IOWA STATE
UNIVERSITY

Department of Nuclear Engineering
261 Sweeney Hall
Ames, Iowa 50011-2230

Telephone 515-294-5840

Docket No. 50-116

March 24, 1988

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Attn: Director, Office of Nuclear Reactor Regulation

Dear Sir:

Pursuant to paragraph (c)(2) of Part 50.64, we are submitting our current schedule to meet the requirements for conversion from HEU to LEU fuel at the Iowa State UTR-10 facility. The schedule is essentially the same as that proposed by us one year ago, in our first communication with NRC regarding fuel conversion.

We submitted our proposal for an assistance grant to DOE May 15, 1987. A copy of this proposal is enclosed. On July 27, 1987, the Contracts and Grants Office at ISU was notified that DOE would support the conversion project with $134,210 over two years, beginning September 1, 1987 (copy enclosed). The work was initiated then, as described in the DOE proposal, and we plan to submit an updated Safety Analysis Report to NRR this summer.

The summer of 1989 is still the target date for the conversion. We plan to shut the reactor down in April 1989 and begin shipments of used and unused HEU fuel to DOE then. LEU fuel will be received and installed between June and August of 1989. Adherence to this schedule depends on certain factors beyond our control, such as a timely review of the SAR by NRR, and the availability of LEU fuel, shipping casks, etc.

A020
1/1

Since the safety analysis of the LEU core is still in progress, it is premature to include necessary changes in the license, facility, or procedures. The changes will be submitted as part of the updated SAR this summer.

Sincerely,

RAHendrickson

Richard A. Hendrickson
Reactor Manager

Approved:

Bernard I Spinrad

Bernard I. Spinrad
Professor and Chair

/rpa

C: L. E. Burkhart
R. A. Danofsky
W. R. Madden
E. E. Sobottka
NRC Region III

Enclosures

Department of Energy
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439

Mr. Richard Hasbrook
Contract and Grants Office
Iowa State University
204 Beardshear Hall
Ames, Iowa 50011

JUL 27 1987

Dear Mr. Hasbrook:

SUBJECT: PROPOSED NEW GRANT NO. DE-FG02-87ER75360 FOR A PROJECT ENTITLED "LOW ENRICHMENT (LEU) FUEL CONVERSION FOR IOWA STATE UNIVERSITY"

Subject to the award of a Grant document, the Department of Energy can provide support in the amount of $134,210.00 for the proposed period September 1, 1987 through August 31, 1989.

The Project Director for the research described in your proposal is Prof. Robert E. Williams.

Upon receipt of the items requested on the enclosed Requirements Sheet, a Grant will be prepared for the proposed project. The requested items should be returned by August 15, 1987 to allow award of the Grant by September 1, 1987.

This notification should in no way be construed as a commitment on the part of the Department of Energy to reimburse costs incurred prior to the award of the Grant.

Please contact us if you have any questions.

Sincerely,

Valdean R. Ohlsson

Valdean R. Ohlsson
Contract Specialist
Acquisition and Assistance
Operations Branch

Enclosure:
As Stated

cc: Prof. Robert Williams, w/o encl.

RECEIVED
JUL
CONTRACTS & GRANTS OFFICER

Celebrating the U.S. Constitution Bicentennial — 1787-1987

IOWA STATE
UNIVERSITY

Department of Nuclear Engineering
261 Sweeney Hall
Ames, Iowa 50011

Telephone 515-294-5840

May 15, 1987

Mr. Richard E. Stephens, Director
Division of University and Industry Programs
Office of Field Operations Management
Office of Energy Research
U.S. Department of Energy
Washington, D. C. 20585

Dear Mr. Stephens:

Enclosed is the official proposal for a assistance grant for the conversion of the ISU reactor to LEU fuel. It is unchanged from the draft copy sent to you earlier.

I apologize for being behind schedule on submitting the proposal. Thank you for your patience.

Sincerely,

Robert E Williams

Robert E. Williams, Ph.D.
Assistant Professor of Nuclear Engineering

/rpa

Enclosure

A Proposal for an / The complete mailing
for the Conve Address is:
Iowa State U
UTR-10 Research
Low Enrichment

Mr. Richard E. Stephens, Director
Division of University and Industry Programs
Office of Field Operations Management
U. S. I Office of Energy Research
Offic U.S. Department of Energy
Division of Uni Washington, D.C 20585

