Cornell University
Ithaca, New York 14853

Docket No. 50-157

MATERIAL IN SUPPORT OF APPLICATION
TO RENEW AND AMEND FACILITY LICENSE R-80
FOR THE CORNELL TRIGA REACTOR

September 15, 1980

References:
(1) Request dated May 27, 1980, for renewal of Facility License R-80
(2) Letter with enclosures dated June 25, 1979, from Robert W. Reid, NRC
(3) Facility License R-80, as amended in entirety August 18, 1975, and further amended by Amendment No. 7 dated October 24, 1978
(4) Technical Specifications for Facility License R-80 dated August 18, 1975, and amended by Amendment No. 7 dated October 24, 1978
(5) Final Safeguards Report to the U.S. Atomic Energy Commission for the Cornell University TRIGA Reactor dated May, 1961 (designated as report number CURL-2)
(6) Applicable sections of Title 10 Code of Federal Regulations, of Regulatory Guides 2.1 - 2.6, and of ANSI Standards series ANS-15

W. D. Cooke
Vice President for Research

Sophie F. Capolongo

SOPHIE F. CAPOLONGO
Notary Public, State of New York
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Term Expires March 30, 19 81

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1. SUMMARY

The purpose of this document and its attachments is to support the application for renewal and amendment of Facility License R-80 for the Cornell University TRIGA reactor.

A class 104c license of 20 year duration is requested. An increase in authorized maximum steady state power from 100 to 500 kilowatts and in authorized maximum reactivity insertion in pulse mode from $2 to $3 is requested. Amendment of the Technical Specifications to incorporate these changes, to reflect current regulations, and to update descriptions is also requested.

The TRIGA reactor has been a very important component of broad teaching, research, and service programs of Cornell University in both basic and applied areas of science and engineering. The renewal and amendment to upgrade operations will provide the opportunity to continue and improve these programs.

To summarize the substance of this application, reference should be made to the Table of Contents. Section 3 gives detailed information and discussions addressed to individual subdivisions of Title 10, Code of Federal Regulations, Chapter 1, Part 50. Some of the supporting arguments for renewal and amendment are stated in this section. Many, however, are to be found in the four Appendices and in the Attachments, in particular Attachment A, which is an updating supplement to the original May, 1961, Final Safeguards Report -- all of which, taken together, comprise the Application.

2. BRIEF HISTORY

The principal licensing and operating stages in the history of License R-80 are summarized below.

A construction permit was applied for on February 24, 1960, and permit CPRR-58 was issued on June 29, 1960.

Application for conversion to an operating license was made June 1, 1961, and license R-80 was issued on January 11, 1962.

Initial criticality for steady state operation was on January 12, 1962.

Amendment to permit pulse mode operation was applied for April 23, 1964, and the license amendment was issued August 17, 1964.

Initial pulse mode operation was on September 4, 1964.

In spring 1964 the aluminum clad fuel elements were replaced with stainless steel clad elements because of their superior mechanical durability and their suitability for operation at higher power and higher pulse reactivity insertions.

The most recent amendment to the license was No. 7, issued October 24, 1978.

3. PARTICULARS OF THE APPLICATION
(in same order as sections of 10 CFR 50)

3.1 Filing of Application (10 CFR 50.30)

(e) Cornell University is exempt from payment of a filing fee under this paragraph.

(f) Information relevant to the development of an Environmental Impact Appraisal as required by this paragraph and the interpretation thereof by NRC is summarized in Appendix III of this application, entitled Environmental Considerations.

3.2 General Information (10 CFR 50.33)

(a) The name of the applicant is Cornell University.

(b) The address of the applicant is Ithaca, New York 14853.

(c) Cornell University is an institution of higher learning.

(d) (3) (i) Cornell University is a corporation, incorporated in the State of New York, and having as its pricipal location of business Ithaca, New York.

