UNIVERSITY OF FLORIDA
TRAINING REACTOR
LICENSE NO. R-56
DOCKET NO. 50-83

UFTR SAFETY ANALYSIS REPORT CHANGE PAGES
FOR
LICENSE RENEWAL APPLICATION

REDACTED VERSION*
SECURITY-RELATED INFORMATION REMOVED

*REDACTED TEXT AND FIGURES BLACKED OUT

UNIVERSITY OF
FLORIDA

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February 25, 2003

Attn: Document Control Room
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Changes to Support UFTR
Relicensing Application:
Corrections to FSAR Submittal

University of Florida Training Reactor (UFTR)
Facility License R-56, Docket No. 50-83

As part of our ongoing internal review of the relicensing submittal for the University of Florida Training Reactor made by letter dated July 29, 2002, a number of duplicating (printing) errors have been discovered. These errors are primarily the result of computer formatting and retrieval errors made during the document conversion process for duplication (printing) of the Final Safety Analysis Report (FSAR) to provide the copies necessary for the license renewal application. There are no actual changes to the FSAR, only corrections of errors caused by the duplication process itself as outlined below. Please note that because the pages in the July 29, 2002 submittal were printed on two sides, in some cases, a page included with this submittal will be unchanged when the correction only applies to one side.

Chapter 2: On page 2-ii, in the Index of Tables, the page number listed for Table 2-4B is 2-33 but should be 2-34; similarly, the page numbers listed for Tables 2-10 through 2-15 are various values from page 2-47 to 2-54 but should be pages 2-40 through 2-45. These pagination errors are again due to computer conversion and retrieval problems. In this case pages 2-i and 2-ii are being replaced.

Chapter 4: On page 4-iii in the Index of Figures, Figure 4-20 is listed to be on page 4-54 but is actually on page 4-55 so page 4-iii is being replaced to make this correction. Pages 4-36 through 4-70 (containing Figures 4-1 through 4-36) were missing in the submittal, again due to computer formatting and transfer problems. Pages 4-70 and 4-71 in the submittal should have been pages 4-71 and 4-72. Because the misnumbered reference page 4-69 is printed on the back of page 4-35, pages 4-35, 4-69 and 4-70 in the submittal are being replaced and the missing figures for pages 4-36 through 4-70 added along with properly paginated reference pages 4-71 and 4-72.

Chapter 9: On page 9-5, in Section 9.2.4.4, item 3, the reactivity symbol is corrected from ?k/k to $\Delta k/k$. Because page 9-6 is on the reverse of the corrected page, both pages are being replaced.

Chapter 10: On page 10-i, the Table of Figures incorrectly lists Figure 10-7 as being on page 10-10 when it should have been listed as being on page 10-11. Page 10-i is being replaced to make this correction.

A020

Chapter 11: On page 11-ii, the Index of Tables incorrectly lists Table 11-9 as being on page 11-34 when it should have been listed as being page 11-33, again because of computer formatting and transfer problems. As a result of skipping page 11-33 in the Index of Tables, on page 11-iii, all figures are listed as being on one page higher than correct. In addition, the References are on page 11-46 but were omitted in the listing in the Table of Contents on page 11-iii. Therefore, pages 11-ii (and its reverse 11-i) and 11-iii are being replaced. In addition, because page 11-33 was skipped, originally submitted pages numbered 11-34 to 11-46 (twice) containing Table 11-9, Figures 11-1 through 11-12, and the references are also being replaced with correctly paginated pages 11-33 through 11-46.

Chapter 12: On page 12-13, in Section 12.3.2.2.5, in item 7, in lines 4 and 5 the reactivity symbol was incorrectly formatted by the computer as ?k/k. The corrected page 12-13 has the proper Δk/k symbol in both lines; both page 12-13 and its reverse page 12-14 are being replaced.

As indicated in the original submission, all the revision changes were already fully reviewed by UFTR management and the Reactor Safety Review Subcommittee (RSRS). The pages submitted here simply correct the errors introduced by the computerized duplication process. Nevertheless, this submittal has also been reviewed by UFTR management and the RSRS to assure proper documentation.

This entire package consists of one signed original letter of transmittal with referenced enclosures including a cover sheet indicating how to correct the July 29, 2002 FSAR submittal plus ten copies of the entire package. If further information is required, please advise.

Sincerely,

William G. Vernetson
Director of Nuclear Facilities

WGV/dms
Enclosures

cc: A. Adams, NRC Project Manager
NRC Region II
Reactor Safety Review Subcommittee

Sworn and subscribed this 26th day of February 2003.

Notary Public

Daniel J. Sanetz
MY COMMISSION # DD061176 EXPIRES
September 30, 2005
BONDED THRU TROY FAIN INSURANCE, INC.

CORRECTIONS TO SUBMITTAL OF CHANGES TO SUPPORT RELICENSING APPLICATION FINAL SAFETY ANALYSIS REPORT FOR THE UNIVERSITY OF FLORIDA TRAINING REACTOR FACILITY LICENSE R-56, DOCKET NO. 50-83

The pages included here correct the University of Florida Training Reactor (UFTR) Final Safety Analysis Report (FSAR) submitted with a letter dated July 29, 2002 and other materials to support UFTR relicensing. To assure a complete copy of the FSAR as submitted for relicensing, the following pages should be substituted to replace existing pages as indicated below:

Chapter Affected	Remove Page(s)	Substitute/Add Page(s)
Chapter 2	Pages 2-i to 2-ii	Pages 2-i to 2-ii
Chapter 4	Page 4iii Pages 4-35, 4-69, 4-70	Page 4iii Pages 4-35 to 4-72
Chapter 9	Pages 9-5 to 9-6	Pages 9-5 to 9-6
Chapter 10	Page 10-i	Page 10-i
Chapter 11	Pages 11-i to 11-iii Pages 11-34 to 11-46 (2x)	Pages 11-i to 11-iii Pages 11-33 to 11-46
Chapter 12	Pages 12-13 to 12-14	Pages 12-13 to 12-14

02/25/2003

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Table 4-20 **Overpower transient analysis results: Comparison of estimated UFTR peak temperatures midway through (or at the axial centerline of) the hot plate during 500% and 625% overpower transients. Reactor at full power (100 kW_{th}) [23].**

Fuel Type Plates/Dummies	**HEU** **11/2.5**	
Case Hot channel factor Volumetric flow rate (gpm) Fluid inlet temperature (°F)	 1.5 40 115	 1.5 43.5 105
500 % OVERPOWER		
Fuel Centerline-to-Coolant ΔT (°F)	181.62	181.62
Fuel Centerline Temperature (°F)	310.1	299.12
Clad Outer Temperature (°F)	308.84	297.68
Clad Outer-to-Coolant ΔT (°F)	180.18	180.18
625 % OVERPOWER		
Fuel Centerline-to-Coolant ΔT (°F)	226.98	226.98
Fuel Centerline Temperature (°F)	355.46	344.48
Clad Outer Temperature ((°F)	353.84	342.68
Clad Outer-to-Coolant ΔT (°F)	225.18	225.18

[redacted]

Figure 4-1 Longitudinal Section Diagram of UFTR

[redacted]

Figure 4-2 Transverse Section through the UFTR Core Center

[redacted]

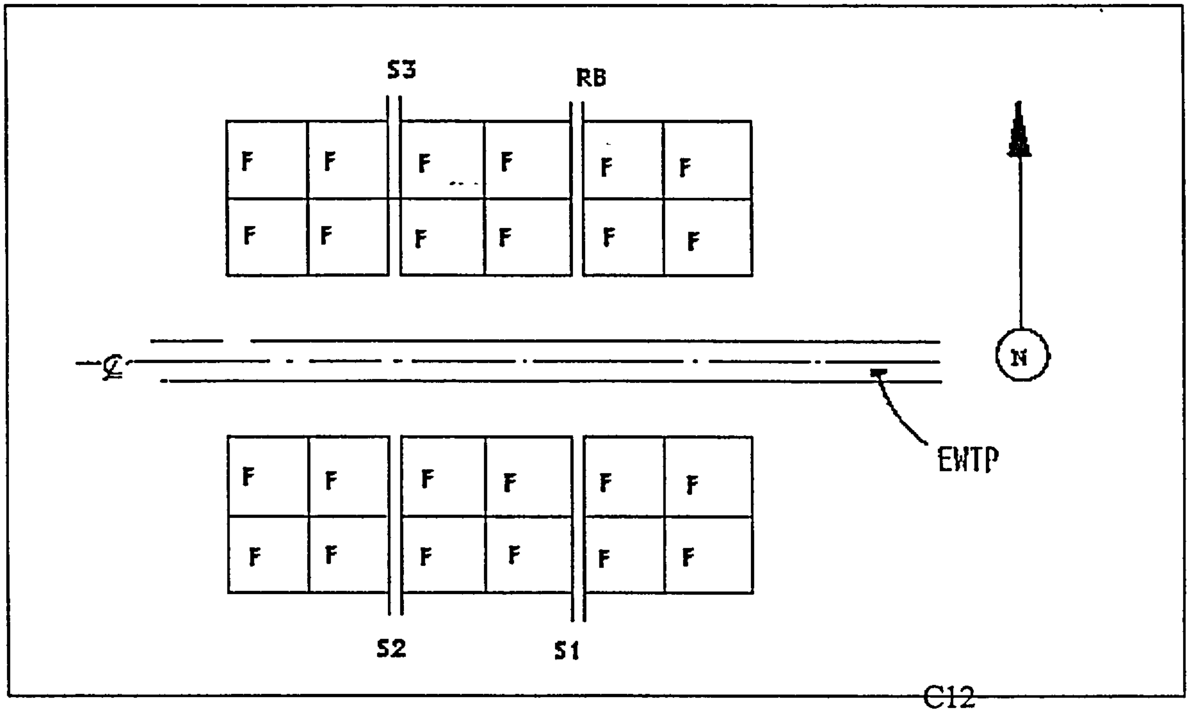
Figure 4-3 Horizontal Section Diagram of UFTR at Beam Tube Level

[redacted]

Figure 4-4 Isometric Sketch of the UFTR with Shielding Removed.

[redacted]

Figure 4-5 Isometric Diagram of UFTR Components



NOMENCLATURE :

F	=	FUEL BUNDLE	S1	=	SAFETY BLADE 1
RB	=	REGULATING BLADE	S2	=	SAFETY BLADE 2
			S3	=	SAFETY BLADE 3

EWTP= EAST-WEST THROUGHPORT
C12 = Reactor graded graphite

Figure 4-6 Vertical Section View of UFTR Core Illustrating Fuel and Fuel Box Arrangement

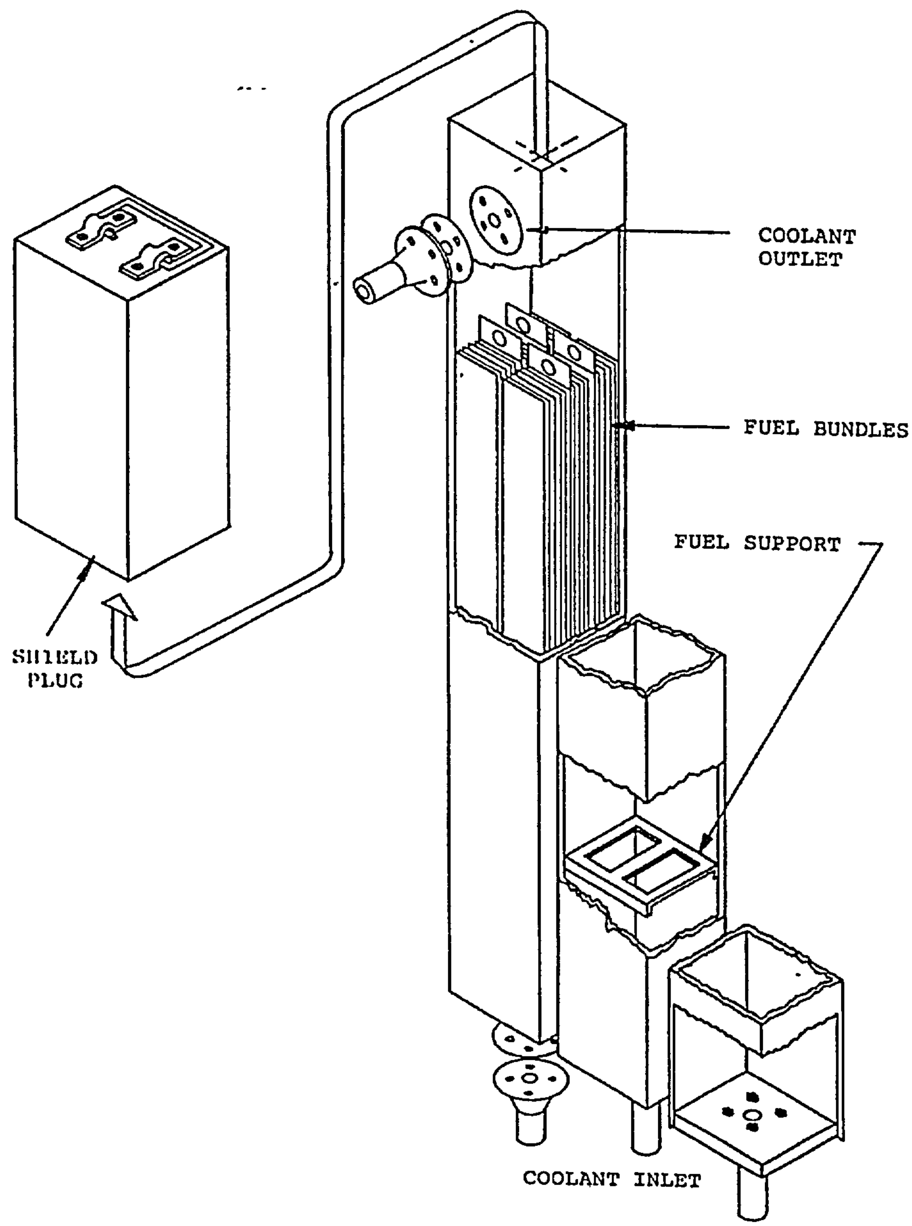
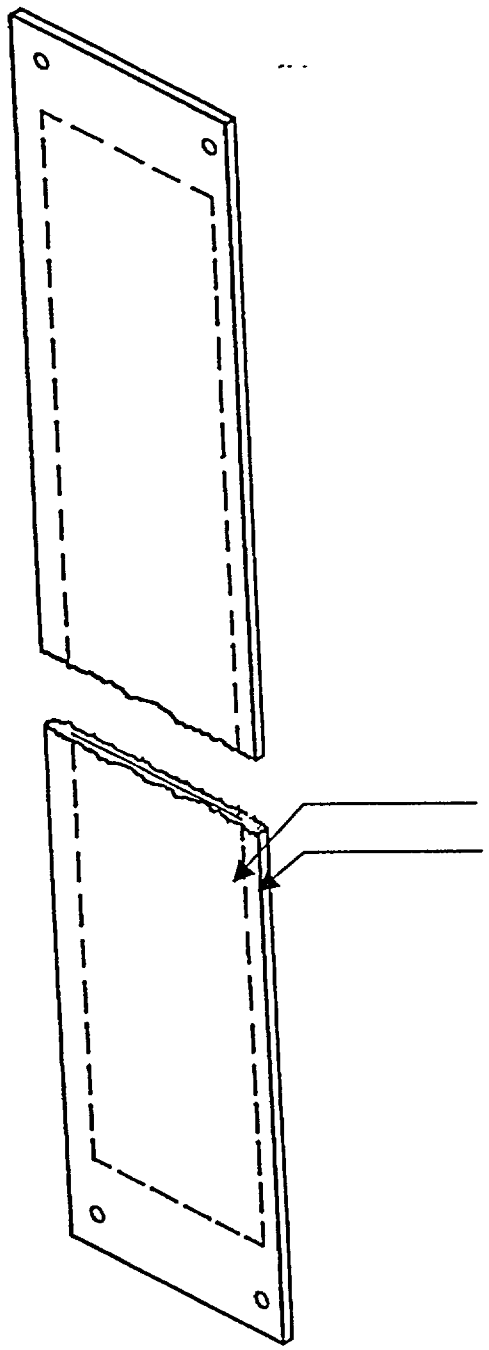


Figure 4-7 Isometric of UFTR Fuel Boxes



Length of plate	25.625"
Width of plate	2.845"
Thickness of plate	0.07"
Thickness of cladding	0.015"
Thickness of U-Al	0.040"
Weight of U-235 per plate	14.5 g
Uranium enrichment	93%

