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University of Florida Training Reactor

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February 26, 2010

Document Control Desk
U.S, Nuclear Regulatory Commission
Washington, DC 20555
Attn: Mr. Duane Hardesty

Dear Mr. Hardesty,

Subject: University of Florida Training Reactor (UFTR) License Renewal (TAC NO. ME 1586), DOCKET NO. 50-83

Enclosed document and associated attachments include our responses to the USNRC's RAIs on our application for renewal of Facility Operating License No. R-56 for the University of Florida Training Reactor (UFTR), which was received on February 3, 2010.

If you need further information, please do not hesitate to contact me at haghighat@ufl.edu or (352) 392-1401 x306.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on Feb. 26, 2010

Sincerely,

Alireza Haghighat, PhD
FP&L Endowed Chair Professor
Director of UFTR

Lisa L. Purvis
Commission # DD608673
Expires November 3, 2010
Bonded Troy Fain · Insurance, Inc. 800-385-7019

Alachua County, Florida
February 26, 2010
Lisa L. Purvis

Cc Jack Donohue, NRC
Gabriel Ghita, UF
David Hintenlang, Interim Chair
Brian Shea, UFTR Manager
Glenn Sjoden, RSRS Chair
UFTR – NRC file

A020
NRR

Responses to NRC's RAIs
Regarding License Renewal for the UFTR

This document includes our responses to the USNRC's RAIs on our application for renewal of Facility Operating License No. R-56 for the University of Florida Training Reactor (UFTR), which was received on February 3, 2010.

Q1. Safety Analysis Report (SAR), Section 1.6, Compliance with the Nuclear Waste Policy Act of 1982. Please provide the contract number of your agreement with the Department of Energy for return of spent fuel and/or high level waste.

Res1. We have a Subcontract, No. 00074551, with Battle Energy Alliance, LLC. This Subcontract is issued under Prime Contract No. DE-AC07-051D14517 between the Department Energy and BEA. For further information see Attachment #1.

Q2. SAR, Section 2.3.1.2.2, Tornadoes. The probability of a tornado striking the University of Florida Training Reactor (UFTR) site is given as 1.9 x 10-3 per year. Please explain how this value was determined.

Res2. The probability is evaluated using Eq. 2.1 (SAR Section 2.3.1) based on the historical weather data from 1950 to 2000. The evaluated probability should be considered as a conservative estimation, not an exact value. Tornadoes remain very rare on the UFTR site. It's highly unlikely that Tornadoes could cause serious damage to the reactor building, and even more unlikely to affect the reactor itself.

Q3. SAR, Section 5.3, Secondary Coolant System. In your response to Request for Additional Information (RAI) 2.b. dated November 26, 2008, you use the Title 10 Code of Federal Regulations (10 CFR) Part 20, Appendix B, Table 3 value of 5 E-4 μCi/ml as the monthly average concentration release limit. However, this value is applicable to release to the sanitary sewer while it appears that discharge from the secondary side of the heat exchanger goes to the storm sewer. Please explain.

Res3. We have corrected the limit and performed the necessary changes to the previous submittal. Attachment #2 demonstrates that for a realistic level of contamination and loss rate, activation is well below the limitation of the 10 CFR Part 20 App. B.

Q4. SAR, Section 7.2.3.4.2, Secondary Coolant System. The SAR indicates that scram upon loss of secondary coolant flow when using city water is immediate. However, Technical Specification (TS) 5.6.2 discusses a 10 second delay upon first reaching 1 kW. Please clarify.

Res4. The City Water System will no longer be used as a means of secondary reactor cooling. The system will remain a source of makeup water to various systems at the UFTR. To prevent city water from being used for secondary cooling, the piping will be isolated using two manual valves on either side of the electrically operated valve (used to initiate city water flow), which will have its

power permanently disconnected. The scram logic will remain in Well Water Mode and be maintained as such via existing procedures. The reason for this measure is discussed in the revised UFTR Technical Specifications.

Q5. SAR, Section 9, Auxiliary Systems. The RAI 9-3 response, dated November 26, 2008, stated that the area monitor system alarm set point is 10 mR/hr. However, TS Table 3-4 states monitor set point is 25 mR/hr. Please state if you are meeting compliance with 10 CFR 70.24 using 70.24 (a)(1) or (a)(2) and provide details as to how you are meeting the regulation.

Res5. We believe we meet the requirements of 10 CFR 70.24 a(2) as discussed below:

The three area radiation monitors (ARMs) are located in the reactor cell in strategic locations for providing full monitoring of the reactor cell.

The size of the reactor cell is 60 feet long, 30 feet wide, and 29 feet high. This means that the maximum diagonal distance of the cell is ~ 73 feet; thereby, indicating that all the monitors are within the 120 feet limit. The three ARMs collectively cover all areas surrounding the reactor. UFTR has been operating with a setpoint of 10 mrem/hr. Note that 10 CFR 70.24 a(2) requires the setpoint should range from 5 to 20 mrem/hr Tech Spec will be updated. If the radiation level were to reach 300 rem/hr within 1 foot of the reactor, the radiation level at 73 feet away, considering $(\frac{1}{4\pi r^2})$ **dispersion, is estimated by:**

$$Dose = 300\frac{rem}{hr}(\frac{4\pi}{4\pi * 73})^2 = 56\frac{mrem}{hr}$$

This is conservatively higher than the upper setpoint of 20 mrem/hr; hence, the UFTR meets the requirement of 10 CFR 70.24 a(2).

Q6. In Appendix E of the UFTR responses to RAIs 11-1 and 11-2, dated November 6, 2008, the undiluted activity of Ar-41 from the reactor at 100 kW is given as C = 8.147E-4 Ci/m3, the total stack flow rate for Ar-41 from the core vent and dilution fan is f = 7.444 m3/s, and the dilution factor is DF = 0.0152168. The resulting flow-diluted release concentration at the top of the stack prior to atmospheric discharge is $\psi = C \times DF =$ *1.24E-5 Ci/m3. In Section 11.1.1.1, Airborne Radiations Sources of the SAR, UFTR applied a stack dilution factor of 0.0281 (i.e., 1/35.6) and C = 6.7E-4 Ci/m3 for full power operation to arrive at a stack concentration prior to discharge of* $\psi = C \times DF =$ *1.88E-5 Ci/*m^3*. Section 11.1.1.1 of the UFTR SAR also provided the activity at the stack discharge as directly measured to be* ψ *= 2.48E-5 Ci/m3. What is the explanation for the differences between these calculated and measured values?*

Res6. Since there are uncertainties in the flow rates of dilution fan and core vent, and the activation level of Ar-41, the dilution factor varies; consequently, the information provided in the SAR should be substituted by more recent data.

Q7. For the calculations presented in Table 9 of Appendix E of the UFTR responses to RAIs 11-1 and 11-2, dated November 6, 2008, our understanding is that the parameters for the Table 9 calculations are continuous Ar-41 release rate of 9.228E-5 Ci/s, stability class A, standard terrain, effective release height of 12.3 m, wind speed at the point of discharge of 3.99 m/s, and the downstream receptor at 0 m on the plume centerline. Using the input parameters with EPI code 7.0, we calculated the Ar-41 activity concentrations and radiation doses as shown in Table 1 below which show some inconsistency. Please confirm the use of the parameters above. If incorrect, please provide correct values. Please describe how a wind velocity of 3.99 m/s was obtained at the stack discharge.

Res7. We believe that the results shown in Table 9 are rather similar, and the observed relatively small differences should be attributed to the different methodologies employed in the two software used. Attachment 3 exlpains how the wind speed is determined.

Q8. SAR Section 11.2.2.1 Gaseous Waste Management and Table 11-4, indicates that the limit on operations of 235 hours/month is intended to satisfy the 10 CFR 20.1302 dose limit of 50 mrem/yr. Provisions in 10 CFR 20.1101(d) require that a total effective dose equivalent to the maximally-exposed member of the public should not exceed 10 mrem/yr for purposes of As Low As Reasonably Achievable (ALARA); if this dose constraint is exceeded, the licensee shall report this to NRC and take appropriate corrective action to ensure against recurrence. How does UFTR ensure compliance with the provisions of radiation protection programs of 10 CFR 20.1101?

Res8. As far as the limit on the operations hour, we believe the number of hours of operations is inappropriate, because several variables such as reactor operations (kw-hr), flow rate of core vent, flow rate of dilution fan, and environmental conditions impact the release concentration of Ar-41. Moreover, our reported data corresponding to highly conservative conditions, which are not realistic; e.g., we have considered the direction of flow directly toward the residential area (dorm), which is highly unrealistic. As discussed in the attachment #3, considering annual averaged conditions, the concentration at the residential reduces to a value significantly lower than the background that is not measurable. This result is in agreement with the measurements conducted by the University's radiation safety office.