IOWA STATE UNIVERSITY
DEPARTMENT OF NUCLEAR ENGINEERING

May, 1987

Robert E Williams
Robert E. Williams

RA Hendrickson
Richard A. Hendrickson

Alfred F. Rohach
Alfred F. Rohach

Proposed Period:
August 1, 1987 to May 31, 1990
Requested Funds:
$170,915

Approved by
Richard E. Hasbrook
Richard E. Hasbrook
Contracts and Grants Office

TABLE OF CONTENTS

I. Introduction

On March 27, 1986 the U.S. Nuclear Regulatory Commission revised Title X of its Code of Federal Regulations governing non-power nuclear reactors. A licensee using high enrichment uranium (HEU) fuel must replace all HEU fuel in its possession with available low enrichment uranium (LEU). This revised regulation, 10 CFR 50.64, further states that this conversion requirement is contingent upon: (1) the availability of LEU fuel acceptable to the Commission, and (2) Federal Government funding for the conversion.

The UTR-10 research reactor at Iowa State University, currently using 92% enriched uranium fuel, is going to be converted to LEU fuel. The DOE's RERTR program has developed LEU fuel apparently suitable for the UTR-10 reactor. Also, DOE has notified ISU that funding is available for the safety analysis phase of the conversion process (See Appendix A).

This document is a proposal to DOE for those funds, in the form of an assistance grant. The proposal summarizes the expected changes in the facility, the computations and experiments needed to carry out the conversion, and the work plan for completion of the task. A DOE reimbursement of $170,915 is requested to cover the direct costs of conversion. ISU will bear the indirect costs, as requested by DOE (Appendix A).

II. LEU Fuel for the UTR-10 Reactor

The core of the UTR-10 reactor, as defined in the license technical specifications, consists of a 3′ 8" by 4′ 8" stack of graphite* 4 feet high, in which two rows of fuel assemblies are located[2]. Ordinary water circulates through the assemblies during operation, serving as moderator and coolant. The core tanks, each holding six fuel assemblies, are separated by an 18-in thick internal reflector (See Appendix B). Control is maintained with four control elements: one regulating rod, one shim-safety rod, and two safety rods. The control elements are actually boral plates located between the core tanks and the external reflector, but the SAR refers to them as control rods.

According to the current plan proposed by the RERTR group at ANL, ISU will be one of 14 reactors to receive standard uranium silicide plates[3]. Properties of the existing HEU fuel in the UTR-10 reactor and the proposed standard LEU plates and elements are given in Table 1. The primary consideration in the fuel conversion is that the dimensions of the fuel assemblies do not change; they must be able to be positioned in the 12 existing fuel assembly locations.

Because the fuel meat thickness of the LEU plates is half that of

*This core definition, including the graphite, is taken from the facility SAR, reference 2. It must be emphasized, however, there is <u>no graphite in the fuel region</u>, and that, strictly speaking, the reactor consists of two independently subcritical cores immersed in a graphite reflector.

Table 1. Comparison of HEU and LEU fuels for the UTR-10 Reactor

	HEU[2]	LEU[3]
Fuel Meat	$UAl_4 - Al_x$	$U_3Si_2 - Al_x$
Enrichment	93%	19.75%
U density (g/cm^3)	0.61	3.47
Fuel meat dimensions:		
thickness (mils)	40	20
width (in)	2.75	2.32-2.47
length (in)	23	22.5-24.0
Clad thickness (mils)	20	15
Plate: thickness (mils)	80	50
width (in)	3.0	3.0
Grams ^{235}U per plate	22	12.5
Plates per fuel assembly[(a)]	12	24
Grams ^{235}U per assembly	200-262	300[(b)]
Critical mass (g)	2947	3600[(b)]

Notes: (a) The fuel assembly dimensions must remain unchanged (3" x 5.54" s 29.87").

(b) To be determined more accurately during the safety analysis phase of this study.

the HEU plates, twice as many fuel plates per assembly will most likely be necessary. The LEU elements will result in less efficient neutron moderation since 1) the water volume will be reduced by 5.2% and 2) the water gap between adjacent fuel plates will be reduced from 0.4 in to about 0.17 in. This dense packing of fuel plates will presumably result in a "harder" neutron flux spectrum, i.e. an increase in the fast neutron flux relative to the thermal flux. Note that although a few reactors will also have to squeeze more LEU plates into their assembly, only ISU will have to double the number of plates.

The hardening of the flux spectrum in concert with the introduction of a great deal of ^{238}U will cause:

i) an increase in fast fissions,

ii) an increase in resonance absorption,

iii) a decrease in the prompt neutron lifetime, and

iv) an increase in fast neutron leakage.