Figure 4-8 Schematic showing UFTR HEU Fuel Plate Geometry

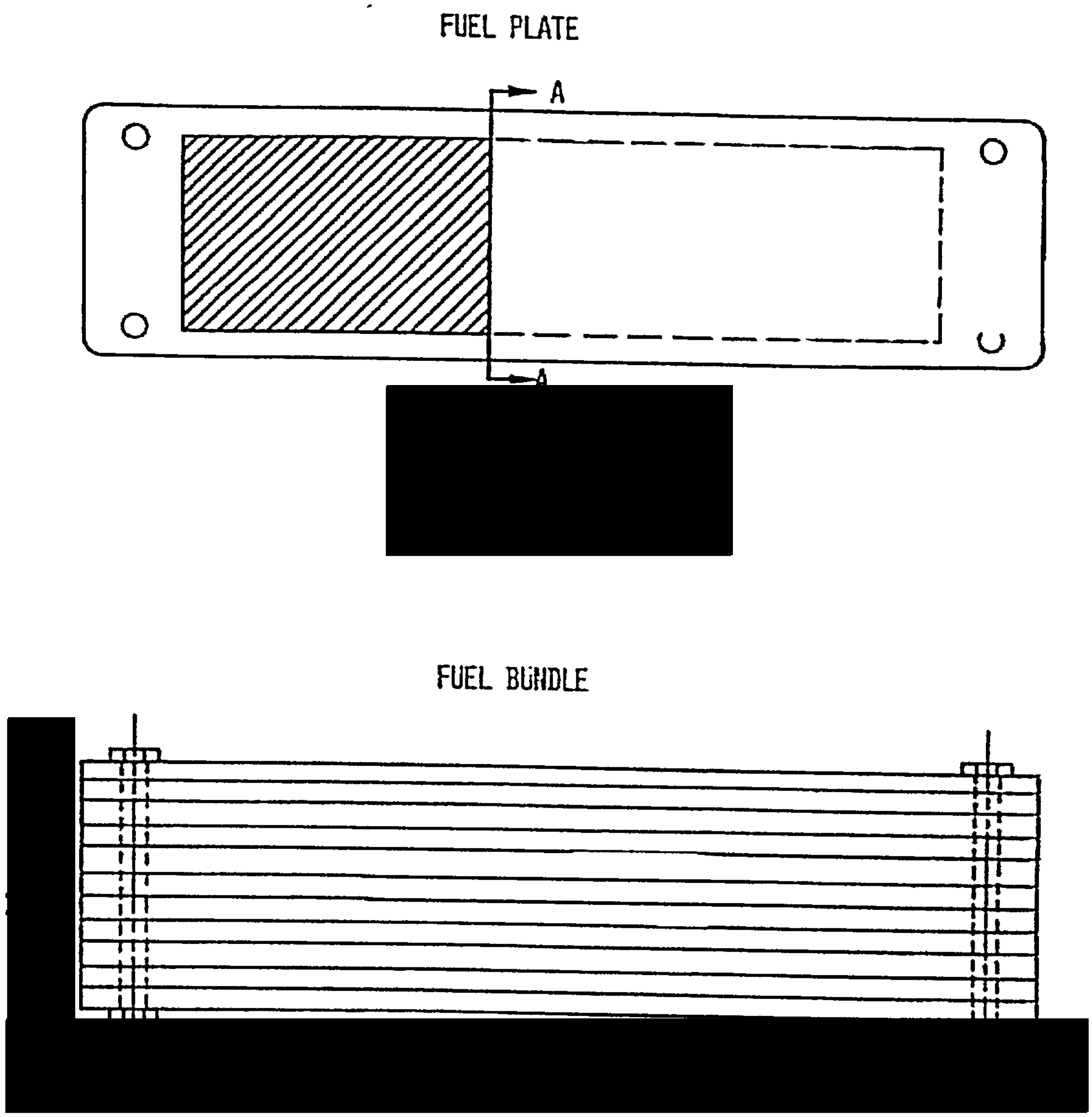


Figure 4-9 UFTR Fuel Plate and Fuel Bundle Geometric Arrangement

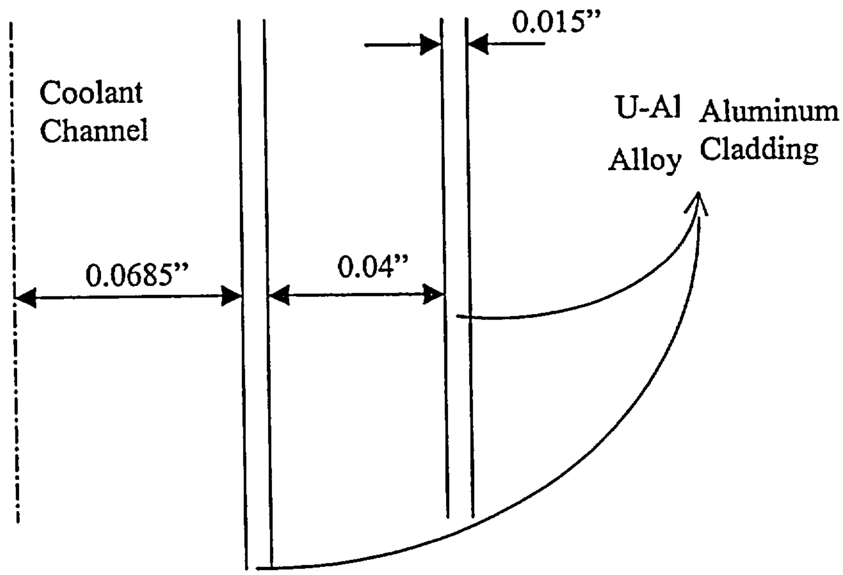


Figure 4-10 Fuel Plate/Coolant Channel Enlargement Showing UFTR Cell Arrangement Detail

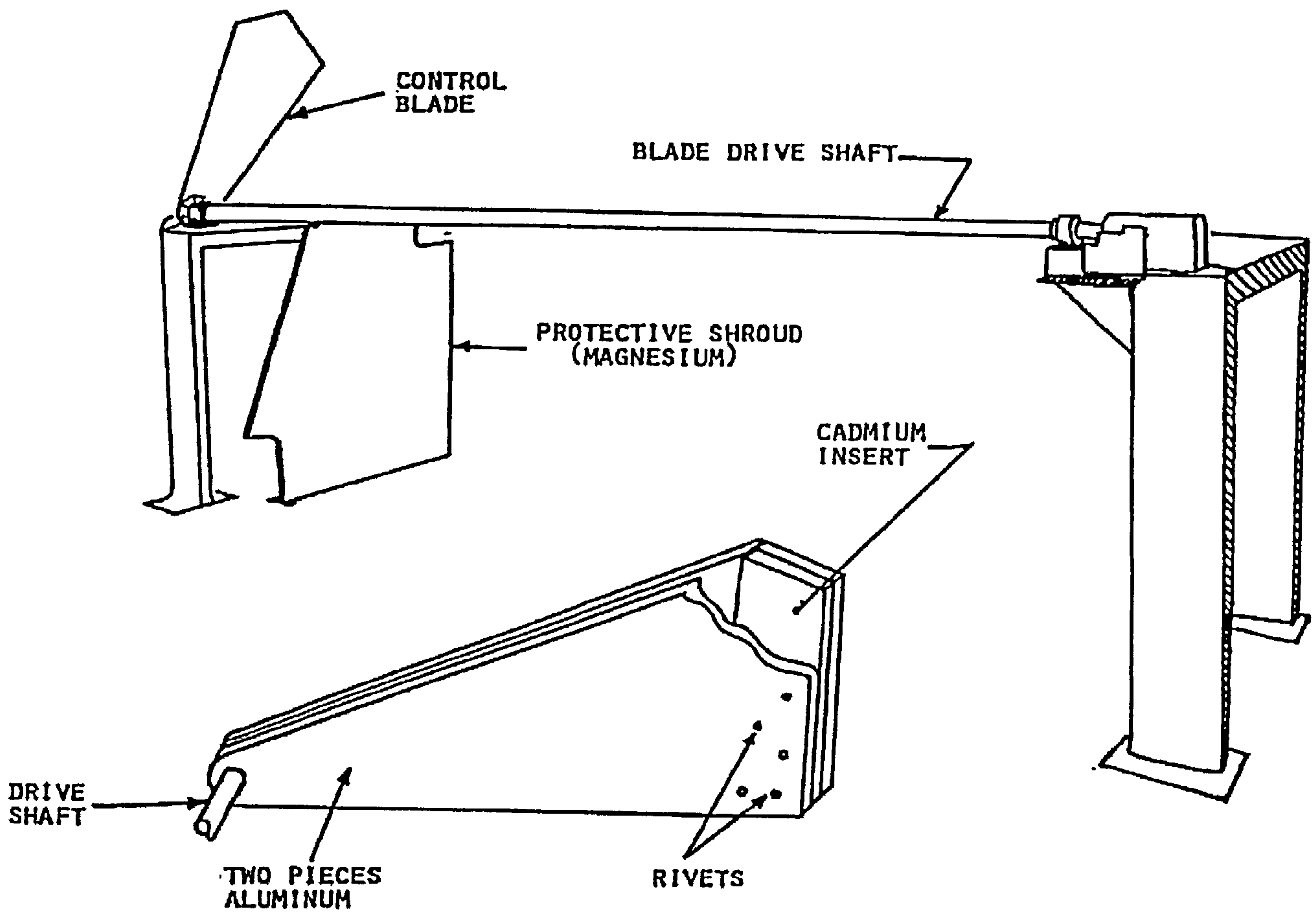


Figure 4-11 UFTR Control Blade and Drive System

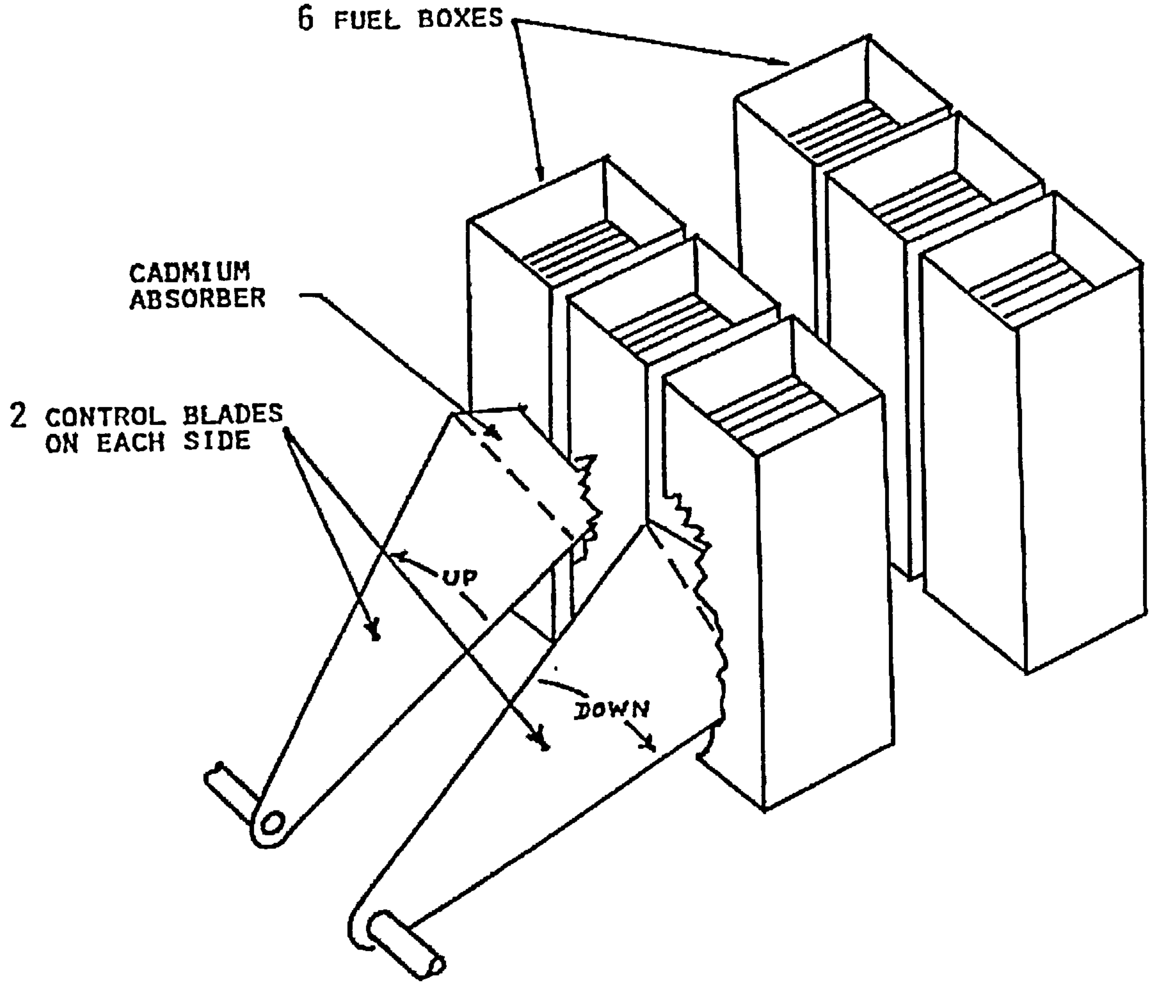


Figure 4-12 UFTR Core Sketch showing operation of Control Blades

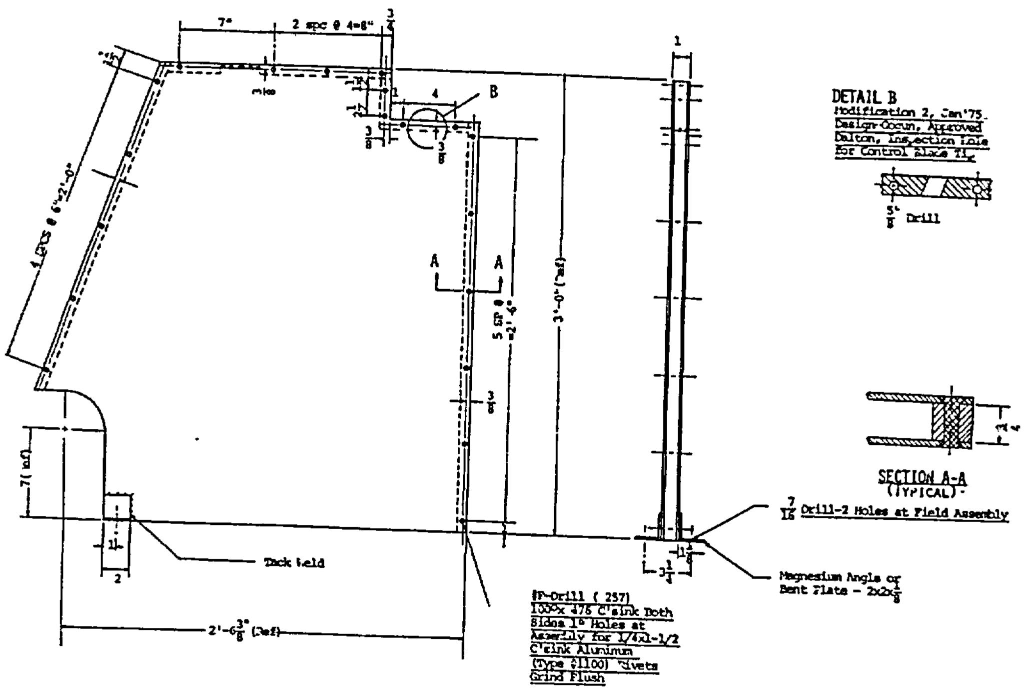


Figure 4-13 UFTR Control Blade Shroud Assembly

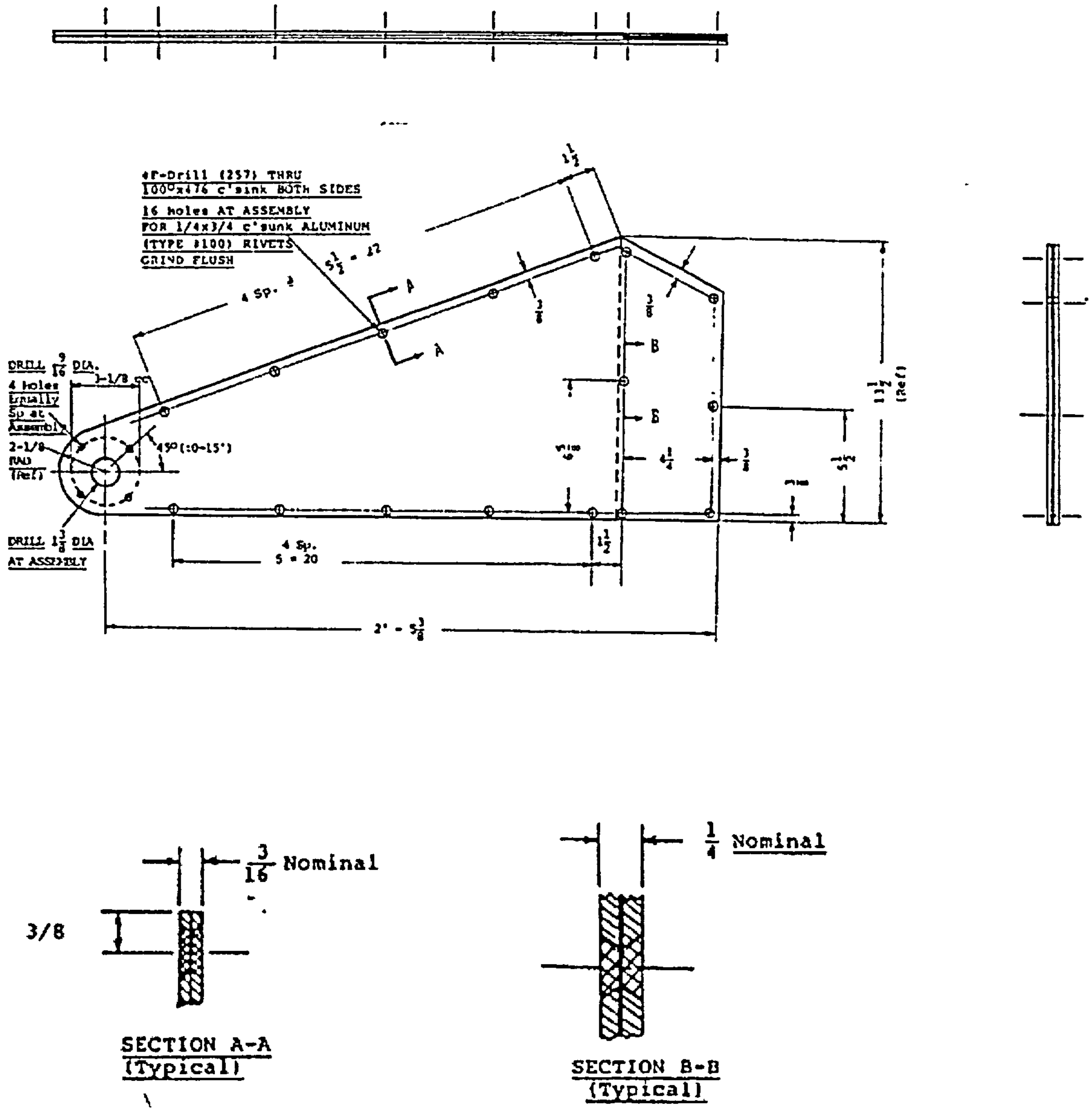


Figure 4-14 UFTR Control Blade Assembly

[redacted]