Further, we have provided results of calculation of the number of hours of operations for the maximum of amount of concentration, which occurs at the Weil Hall. According to these calculations, reactor can operate at full power for ~228 hours/month resulting in monthly averaged dose of 50 mrem/hr, or ~47 hr/month of operations for maintaining the 10 mrem/hr limit for achieving ALARA. However, again, we believe it is not appropriate to put a limit on the number of hours of operations, rather, it is necessary to continuously monitor the amount of release radioactivity, and maintain the monthly averaged concentration sufficiently low so that we can meet the 10 mrem/hr limit for achieving the ALARA.

Q9. SAR Section 11.2.2.1, Gaseous Waste Management (p.11-23), it is indicated that if the activity level in the reactor vent discharge system exceeds 4000 cps, a monitor will *actuate a warning light and an audible alarm in the reactor control room. The relationship between this count rate alarm and the allowed activity discharge limit is unclear.*

a) Explain the relationship between the 4000 cps measurement by the stack monitoring system and the stack-diluted discharge concentration. Assuming 235 effective full-power hours of operation per month, would this maximum Ar-41 concentration and radiation doses for members of the public be below 1.00E-8 Ci/ml3 (Appendix B to 10 CFR Part 20) and 50 mrem/yr (10 CFR 20.1302)?
b) Is there a relationship between Ar-41 activity and the 4000 cps measurement that ensures that the highest dose to the public is limited to 10 mrem/yr (10 CFR 20.1101)?

Res9. The limit on the count at the reactor vent discharge has no relation with the Ar-41, because Ar-41 concentration is monitored on a biannual basis. The measured count rate during operations keeps the operator informed of any significant change in the radiation level on a relative basis. This count rate includes all sources of activity, and simply is a trending data for the reactor operator.

Q10. The Environmental Dosimetry results for the UFTR (reference facility annual report for 2005-2006, 2006-2007 and 2007-2008) for dosimeters 3, 4, 6, 8, 9, 10 and 11 document the same results in each of these years for all four categories and dosimeters 5 and 12 only differ on one. In contrast, the reports of previous years indicate the max environmental result was in single-digit millirem, while these later reports document readings in the 100's of millirem with the stack at 1700+ mrem. Please validate the high level of agreement for the readings in the annual reports for 2005-2006, 2006-2007 and 2007-2008 and explain the significant change in later reports.

Res10. By mistake a cumulative data was used; this information is corrected in all reports, and attachments #4, #5, and #6 provide the corrected annual reports for 2005-06, 2006-07, and 2007-08.

Q11. In a supplement to the application dated October 13, 2009, University of Florida (UF) indicated that the cost for decommissioning the UFTR was $2.7 million in 2009 dollars, with the cost being adjusted for inflation using the Consumer Price Index (CPI) (CPI for all urban consumers, US city average, all items (Base 1982)) and the Low Level Waste Disposal Adjustment Factor. In order for the NRC staff to complete its review of the UFTR decommissioning cost estimate, please provide the following additional information:

a) Documentation supporting the basis for the Waste Burial Adjustment Factor (FB) for the Adjusting Base from 1986 to 1982 as was documented in the October 13, 2009 supplement to the application.
b) The specific line items on Table II of the October 13, 2009 supplement to the application identifying the $118,000 Radioactive Waste disposal cost.

Clarify whether a 25 percent contingency factor is included in the updated 2009 decommissioning cost estimate provided in the October 13, 2009 supplement to the application.

Res11. Since, we discovered errors in our previous decommission document, we are submitting attachment #7, which includes the details of the CPI and waste disposal adjustment and the full decommission report. Table II in this document lists the total waste management costs is $113,000, which is based on a price quote from radioactive waste disposal company. The specific line items of the quote will be provided after further communication with the company.

The new estimated decommission cost as of December 2009 is $3.28 million, including the 25% contingency overhead, as indicated in Table II of the decommission report.

Q12. The July 18, 2002 application, and the October 13, 2009 supplement to the application, includes a statement of intent (SOI) as the method to provide decommissioning funding assurance for the UFTR as provided for by 10 CFR 50.75(e)(1)(iv). Where UF intends to use a SOI, the NRC staff must find that the applicant "is a Federal, State, or local government licensee." The application indicates that the applicant is a State government organization and that the decommissioning funding obligations of the applicant are backed by the State government. However, corroborating documentation must also be provided. Further, the applicant must provide documentation verifying that the signator of the SOI is authorized to execute said document that binds the University. This document may be a governing body resolution, management directives, or other form that provides an equivalent level of assurance. As the application does not provide all of the above information, please submit the following:
a) An updated SOI which includes the current (2010 dollars) cost estimate for decommissioning, a statement that funds for decommissioning will be obtained when necessary, and the signator's oath or affirmation attesting to the information. (Refer to Section 16.4 of Appendix A of NUREG-1757, Vol. 3, "Consolidated NMSS Decommissioning Guidance.")

Res12. We will submit a new commitment letter from our CFO to reflect on corrected cost of decommissioning of $3.2 M rather than $2.7 M. Corroborating documentation to the SOI is also being prepared. We will try to include these documents in a separate submittal as soon as possible.

Q13. Please provide an update to SAR Section 5 and other sections of the SAR as applicable with the description of the replacement primary piping and any changes to instrumentation types or sensing locations.

Res13. We will provide this document in a separate submittal by March 8, 2010.

Attachment 1

Copy of Subcontract, No. 00074551, for return of spent fuel

STANDARD RESEARCH SUBCONTRACT NO. 00074551 **"REACTOR FUEL ASSISTANCE AND FUEL ELEMENTS"**	Battelle Energy Alliance, LLC (BEA) 2525 Fremont Avenue P. O. Box 1625 Idaho Falls, ID 83415-3890
Subcontractor: University of Florida Office of Engineering Research 339 Weil Hall Gainesville, FL 32611 To: Roslyn S. Heath PI: W. Vernetson **Period of Performance:** June 1, 2008 – December 31, 2012 **Award Amount:** $0.0	**Contractor's Procurement Representative** Lynda Keller Subcontract Administrator 208-526-5597 208-526-5780 Lynda.Keller@inl.gov

Introduction

This is a standard research subcontract for unclassified research and development work, not related to nuclear, chemical, biological, or radiological weapons of mass destruction or the production of special nuclear material for use in weapons of mass destruction. This Subcontract is between Battelle Energy Alliance, LLC (BEA) (Contractor) and University of Florida (Subcontractor). The Subcontract is issued under Prime Contract No. DE-AC07-05ID14517 between the Contractor and the United States Department of Energy (DOE) for the management and operation of the Idaho National Laboratory (INL).

Agreement

The parties agree to perform their respective obligations in accordance with the terms and conditions of the Schedule, General Provisions and other documents attached or incorporated by reference, which together constitute the entire Subcontract and supersedes all prior discussions, negotiations, representations, and agreements.

BATTELLE ENERGY ALLIANCE, LLC (BEA)	UNIVERSITY OF FLORIDA
By: Lynda Keller	By: Roslyn S Heath
Name: Lynda Keller	Name: Roslyn S Heath
Title: Subcontract Administrator	Title: Assistant Director for Research
Date: 6/4/08	Date: 6/5/08

SCHEDULE OF ARTICLES

1. Statement of Work

The Subcontractor shall furnish the following services, in accordance with the requirements, terms and conditions specified or referenced in this Subcontract:

Provide for utilization of the reactor owned by the Subcontractor in a program of education and training of students in nuclear science and engineering, and for faculty and student research. The Subcontract provides for the continued possession and use of Department of Energy (DOE)-owned nuclear materials, including enriched uranium, in reactor fuel without incremental charge of use, burn-up, and reprocessing while used for research, education and training purposes.

The DOE-owned nuclear materials were originally provided to Subcontractor under Subcontract No. C88-101864-001, reissued as K97-176844-003, and again reissued as 00000071-002. The nuclear materials will now reside with this Subcontract No. 00074551.

The Subcontractor's Principal Investigator assigned to this work is W. Vernetson. The Principal Investigator shall not be replaced or reassigned without the advance written approval of the Contractor's Subcontract Administrator.