Of these four effects, the dominant one on criticality is the increase in fast neutron leakage. Although the fast fission effect will increase, it will nevertheless still be very small. Likewise, resonance capture is predicted to be a quite small effect since the ratio of moderator atoms to ^{238}U atoms in the core will be high. However, fast neutron leakage on the other hand is already large for the HEU core and will become larger for the LEU core, despite the value of the graphite reflector. As for neutron lifetime, although it is expected to decrease, this should not be by a large amount since a significant contribution to lifetime comes from the diffusion time of neutrons thermalized in the reflector and returning as thermal neutrons to the core.

Finally, the energy spectrum of the neutrons passing through the boral control rods may affect their reactivity worths. Because the rods are positioned between the fuel and the external reflector, they absorb many neutrons that would be reflected into the fuel.

In summary, the dense packing of LEU fuel plates will result in many changes in the UTR-10 reactor. The goal of the computational phase of the conversion will be to predict how the hardening of the flux spectrum will affect reactor parameters.

III. Safety Analysis Phase - Computations

A series of calculations are planned to investigate the effects of the changes described above on the performance characteristics of the UTR-10, and on any possible safety related questions that may arise. This effort has already begun with the receipt from RERTR of a package of computer codes including:

i) LEOPARD - to calculate few group macroscopic cross sections needed for 2DBUM from constituent atom densities and its cross section library.

ii) 2DBUM --- a 2 dimensional diffusion code to predict neutron flux and power distributions criticality, reactivity coefficients, etc.

iii) PLTEMP -- to calculate fuel and moderator temperatures based on flow conditions and power densities.

iv) PARET --- to calculate the energy released in reactor transients and resulting heat fluxes and fuel temperatures.

v) NATCON -- to predict the results of a loss of coolant flow on UTR-10 fuel and moderator temperatures.

In order to gain confidence in the above codes, we intend to perform calculations on the existing HEU fuel load in the UTR-10 reactor. Results of these calculations will be compared with established operating parameters (fuel mass, moderator temperature coefficient, control rod worths, etc). We also plan to measure the prompt neutron lifetime and the neutron flux spectrum, and compare these with calculated values. The comparisons will allow us to assess how likely we will be able to predict these parameters for the LEU core.

Some of the calculations may require additional codes. Because of the small size and split core of the UTR-10, the infinite multiplication factor is necessarily about 1.5. The high degree of leakage will probably require the use of 3D codes to accurately model this core. In addition, areas with steep flux gradients, such as control rods and environs, may require transport theory codes. Predicting the flux spectrum in the moderator between adjacent fuel plates may also require transport codes, rather than the homogenized cells used in 2DBUM.

The conversion from HEU to LEU fuel will probably not significantly change the accident analyses for the UTR-10. As it is, the design basis accident for the facility is a fuel handling accident in which an element is dropped, the clad is sheared from one side of a fuel plate, and volatile fission products are released[2,4]. The switch to LEU fuel will alter this scenario because the radioisotope inventory per fuel plate will drop by about a factor of two. The rate of plutonium production will need to be calculated, however, to determine how the presence of Pu affects the design basis accident.

A factor that could exacerbate a reactor transient would be a decrease in the prompt neutron lifetime as a result of conversion. For a sudden insertion of the allowed excess reactivity of 0.5% $\Delta k/k$, the resulting reactor period decreases somewhat with the prompt lifetime. The energy release in the transient would therefore increase in this case. The PLTEMP and PARET codes will be used to model this transient, but measured β_e/ℓ^* must be used for reliable results.

IV. Safety Analysis Phase - Experiments

The conversion from HEU to LEU will, of course, necessitate a series of standard core physics measurements for assurance that no technical specifications are exceeded. In addition, we are proposing two sets of measurements to investigate reactor characteristics most likely to be effected by the conversion, namely flux spectrum and prompt neutron lifetime measurements. These experiments will be performed on the HEU core and then repeated after the conversion.

Standard core physics measurements include reactivity worths of fuel mass changes and the four control rods, and the moderator temperature coefficient. From these experiments, we can calculate the excess reactivity, shutdown margin, reactivity addition rates, and the effects of changing moderator temperature. No doubt, these measurements will be repeated several times, until the optimum distribution of LEU fuel in the UTR-10 is obtained. (Control rod worths will be particularly sensitive to fuel location changes.) Following these low power experiments, a full power measurement of core thermal power will be needed to recalibrate nuclear instrumentation. Procedures for all of these measurements exist, as they are a major part of our surveillance requirements. Unless some surprises emerge from the calculations, we expect no difficulty in conforming to existing technical specifications.