(ii) The names, addresses, and citizenship of its principal officers are as follows (all those named are U.S. citizens):

Name	Home Address	Office Held
Frank H.T. Rhodes	603 Cayuga Heights Rd. Ithaca, NY	President
W. Keith Kennedy	3 Sandra Pl., Ithaca, NY	Universit- Provost
Thomas Meikle, Jr.	333 E. 69 St., New York, NY	Provost for Medical Affairs
William G. Herbster	903 Wyckoff Rd,Ithaca,NY	Senior Vice President
W. Donald Cooke	38 Deerhaven Rd., Ithaca, NY	Vice President for Research
William D. Gurowitz	119 Oak Hill Rd., Ithaca, NY	Vice President for Campus Affairs
Robert T. Horn	113 1/2 Northview Rd., Ithaca, NY	Vice President, Treasurer, and Chief Investment Officer
Robert M. Matyas	409 Hanshaw Rd., Ithaca, NY	Vice President for Facilities and Business Operations
Richard M. Ramin	5 Brookhaven Drive, Ithaca, NY	Vice President for Public Affairs
Alison P. Casarett	144 Pine Tree Rd,Ithaca, NY	Vice Provost
Larry I. Palmer	377 Comfort Rd., Ithaca, NY	Vice Provost
James W. Spencer	416 Klinewoods Rd,Ithaca NY	Vice Provost
Walter J. Relihan, Jr.	402 Cayuga Heights Road, Ithaca, NY	Secretary of the Corporation and University Counsel

3.2 General Information (con't)

The University has no "directors." A list of its 59 trustees can be furnished if required.

(d) (3) (iii) Cornell University is neither owned, controlled, nor dominated by an alien, a foreign corporation, nor foreign government.

(4) Cornell University is not acting as an agent or representative of another person in filing this application.

(e) The class of license applied for is 104c.

The use to which the reactor will be put is to serve a broad program of instruction, research, and service in fields of engineering, physical science, and biological science. This is a continuation of the functions of the reactor as it has been used in the past. Further description of past patterns of use and of expected future uses is provided in section 6 of Attachment A to this application, entitled Supplement No. 1 to the Final Safeguards Report to the U.S. Atomic Energy Commission for the Cornell University TRIGA Reactor, and designated as report number CURL-2 (Suppl. 1).

The period of time for which the license is sought is twenty years.

Amendment of the license is requested to increase the maximum authorized steady state power from 100 kW(thermal) to 500 kW(thermal) and the maximum authorized reactivity insertion in pulse mode from $2.00 to $3.00. These limits, though higher than at present, are equal to or less than those that extensive experience at similar TRIGA reactors elsewhere has demonstrated safe and reliable operation. The new limits are needed to permit more effective use of the reactor for several experimental programs and to make possible some that could not be carried out at the present level. Not all uses require the higher limits; consequently, the average power and average integrated power in kW-hours are expected to increase in a smaller ratio than the limits themselves.

Amendment of the license is also requested to reflect the enrichments as well as the quantities in the description of the special nuclear material that the license permits.

Specific wording of changes in the license to incorporate the requested amendments is proposed in Attachment B to this application, entitled Proposed Changes to Technical Specifications and License.

The only other NRC license issued to Cornell University for use on the Ithaca campus is Facility License R-89 for the Zero Power Reactor, a critical facility housed in the same building as the TRIGA reactor.

(f) Information relevant to the financial qualifications of Cornell University to operate the reactor in accordance with regulations including annual operating costs, costs of permanently shutting down the reactor, and annual costs to maintain the shutdown reactor in a safe condition is supplied in Appendix I of this application.

3.2 General Information (con't)

(h) The proposed increases in limits on steady state power and on pulse reactivity insertion require no alterations in or new construction on the reactor other than changes such as relatively simple modifications and recalibrations of instrumentation to accommodate the increased range. Appendix IV to this application, entitled Outline of Plans for Tests and Initial Operation at 500 kW and $3 Pulses, provides some details. The requirement of this paragraph of stating "earliest and latest dates for completion of ... alteration" is felt to be inapplicable in this case.

3.3 Technical Information (10 CFR 50.34)

(b) Final Safety Analysis Report (FSAR). The FSAR submitted June 1, 1961, with the application for an operating license, entitled Final Safeguards Report to the U.S. Atomic Energy Commission for the Cornell University TRIGA Reactor and designated as report number CURL-2, is in many respects still suitable for the present application for license renewal. Therefore, instead of preparing a complete new FSAR, we have written an updating supplement entitled Supplement No. 1 to the FSR, designated by report number CURL-2 (Suppl. 1) and submit it as Attachment A to this Application. The Supplement clearly states which sections of the earlier document still apply and supplies additional or new sections where needed. The Hazards Analysis section was thoroughly revised using current analysis techniques, information, and standards; also, it was done for the higher power and higher pulse reactivity being requested.