2. Reports and Data Requirements

a. Progress Reports

1. Distribution of the DOE/NRC Form 741, Nuclear Material Transaction Report, shall include JSG/MM. Copies of DOE/NRC Forms 742, Material Balance Report, and 742C, Physical Inventory Listing, shall be sent to the Contractor point-of-contact for nuclear material management and accountability.

2. Annually, in conjunction with submittal of the Material Balance Report and Physical Inventory Listing reports, the Subcontractor is required to submit information listed below so that the Contractor can meet DOE requirements for annual reporting contained in DOE Order 5660.1B, Management of Nuclear Materials. The Subcontractor is required to notify the Contractor of the following:

   2.1. Fuel usage in grams Uranium 235 and number of fuel elements.

   2.2. Current inventory of unirradiated fuel elements in storage.

   2.3. Current inventory of fuel elements in core.

   2.4. Current inventory of useable irradiated fuel elements outside of core.

   2.5. Current inventory of spent fuel elements awaiting shipment.

   2.6. Projected fuel needs for the next five years.

   2.7. Current inventory of all other nuclear material items under Idaho Field Office (DOE-ID) assigned project identification number; i.e., those project numbers beginning with the character "J".

   2.8. Current Subcontractor point-of-contact for nuclear material accountability.

b. Final Report:

The Subcontractor shall furnish within 6 months after the shipment of all remaining material under this Subcontract, a report indicating the amount of material returned and whether additional material requests are planned.

3. Period of Performance

The work described in the Statement of Work is effective June 1, 2008, and shall be completed on or before December 31, 2012.

4. Reactor Fuel Special Provisions

a. Title to all special nuclear materials loaned to the Subcontractor under this Subcontract shall at all times be and remain the United States Government.

b. The Contractor will not charge the Subcontractor for materials (1) consumed in the operation of the facility until expiration of this Subcontract, and (2) not recovered in reprocessing subsequent to the ultimate return of the special nuclear material.

c. As a Nuclear Regulatory Commission (NRC) Licensee, the Subcontractor shall, in addition to complying with 10CFR 73.37 and 73.72, be responsible for performing (or contracting others to perform) the actions necessary for compliance with the Order for Safeguards and Security Compensatory Measures on the Transportation of Spent Nuclear Fuel greater than 100 grams, as modified by the NRC from time to time. If required, arrangements for armed escorts are the responsibility of the Subcontractor.

d. If the Subcontractor desires to return material provided under this Subcontract, the Subcontractor shall submit a request to the Contractor, preferably within 18 months, but no later than 6 months, from the time which the Subcontractor desires to return the materials to the DOE, indicating the characteristic and amount of material the Subcontractor desires to return. The Contractor will provide requirements for documentation and instructions for returning the material. At the Contractor's option, the Contractor will provide a shipping container and provide funds directly to a Carrier, or under a Separate Purchase Order (subject to negotiated cost limitations), the Contractor will reimburse the Subcontractor for commercial shipping container rental, use of a Carrier, and other costs for activities incident to the shipment of the material. The Subcontractor has no responsibility for receipt at a DOE facility, storage nor processing of such material. The Subcontractor's obligation is to return material in the form defined, as affected by the activities listed above in Article 1.

e. Except as otherwise provided herein, the Subcontractor is responsible for and will pay the Contractor any charges imposed by the Contractor for material delivered to the Subcontractor and not ultimately returned to the Contractor.

g. Notwithstanding any other provision of this Subcontract, the Contractor or the Government shall not be responsible for or have any obligation to the Subcontractor for decontamination or decommissioning (D&D) of any of the Subcontractor's facilities.

h. The Subcontractor is responsible for the management, accountability and control of DOE-owned nuclear material in its possession. Nuclear material supplied under this Subcontract by the DOE shall comply with the following requirements:

1. Nuclear material is accounted for with a 10-digit alphanumeric, budget and reporting project identification number, which is assigned and controlled by Idaho Operations (NE-ID). The Subcontractor is not allowed to make changes to this number.

2. The project identification number must be recorded in the Project Number field on the DOE/NRC Form 741, "Nuclear Material Transaction Report", involving any activity, e.g., receipts, removal and adjustments (Reference NUREG BR-0006, "Instructions for Completing Nuclear Material Transaction Reports"); and DOE/NRC Form 742C, "Physical Inventory Listing" (Reference NUREG BR-0007, "Instructions for the Preparation and Distribution of Material Status Reports").

i. In the event the terms and conditions of this Subcontract are not in agreement with NRC rules and regulations, the NRC requirements will take precedence.

5. Subcontract Administration

a. The Contractor's Subcontract Administrator for this Subcontract is Lynda Keller. The Subcontract Administrator is the only person authorized to make changes in the requirements of this Subcontract or make modifications to this Subcontract, including changes or modifications to the Statement of Work and the Schedule. The Subcontractor shall direct all notices and requests for approval required by this Subcontract to the Subcontract Administrator.

Any notices and approvals required by this Subcontract from the Contractor to the Subcontractor shall be issued by the Subcontract Administrator.

b. The Contractor's Technical Representative for this Subcontract is D. Morrell. The Technical Representative is the person designated to monitor the Subcontract work and to interpret and clarify the technical requirements of the Statement of Work. The Technical Representative is not authorized to make changes to the work or modify this Subcontract.

c. The Contractor's Materials Management and Accountability representative for this Subcontract is M. Wilkinson. Progress reports as specified in Section 2.a. shall be provided to the representative according to the timeliness established by DOE and NRC directives.

d. The Subcontractor's Subcontract Administrator for this Subcontract is R. Heath.

6. Supplier Performance Evaluation System (SPES)

Contractor evaluates subcontractor performance in accordance with the SPES. The Subcontractor shall be formally evaluated no less than quarterly as applicable, and upon completion of the work. A minimum score of 80 points out of 100 is required to maintain approved status. Information concerning the SPES is available for review at: http://www.inl.gov/procurement/forms.shtml. Select INL Supplier Management Program.

7. Lower-tier Subcontractors

Subcontractor shall not subcontract performance of any portion of the work being performed at the INL without the advanced written approval of Contractor, (excluding material deliveries). Lower-tier subcontracts and purchase orders must include provisions to secure all rights and remedies of

Contractor and the Government provided under this Subcontract, and must impose upon the lower-tier subcontractor all of the general duties and obligations required to fulfill this Subcontract. Subcontractor is responsible for the performance and oversight of all lower-tier subcontractors

8. Order of Precedence

In the event of any inconsistency between provisions of this Subcontract, the inconsistency shall be resolved by giving precedence as follows: (a) Subcontract Change documents, if any, (b) Subcontract, (c) Specifications or Statement of Work, (d) General Provisions, and (e) other provisions of this Subcontract, whether incorporated by reference or otherwise. However, Subcontractor shall notify Contractor prior to performing work based on resolution of any inconsistency by he order of precedence set forth herein.

9. Applicable Documents

The following documents are applicable to Subcontract:

a. 10 CFR 73.37 and 73.72.

b. Order for Safeguards and Security Compensatory Measurements on the Transportation of Spent Nuclear Fuel.

c. DOE/NRC Form 741, Nuclear Material Transaction Report.

d. DOE-NRC form 742, Material Balance Report.

e. DOE/NRC Form 742C, Physical inventory Listing.

f. NUREG BR-0006, Instructions for Completing Nuclear Material Transaction reports.

g. NUREG BR-0007, Instructions for the Preparation and Distribution of Material Status Reports.

h. DOE Order 5660.1B, Management of Nuclear Materials.

GENERAL PROVISIONS

CLAUSE 1 - PUBLICATIONS

A. The Subcontractor shall closely coordinate with the Contractor's Technical Representative regarding any proposed scientific, technical or professional publication of the results of the work performed or any data developed under this Subcontract. The Subcontractor shall provide the Contractor an opportunity to review any proposed manuscripts describing, in whole or in part, the results of the work performed or any data developed under this Subcontract at least forty-five (45) days prior to their submission for publication. The Contractor will review the proposed publication and provide comments. A response shall be provided to the Subcontractor within forty-five (45) days; otherwise, the Subcontractor may assume that the Contractor has no comments. Subject to the requirements of Clause 9, the Subcontractor agrees to address any concerns or issues identified by the Contractor prior to submission for publication.

B. Subcontractor may acknowledge the Contractor and Government sponsorship of the work as appropriate.

CLAUSE 2 – NOTICES

A. The Subcontractor shall immediately notify the Contractor's Subcontract Administrator in writing of: (1) any action, including any proceeding before an administrative agency, filed against the Subcontractor arising out of the performance of this Subcontract; and (2) any claim against the Subcontractor, the cost and expense of which is allowable under the terms of this Subcontract.