Figure 4-15 Geometric Arrangement of Major UFTR Experimental Facilities

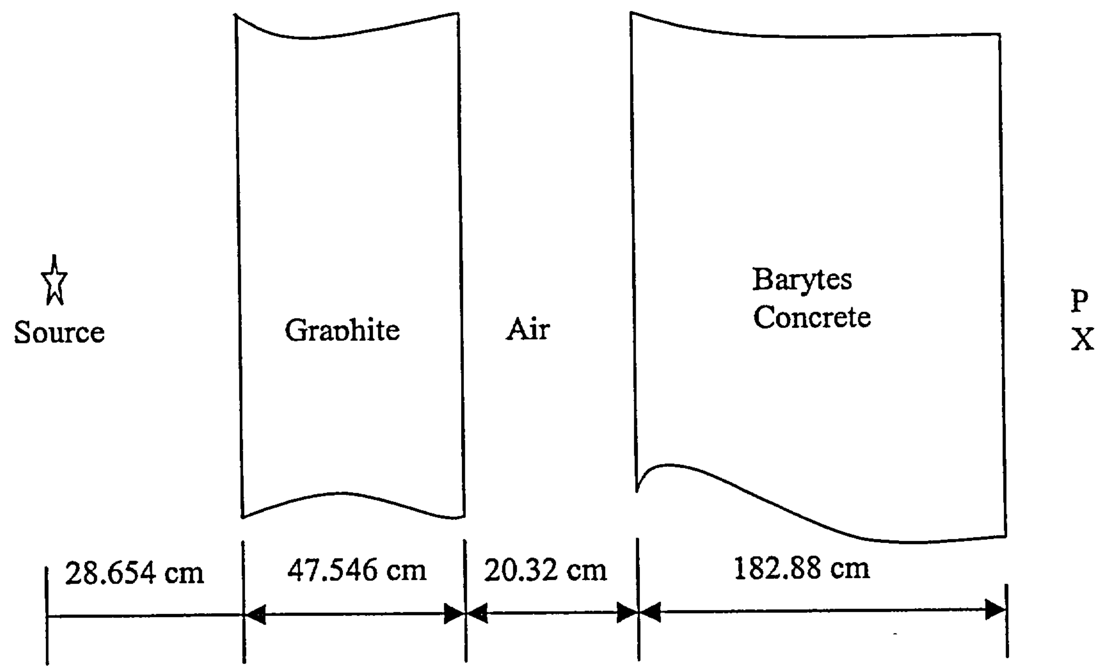


Figure 4-16 Core Gamma Shielding Model for North or South Face of the UFTR [6]

[redacted]

Figure 4-17 UFTR Core Map

[redacted]

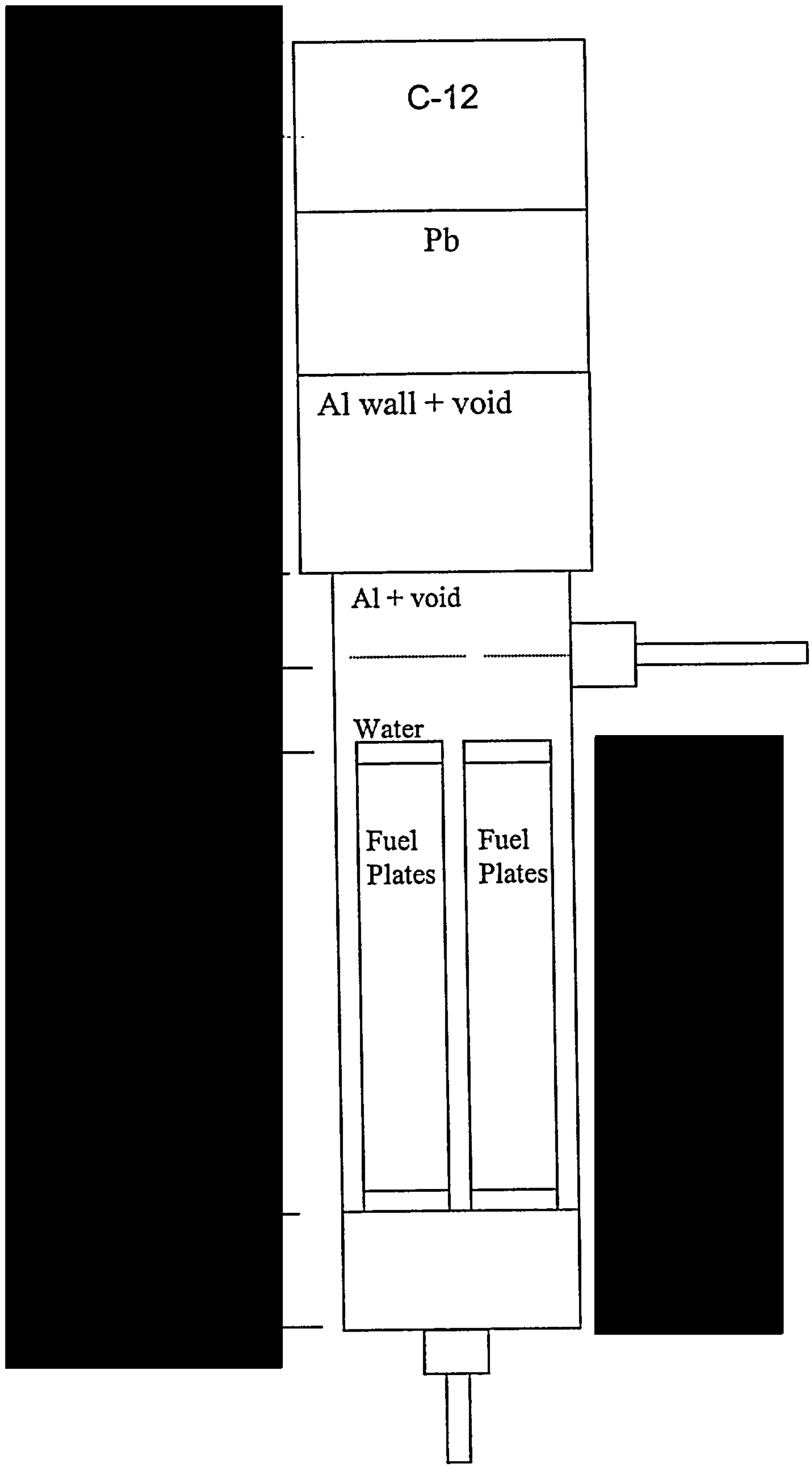


Figure 4-18 UFTR Fuel Box Axial View, dimensions in mm

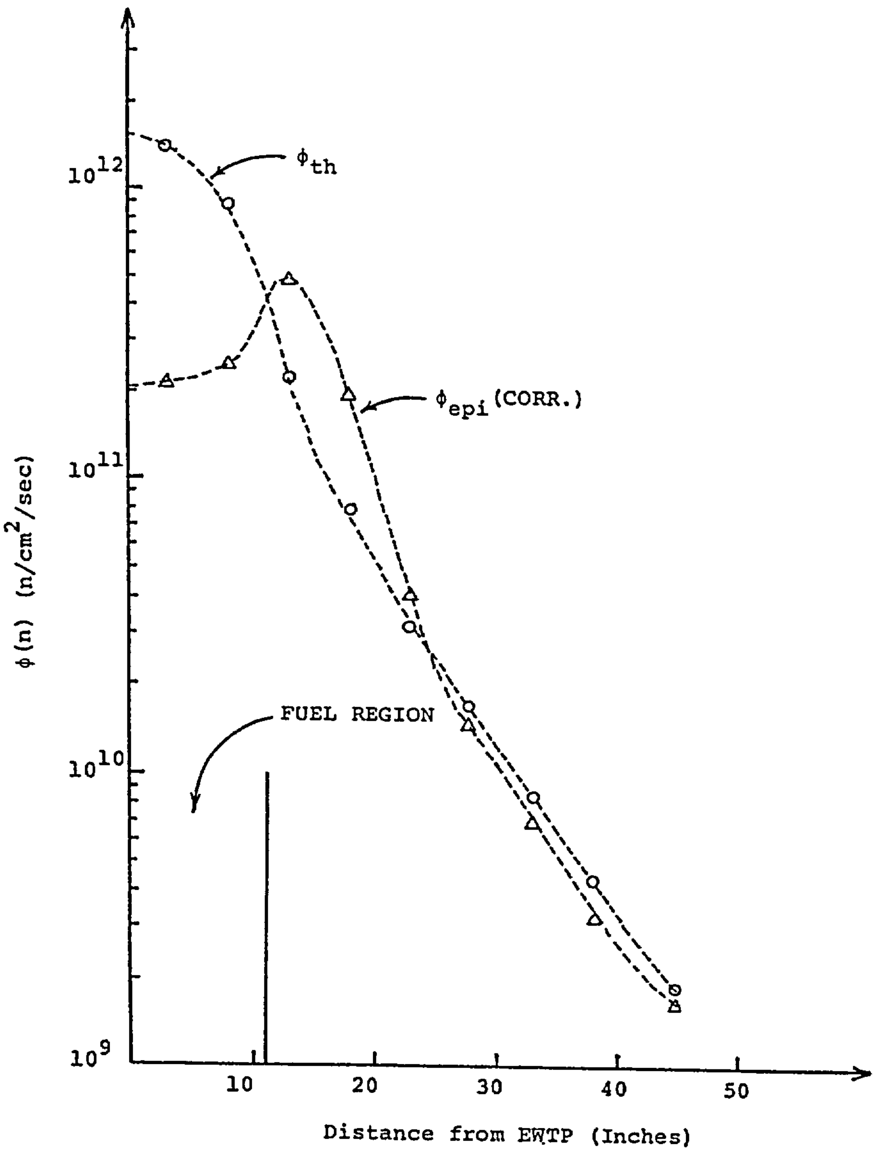


Figure 4-19 UFTR Absolute Flux Measurements Results in CVP (Gold Foil) [2]

[redacted]

Figure 4-21 UFTR Quarter Fuel Box Unit Assembly [6]

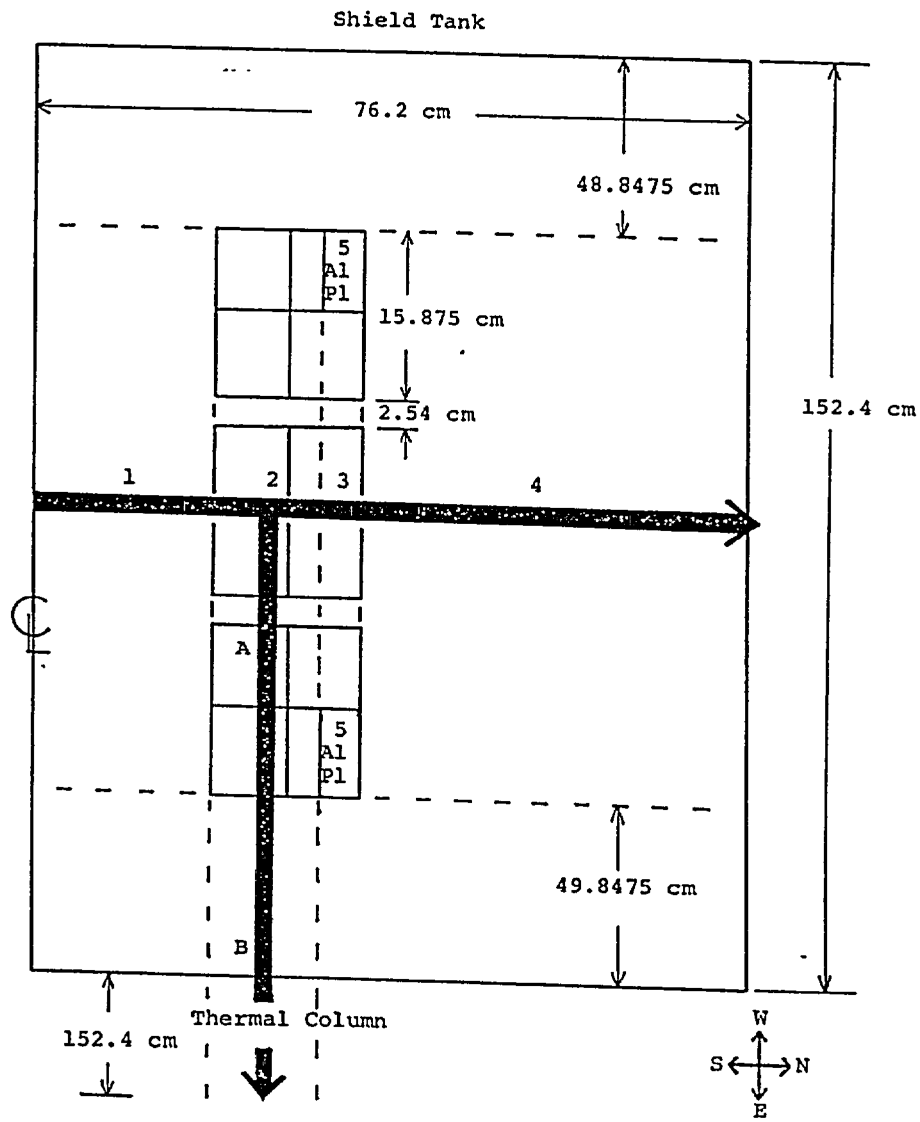


Figure 4-22 Model of UFTR Core region (Top View) used for CORA Calculations [6]

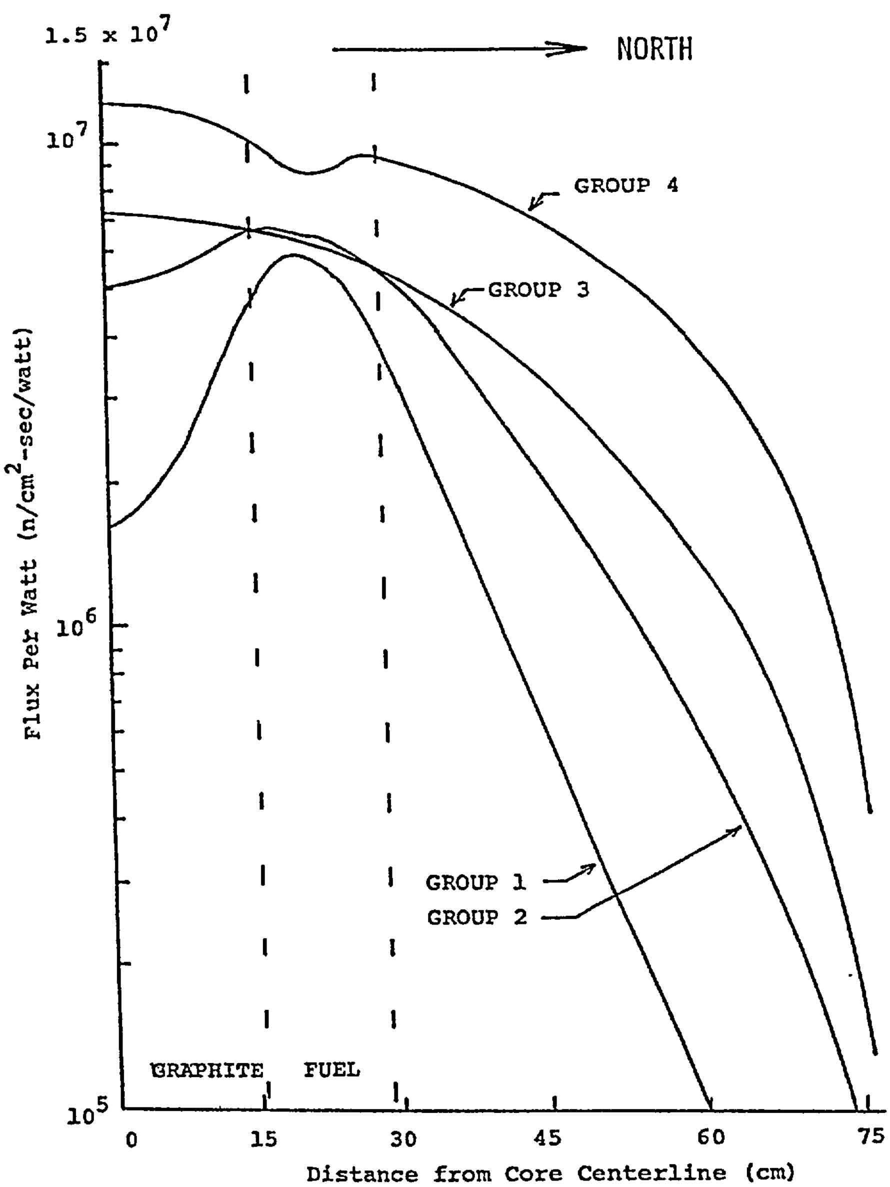


Figure 4-23 Group-dependent Fluxes Along the North-South Direction – Cora Code Calculations [6]