The major change expected as a result of fuel conversion is the hardening of the flux spectrum. The first experiment planned is the measurement of the neutron flux as a function of energy midway between adjacent fuel plates, for both HEU fuel assemblies, and LEU assemblies. By activating radioisotopes produced via neutron reactions with varying thresholds or resonances, the flux spectrum can be calculated from the foil activities and energy-dependent cross-section data[5]. Conducting these experiments will require the design and construction of a foil holder, selection of appropriate sets of activation foils, absolute efficiency calibration of our HPGe detector, and unfolding the flux spectrum from computer codes such as LSL-M2[6] or STAY'SL[7]. A set of flux spectrum measurements will be compared with multigroup diffusion or transport code predictions.

The second experiment planned is the two-part measurement of the ratio of the effective delayed neutron fraction (β_e) to the prompt neutron lifetime (ℓ^*), before and after the conversion. In 1971 and 1975, reactor oscillator and pile noise measurements of $\beta e/\ell^*$ provided a consensus value of 43 sec^{-1} for the UTR-10, the value used for transient analyses in the SAR[2]. Because of the importance of $\beta e/\ell^*$ in the analyses of power transients, we need $\beta e/\ell^*$ measurements with state-of-the-art equipment (1) on the HEU core for verification of the measurement method, and (2) on the LEU core for use in the updated SAR. The $\beta e/\ell^*$ values are based on measurements of the upper break frequency of the reactivity transfer function. The upper break frequency is determined from an analysis of data obtained from any of several different measurement methods: Two appropriate techniques for the UTR-10 use, as inputs to the transfer function, are (1) the inherent neutron noise, or (2) reactivity variations from a mechanical reactor oscillator. In either case, signals from in-core neutron detectors are processed to calculate the magnitude of the transfer function. Although a "small" detector is preferred since it minimizes measurement distortions, it has low efficiency because of its small volume and this leads to poor measurement results. The low-efficiency problem encountered with the neutron noise method can be overcome by using the "two-detector" technique[8].

The experiments proposed above constitute an important part of the conversion process. Since the LEU fuel elements for the UTR-10 are expected to have a significant effect on the flux spectrum, we have a unique chance to measure differences between the HEU and LEU fuels, and compare measured values with predicted values. It is expected that interested graduate students will investigate these areas and produce one or two M.S. theses.

V. Fuel Transfer

The Department of Energy is funding all fuel fabrication and delivery costs, directly. DOE is providing shipping casks, and reimbursing transportation costs, as well. Section V of this request for an assistance grant will address only those activities necessary at ISU in order to prepare to ship used fuel, and receive and load LEU fuel.

There are many tasks that must be completed before used HEU fuel can be shipped off campus. The reactor staff and Environmental Health and Safety (EH&S) Department staff must assure that all DOT and NRC regulations are satisfied. In addition, the inventory changes must be documented, and quality assurance and security procedures must be developed and implemented regarding the transportation of used HEU fuel. Our estimate of the number of staff hours is based on our experience with the fuel transfer mandated by NRC in November 1985. We shipped about 750 grams of unused HEU fuel to Oak Ridge in February 1986.

One modification in our fuel handling equipment will be necessary. Currently, we have to place our fuel handling cask on top of the reactor shutdown closure or on top of the fuel storage pit to load or remove fuel from the core or pit. The cask is free standing while the grappling tool is used to lift or lower a fuel element into or out of the cask. In order to lower an assembly into a MH-1A package, it will be necessary to suspend our cask from the overhead crane while lowering the assembly. It is currently impossible to use the grappling tool while the cask is suspended; the suspension mechanism will have to be redesigned.

VI. Schedule for Conversion

A summary of milestones in the conversion process and expected dates for completion is presented in Table 2. The entire process, from receipt of funds to submission of final reports will take just under three years to complete. We assume that LEU fuel and the necessary shipping casks, will be available, and that no more than a nine month review period will be required by NRC.

Table 2. Proposed Schedule for Completion of HEU to LEU Conversion

Date	Activity
8/87	Begin calculations required for Safety Analysis Report[1]
6/88	Submit revised Safety Analysis Report to NRR
3/89	Receive enforcement order for conversion from NRC[2]
5/89	Begin shipment of HEU from Iowa State[3]
6/89	Complete shipment of HEU fuel from Iowa State[3]
7/89	Receive LEU at Iowa State and begin loading fuel[3]
8/89	Complete loading of fuel[3]
5/90	Submit final reports to NRC, DOE

(1) Subject to the timely receipt of requested funding from DOE.

(2) Subject to the timely completion of the SAR review by NRR.

(3) Subject to the timely availability of shipping casks and LEU.