B. If, at any time during the performance of this Subcontract, the Subcontractor becomes aware of any circumstances which may jeopardize its performance of all or any portion of the Subcontract, it shall immediately notify the Contractor's Subcontract Administrator in writing of such circumstances, and the Subcontractor shall take whatever action is necessary to cure such defect within the shortest possible time.

CLAUSE 3 – ASSIGNMENTS

The Contractor may assign this Subcontract to the Government or its designee(s). Except as to assignment of payment due, the Subcontractor shall have no right to assign or mortgage this Subcontract or any part of it without the prior written approval of the Contractor's Subcontract Administrator, except for subcontracts already identified in the Subcontractor's proposal.

CLAUSE 4 – DISPUTES

A. Informal Resolution

1. The parties to a dispute shall attempt to resolve it in good faith, by direct, informal negotiations. All negotiations shall be confidential. Pending resolution of the dispute, the Subcontractor shall proceed diligently with the performance of this Subcontract, in accordance with its terms and conditions.
2. The parties, upon mutual agreement, may seek the assistance of a neutral third party at any time, but they must seek such assistance no later than 120 days after the date of the Contractor's receipt of a claim. The requirement to seek the assistance of a neutral third party may be waived or modified only with the consent of all parties. The parties may

request the assistance of an established Ombudsman Program, where available, or hire a mutually agreeable mediator, or ask the DOE Office of Dispute Resolution to assist them in selecting a mutually agreeable mediator. The cost of mediation shall be shared equally by both parties. If requested by both parties, the neutral third party may offer a non-binding opinion as to a possible settlement. All discussions with the neutral third party shall be confidential.

3. In the event the parties are unable to resolve the dispute by using a neutral third party or waive the requirement to seek such assistance, the Contractor will issue a written decision on the claim.

B. Formal Resolution

1. If a dispute has not been resolved by informal resolution, it may be submitted to binding arbitration upon agreement of both parties, by and in accordance with the Commercial Arbitration Rules of the American Arbitration Association (AAA). If arbitration is agreed to by both parties, such decision is irrevocable and the outcome of the arbitration shall be binding on all parties.

2. Each party to the arbitration shall pay its pro rata share of the arbitration fees, not including counsel fees or witness fees or other expenses incurred by the party for its own benefit.

3. Judgment on the award rendered by the arbitrator may be entered in any court having jurisdiction.

C. Litigation

If arbitration is declined for such disputes, the parties may pursue litigation in any court of competent jurisdiction.

D. Governing Law

This Subcontract shall be interpreted and governed in accordance with all applicable federal and state laws and all applicable federal rules and regulations.

CLAUSE 5 - RESPONSIBILITY FOR TECHNOLOGY EXPORT CONTROL

The parties understand that materials and information resulting from the performance of this Subcontract may be subject to export control laws and that each party is responsible for its own compliance with such laws.

CLAUSE 6 – COST ACCOUNTING STANDARDS (CAS) LIABILITY

[Applicable to Subcontracts exceeding $500,000]

Clause 10 below incorporates into these GENERAL PROVISIONS clauses entitled, "*COST ACCOUNTING STANDARDS" and "ADMINISTRATION OF COST ACCOUNTING STANDARDS.*" Notwithstanding the provisions of these clauses, or of any other provision of the Subcontract, the Subcontractor shall be liable to the Government for any increased costs, or interest thereon, resulting from any failure of the Subcontractor, with respect to activities carried on at the site of the work, or of a subcontractor, to comply with applicable cost accounting standards or to follow any practices disclosed pursuant to the requirements of such clause.

CLAUSE 7 - DISCLOSURE AND USE RESTRICTIONS FOR LIMITED RIGHTS DATA

Generally, delivery of Limited Rights Data (or Restricted Computer Software) should not be necessary. However, only if Limited Rights Data will be used in meeting the delivery requirements of the subcontract, the following disclosure and use restrictions shall apply to and shall be inserted in, any FAR 52.227-14 Limited Rights Notice on any Limited Rights Data furnished or delivered by the Subcontractor or a lower-tier subcontractor:

A. These "Limited Rights Data" may be disclosed for evaluation purposes under the restriction that the "Limited Rights Data" be retained in confidence and not be further disclosed;

B. These "Limited Rights Data" may be disclosed to other contractors participating in the Government's program of which this Subcontract is a part for information or use in connection with the work performed under their contracts and under the restriction that the "Limited Rights Data" be retained in confidence and not be further disclosed; and

C. These "Limited Rights Data" may be used by the Government or others on its behalf for emergency repair or overhaul work under the restriction that the "Limited Rights Data" be retained in confidence and not be further disclosed.

CLAUSE 8 - ORDER OF PRECEDENCE

Any inconsistencies in the documents comprising this Subcontract shall be resolved by giving precedence in the following order: (a) the SCHEDULE OF ARTICLES and this Subcontract Signature Page; (b) these GENERAL PROVISIONS; (c) other referenced documents, exhibits, and attachments; and (d) any referenced specification or *Statement of Work.*

CLAUSE 9 – SECURITY REQUIREMENTS

A. This Subcontract is intended for unclassified, publicly releasable research or development work. The Contractor does not expect that results of the research project will involve classified information or Unclassified Controlled Nuclear Information (UCNI) (See 10 CFR part 1017). However, the Contractor may review the research work generated under this Subcontract at any time to determine if it requires classification or control as UCNI.

B. If, subsequent to the date of this Subcontract, a review of the information reveals that classified information or UCNI is being generated under this Subcontract, then the security requirements of this Subcontract must be changed. If such changes cause an increase or decrease in costs or otherwise affect any other term or condition of this Subcontract, the Subcontract shall be subject to an equitable adjustment as if the changes were directed under the Changes clause of this Subcontract.

C. If the security requirements are changed, the Subcontractor shall exert every reasonable effort compatible with its established policies to continue the performance of work under the Subcontract in compliance with the change in the security requirements. If the Subcontractor determines that continuation of the work under this Subcontract is not practicable because of the change in security requirements, the Subcontractor shall notify the Contractor's Procurement Representative in writing. Until the Contractor's Procurement Representative provides direction, the Subcontractor shall protect the material as directed by the Contractor.

D. After receiving the written notification, the Contractor's Procurement Representative shall explore the circumstances surrounding the proposed change in security requirements and shall endeavor to work out a mutually satisfactory method to allow the Subcontractor to continue performance of work under this Subcontract.

E. Within 15 days of receiving the written notification of the Subcontractor's stated inability to proceed, the Contractor's Procurement Representative must determine whether (1) these security requirements do not apply to this contract or (2) a mutually satisfactory method for continuing performance of work under this Subcontract can be agreed upon. If this determination is not made, the Subcontractor may request the Contractor's Procurement Representative to terminate the Subcontract in whole or in part. The Contractor's Procurement Representative shall terminate the Subcontract in whole or in part, as may be appropriate, and the termination shall be deemed a termination under the terms of the Termination for the Convenience of the Government clause.

CLAUSE 10 - CLAUSES INCORPORATED BY REFERENCE

The FEDERAL ACQUISITION REGULATION (FAR) and the U.S. DEPARTMENT OF ENERGY ACQUISITION REGULATION (DEAR) clauses listed below, which are located in Chapters 1 and 9, respectively, of Title 48 of the Code of Federal Regulations, are incorporated by this reference as a part of these GENERAL PROVISIONS with the same force and effect as if they were given in full text, as prescribed below.

The full text of the clauses may be accessed electronically at http://www.arnet.gov/far/ (FAR) and http://professionals.pr.doe.gov/ma5/MA-5Web.nsf/Procurement/Acquisition+Regulation (DEAR).

As used in the clauses, the term "contract" shall mean this Subcontract; the term "Contractor" shall mean the Subcontractor; the term "subcontractor" shall mean the Subcontractor's subcontractor, and the terms "Government" and "Contracting Officer" shall mean the Contractor, except in FAR clause 52.227-14, and DEAR clauses 970.5227-4, 952.227-11, 970.5232-3 and 52.245-5 Alternate I, in which clauses "Government" shall mean the United States Government and "Contracting Officer" shall mean the DOE/NNSA Contracting Officer for Prime Contract DE-AC07-05ID14517 with the Contractor. As used in DEAR clauses 952.204-72 and 952.227-9, the term "DOE" shall mean DOE/NNSA or the Contractor.

The modifications of these clause terms are intended to appropriately identify the parties and establish their contractual and administrative reporting relationship, and shall not apply to the extent they would affect the U.S. Government's rights. The Subcontractor shall include the listed clauses in its subcontracts at any tier, to the extent applicable.