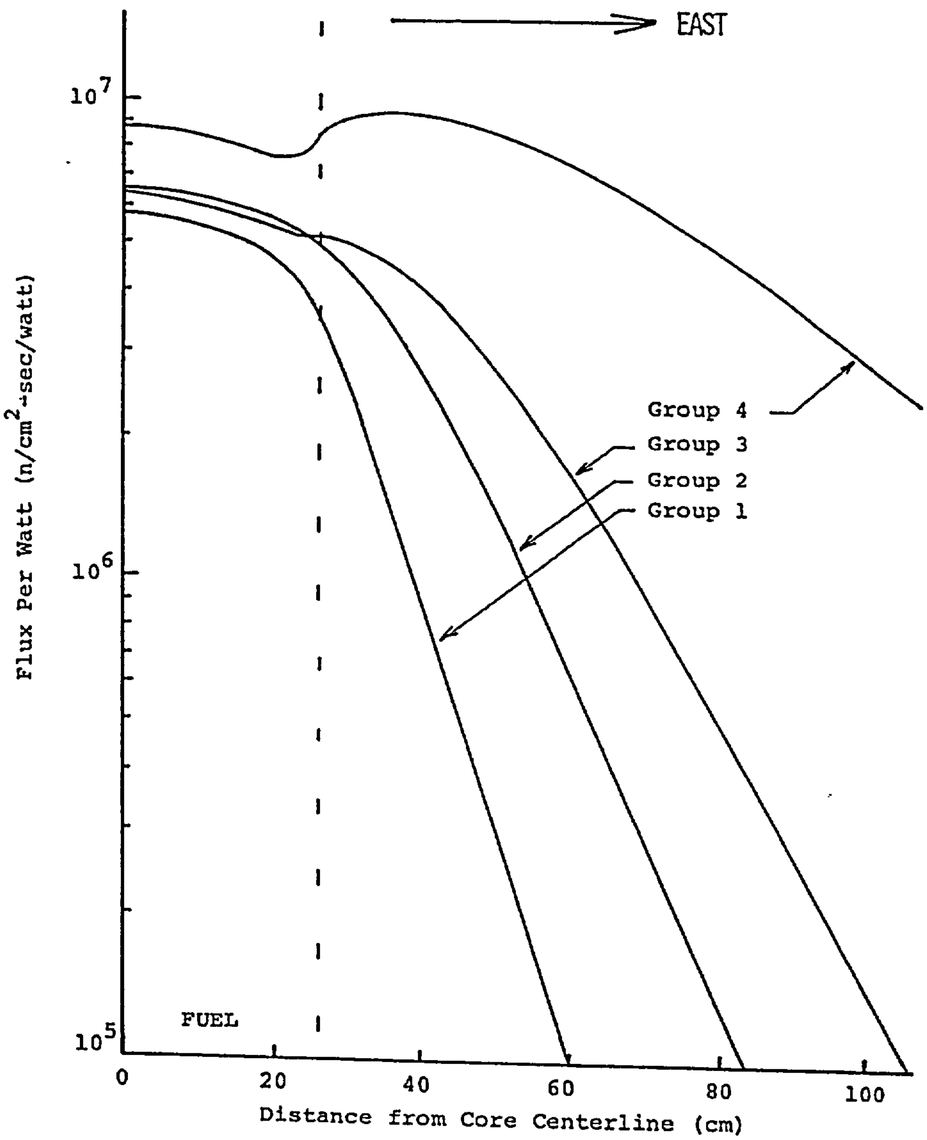


Figure 4-24 Group-dependent Fluxes Along the East-West Direction – Cora Code Calculations [6]