Most of the material required under paragraph (b) appears in appropriately named sections of CURL-2 and the Supplement. For clarity, required material presented in other places than CURL-2 and Supplement No 1. is specifically listed below:

(6)(iii) Plans for preoperational testing and initial operation at 500 kW and $3 pulses are given in Appendix IV of the Application.

(v) A proposed emergency plan for Ward Laboratory is presented as Attachment C. This plan furnishes a description in the format and nomenclature recommended in Regulatory Guide 2.6 of emergency planning and procedures that have been in force at Ward Laboratory from the start.

(7) Technical qualifications of Cornell University personnel for operating and carrying on activities using the reactor are provided in Appendix II of this Application.

(8) An operator requalification program submitted to and approved on November 4, 1974, by the NRC, is in force at Ward Laboratory. The plan covers both TRIGA and ZPR.

(c) A physical security plan covering both R-80 and R-89, submitted to and approved on September 16, 1974, by the NRC, is in force at Ward Laboratory. A careful review of this plan in the light of applicable sections of 10 CFR 73 as currently issued shows that, in our opinion, it fully meets all requirements except for being written in the newly recommended format and nomenclature. A rewritten version will be submitted for approval (separately and in accordance with 10 CFR 2.790) when it is ready.

3.4 Technical Specifications (10 CFR 50.36 and 50.36a)

(c) The Technical Specifications currently in force were approved August 18, 1975, and were amended October 24, 1978. Additional amendments are proposed in Attachment B of this Application. The proposed versions reflect the increased power and pulse reactivity limits, include specific reference to ALARA requirements of ANS 15.12 regarding effluents to offsite, update organizational and administrative items, and incorporate new requirements on pool water quality and on prohibition of explosives.

3.5 Restricted Data (10 CFR 50.37)

Cornell University agrees that it will not permit any individual to have access to Restricted Data until the Civil Service Commission shall have made an investigation and report to the Commission on the character associations, and loyalty of such individual, and the Commission shall have determined that permitting such person to have access to Restricted Data will not endanger the common defense and security. The agreement of the applicant in this regard shall be deemed part of the license or construction permit, whether so stated therein or not.

APPENDIX I

FINANCIAL QUALIFICATIONS

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Qualified in Tompkins County
Term Expires March 30, 1981

I.1 GENERAL DESCRIPTION

Cornell University is a private, endowed institution. The J. Carlton Ward, Jr. Laboratory of Nuclear Engineering is administratively part of the Nuclear Science and Engineering Program (a department except for the title) which in turn is part of the College of Engineering. Ward Laboratory houses three licensed facilities: a TRIGA reactor (NRC license R-80), a Zero Power Reactor (NRC license R-89), and a gamma irradiation cell, New York State license 5-3A. A 3 MV Dynamitron accelerator, currently not in use, is also housed in Ward Laboratory.

The activities of the Nuclear Science and Engineering Program are funded by three types of sources: (1) appropriations in the University budget, as allocated by the Dean of the College, (2) earnings from providing services using Ward Laboratory facilities, and (3) research grants and contracts. (Cornell University is also the land grant college of the State of New York and receives State funds for operations of several of its colleges, but Engineering is not one of them.) Table I.1 shows the amount of each type for each of the last three fiscal years (July 1 - June 30).

Table I.1

	1977-78	1978-79	1979-80
Appropriated salaries and benefits	$134,845	$181,893	$193,627
Appropriated general expenses	7,900	9,250	9,600
Earnings from all facilities	31,669	39,090	30,994
Research grants and contracts*	88,592	25,225	80,556
	$263,006	$255,458	$314,777

* Amounts do not include research in the Laboratory of Plasma Studies

It should be noted that these funds cover all programs and activities of Nuclear Science and Engineering; operation and staffing of Ward Laboratory facilities only a part, and are not separately budgeted. Estimated prorated costs of operation of each of the two NRC-licensed facilities are provided in the next section.

The appropriated funds in the budget of the University are determined by annual reviews and approvals at several levels up to and including the Board of Trustees. The income from rendering services and success in securing grants and contracts are subject to variation. Figures such as those in Table I.1 cannot be guaranteed or predicted with certainty for future years. Nevertheless, the University recognizes its continuing responsibilities and obligations for safe operation of the facilities of Ward Laboratory and for their eventual permanent shutdown and subsequent disposal and/or maintenance in a safe condition.