APPLICABLE TO ALL SUBCONTRACTS UNLESS OTHERWISE INDICATED BELOW:

DEAR 952.204-71	SENSITIVE FOREIGN NATIONS CONTROLS (APR 1994). Applies if the Subcontract is for unclassified research involving nuclear technology.
FAR 52.216-7	ALLOWABLE COST AND PAYMENT (DEC 2002). Substitute 31.3 in subcontracts with educational institutions and 31.7 in subcontracts with nonprofit organizations for 31.2 in paragraph (a).
FAR 52.216-15	PREDETERMINED INDIRECT COSTS RATES APR 1998).
FAR 52.222-21	PROHIBITION OF SEGREGATED FACILITIES (FEB 1999).
FAR 52.222-26	EQUAL OPPORTUNITY (APR 2002).

FAR 52.223-3	HAZARDOUS MATERIAL IDENTIFICATION AND MATERIAL SAFETY DATA SHEETS (JAN 1997) AND ALTERNATE I. Applies only if Subcontract involves delivery of hazardous materials.
FAR 52.225-13	RESTRICTIONS ON CERTAIN FOREIGN PURCHASES (DEC 2003).
DEAR 970.5227-4	AUTHORIZATION AND CONSENT (AUG 2002), Paragraph (a).
DEAR 952.227-9	REFUND OF ROYALTIES (FEB 1995). Applies if "royalties" of more than $250 are paid by a subcontractor at any tier.
DEAR 952.227-11	PATENT RIGHTS - RETENTION BY THE CONTRACTOR (SHORT FORM) (FEB 1995). (Applies only if Subcontractor is a nonprofit organization as set forth in 48 CFR 27.301. If Subcontractor does not qualify in accordance with 48 CFR 27.301, it may request a patent waiver pursuant to 10 CFR 784.)
FAR 52.227-14	[Check provision below that applies OR include only applicable provision]. _____ RIGHTS IN DATA-GENERAL (JUN 1987) with ALTERNATE V and DEAR 927.409 Paragraphs (a) and (d)(3). Applies if the Subcontract is for development work, or for basic and applied research where computer software is specified as a Deliverable in the Statement of Work or other special circumstances apply as specified in the agreement. _X___ RIGHTS IN DATA-GENERAL (JUN 1987) with ALTERNATE IV, subparagraph (c)(1) and DEAR 927.409, subparagraph (a) Definitions. Applies if the Subcontract is for basic or applied research and computer software is not specified as a Deliverable in the Statement of Work, and no other special circumstances apply per DEAR 927.409.
FAR 52.227-23	RIGHTS TO PROPOSAL DATA (TECHNICAL) (JUNE 1987). Applies if the Subcontract is based upon a technical proposal.
FAR 52.229-10	STATE OF NEW MEXICO GROSS RECEIPTS AND COMPENSATING TAX (APR 2003). Applies if any part of this Subcontract is to be performed in the State of New Mexico.
FAR 52.232-20	LIMITATION OF COST (APR 1984). Applies if the Subcontract is fully funded.
FAR 52.232-22	LIMITATION OF FUNDS (APR 1984). Applies if the Subcontract is incrementally funded.
FAR 52.242-15	STOP-WORK ORDER (AUG 1989) with ALTERNATE I (APR 1984).
FAR 52.243-2	CHANGES – COST-REIMBURSEMENT (AUG 1987), WITH ALTERNATE V
FAR 52.244-2	SUBCONTRACTS (AUG 1998). Insert in Paragraph (c): "Any subcontract or purchase order for other than "commercial items" exceeding the simplified acquisition threshold. ("Commercial item" has the meaning contained in FAR 52.202-1, Definitions.)"
DEAR 970.5245-1	PROPERTY (DEC 2000).
FAR 52.246-9	INSPECTION OF RESEARCH AND DEVELOPMENT (SHORT FORM) (APR 1984).

FAR 52.247-63	PREFERENCE FOR U. S. FLAG AIR CARRIERS (JUNE 2003). Applies if the Subcontract involves international air transportation.
FAR 52.247-64	PREFERENCE FOR PRIVATELY OWNED U.S.-FLAG COMMERCIAL VESSELS (APR 2003).
DEAR 952.247-70	FOREIGN TRAVEL (DEC 2000).
FAR 52.249-5	TERMINATION FOR CONVENIENCE OF THE GOVERNMENT (EDUCATIONAL AND OTHER NONPROFIT INSTITUTIONS) (SEP 1996).
DEAR 952.217-70	ACQUISITION OF REAL PROPERTY (APR 1984). Applies if the Subcontract involves leased space that is reimbursed.
DEAR 970.5232-3	ACCOUNTS, RECORDS, AND INSPECTION (DEC 2000)

APPLICABLE IF THE SUBCONTRACT IS FOR $10,000 OR MORE:

FAR 52.222-35	EQUAL OPPORTUNITY FOR SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA AND OTHER ELIGIBLE VETERANS (DEC 2001).
FAR 52.222-36	AFFIRMATIVE ACTION FOR WORKERS WITH DISABILITIES (JUNE 1998).
FAR 52.222-37	EMPLOYMENT REPORTS ON SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA AND OTHER ELIGIBLE VETERANS (DEC 2001).

APPLICABLE IF THE SUBCONTRACT EXCEEDS $100,000:

FAR 52.203-5	COVENANT AGAINST CONTINGENT FEES (APR 1984)
FAR 52.203-6	RESTRICTIONS ON SUBCONTRACTOR SALES TO THE GOVERNMENT (JULY 1995).
FAR 52.203-7	ANTI-KICKBACK PROCEDURES (JULY 1995), excluding Paragraph (c)(1).
FAR 52.203-10	PRICE OR FEE ADJUSTMENT FOR ILLEGAL OR IMPROPER ACTIVITY (JAN 1997).
FAR 52.203-12	LIMITATION ON PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS (JUNE 2003).
FAR 52.219-8	UTILIZATION OF SMALL BUSINESS CONCERNS (MAY 2004).
FAR 52.222-04	CONTRACT WORK HOURS AND SAFETY STANDARDS ACT - OVERTIME COMPENSATION (SEP 2000).
DEAR 970.5227-5	NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT (AUG 2002).

APPLICABLE IF THE SUBCONTRACT EXCEEDS $500,000:

FAR 52.215-10	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA (OCT 1997) if subcontract exceeds $550,000.

FAR 52.215-11	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA-MODIFICATIONS (OCT 1997) not used when 52.215-10 is included. In subcontracts greater than $550,000.
FAR 52.215-12	SUBCONTRACTOR COST OR PRICING DATA (OCT 1997). Applies if 52.215-10 applies.
FAR 52.215-13	SUBCONTRACTOR COST OR PRICING DATA-MODIFICATIONS (OCT 1997). Applies if 52.215-11 applies.
FAR 52.219-9	SMALL BUSINESS SUBCONTRACTING PLAN (JAN 2002). Applies unless there are no subcontracting possibilities.
FAR 52.227-16	ADDITIONAL DATA REQUIREMENTS (JUNE 1987).
FAR 52.230-2	COST ACCOUNTING STANDARDS (APR 1998), excluding paragraph (b). Applies to nonprofit organizations if they are subject to full CAS coverage as set forth in 48 CFR Chapter 99, Subpart 9903.201-2 (FAR Appendix B).
FAR 52.230-3	DISCLOSURE AND CONSISTENCY OF COST ACCOUNTING PRACTICES (APR 1998), excluding paragraph (b). Applies to nonprofit organizations if they are subject to modified CAS coverage as set forth in 48 CFR Chapter 99, Subpart 9903.201-2 (FAR Appendix B).
FAR 52.230-5	COST ACCOUNTING STANDARDS – EDUCATIONAL INSTITUTION (APR 1998), excluding paragraph (b).
FAR 52.230-6	ADMINISTRATION OF COST ACCOUNTING STANDARDS (NOV 1999).