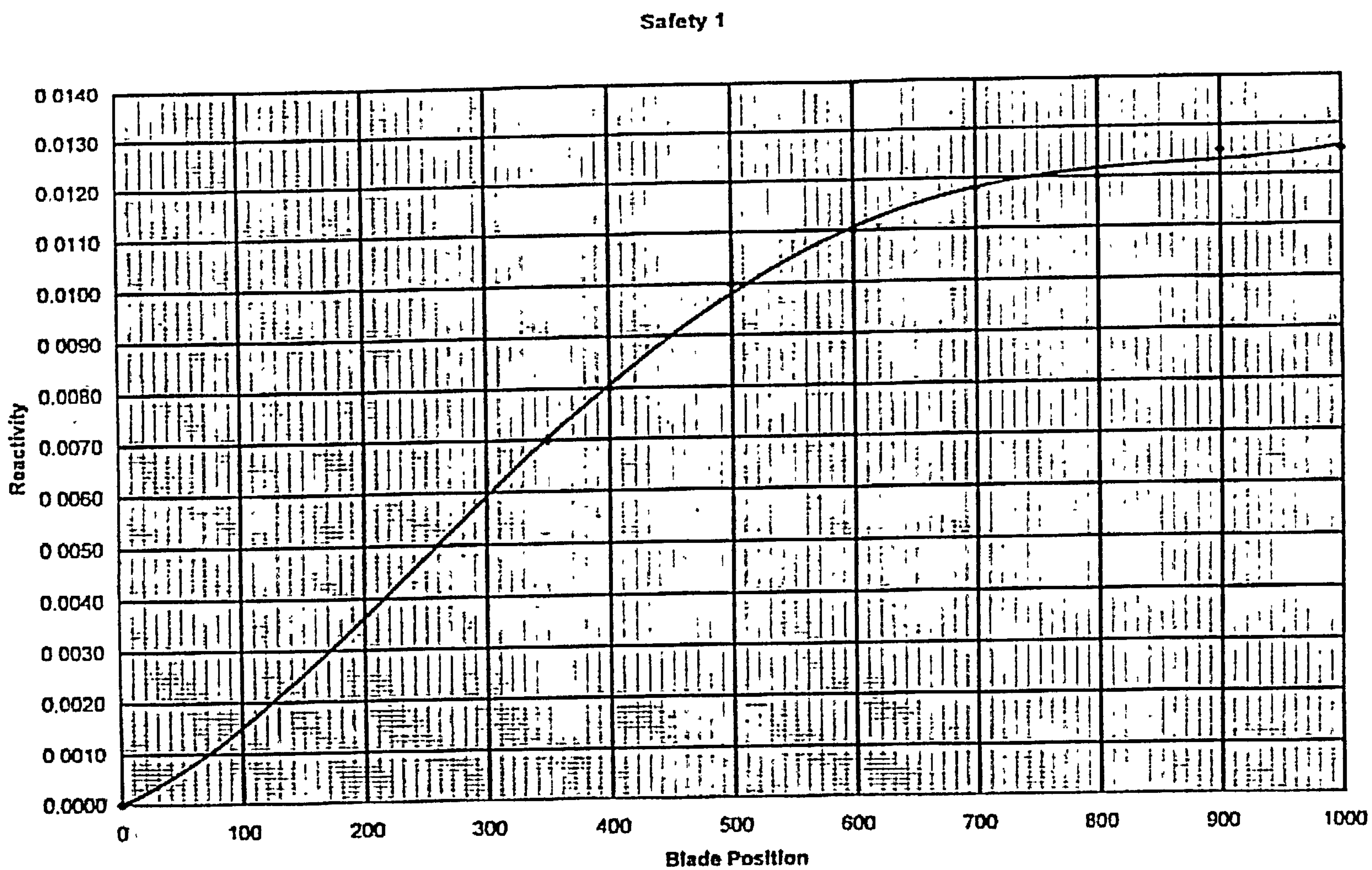


Figure 4-25 Reactivity Integral Rod Worth Curve for UFTR Safety Blade #1

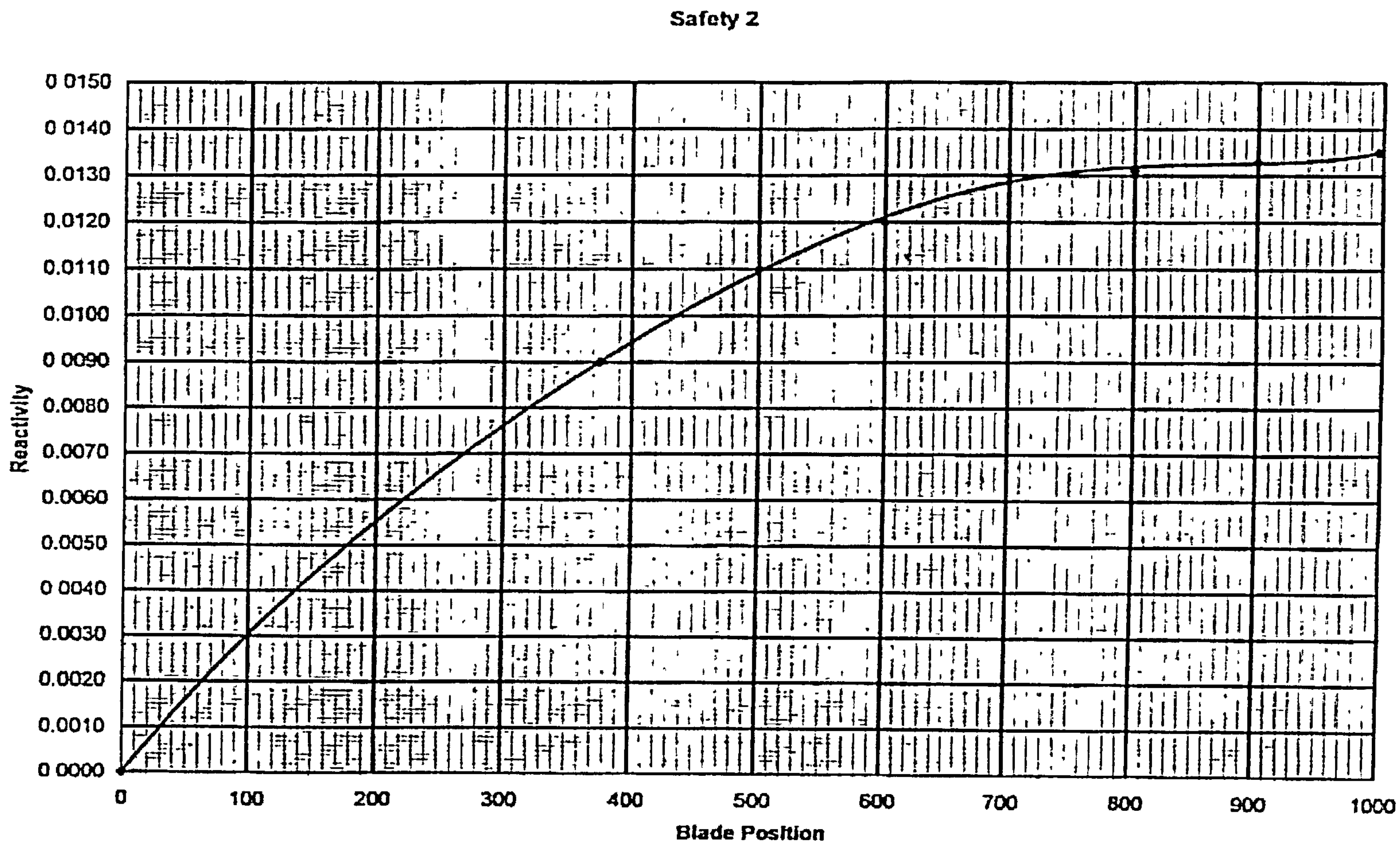


Figure 4-26 Reactivity Integral Rod Worth Curve for UFTR Safety Blade #2

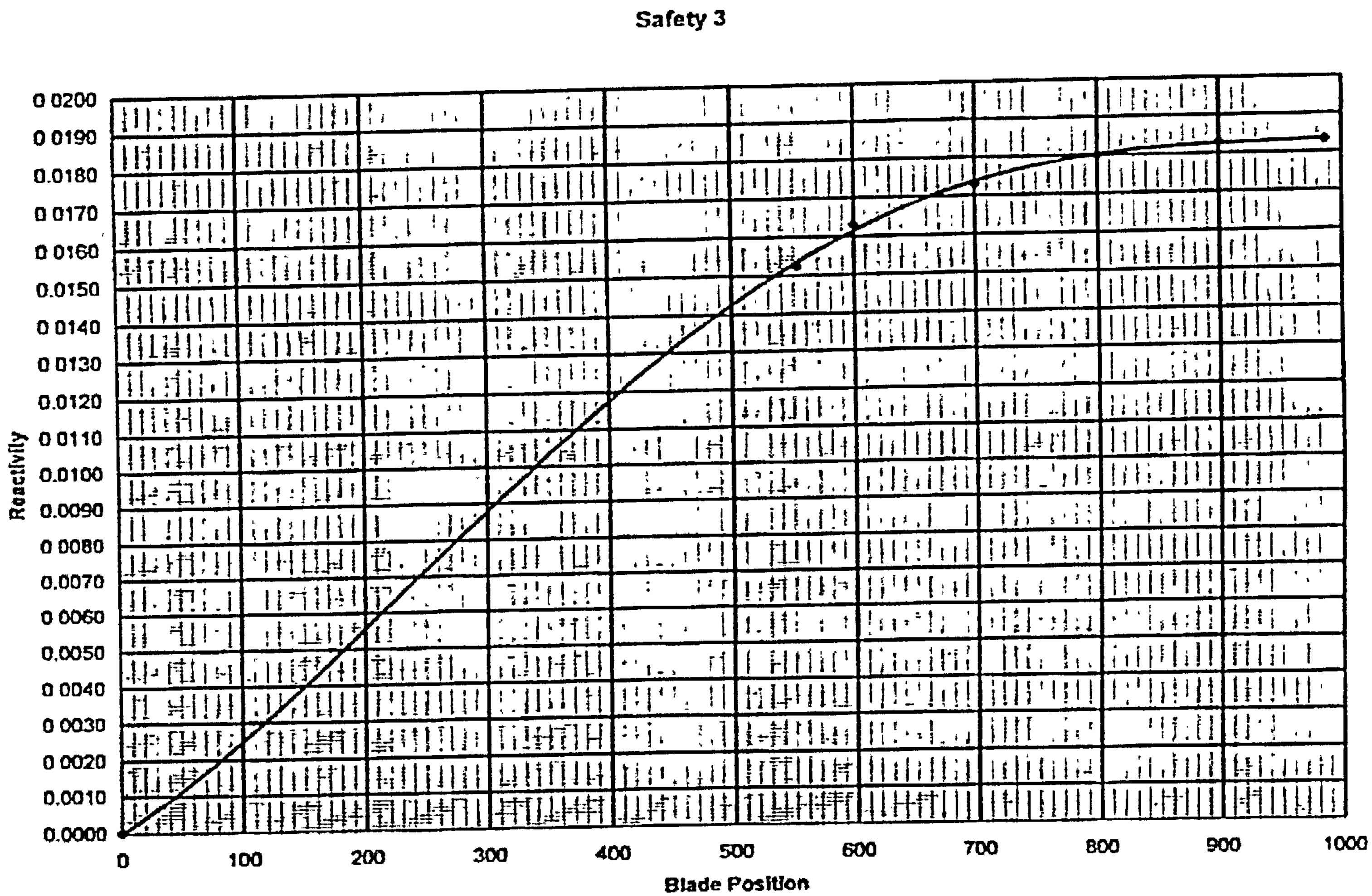


Figure 4-27 Reactivity Integral Rod Worth Curve for UFTR safety Blade #3

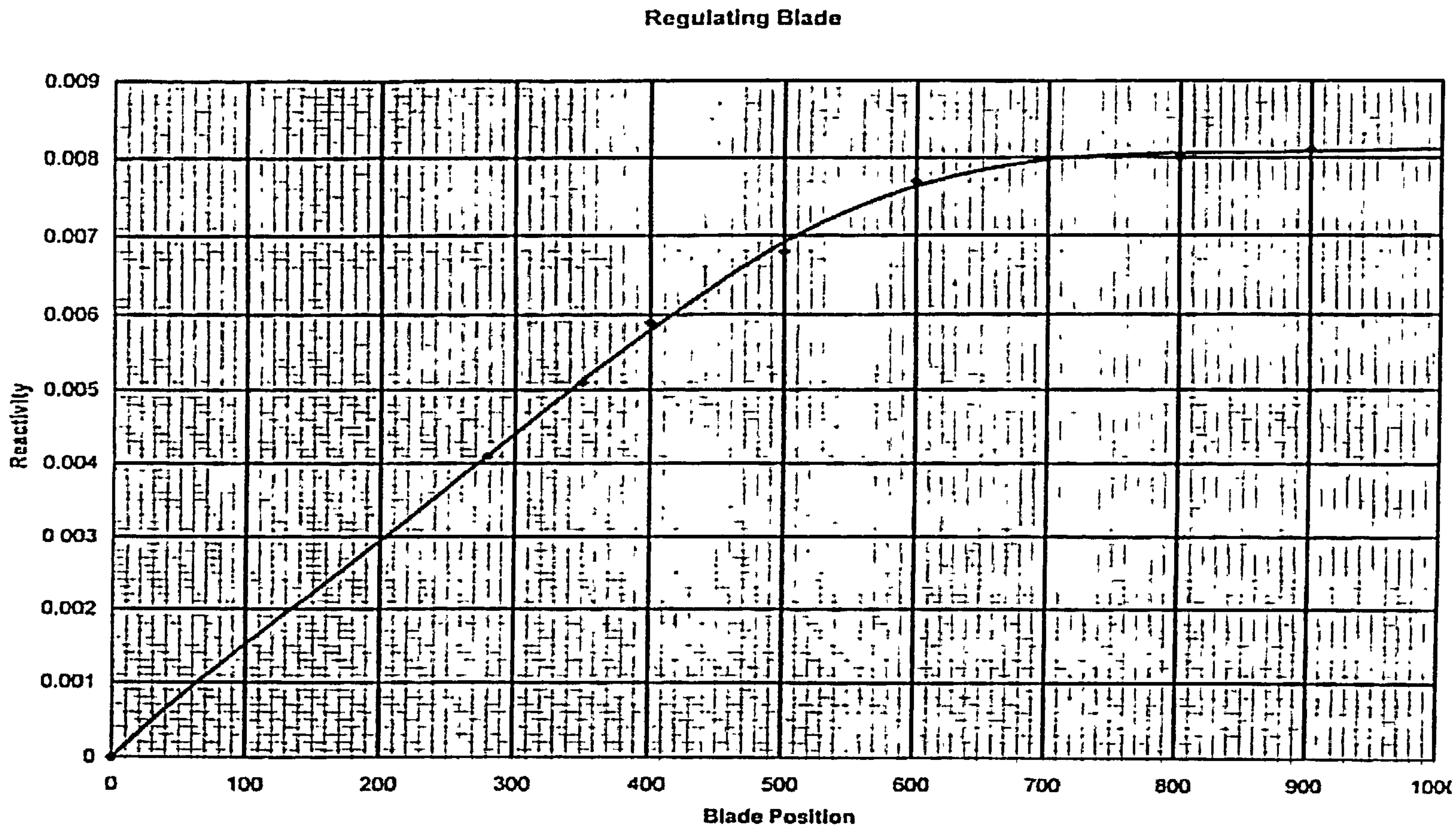


Figure 4-28 Reactivity Integral Rod Worth Curve for UFTR Regulating Blade

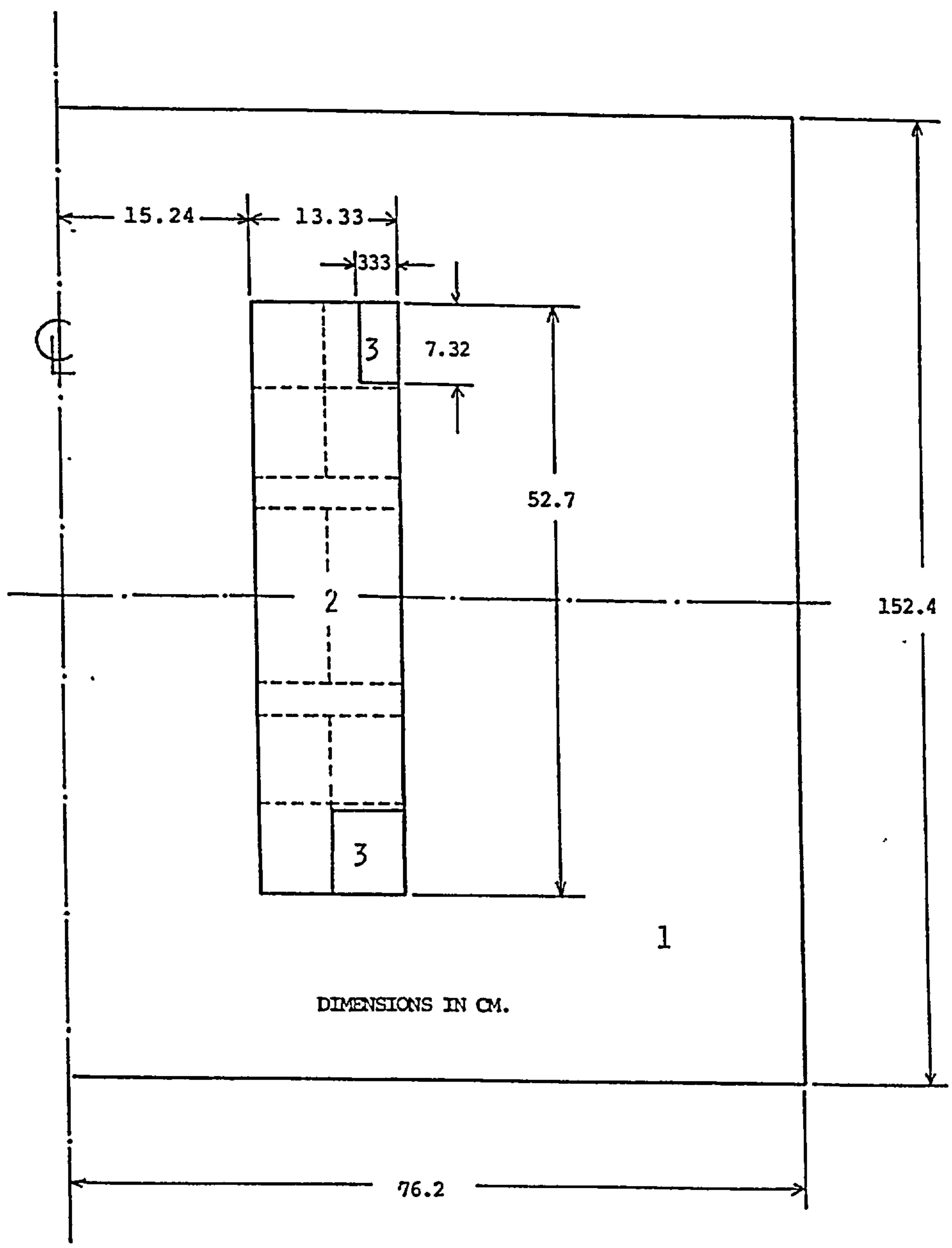


Figure 4-29 Reactor Model Used for Exterminator Code Calculation[19]

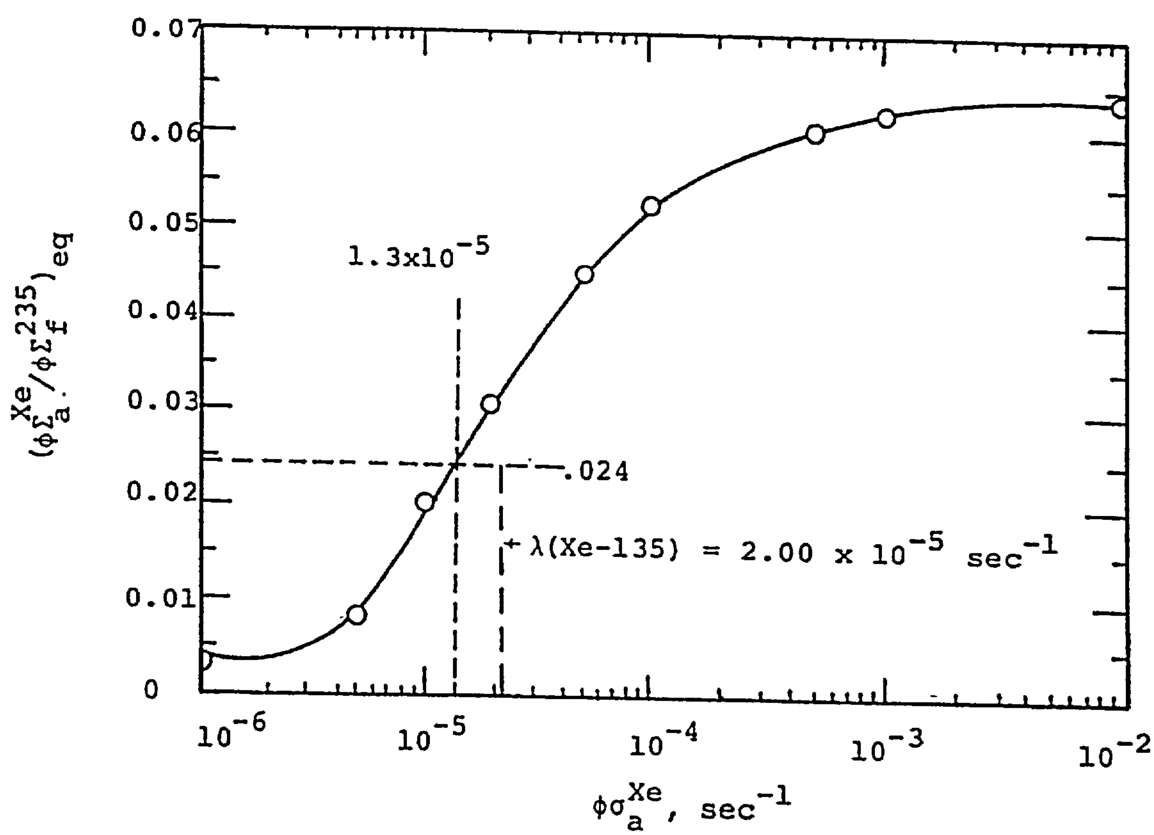


Figure 4-30 Equilibrium Xenon-135 in a Highly Enriched Reactor [21]

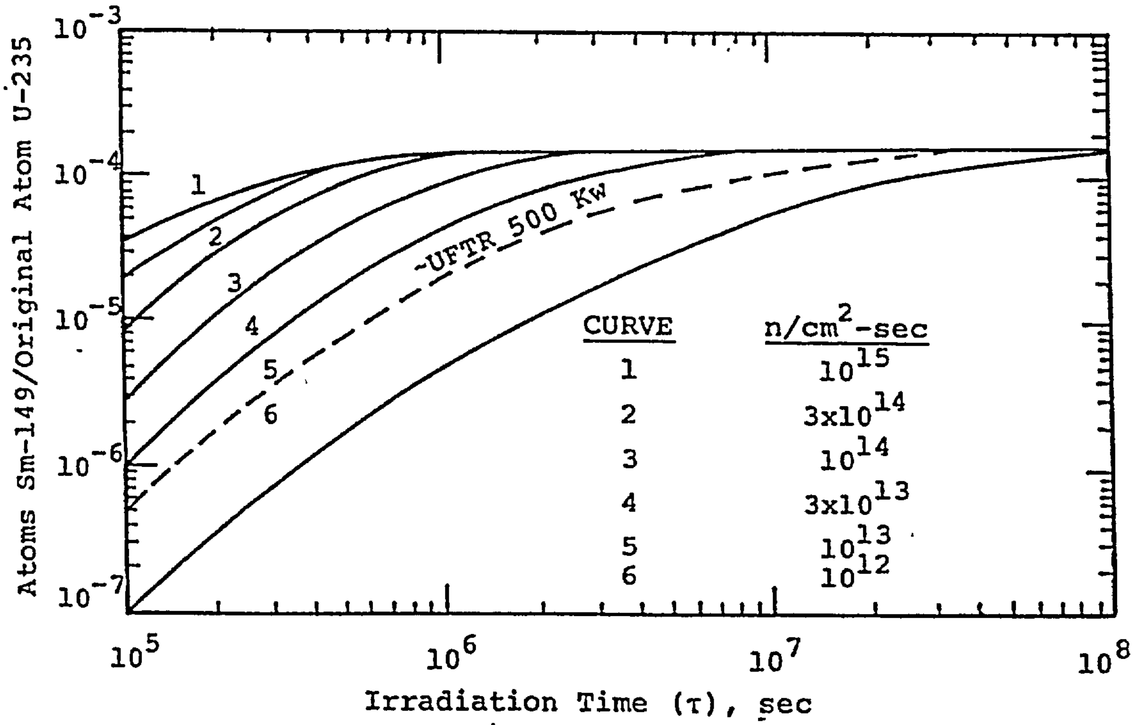


Figure 4-31 Samarium-149 Buildup with Irradiation Time [21]

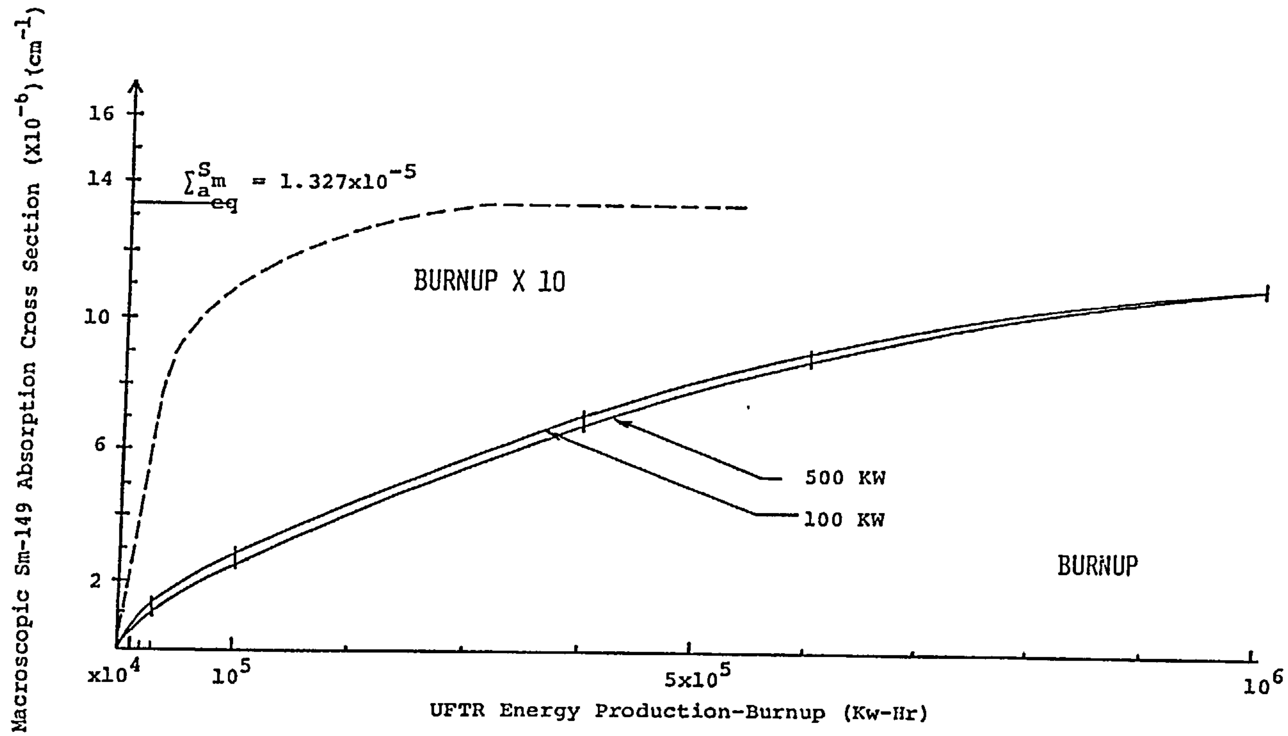


Figure 4-32 Samarium-149 Buildup for Operation at 100 and 500 kWth [19]

