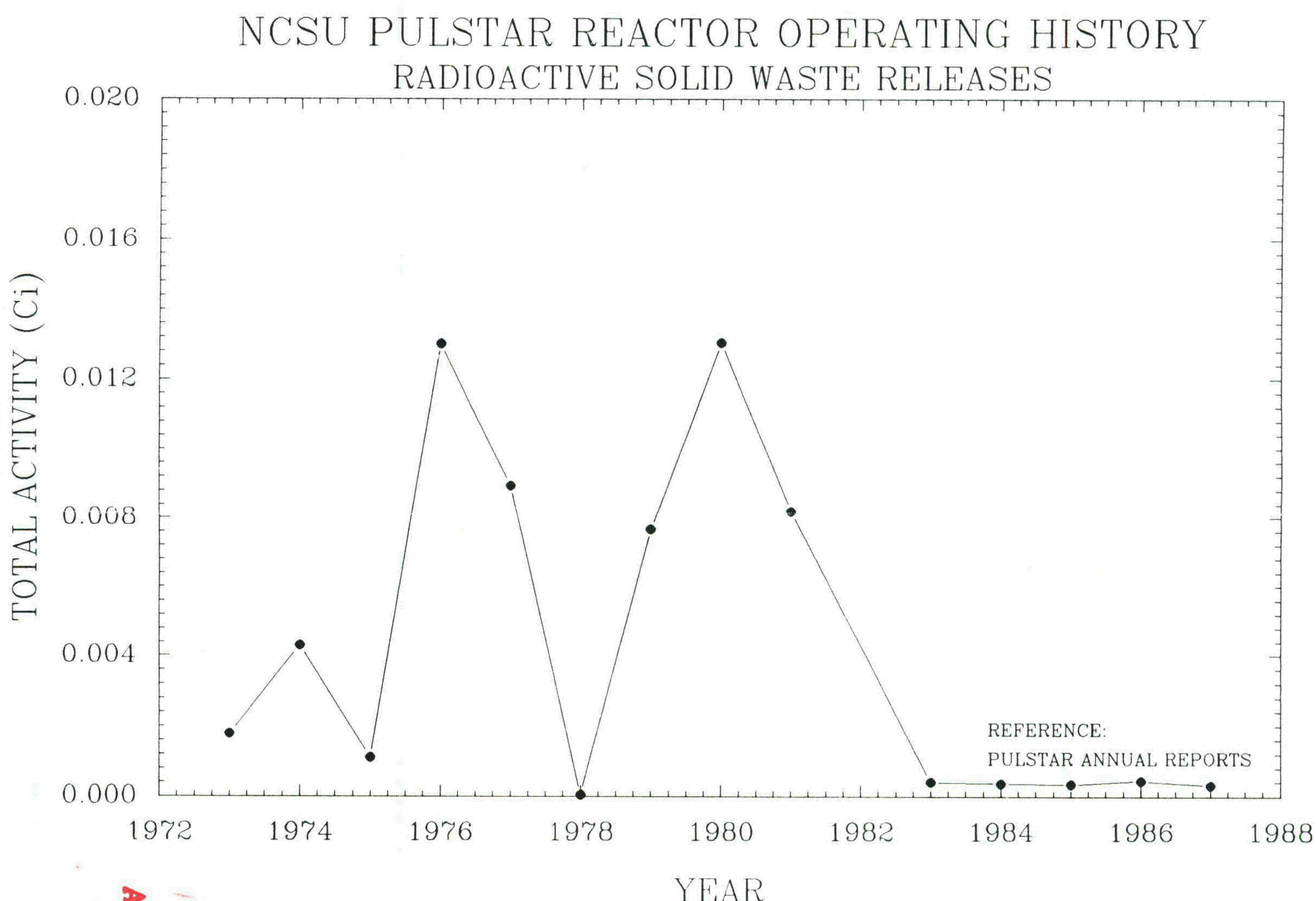
Ar 41 AVERAGE RELEASE CONCENTRATION



ER FIGURE 5


NCSU PULSTAR REACTOR OPERATING HISTORY
RADIOACTIVE LIQUID EFFLUENTS
TOTAL ACTIVITY (μCi)
400
300
200
100
0
1972
1974
1976
1978
1980
1982
1984
1986
1988
YEAR
REFERENCE:
PULSTAR ANNUAL REPORTS
LIQWAST.GRA