Our schedule was influenced by two major factors, student participation and reactor usage. Graduate students will be assisting with conversion calculations and measurements. While we realize the computations could be completed more quickly by the RERTR group, we wish to utilize the codes supplied to us by RERTR. It is expected that two or three masters theses will result from conversion-related work.

The second major factor is reactor use. Each year, the period of minimum reactor operations is from late April until early September. Our license and limited fuel storage space will preclude operations during the actual fuel exchange period. Scheduling the fuel exchange in the summer of 1989 will result in the least possible disruption in reactor use.

A more detailed work plan for the conversion is given in Table 3. The plan outlines the tasks to be completed in each academic semester.

Table 3. Details of Conversion Work Plan

Fall 1987: Implement RERTR codes at ISU and check benchmarks

Begin 2DBUM calculations

Assess the need for 3D and/or transport codes

Design and order equipment for flux spectrum and β_e/ℓ^* measurements

Spring 1988: Complete all neutronics calculations and preliminary safety analysis

Procure equipment and begin experiments

Compare measurements and calculations of HEU

Identify and implement any necessary changes in computational methods

Summer 1988: Propose any changes required in technical specifications, emergency and security plans, training and requalification programs, etc.

Prepare and submit to NRC the updated safety analysis (application to convert)

Fall 1988: (Review period)

Make any revisions in conversion plan required by NRC

Complete all HEU core experiments

Work with B & W on LEU fuel assembly design

Spring 1989: Prepare for shipping used HEU fuel

--develop procedures consistant with NRC and DOT regulations

--make arrangements for shipping casks

--modify building fuel transfer cask

Receive order to convert

Begin to ship HEU

Summer 1989: Complete HEU shipments

Receive LEU fuel plates

Construct LEU fuel assemblies

Load LEU fuel for initial startup, and low power core physics measurements

Fall 1989: Complete all core parameter measurements

Repeat flux spectrum and β_e/l^* experiments for LEU fuel

Compare predicted and actual LEU core characteristics

Analyze any discrepancies and their impact on safety analysis

Spring 1990: Make final changes in procedures

Prepare and submit final reports to DOE and NRC

VII. Budget

The total amount requested of DOE over the period August 1987 through May 1990 is $170,915. As requested, indirect costs will be born by Iowa State University since this is an assistance grant rather than a research proposal. Table 4 is a list of the yearly expenditures, corresponding to the workplan presented in Table 3.

By far, the largest portion of the grant will be salaries of the faculty, students, and technicians working on the conversion project. The division of labor among the faculty is as follows:

Dr. Richard A. Hendrickson, Reactor Manager and Professor

--administrative functions such as NRC communications, SNM inventory, etc.

--supervision of $\beta e/\ell^*$ measurements

--assistance in the preparation of the updated Safety Analysis Report

Dr. Alfred F. Rohach, Professor

--supervision of computational work in the safety analysis phase

--assistance in the preparation of the updated SAR

Dr. Robert E. Williams, Assistant Professor and Senior Reactor Operator

--project management, liason with DOE

--supervision of flux spectrum measurements

--preparation of the updated SAR

--training additional technicians, RO's

--supervision of HEU fuel transfer, LEU fuel loading, and startup experiments

--preparation of final reports to DOE and NRC

Additional personnel requirements are:

--two half-time graduate research assistants to perform calculations and conduct experiments

--technicians required by fuel transfer procedures (crane operators, helpers)

--reactor operators required for experimental measurements, fuel loading, start up experiments

--health physics technicians required to monitor all materials removed from the core, monitor all experiments, survey shipping cases for quality assurance, etc.

Faculty member's workload on the conversion project are:

--Hendrickson 10%

--Rohach 10% (9 months)

25% (2 months, summer 1988)

--Williams 10% (academic year)

50% (2 months, summer 1988)

100% (2 1/2 months, summer 1989)

The ISU Engineering Research Institute policy for budgeting future salaries now calls for 10% increases per year; the Nuclear Engineering Department policy calls for increasing graduate student monthly salaries by $50 per year.

An additional list of equipment costs is presented in Table 5. The fission chambers, filters, and picoammeter are required for the β_e/l^* measurements described in Section IV (ISU already has one picoammeter; two will be needed). Foils and flux wires will be needed for the neutron flux spectrum measurements. The prices are 1987 quotations from the vendors indicated. All equipment will be purchased this year because measurements of the HEU core will begin shortly after receipt of funds.

Under the heading of supplies and services, there are a few major items in addition to routine services like phone costs, drafting services, shop time, etc. In the first year four irradiation foil holders will have to be built, and NBS calibration services will be required for absolute flux measurement. Modifications to the suspension system of the reactor fuel transfer cask will be made in the second year.