The most recent annual report of Cornell University is hereby submitted as Attachment I-A as evidence on its general financial condition and ability to meet the estimated costs (given in the following sections) for operation of the two NRC-licensed facilities, for their permanent shutdown, and for their safe maintenance or disposal.

I.2 ESTIMATED ANNUAL OPERATING COSTS

The estimated prorated annual costs for operation of the TRIGA reactor and Zero Power Reactor are tabulated below. The salary and benefit figures include appropriate fractions for the time of the following individuals: Laboratory Director (a faculty member), Reactor Supervisor, one electronics engineer, two technician-operators, and one secretary, for the 1979-80 fiscal year. The figures in the other categories are based on recent experience, and include allowance for replacements and improvements to keep the facilities up to contemporary performance standards.

General costs such as utilities, janitorial services, and building maintenance that are covered by centralized accounts rather than by Nuclear Science and Engineering funds are not included.

	TRIGA	ZPR
Prorated salaries and benefits	$38,500	$6,500
Supplies and services	2,000	500
Maintenance and replacement	2,500	350
Major improvements (average/year)	12,000	750
	$55,000	$8,100

I.3 ESTIMATED COSTS OF PERMANENTLY SHUTTING DOWN THE REACTORS

The shutting down option chosen for the purposes of this cost estimate is that of (1) removal of the fuel and some structures and mothballing the remaining structures, (2) maintaining radiation surveillance for several years, and (3) final removal, demolition and/or conversion, and decontamination of the remaining structures.

Stage (1) will include fuel removal and disposition, removal or decontamination of piping and process equipment external to the core structure, sealing off to prevent unauthorized access to the structures being left in place, removal or decontamination of ancillary facilities such as sample transfer systems and ventilation systems, and general decontamination. It would be expected to carry out stage (1) in about 18 months with Cornell employees doing much of the work.

The length of stage (2) will depend upon the levels and halflives of the radioactivities that are encountered and upon the plans that are developed for

further use of the building. Probably the elapsed time from removal of fuel to the end of stage (2) will be at least three years. The surveillance and security control under a possession-only license will require only limited manpower. (See section I.4.)

Stage (3) will require more manpower in general, and several persons trained in radiation measurements and decontamination procedures will be needed. At this time it appears likely that partial demolition followed by conversion will be the choice, since the remaining radioactivities from our levels of operation will be small and the building as a whole will be useful for other experimental programs that employ radiation and therefore can be conducted in a controlled radiation area.

Cost estimates for the above can be roughly estimated as given below. The figures are based in part on our own experience in fuel shipments and in part on estimates from other facilities.

	TRIGA	ZPR
Removal and shipment of fuel	$25,000	$15,000
Shipment of other structures	20,000	10,000
Manpower during stage (1)	100,000	50,000
Miscellaneous and contingency	25,000	12,000
	$170,000	$77,000
Final demolition/conversion	$250,000	$70,000

I.4 ESTIMATED ANNUAL COST OF MAINTAINING SHUTDOWN FACILITY

The costs in this category are those of maintaining security and surveillance during the mothball stage before final demolition or conversion. It is assumed that the equivalent of one full-time trained person will be necessary, at an annual cost (salary, benefits, and overhead) of $40,000.

APPENDIX II

TECHNICAL QUALIFICATIONS

Cornell University has operated and used the Ward Laboratory facilities since 1962. The record shows that the institution and the individuals responsible for Ward Laboratory have been able to carry on NRC-licensed activities safely and efficiently.

The ultimate dependence for safe operations is on the individuals doing the day-to-day operating and the daily supervision of operations. Accordingly, names and brief qualifications are given below for the current staff and Laboratory Safety Committee members.