(END OF GENERAL PROVISIONS)

Attachment 2

Response to RAI (Oct. 2009 submittal)

Responses

to

REQUEST FOR ADDITIONAL INFORMATION
UNIVERSITY OF FLORIDA TRAINING REACTOR
DOCKET NO. 50-83

by

Alireza Haghighat, Director of UFTR
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(November 26, 2008)
(October 2009, updated on release limit)

Responses to
REQUEST FOR ADDITIONAL INFORMATION
UNIVERSITY OF FLORIDA TRAINING REACTOR
DOCKET NO. 50-83

Question 1: *Your letter dated April 7, 2008, states that the normal operating pressure for the secondary side is not monitored, but that secondary flow rate is about 4 times higher than the primary flow rate so the dynamic pressure of the secondary system is expected to be higher than the primary system pressure. Therefore, if a significant leak is developed on the primary/secondary boundary, the resistivity of the primary water is expected to change, which is constantly monitored and controlled. The technical specifications (TSs) limits on primary flow rate are greater than 36 gpm or 41 gpm depending on fuel coolant channel spacing tolerance, and the TSs limits on secondary flow rate are greater than 60 gpm when using a well system and 8 gpm when using city water.*

Is the assumption that a significant leak would be detected in the primary water resistivity valid if the reactor is operating at the TS limit of 36 gpm or 41 gpm primary flow rate (or normal primary flow rate if it is in excess of the allowed TS limit) and 60 gpm or 8 gpm secondary flow rate? In your response, address how the primary and secondary pressures are affected by the flow characteristics in the heat exchanger.

Response 1:

The resistivity of primary water is monitored. If some fission products leak into the primary coolant due to fuel failure, this will cause resistivity change in the primary water regardless of the flow rates.

The shell-tube type heat exchanger is one of the Type AHTR series, manufactured by AMETEK (Type 316 Stainless Steel, U-tube configuration), with one pass on the shell side for the secondary coolant, and two-pass on the tube side for the primary coolant.

Here we use the Kern method (Refs. 1 and 2) to estimate the shell-side and tube-side pressure drop.

The shell-side pressure drop can be estimated by the following equation.

$$\Delta p_s = \frac{f_s G_s^2 N_s \cdot D_s}{2\rho D_e \phi_s} \qquad (1)$$

Where

$f_s = \exp(0.576 - 0.19 * \ln(Re_s))$ *is Fanning friction factor on shell side (Note the factor also takes entrance and exit pressure losses into account)*

D_s *= shell inner diameter*

$G_s = \frac{m_s}{A_s}$ *is the shell side mass velocity*

m_s = *the shell side mass flow rate*

$A_s = \frac{D_s CB}{P_T}$ *is the shell side cross flow area*

C = the distance between tubes (see Figure 1)

P_T = *tube pitch size (see Figure 1)*

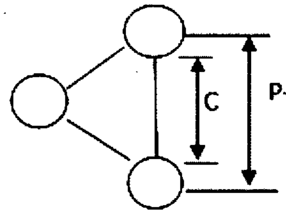


Figure 1 - Triangle pitch size parameters

$(Re_s = \frac{G_s D_e}{\mu_s})$ = *shell-side Reynolds number (Eq. 1 is valid for* $400 < Re < 1 \times 10^6$*)*

$[D_e = \frac{4 \times free\ flow\ area}{wetted\ perimeter} = \frac{4 \times (\frac{P_T^2 \sqrt{3}}{4} - \frac{\pi d_o^2}{8})}{\pi d_o / 2}]$ = *Equivalent diameter of the shell side for triangular pitch.*

d_o = *Tube outer diameter*

ρ = *shell side water density*

L_s= *shell side length*

B = baffle spacing

N_s = *number of times the shell side water passes across the tube bundle* ($N_s = L_s/B$)

$\phi_s = (\frac{\mu_s}{\mu_w})^{0.14}$

μ_s = *the shell side water viscosity at shell side water temperature*

μ_w = *the shell side water viscosity at tube wall temperature*

The tube side pressure drop is calculated by the following equation

$$\Delta p_t = (4f_t \times \frac{LN_p}{d_i} + 4N_p)\frac{\rho V_t^2}{2} \qquad (2)$$

Where,

$[f_t = (1.58 \ln(Re) - 3.28)^{-2}]$ = *the friction factor on the tube side*

N_p = *the number of passes on the tube side*

L = tube length.

d_i = *tube inner diameter*

V_t = *the average flow speed (m/s)*

The first part of Eq. 2 accounts for the pressure drop due to friction, and the second part accounts for pressure drop due to the change of direction of U-tubes.

In order to use Eqs 1 and 2, parameters given in Table 1 are considered.

Table 1 - Parameters used to evaluate pressure drop in the heat exchanger.

Parameters	*value*
tube inner diameter	*5.35E-02 m*
tube outer diameter	*6.35E-03 m*
shell inner diameter	*2.06E-01 m*
shell length	*1.10E+00 m*
tube length	*1.00E+00 m*
number of baffle	*10*
pitch size (Pt)	*1.27E-02 m*
tube distance (C)	*6.35E-03 m*
number of passes (tube side)	*2*
number of tubes	*126*
Average Primary Coolant Temp.	*86.5 ˚F*
Average Secondary Coolant Temp.	*75.3 ˚F*

For reference, we use primary flow rate at 40 gpm, and secondary flow rate at 200 gpm (well water). The effects of different flow rates will be discussed later. In Table 2, the temperatures are the average measured values, and they are used to look up the viscosity values.

Table 2 - Pressure drop in the heat exchanger for the reference case (primary flow rate = 40 gpm, secondary flow rate = 200 gpm)

	Flow rate (gpm)	*Pressure Drop (psi)*
Shell-side (Secondary)	*200*	*2.18*
Tube-Side (Primary)	*40*	*4.42*

Above table indicates that the pressure drops in the primary and secondary sides are relatively small, and moreover the primary drop is larger than the secondary side.

The heat exchanger shell-side and tube-side inlet/outlet pressures are not monitored in UFTR. However, we can estimate the pressures based on the piping layout and pump characteristics. Figure 5-5 in UFTR SAR shows the schematic of UFR secondary coolant system. The figure is also attached in this document (Appendix A). A simplified version of Figure 5-5 in SAR is used here to estimate the primary outlet and secondary inlet pressures as shown in Figure 2

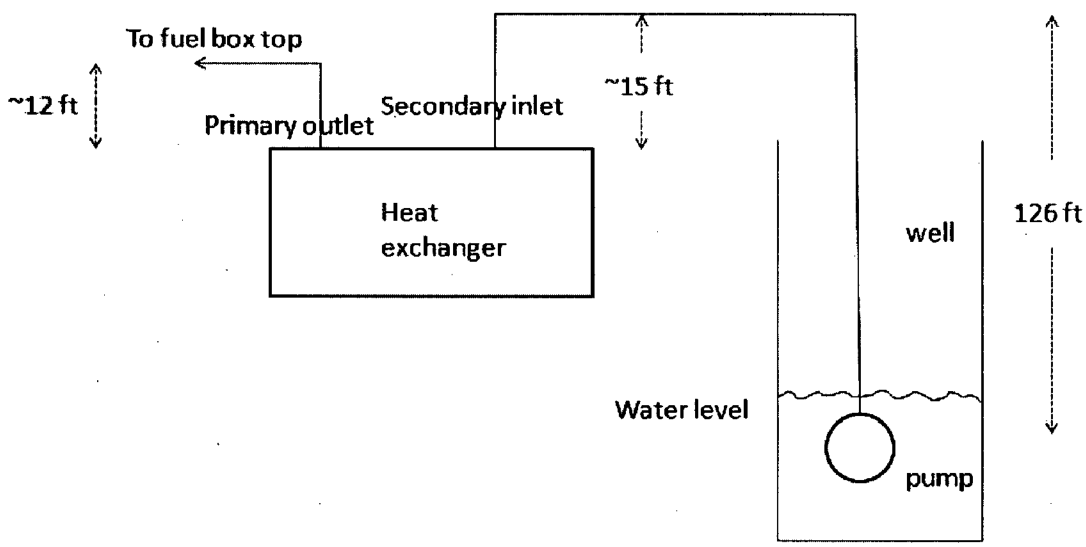


Figure 2 schematic of UFTR secondary coolant system used for determination of heat exchanger inlet/outlet pressures.

The well pump, model 150H10 is manufactured by Goulds Pumps, ITT Industry. The specifications of the pump are given in Appendix B. According to the data given in the Appendix, the pump at 10 hp, for 200 gpm, has a dynamic head of 163 ft. In Figure 3, the *height difference between the pump and heat exchanger is ~111 ft (126 ft minus 15 ft). Assuming no significant pressure loss in the pipes, the secondary inlet pressure is about 50 ft (163 ft minus 111 ft) water above the atmosphere pressure. While on the primary side, the height from the heat exchanger to the top of fuel box (where the pressure is atmosphere) is ~12 ft. The primary outlet pressure is about 12 ft water above the atmosphere pressure. Considering 1 psi is equal to 2.306 ft water, then the inlet pressure for the secondary is ~36.4 psi, and the outlet pressure for the primary is ~19.9 psi. Considering the expected pressure drop in the heat exchanger give in Table 2, the secondary outlet pressure is ~34.2 psi, which is ~72% higher than the primary outlet pressure. This difference increases as the secondary flow rate decreases, e.g., at 100 gpm with a dynamic head of 238 ft, the pressure difference is ~251%. This means that there is always a negative pressure which prevents any leak from the primary loop to the secondary loop.*

Figures 3 and 4 show the pressure drop as a function of flow rate for the primary and secondary sides, respectively.