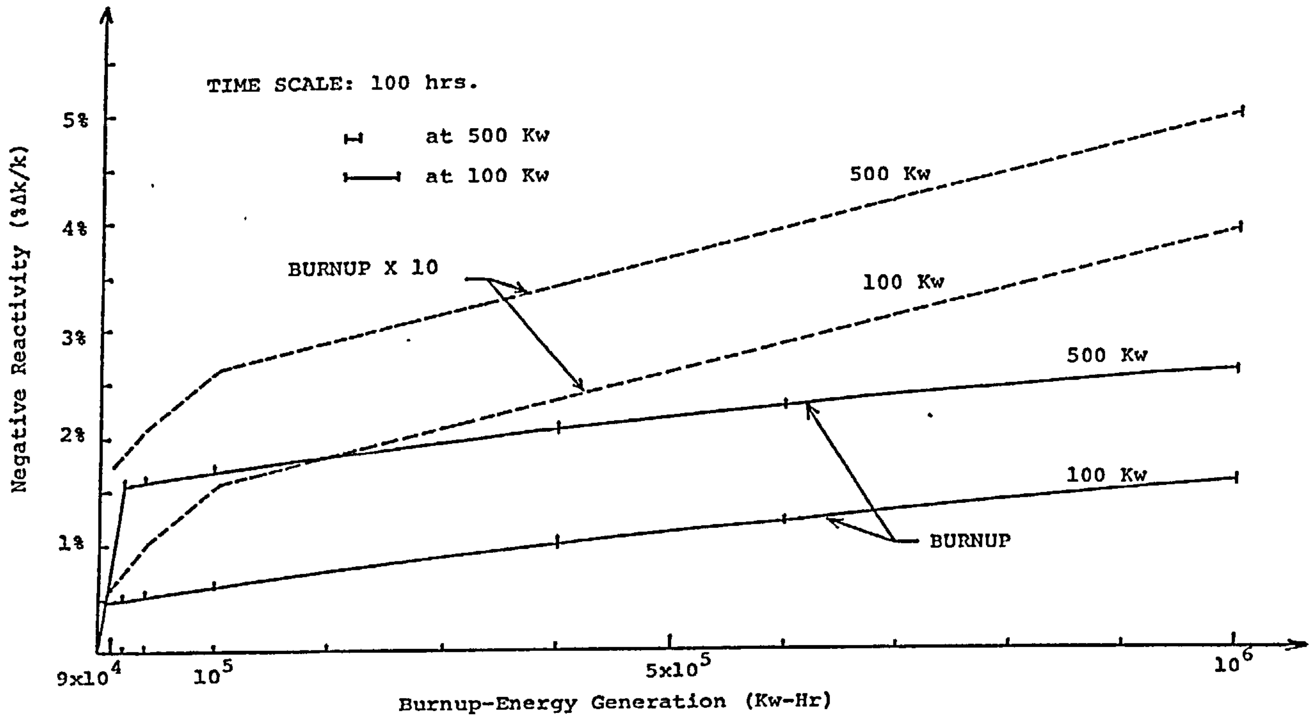


Figure 4-33 Reactivity Drop with Burn-up for Operation at 100 and 500 kW [19]

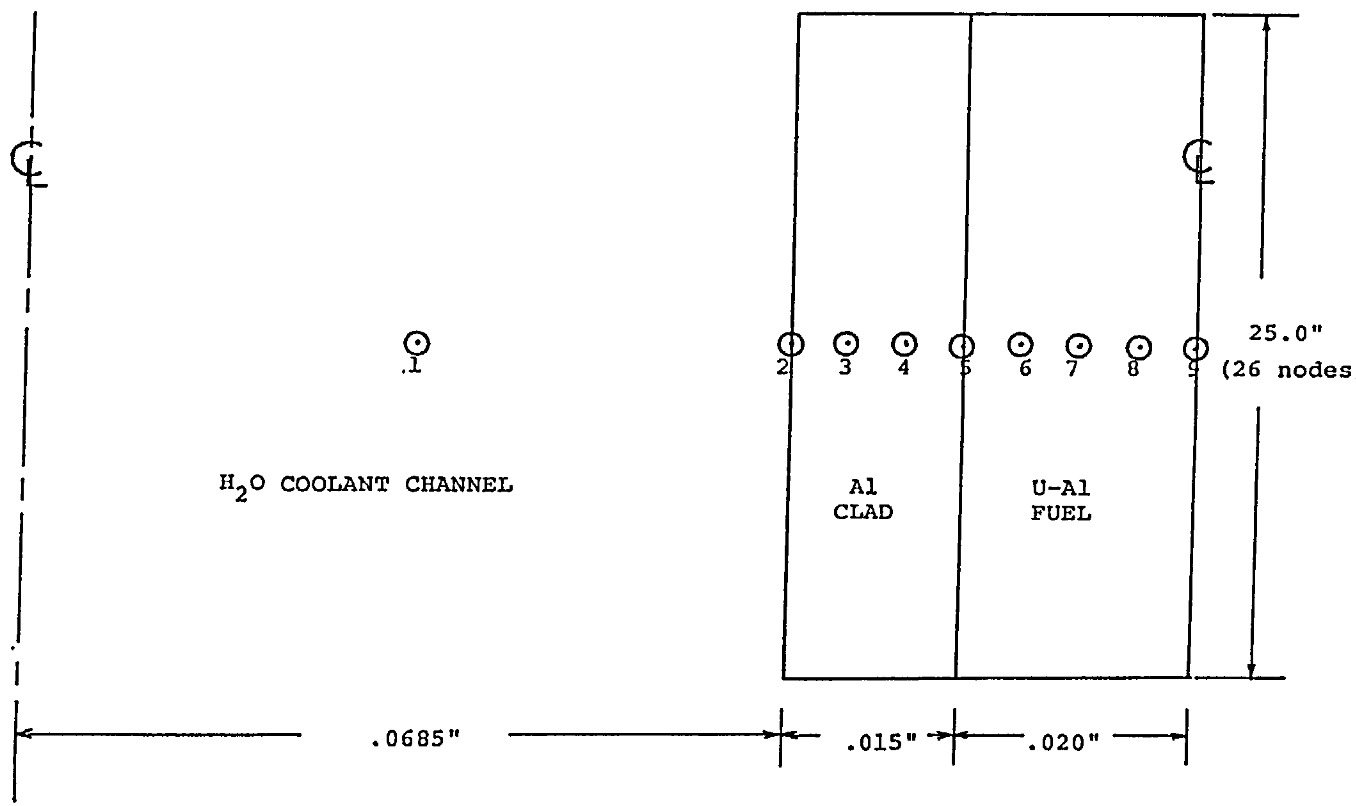


Figure 4-34 Grid for Nodal Point Distribution Used for UFTR Heat Transfer Calculation [6]

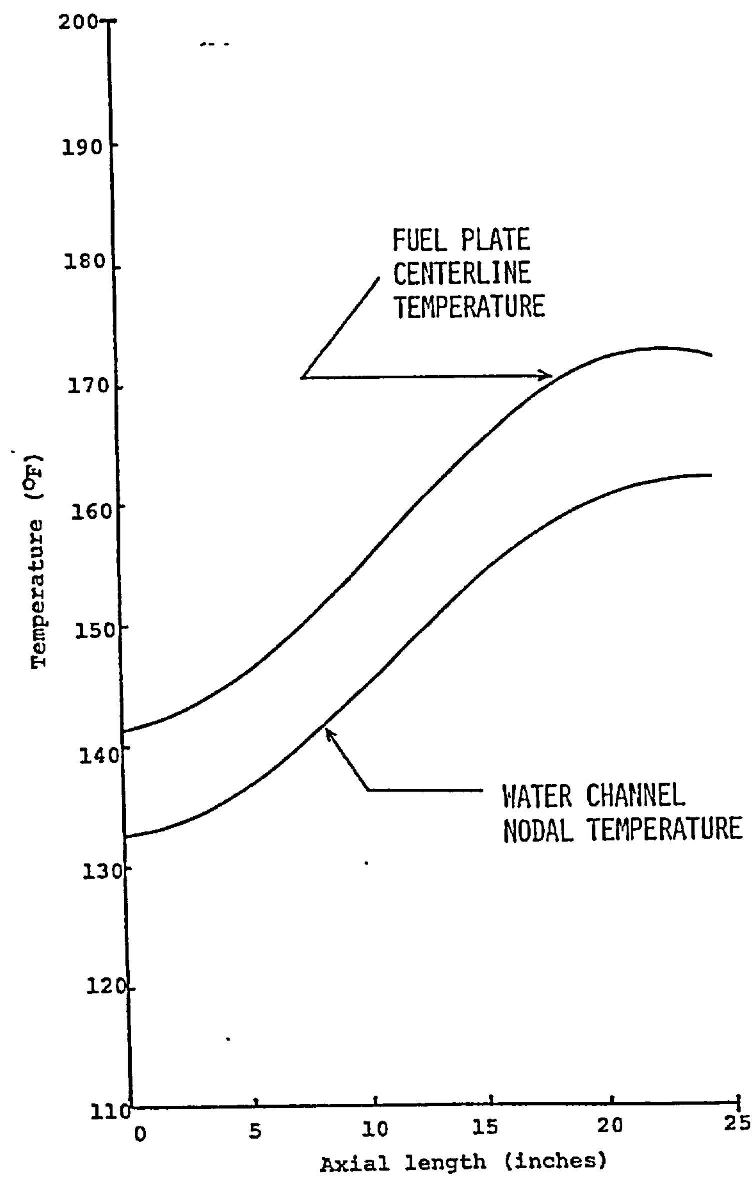


Figure 4-35 Temperature Distribution of the "Hottest" Fuel Plate and Water Channel at 100 kWth (Coolant Flow rate = 31.2 gpm)[6]

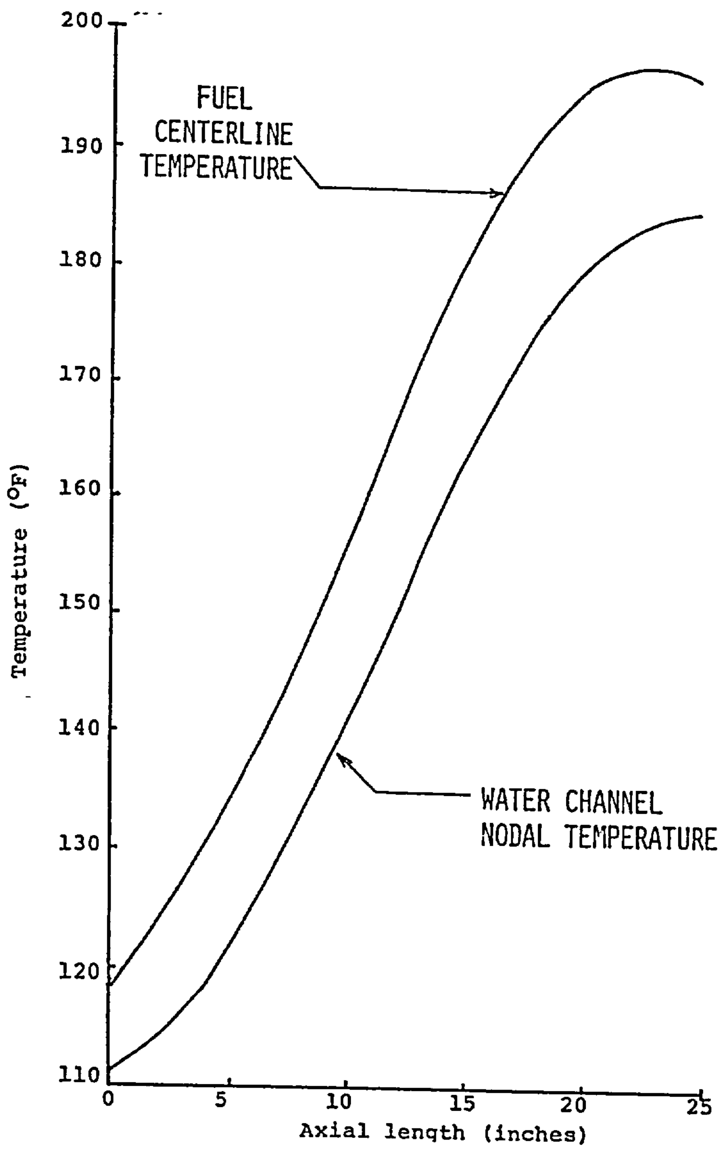


Figure 4-36 Temperature Distribution of the "Hottest" Fuel Plate and Water Channel at 500 kWth (Coolant Flow rate = 65 gpm) [6]

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2. All the requirements specified in the UFTR Technical Specifications must be satisfied.
3. The pre-nuclear testing program, as defined in the fuel handling procedures [1], must be satisfactorily completed.
4. Neutron source(s) must be installed to assure a minimum count rate on the start-up channel.
5. Visual inspection and cleaning of any fuel assembly or dummy assembly must be performed before insertion into the core.
6. All operations must be previously approved by the Reactor Manager.
7. Only licensed reactor operators may insert fuel into the reactor.
8. Minimum personnel requirements must be met as specified in applicable procedures [1].

9.2.4.4 Fuel Loading to Critical and Operating Reactivity

The following conditions apply for fuel loading to critical and operating reactivity:

1. All fuel loading (including dummy assemblies) will be performed with the water out of the core and all the control blades fully inserted.
2. All counts for subcritical multiplication will be taken with the primary water up, and as specified in applicable fuel handling procedures[1].
3. At no time will the reactor core be loaded with reactivity in excess of 2.3% $\Delta k/k$.
4. Fuel loading increments must be carefully controlled. Regulations and limitations for both an unfueled and partially fueled UFTR core must be followed as outlined in applicable fuel handling procedures [1]. These regulations and limitations are designed to assure that the amount of fuel loaded in any one step will not result in exceeding the critical mass for water-up and two safety blades fully withdrawn.
5. All fuel loading shall be made from the most reactive to the least reactive location as a further safety precaution.
6. Full or partial dummy assemblies may be used during fuel loading to occupy empty positions to support assemblies.
7. Full or partial dummy assemblies must be used to fill any vacant position in the core after fuel loading is completed.

9.2.4.5 Fuel Removal and Storage

Before attempting fuel removal operations, two preliminary precautionary measures must be taken. First, precautions must be taken to limit the vertical movement of the fuel. The necessary safety line and its length will be determined using a dummy fuel element. Second, all necessary monitoring and alarm systems shall be checked for operability.

The following requirements must be met before actual operations for removal of fuel from the core are undertaken:

1. The shield tank must be prepared to receive fuel for inspection as specified in applicable fuel handling procedures [1].
2. Fuel pits must be prepared as necessary to receive the fuel.
3. All neutron and radiation monitoring systems must be in operation.
4. The Reactor Vent System must be in operation.
5. The neutron source must be installed in the reactor to assure the detection of fission events by the instrumentation.
6. Reactor shielding must be unstacked as necessary to permit core area accessibility.
7. Reactor primary coolant must be up and the console key must be removed from the console.
8. A reactor operator should be at the console.
9. Removal of shield plug and wedging pin from the fuel box shall be performed under direct supervision of the person in charge and radiation control personnel must be present for surveying at time of shield plug removal.

When removing fuel from the irradiated fuel storage pit, the shield tank shall be prepared if inspection of fuel is required. In addition, other fuel storage pits shall be prepared if change of fuel locations within the fuel pits is the only required operation.

Detailed descriptions of the procedural steps to be followed during transfer of fuel to and from the fuel transfer cask and for fuel inspection are contained in applicable procedures for the UFTR facility [1].

9.3 Fire Protection Systems and Programs

Since none of the materials of construction of the reactor are inflammable, and since the reactor building is of fireproof construction and will not be used for storage of large quantities of inflammable materials, a fire of any consequence is considered very unlikely.

Conventional fire equipment is located in the reactor cell and throughout the reactor building. Two CO_2 extinguishers are available in the reactor room itself, and one more is located in the control room at the control console. A fire hose and fire extinguisher are also located outside the control room in the ground floor foyer area referred to as the Limited Access Area in Chapter 3 of this report.

An automatic fire alarm system monitors the reactor cell and the remainder of the reactor building continuously. The system used is a four-zone system with local monitoring and a control station. The system is completely supervised with emergency battery back-up. Minimum equipment installed includes:

1. Three (3) Ionization Detectors.
2. One (1) Thermal (Heat) Detectors.
3. Seven (7) Pull Stations.
4. Six (6) Horns.

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Table 11-9 UFTR Average Undiluted Ar-41 Concentration and Effective Full Power Hours (EFPH)

Survey date	Average Undiluted Ar-41 Concentration (10^{-8} μCi/ml)	Monthly Limit on Energy Generation (EFPH)
April 2001	9.598	75.0156
August 2000	9.543	75.4480
January 2000	8.520	85.5070
July 1999	11.1937	64.3219
January 1998	6.773	106.3044
July 1997	6.982	103.1223
January 1997	8.504	84.6660
July 1996	7.671	93.8600
February 1996	8.930	80.6271
August 1995	8.003	89.9663

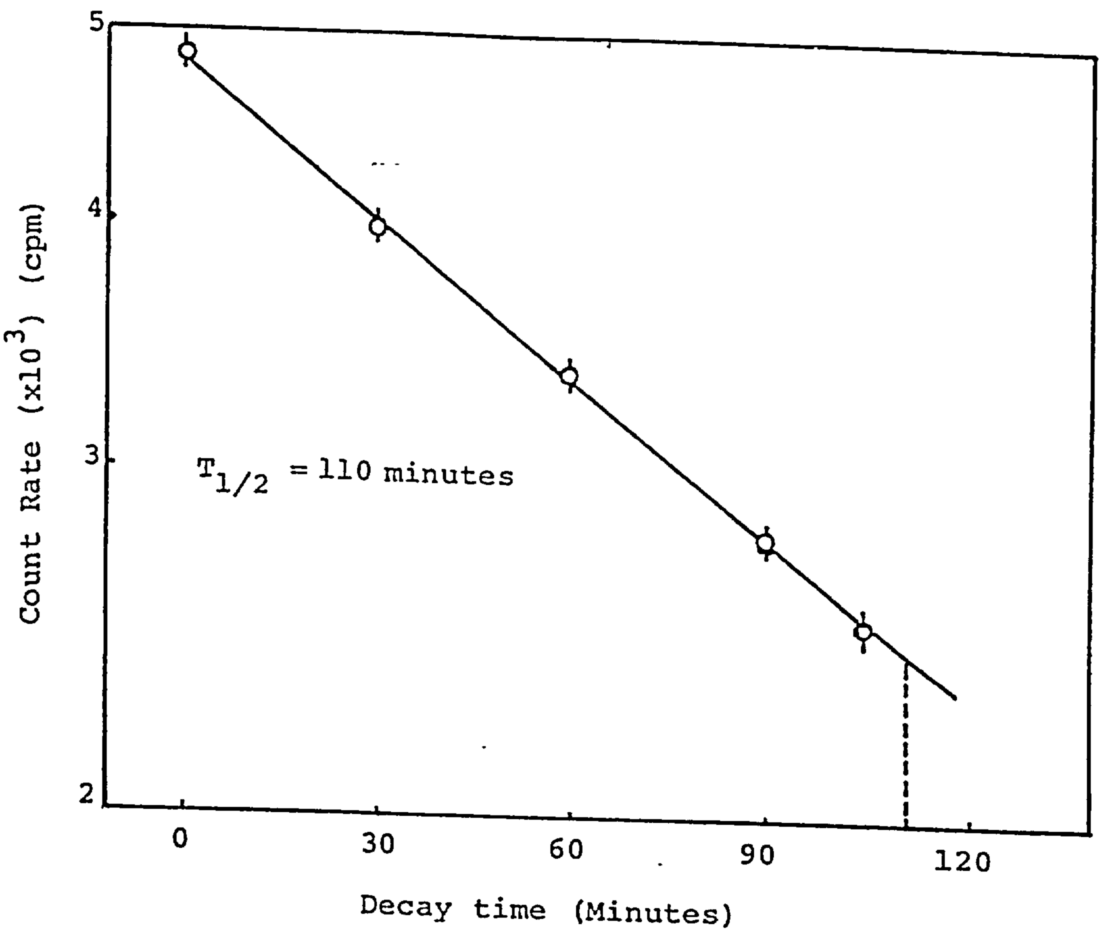

Figure 11-1 Data for Half-Life Determination of UFTR Stack Sample [3]