Finally there is a $2,000 request for travel expenses. It is expected that attending future RERTR and TRTR meetings concerning the HEU to LEU conversion will be necessary. There may also be a need to travel to Argonne or Babcock and Wilcox for consultations.

Table 4. Budget

Item	First Year Paid by DOE	First Year Paid by ISU	Second Year Paid by DOE	Second Year Paid by ISU	Third Year (10 Months) Paid by DOE	Third Year (10 Months) Paid by ISU
Personnel Costs						
Principle Investigator, R. E. Williams 10% time, 9 months (AY) 50% time, 2 months (SS 88) 100% time, 2½ months (SS 89)	8,285		16,320		4,750	
Co-Investigator, R. A. Hendrickson 10% time	5,600		6,160		5,650	
Co-Investigator, A.F. Rohach 10% time, 9 months 25% time, 2 months	6,415					
Total Faculty Salaries	$20,300		$22,480		$10,400	
Faculty Fringe Benefits @ 21.7%	4,405		4,880		2,255	
Reactor Operators/Technicians						
RO @ $10/hr 400 hr			4,000		1,000	
Technicians @ $6/hr 600 hr			3,600			
Health Physics @ $20/hr 320 hr			6,400			
Fringe Benefits @ 25.6%			1,640			
Research Assistants, 2 @ $900/month (½ time)	21,600		22,800		20,000	
RA Fringe Benefits @ $25/month/student	600		600		500	
Computing	4,000		500		500	
Travel	700		1,500		800	
Publication Costs	500				1,000	
Supplies and Services	2,500		1,250		250	
TOTAL DIRECT COSTS	$54,605		$69,650		$36,705	
INDIRECT COST @ 36%		19,660		25,075		13,215
Equipment	9,955					
TOTAL	$64,560	$19,660	$69,650	$25,075	$36,705	$13,215
3-Year Cumulative					$170,915	$57,950

Table 5. Equipment Budget

Item	
2 LND-30772 1" x 8" fission chambers @ $1650 each	$3,300
2 Krohn-Hite 3321 Variable Filters @ $1125 each	$2,250
1 Keithley 485 Picoammeter	$2,100
Cables, connectors and batteries	$ 300
Reactor Experiments:	
1 set of Neutron dosimetry foils Cat. no. 1553	$1,195
1 flux-wire evaluation kit Cat. no. 1650	$ 810
	$9,955

VIII. References

1. Title X, Code of Federal Regulations (10 CFR 50.64).

2. R. A. Hendrickson, R. A. Danofsky, A. F. Rohach, and D. M. Roberts, Safety Analysis Report for the Training Reactor UTR-10, Report ISU-ERI-Ames-82418 (August 1981).

3. H. H. Young, K. R. Brown, and J. E. Matos, "Conversion and Standardization of University Reactor Fuels Using Low-Enrichment Uranium: Plans and Schedules". Presented at the International Meeting on Reduced Enrichment for Research and Test Reactors (RERTR), November 3-6, 1986, Gattlinburg, Tennessee.

4. Safety Evaluation Report, related to the renewal of the operating license for the Research Reactor at the Iowa State University, U.S. Nuclear Regulatory Commission, NUREG-1016 (September 1983).

5. N. Tsoulfanidis, Measurement and Detection of Radiation, pp. 452-456, McGraw Hill (1983).

6. F. W. Stallmann, "LSL-M2: A Computer Program for Least-Squares Logarithmic Adjustment of Neutron Spectra", NUREG/CR-4349 (March 1986).

7. F. G. Perey, "Least Squares Dosimetry Unfolding: The Program STAYSL, ORNL/TM-6062 (1977); modified by L. Greenwood, Argonne National Laboratory (1979).

8. Uhrig, R. E., Random Noise Techniques in Nuclear Reactor Systems, The Ronald Press Company, New York (1970).

APPENDIX A

Communications with DOE

Department of Energy
Washington, D.C. 20545

NOV 21 1986

Dr Robert E. Williams
Department of Nuclear Engineering
Iowa State University
Ames, IA 50011

Dear Dr. Williams:

This letter is to inform you that funding is available during FY-87 through the U.S. Department of Energy to initiate the conversion of your reactor from HEU to LEU fuel. It is requested, therefore, that you submit a proposal, including a detailed cost estimate, to accomplish the safety analysis phase of the conversion. The proposal should not include costs for the new fuel,spent fuel cask rental, or fuel shipping since these tasks are being handled by others.