ER FIGURE 6


NCSU PULSTAR REACTOR OPERATING HISTORY
RADIOACTIVE SOLID WASTE RELEASES
TOTAL ACTIVITY (Ci)
0.020
0.016
0.012
0.008
0.004
0.000
1972
1974
1976
1978
1980
1982
1984
1986
1988
YEAR
REFERENCE:
PULSTAR ANNUAL REPORTS
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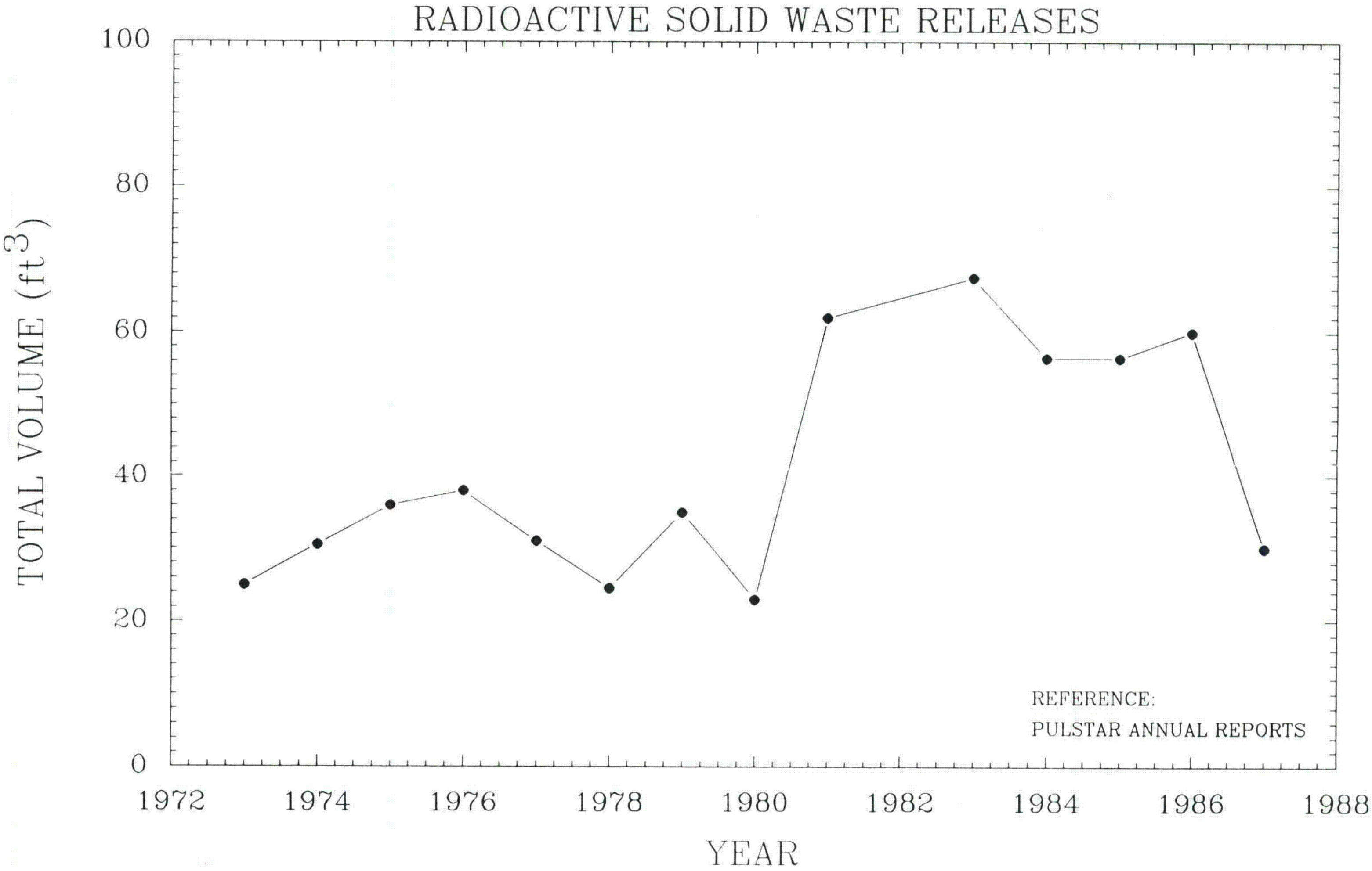
ER FIGURE 7

NCSU PULSTAR REACTOR OPERATING HISTORY
RADIOACTIVE SOLID WASTE RELEASES



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ER FIGURE 8