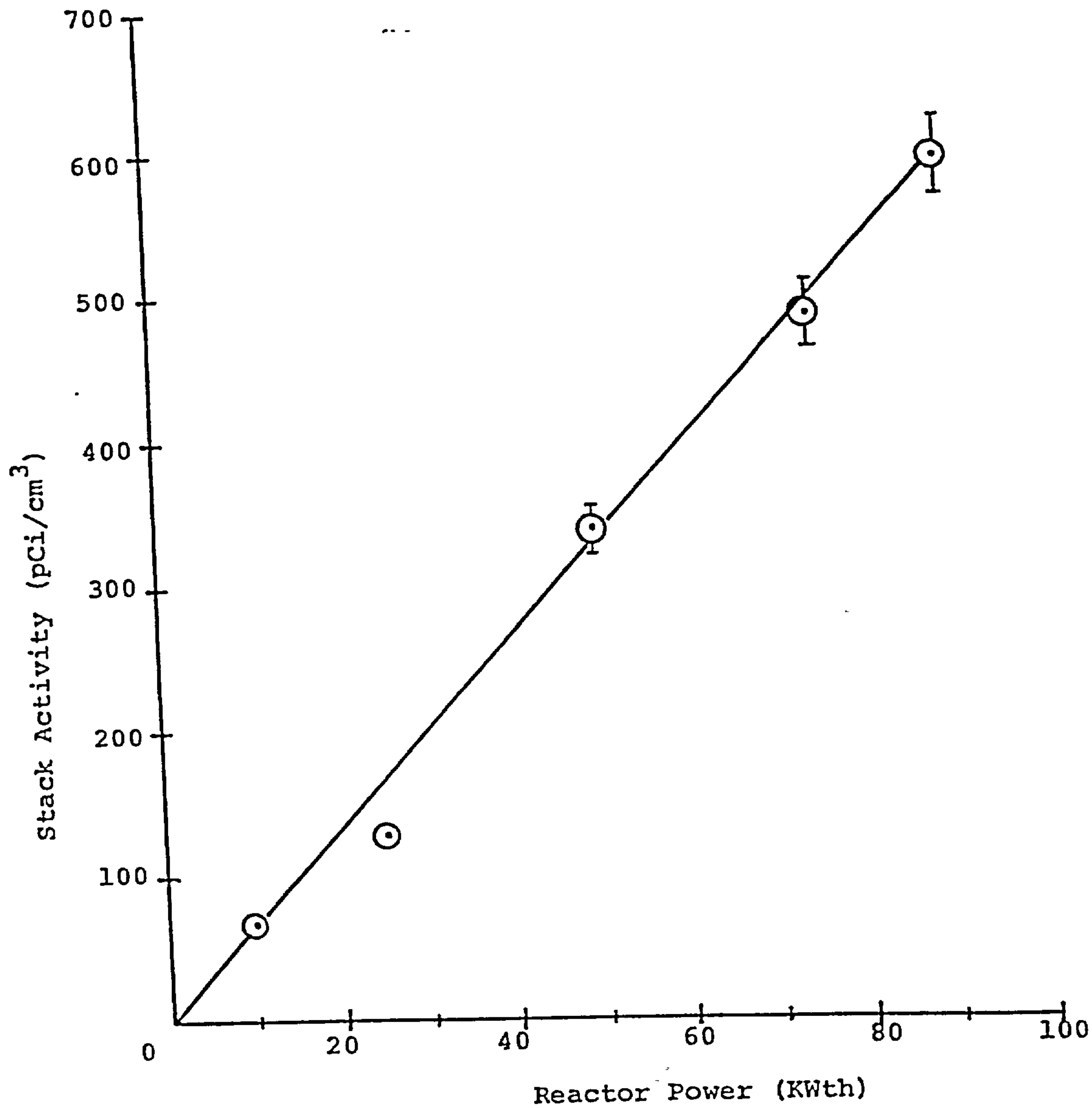

Figure 11-2 Experimental Determination of Argon41 Stack Concentration with UFTR Operating Power [3]

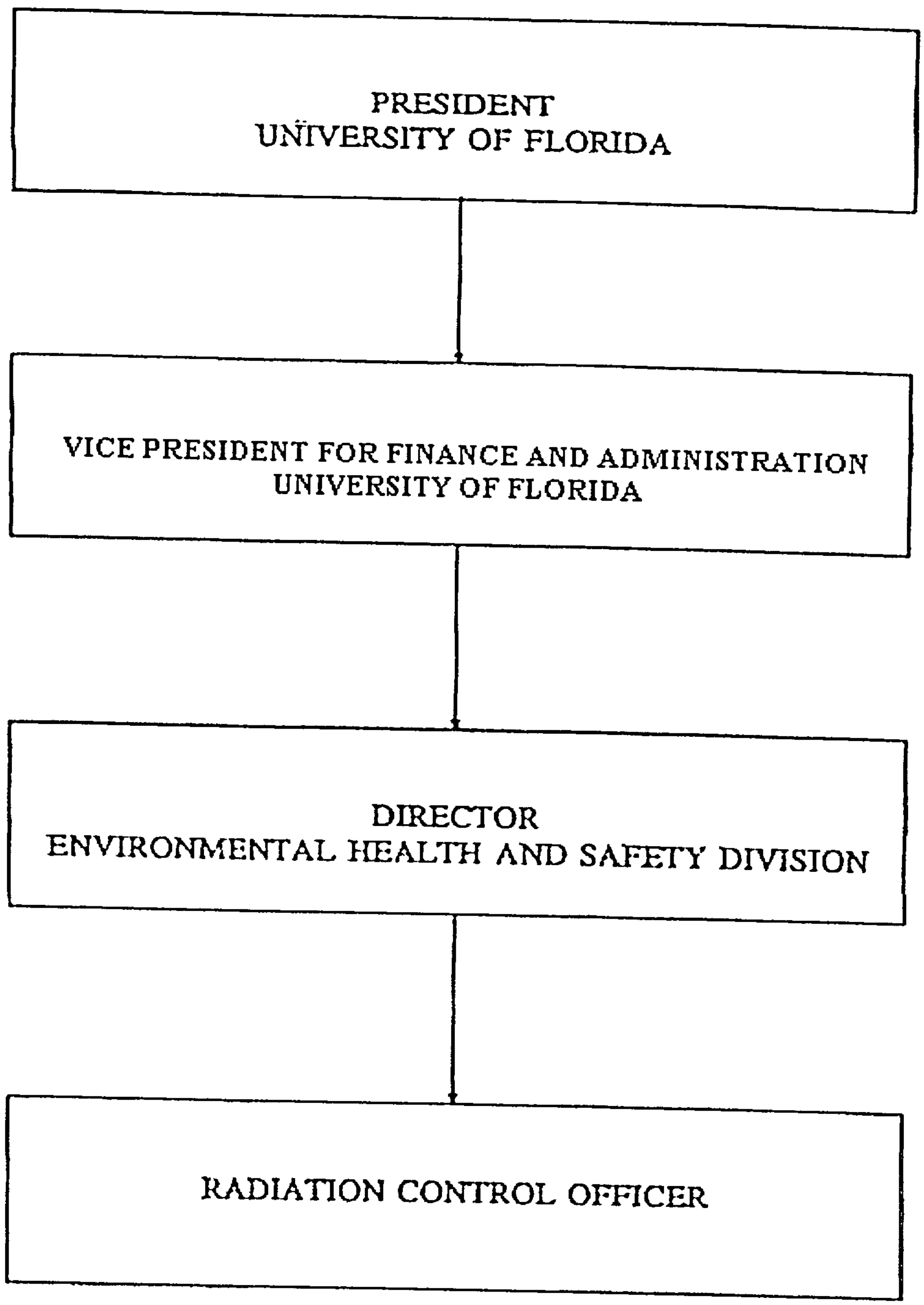

Figure 11-3 Line Responsibility Flow Diagram for the University of Florida Radiation Control and Radiological Services Department

[redacted]

Figure 11-4 Results of Radiation Survey around UFTR at 100 kWth Power Operation [1]

[redacted]

Figure 11-5 Gamma Exposure Rates at Port Level for 100kWth Operation with no external Shielding and Top Shield Block Removed [1]

[redacted]

Figure 11-6 Gamma Exposure Rates at Ground Level for 100kWth Operation with no External Shielding and Top Shield Block Removed [1].

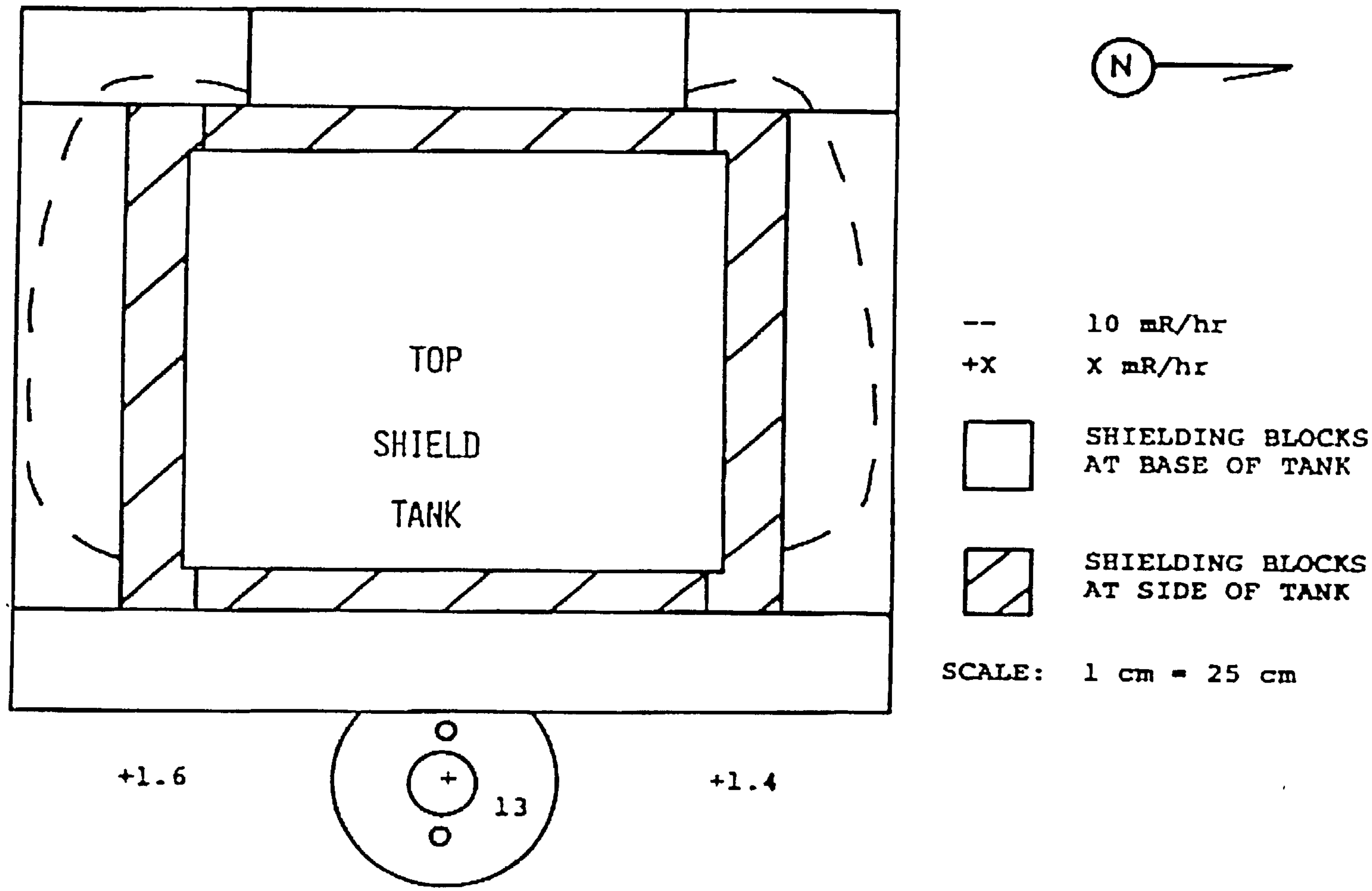

Figure 11-7 Gamma Exposure Rates around the UFTR Shield Tank for 100kWth Operation with Readings Made at the Top of Base Shielding (25 cm above reactor surface)[1].

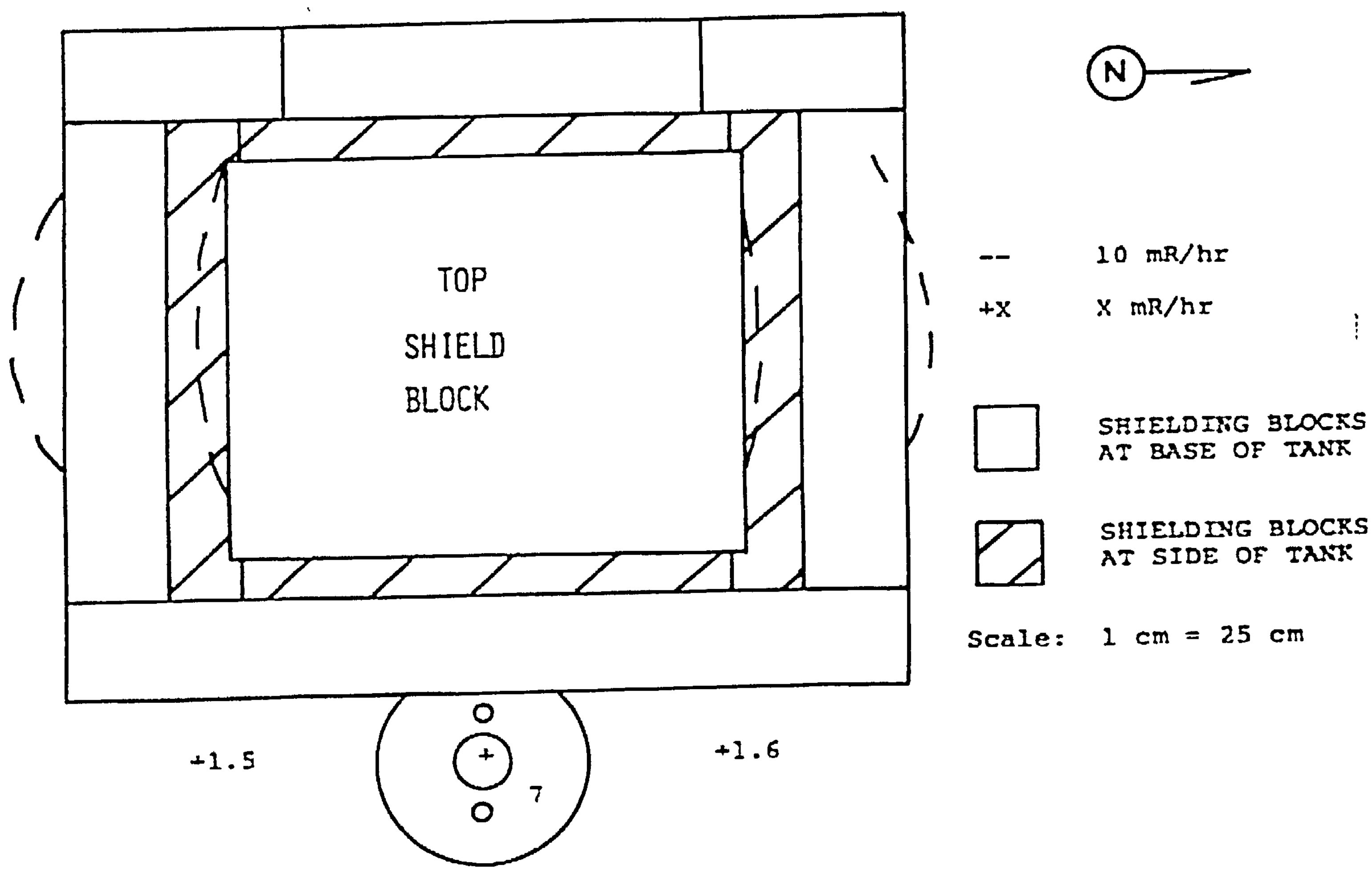

Figure 11-8 Gamma Exposure Rates around the UFTR Shield Tank for 100kWth Operation with Readings Made at the Top of Base Shielding (101 cm above reactor surface) [1].