You are also reminded that technical assistance for safety documentation review and analysis is available through the RERTR program at the Argonne National Laboratory. Your proposal should be coordinated with and reflect the degree of support to be provided by RERTR/ANL.

We would like to receive your proposal by January 15, 1987. Please direct it to:

Mr. Richard E. Stephens, Director
Division of University and Industry Programs
Office of Field Operations Management
Office of Energy Research
U.S. Department of Energy
Washington, D.C 20585

If you have any questions, please call me or Keith Brown on 301-353-3995.

Sincerely yours,

Harold H. Young

Harold H. Young
Division of University & Industry Programs
Office of Field Operations Management
Office of Energy Research

cc: R. Stephens, ER-44
A. Travelli, RERTR/ANL

IOWA STATE
UNIVERSITY

Department of Nuclear Engineering
261 Sweeney Hall
Ames, Iowa 50011

Telephone 515-294-5840

January 12, 1987

Mr. Richard E. Stephens, Director
Division of University and Industry Programs
Office of Field Operations Management
Office of Energy Research
U.S. Department of Energy
Washington, D.C. 20585

Dear Mr. Stephens:

I received a letter from Harry Young dated November 21, 1986, stating that funds for conversion of our UTR-10 reactor at ISU from HEU to LEU fuel are now available. He requested I send our proposal for a DOE assistance grant for the cost of the safety analysis phase of the conversion by January 15, 1987. I am currently working on this proposal, but I will not be able to meet the January 15 deadline.

On December 12, I talked with Keith Brown by phone, and requested some additional time to get our proposal together. He indicated I could take a few more weeks, so my plan is to submit the proposal early in February. I just wanted to let you know that we have every intention of starting the conversion process as soon as possible, and that you will receive our proposal shortly.

Please let me know if there is anything else I need to do (515-294-9279).

Sincerely,

Robert E Williams

Robert E. Williams Ph.D.
Assistant Professor of Nuclear Engineering

REW:rpa

Department of Energy
Washington, DC 20585

APR 21 1987

Dr. Robert Williams
Nuclear Engineering
Iowa State University
Ames, Iowa 50011

Dear Dr. Williams:

As per our telephone discussion regarding submittal of a proposal for financial assistance to complete the analytical studies required to accomplish conversion of the Iowa State University reactor from high enriched to low enriched uranium fuel, it is appropriate that only the anticipated direct costs be included in the proposal. ZEH