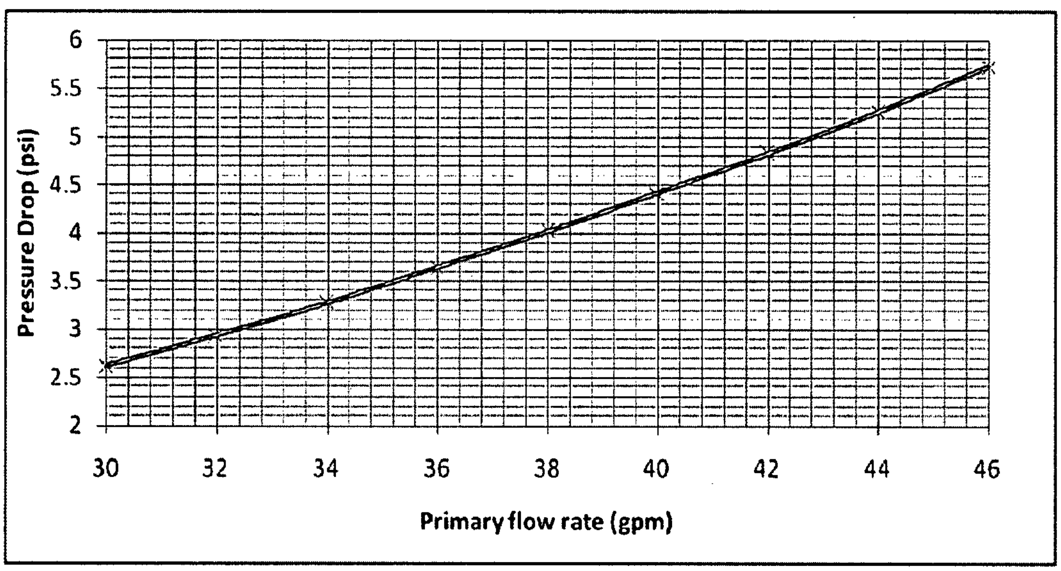


Figure 3 - Primary pressure drop in the heat exchanger for different flow rates

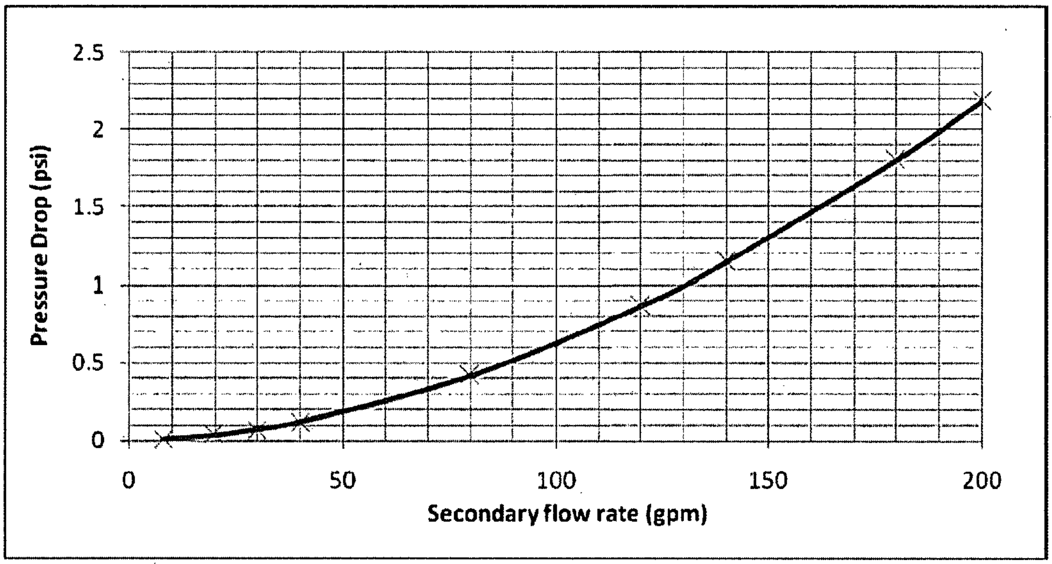


Figure 4 - Secondary pressure drop in the heat exchanger for different flow rates

Above figures show that the primary pressure drop ranges from 2.61 psi to 5.72 psi for a flow rate from 30 gpm to 46 gpm. While the secondary pressure drop is below 2.18 psi for a flow rate up to 200 gpm.

In conclusion, the secondary pressure remains higher than the primary pressure in the heat exchanger when operating on the well water. For city water, the primary pressure drop is still larger than the secondary pressure drop. The primary heat exchanger inlet pressure is likely higher than the secondary inlet pressure. So it is not valid to assume that the secondary pressure is always higher than the primary pressure. However, the activity release is limited even if there is leakage in the heat exchanger (See analysis in Question 2).

Question 2: *Your letter dated April 7, 2008, states that "with conservative assumptions on sodium in the primary coolant system, irradiation time, neutron flux level, cross section, primary-to-secondary leakage and secondary diluting flow, the following values are determined for a 1 liter/hr undetected leak rate continuing for 1 hour with 1 ppm sodium assumed in the primary coolant system. Activation for 10 hours yields ~54 mCi Na-24 in the primary coolant tank at a concentration of ~0.0895 μCi/ml before dilution by the secondary flow. For a 1 liter/hour leak rate undetected for an hour, the concentration assuming 140 gpm well water flow (minimum based on well water flow without flow warning light), the concentration becomes ~2.8E-06 μCi/ml. Public release is allowed at 5E-3 μCi/ml so we conclude that this unlikely event would not be a problem in this regard."*

Question 2a: *What is the basis for the 'assumptions of 1 ppm sodium in the primary coolant, activation for 10 hours, and 1 liter/hour leak rate for 1 hour?*

Response 2a:

The activity release is calculated by the following equation.

$$AR = \phi\sigma_a N(1 - e^{-\lambda t}) \times \frac{LR}{FR} \qquad (3)$$

Where,

AR = Activity release in the unit of μCi/ml
$\phi = 2.0 \times 10^{12}$ $neutrons/cm^2 sec$ *is the core total (fast + thermal) flux at 100 kW*
σ_a *= Microscopic absorption cross section for Na-23*
N = Number of Na atoms in 1 ml primary coolant (Sodium concentration)
λ *= Decay coefficient of Na-24 ($T_{1/2}$=15.02 hrs)*
t = Activation time
LR = Primary to secondary leakage rate
FR = Secondary flow rate

A. Estimation of activity for different operation times and Na-23 concentration
The reason for considering a sodium concentration of 1ppm sodium is based on the measurement results by UF Extension Soil Testing Library. (See attachment). Two water samples are filtered primary coolant and the unfiltered city water (before entering the primary system). Results show that the primary coolant sodium concentration is 0.7 ppm. The current operation time of the UFTR by the Technical Specifications is 6 hrs. We will further examine the effects of operation time and sodium concentration.

Here, in order to examine the effect of higher Na concentration and longer operation times, we evaluate the activity release for concentrations in a range of 1-10 ppm for operation hours of 2 to 10 hrs. Figure 1 compares the activity release for different hours of operation as a function of Na concentration in the primary coolant. Note that these calculations are based on 1 liter/hr leakage rate, and 200 gpm secondary flow rate.