Ward Laboratory Staff

Howard C. Aderhold, Reactor Supervisor
Chief Responsible Person (ZPR, Radioactive Sources and Materials)
SOP-308-8 (TRIGA and ZPR)

Basil E. Blank, Electronics Technician
A.S. (Computer Engineering Technology)
Tampa Technical Institute, 1980

K. Bingham Cady, Associate Professor of Nuclear Science and Engineering
Ph.D. (Nuclear Engineering)
Massachusetts Institute of Technology, 1962
SOP-175-3 (ZPR)

David D. Clark, Professor of Nuclear Science and Engineering
Director, J. Carlton Ward Laboratory of Nuclear Engineering
Ph.D. (Physics)
University of California at Berkeley, 1953
SOP-309-8 (TRIGA and ZPR)

Paul I. Craven, Senior Research Technician
Chief Responsible Person (TRIGA)
SOP-1594-4 (TRIGA)

David A. Hammer, Associate Professor of Nuclear Science and Engineering
Ph.D. (Applied Physics)
Cornell University, 1969

Vaclav O. Kostroun, Associate Professor of Nuclear Science and Engineering
Chief Responsible Person (Dynamitron)
Ph.D. (Physics)
University of Oregon, 1968

Charles R. Strohman, Research Support Specialist II
B.S. (Electrical Engineering
Cornell University, 1977

Laboratory Safety Committee

K. Bingham Cady (Chairman)
Associate Professor of Nuclear Science and Engineering

Alison P. Casarett
Professor of Radiation Biology

Hans H. Fleischmann
Associate Professor of Applied and Engineering Physics

George H. Morrison
Professor of Chemistry

Robert L. Von Berg
Professor of Chemical Engineering
Chief Responsible Person (Gamma Cell)

David D. Clark (ex-officio)
Laboratory Director

William E. Kiker (ex-officio)
Director of Radiation Safety
Ph.D. (Physics)
University of Tennessee, 1964
Extensive experience in radiation safety and protection.

Mark Nelkin (ex-officio)
Nuclear Science and Engineering Program Representative
Professor of Applied and Engineering Physics

Howard C. Aderhold (ex-officio, Secretary)
Reactor Supervisor

Appendix III

ENVIRONMENTAL CONSIDERATIONS

In this section we provide the information for an Environmental Impact Appraisal by NRC. As a matter of policy, the NRC has determined that research reactors and critical facilities under 2 MWt do not require Environmental Impact Statements, but that an Environmental Impact Appraisal is required to substantiate the policy for each research reactor license application.

Facility Description

The Ward Laboratory is fully described in the May, 1961, edition of the Final Safeguards Report and the 1980 Supplement. The building has all normal connections to the environment: water, sanitary sewer, electricity, telephone, building ventilation systems, doors and windows. In addition, there are several more specialized connections:

1) roof and footer drains connect to a storm sewer discharging into Cascadilla Creek,
2) steam heating supply and condensate return lines connect to the Cornell heating plant system,
3) chilled water from the Cornell cooling system cools the TRIGA pool heat exchanger, the reactor bay air conditioning heat exchanger (30 tons), and other building air conditioning heat exchangers (7 tons),
4) a wet cooling tower services the dynamitron air conditioning system (25 tons),
5) several chemical fume hoods are exhausted to the atmosphere,
6) the TRIGA bay ventilation system has supply and exhaust connections to the atmosphere, and
7) the liquid waste hold-up tank can connect to the sanitary sewer or to a truck pump-out station.

Environmental Impact of Site Preparation and Facility Construction

During Construction of Ward Laboratory and modifications to the Laboratory, a small impact on the environment occurred similar to any comparable building construction. There was no significant effect on the terrain, vegetation, wildlife, or the Cascadilla Creek water or acquatic life. Ward Laboratory does not detract aesthetically from the appearance of the Cornell Campus.

Environmental Impacts of Operation

The main environmental impacts of Ward Laboratory are small discharges of gaseous, liquid, and solid wastes

The following table lists the radioactivity released between July 1, 1974, and April 30, 1980.

Ward Laboratory

Radioactive Waste Release Record

for the period beginning July 1, 1974, and ending April 30, 1980

Year Ending June 30	Liquid	Gaseous	Solid
1980 to date	108 µCi	155 mCi	*26.71 µCi
1979	332 µCi	181 mCi	None
1978	2414 µCi	194 mCi	None
1977	< 10 µCi	162 mCi	None
1976	< 10 µCi	212 mCi	None
1975	< 10 µCi	174 mCi	None

*On December 4, 1979, 5 drums (55 gal.) of solid waste from the TRIGA pool water purification system (resins, carbon, sand, etc.) were removed from Ward Laboratory by Radiation Safety for transport by Teledyne Corporation. The following is a list of the isotopes and amounts: ^{152}Eu - 3.07 µCi, ^{124}Sb - 1.17 µCi, ^{65}Zn - 2.27 µCi, ^{60}Co - 12.9 µCi, ^{54}Mn - 7.3 µCi.