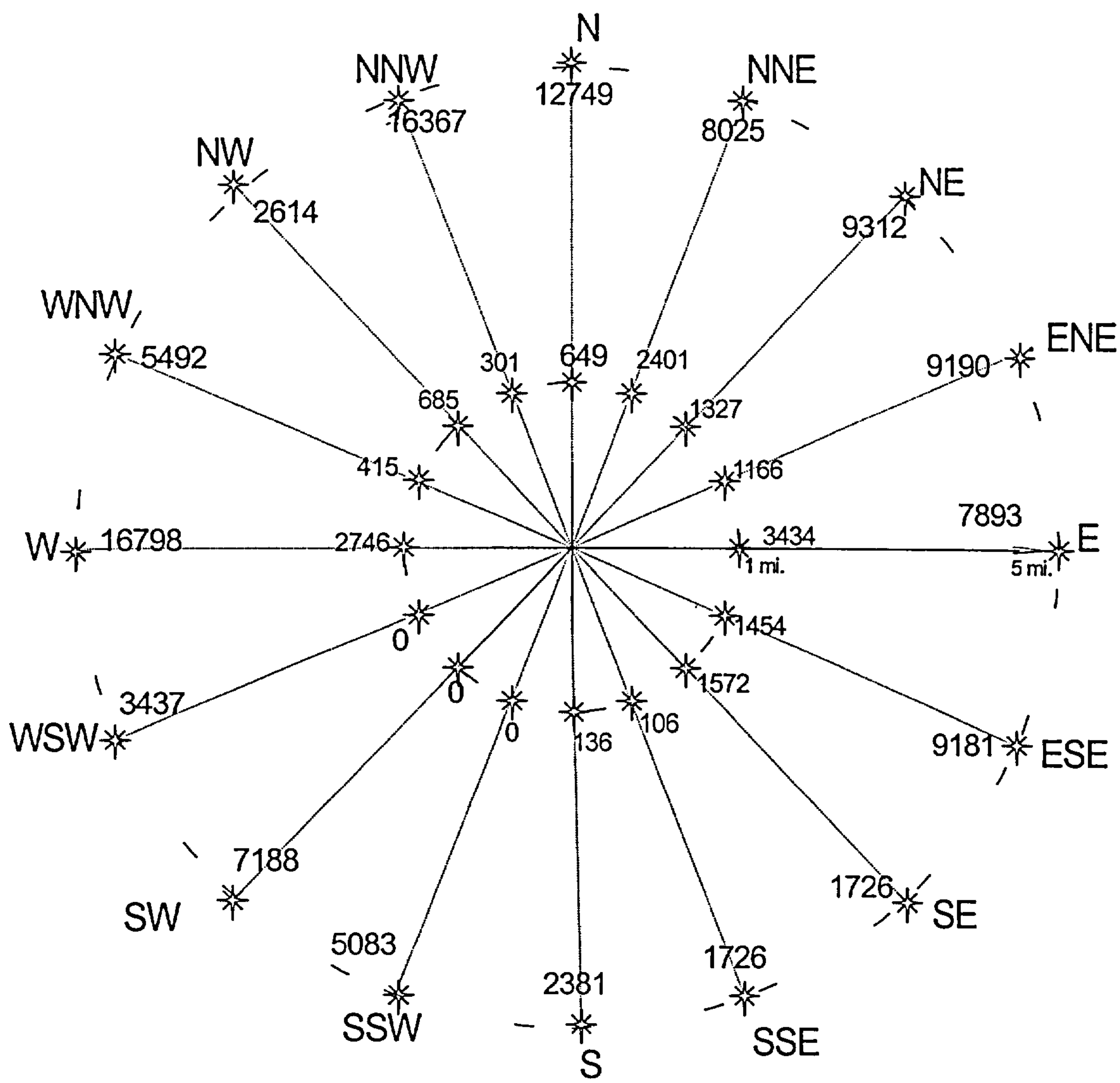

Figure 11-9 Population Distribution with a 1 mile and 5 miles radius around UFTR, based upon 2000 Census Data. 88% of the Gainesville Census County Division (CCD) population was conservatively assumed to be concentrated within a 5 mile radius around UFTR.

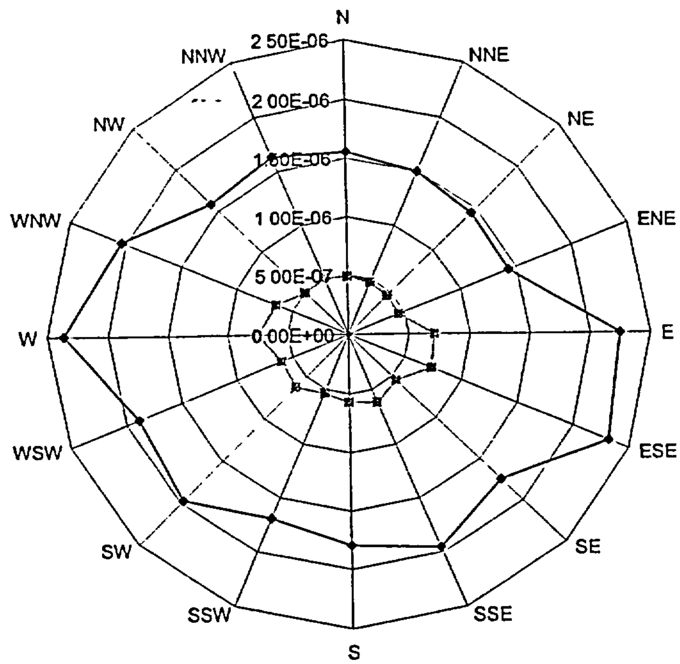

Figure 11-10 **Annual Average Isopleths Obtained with Gainesville Data.**

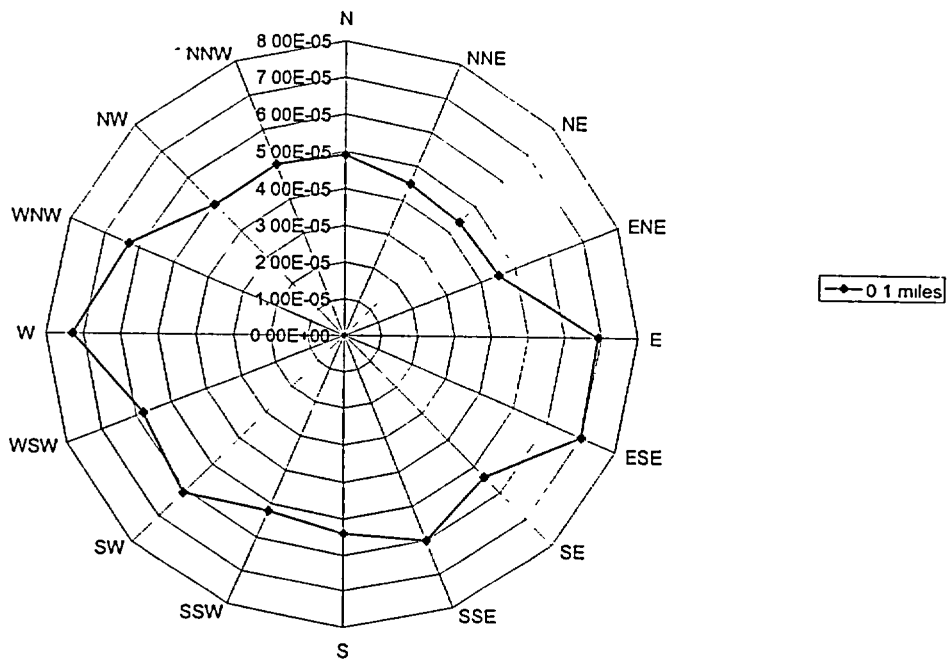

Figure 11-11 Directional Variation of Annual Average Diffusion Coefficients at 0.1 Mile Distance from UFTR

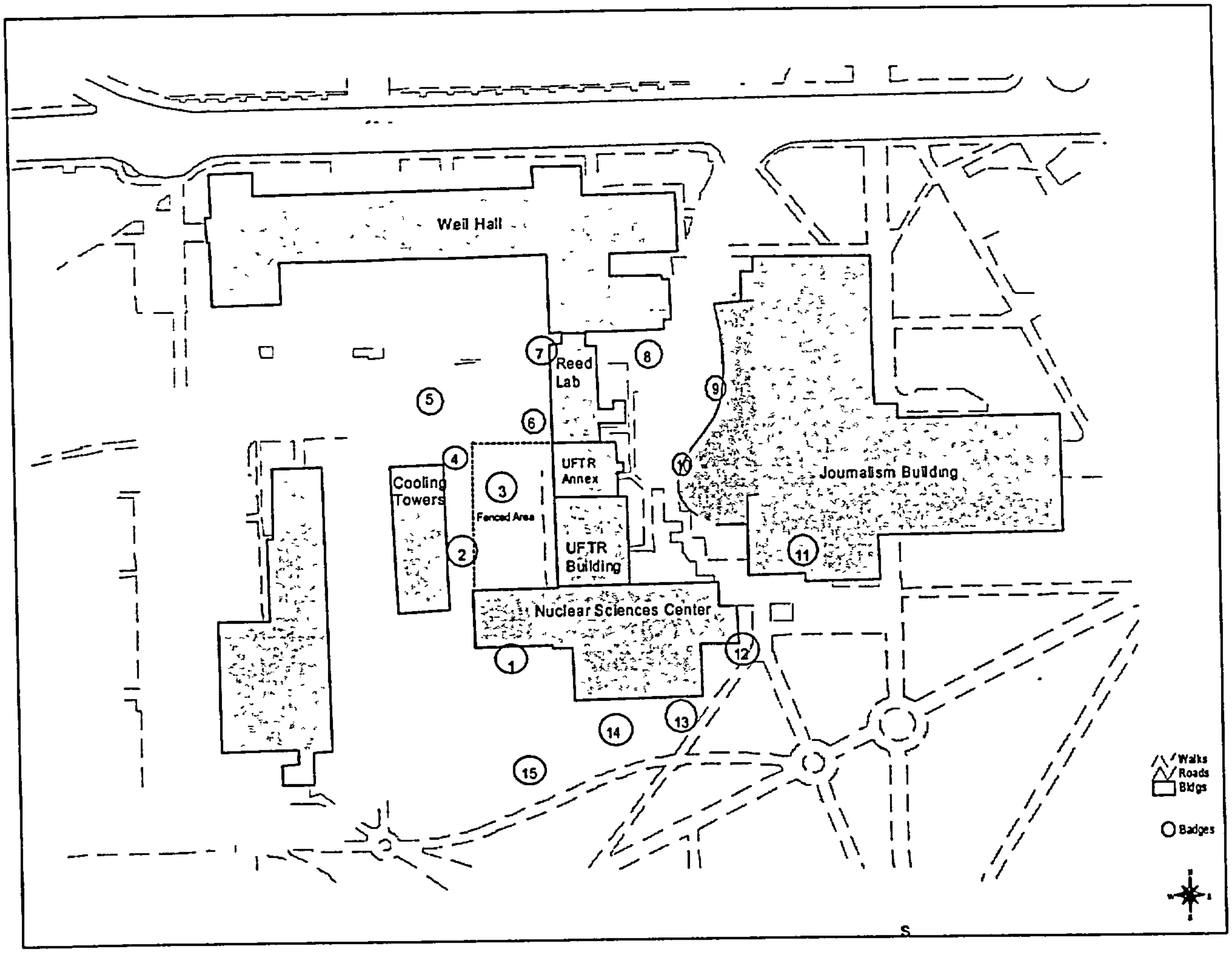

Figure 11-12 Typical Locations of Radiation Monitoring Devices used for Continuous Monitoring of UFTR Site .

References:

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3. *Lochamy Jr, J.C., Determination of Stack Concentration of Argon-41 at the University of Florida Training Reactor, Master's Thesis in Department of Nuclear and Radiological Engineering. 1972, UFL: Gainesville.*
4. *10 CFR 20 Appendix B, Table 2 Column 1 - Standards for Protection Against Radiation.*
5. *University of Florida Radiation Control Guide. February 1997.*
6. *NRE, Department of Nuclear and Radiological Engineering, "Standard Operating Procedures of the University of Florida Training Reactor". 2002, University of Florida: Gainesville, Fl.*
7. *NRC, U.S. Nuclear Regulatory Commission, NRCDose, GASPAR II - Technical Reference and User Guide. 2001.*
8. *NRC, U.S. Nuclear Regulatory Commission, Regulatory Guide 1.109 " Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR 50, Appendix I." October 1977.*
9. *Bureau, U.S.C., Census 2000, Redistricting Law (Public Law 94-171) Summary File. 2000, U.S. Department of Commerce.*
10. *NRC, U.S.NRC Regulatory Guide 1.111. "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors."*
11. *Hawley, S.C., R.L. Kathren, and M.A. Robkin, Analysis of Credible Accidents for Argonaut Reactors NUREG/CR-2079 PNL-3691. 1981, U S Nuclear Regulatory Commission.*
12. *Radiation Control Office-University of Florida - Radiation Control Technique #2, Instructions for Preparation of Radioactive Waste for Disposal. 1999, UF: Gainesville.*

12.3.2.2.4 Semiannual Checks

Surveillance checks, tests and maintenance performed at the UFTR facility on a semiannual basis are summarized below:

1. The control blade drop times are measured from the fully withdrawn position;
2. Special nuclear material inventory is performed;
3. The Argon-41 stack effluent concentration is measured;
4. The control blade controlled insertion times are measured from the fully withdrawn position;
5. Key inventories are performed;
6. Security system batteries are checked and replaced as necessary;
7. Neutron sources are leak checked;
8. Deep well secondary pump fuses are replaced;
9. Emergency call lists are updated;
10. The control blade clutch current bulbs are replaced;
11. The Requalification Training Program binders are reviewed.

12.3.2.2.5 Annual Checks

Surveillance checks, tests and maintenance performed at the UFTR facility on an annual basis are summarized below:

1. Calibration of instruments and test equipment;
2. Calibration of the log N-period channel, power level safety channel, and linear power level channel including performance of a calorimetric heat balance;
3. Measurement of the temperature coefficient of reactivity;
4. Replacement of Fire Alarm System Monitoring Station Batteries;
5. UFTR decommissioning cost is updated;
6. Physical inventory of security-related locks/cores is performed;
7. Measurement of control blade reactivity worth, total excess reactivity, maximum reactivity insertion rate and the shutdown margin to include that the minimum shutdown margin, with the most reactive blade withdrawn, is 2% $\Delta k/k$ and verification that the reactivity insertion rate for any single control blade does not exceed 0.06% $\Delta k/k$ per second, when determined as an average over any ten (10) seconds of blade travel time.

12.3.2.2.6 Biennial Checks

Surveillance checks, tests and maintenance performed at the UFTR facility on a biannual basis are summarized below:

1. Check to assure the void coefficient of reactivity is negative;
2. Evaluation of Standard Operating Procedures manuals for completeness;
3. Evaluation of Standard Operating Procedures for adequacy;
4. Evaluation and recertification of licensed operators;
5. Evaluation of the Emergency plan.

12.3.2.2.7 Five Year Check

Surveillance checks, tests and maintenance performed at the UFTR facility on a five years basis are summarized below.

1. Inspection of selected incore reactor fuel elements.
2. Inspection of the control blade and drive systems for mechanical integrity.

12.4 Required Actions

12.4.1 Safety Limit Violation

The following actions shall be taken in case of a safety limit violation:

1. Reactor shall be shut down, and reactor operations shall not be resumed until authorized by the Nuclear Regulatory Commission;
2. The safety limit violation shall be promptly reported to Level 2 or designated alternates;
3. The safety limit violation shall be reported to the Nuclear Regulatory Commission;
4. A safety limit violation report shall be prepared. The report shall describe the following:
   a) applicable circumstances leading to the violation including, when known, the cause and contributing factors;
   b) effect of the violation upon reactor facility components, systems, or structures and on the health and safety of personnel; and
   c) corrective action to be taken to prevent recurrence.

12.4.2 Other occurrences

In case of the followings occurrences:

1. Release of radioactivity from the site above allowed limits;
2. Operation with actual safety-systems setting for a required system less conservative than the limiting safety-system setting specified in the Technical Specifications;
3. Operation in violation of limiting conditions for operation established in the Technical Specifications unless prompt remedial action is taken;
4. A reactor safety system component malfunction that renders the reactor safety system incapable of performing its intended safety function, unless the malfunction or condition is discovered during maintenance, a test or periods of reactor shutdown;
5. An unanticipated or uncontrolled change in reactivity greater than one dollar (reactor trips resulting from a known cause are excluded);