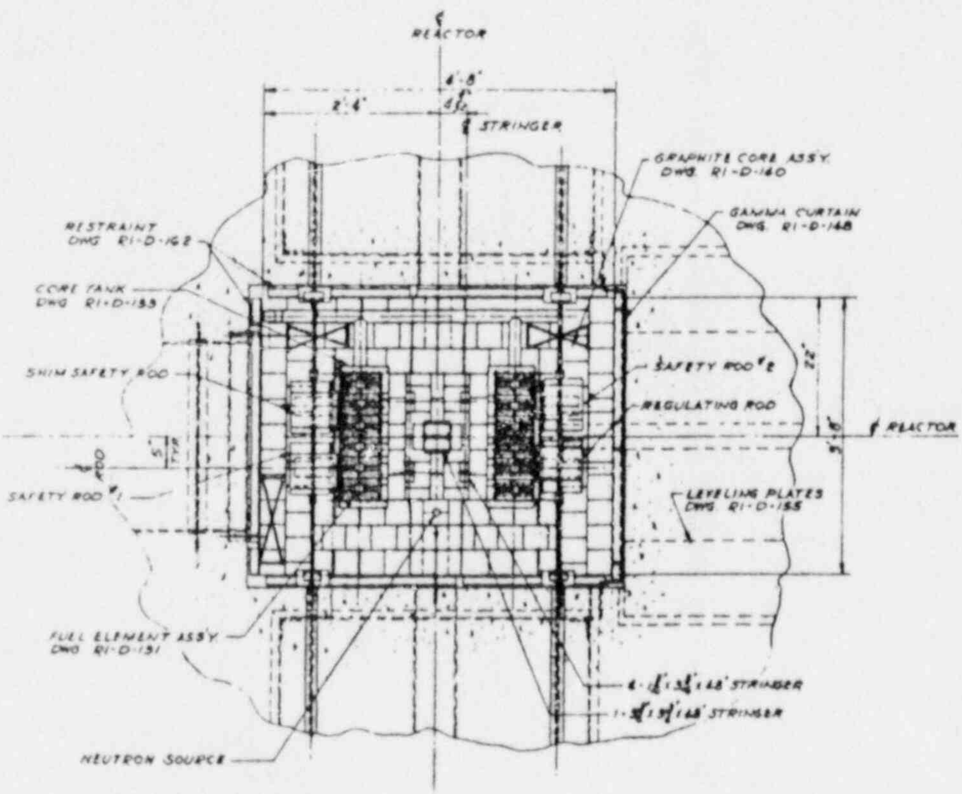
Sincerely yours,

Keith R. Brown

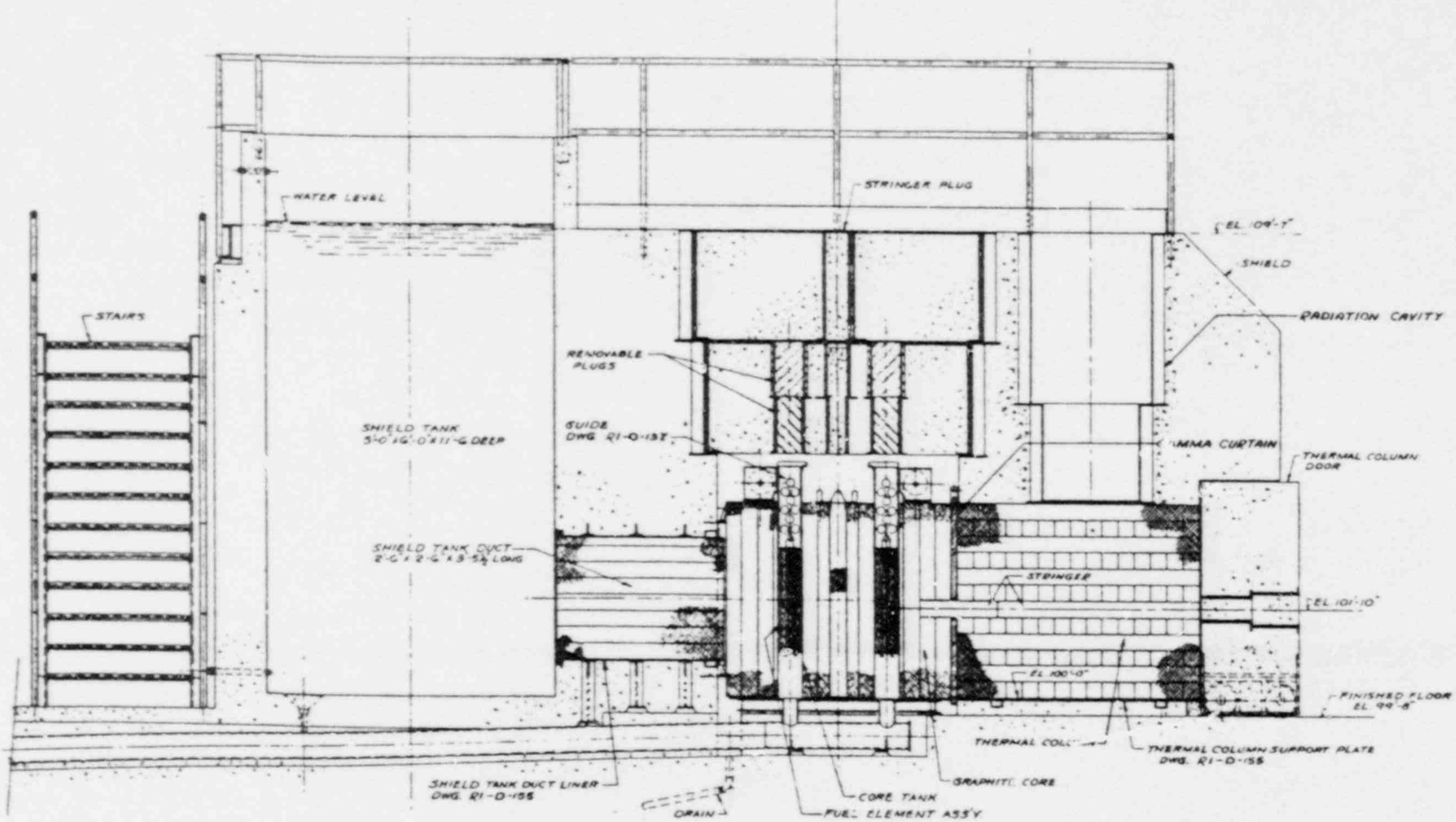
Keith R. Brown
Division of University and Industry Programs
Office of Field Operations Management
Office of Energy Research

APPENDIX B

Core Diagrams



PLAN-CORE AREA



LONGITUDINAL SECTION