The liquid wastes shown in the table come from a waste hold-up tank and are discharged to the sanitary sewer after hold-up and sample analysis by the Radiation Safety Office. The 2.4 millicuries discharged in 1978 were from the cleaning of the walls and equipment in the TRIGA pool. Expected liquid discharges are kept as low as reasonably achievable and are expected to be 5-6 mCi/year and in concentrations smaller than those specified in ANS standard 15.12 and 10 CFR 20.1/

The gaseous waste listed in the table is argon-41 from air activation in the beam ports and sample insertion tubes. The argon-41 is discharged from the reactor bay ventilation system. The expected annual discharges of 3-4 curies/year result in annual doses to individuals in the unrestricted area which are very much smaller than those specified in ANS standard 15.12 and 10 CFR 20.2/

1/ Design Objectives for a Monitoring of Systems Controlling Research Reactor Effluents, ANSI/ANS-15.12-1977 (N647). See also 10 CFR 20, Standards for Protection against Radiation.

2/ ibid.

Solid radioactive wastes consist mainly (by volume) of blotting paper, wipes, gloves, and other low level contaminated wastes. The expected volume of these wastes is several 55 gallon drums per year and is taken from the Laboratory and packaged by the Radiation Safety Office who contracts with a carrier to transport these low level wastes to an NRC approved site in accordance with NRC and DOT regulations.

Environmental Impact of Accidents

Accidents up to and including a maximum hypothetical accident are discussed in the Hazard Analysis.[3/] Under the unlikely event of the worst case assumptions, the doses to individuals in the unrestricted area would be very small compared to the guidelines in 10 CFR 100.[4/] They are also considered negligible with respect to the natural environment.

Environmental Impact of the Use of Raw Materials

The raw materials used in fabricating the materials of construction for the Ward Laboratory and the fissionable materials used in the TRIGA are non-recoverable and unavoidable. The amount of these materials is negligible in comparison with other uses of these same materials and is small compared to the benefits derived from construction and operation of Ward Laboratory.

Costs of Facility Construction and Operation

The cost of construction of the Ward Laboratory facilities was about one million dollars and the annual costs of operating the Laboratory facilities is about $65,000 per year.

Benefits of Facility Operation

The Ward Laboratory reactors are used for research and education. Research areas include:

activation analysis,
tracer isotope studies,
low-energy nuclear physics,
biology,
atomic and molecular physics.

Educational uses include:

undergraduate and graduate engineering courses,
Master of Engineering (Nuclear),

3/ Section 7, Final Safeguards Report for the Cornell University TRIGA Reactor, CURL-2, Supplement 1, 1980.

4/ 10 CFR 100, Reactor Site Criteria.

Master of Science,
Doctor of Philosophy.

Ward Laboratory is a Cornell University facility and like its libraries, is available for use by the entire Cornell community.

Alterations to Facility Operation

Some, but not all, of the benefits could be obtained using radioactive sources and/or accelerators which would be more costly and less efficient. There is no reasonable alternative to a university research reactor for the class of activities it performs.

APPENDIX IV

Plan for Preoperational Tests and Initial Operation at 500 kW and $3 Pulses

1. Facility Changes

   1.1 Installation of pool water cooling system (completed 8/11/76)
   1.2 Installation of N-16 diffuser

2. Steady State Test Plan

   2.1 Adjust core loading and install instrumented fuel elements
   2.2 Perform 100 kW power calibration
   2.3 Reposition neutron detectors and adjust for 500 kW operation and $3 pulse operation
   2.4 Measure and record the following data at 100 kW
       a) fuel element centerline temperatures in B ring and F ring
       b) control rod positions and excess reactivity
       c) radiation levels at pool top and in reactor bay experimental areas
       d) N-16 activity in pool water discharge line
   2.5 Raise TRIGA power in 80-100 kW increments
   2.6 Repeat measurements in 2.4 after each increment
   2.7 Perform 480 kW power calibration
   2.8 Measure and record argon-41 releases

3. Pulse Mode Test Plan

   3.1 Adjust pulse rod to $2.80
   3.2 Pulse reactor with reactivity insertions starting at $1.75 and incrementing by $0.25
   3.3 Measure and record the following data for each pulse
       a) fuel element centerline temperatures in B ring and F ring
       b) peak power (nv)
       c) integrated power (nvt)