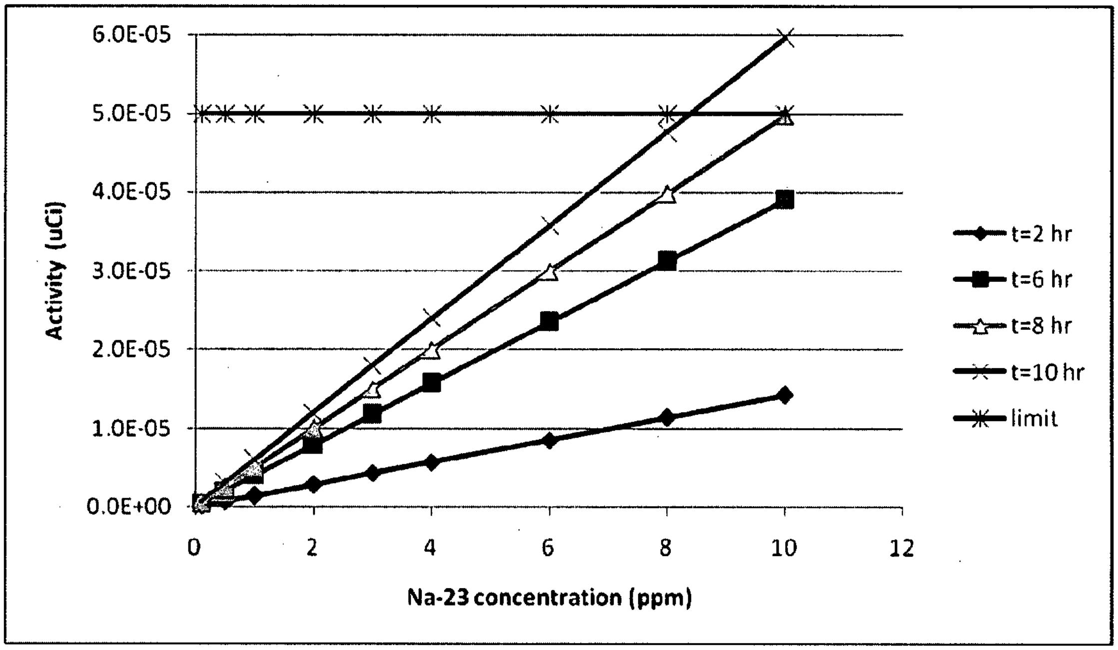


Figure 1 - Comparison of the activity release for different operation time as a function of sodium concentration (100 kW, 1 liter/hr, 200 gpm)

Above figure indicates that the activity is less than the release limit (5e-5 uCi/ml) if sodium concentration is less 10 ppm for a case of 8 hrs of operation. Only the case with a Na-23 concentration of 10 ppm and an operation time of 10 hours exceeds the limit.

B. Estimation of activity release for different leakage rates and Na-23 concentration

Figure 2 compares the activity release for different coolant Leakage Rate (LR) as a function of the Na-23 concentration in the primary coolant for 6 hrs operation time and 200 gpm secondary flow rate, at 100 kW.

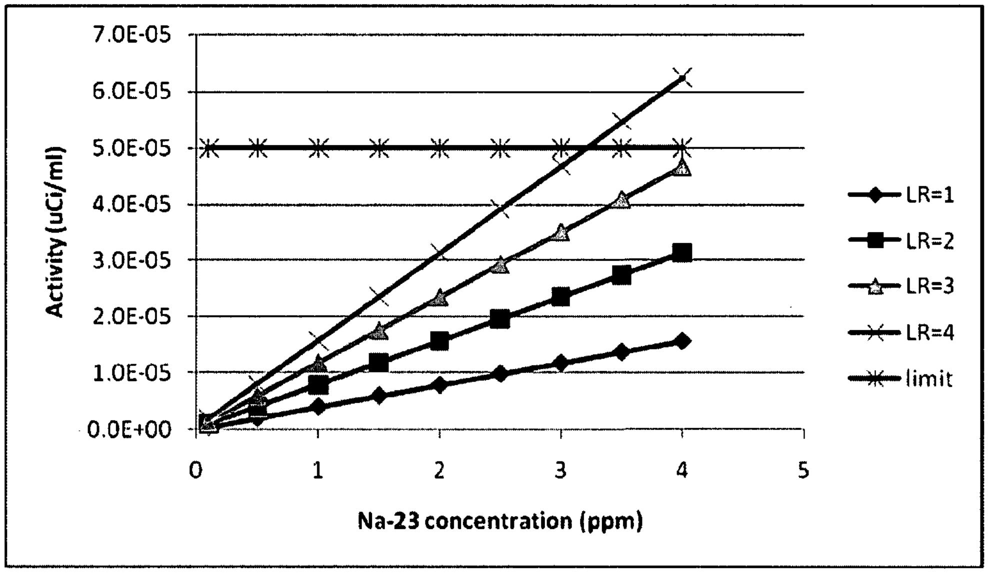


Figure 2 - Comparison of the activity release for different primary to secondary leakage rate as a function of sodium concentration (100 kW, operation time of 6 hrs, and 200 gpm secondary flow rate)

As expected, Fig. 2 shows that activity leakage increases linearly as the primary coolant leakage rate increases. For the case with LR=3 and Na-23 concentration 4 ppm, the activity release is still below the limit.

C. Estimation of activity release for different secondary flow rates and Na-23 Concentration

Well water is the only supply for UFTR secondary system now. Based on the current UFTR Technical Specifications, the nominal well water flow rate is ~200 gpm. A warning is triggered if flow drops to 140 gpm or less, and the reactor is tripped if the flow rate drops to 60 gpm or less. Figure 3 compares the activity release for different flow rates as a function of Na-23 concentrations, for an operation time of 6 hrs and leakage rate (primary to secondary) of 1 liter/hr at 100 kW.

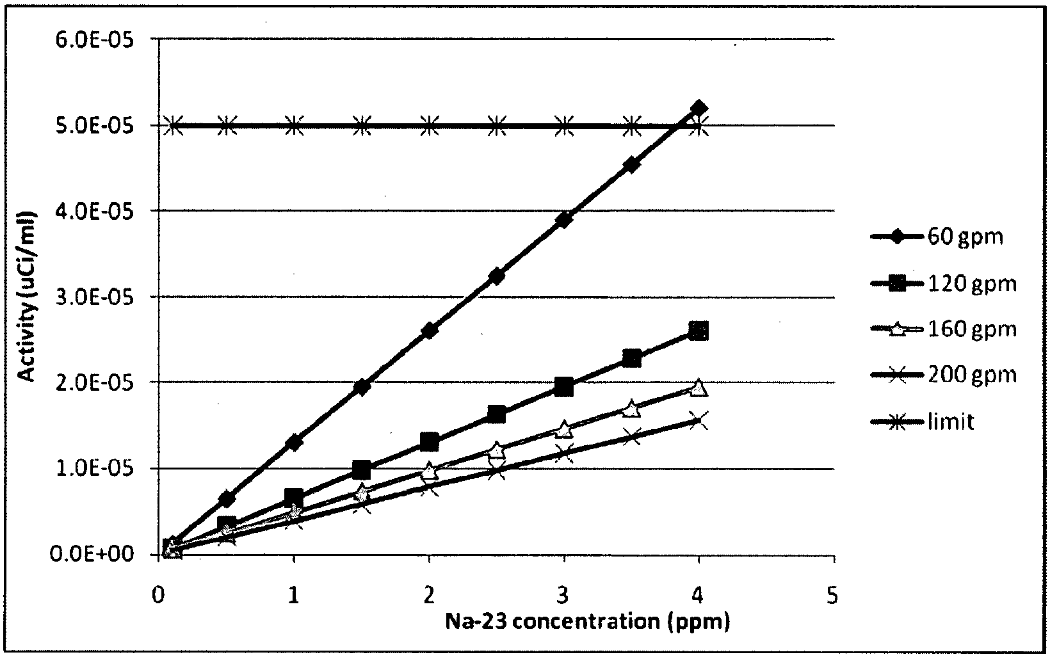


Figure 3 - Comparison of the activity release for different secondary flow rate as a function of Na-23 concentration for 1 liter/hr leakage (operation time of 6 hrs, 100 kW).

Figure 3 shows that the only case exceeding the release limit is the case with 4 ppm Na-23 concentration and a secondary flow rate of 60 gpm.

Question 2b: *How is the public release limit (5E-3 μCi/ml) derived? Appendix B to 10 CFR Part 20, Table 2, Column 2, lists an average yearly concentration release limit of 5E-5 μCi/mi for water effluents, and Table 3 list a monthly average concentration release limit to sewers as 5E-4 μCi/ml.*

Response 2b:
The release limit has been updated to the limit 5E-5 μCi/ml

Question 2c. *As discussed previously, the TS limit on secondary flow rate is 60 gpm when using well water and 8 gpm using city water. Therefore, provide an estimated effluent concentration assuming the allowed TS limits for secondary flow.*

Response 2c:
The analysis on the secondary flow rate is discussed in Section D in the answer to question 2.a

Question 2d: *What is the basis for your conclusion that a primary to secondary leak is unlikely?*

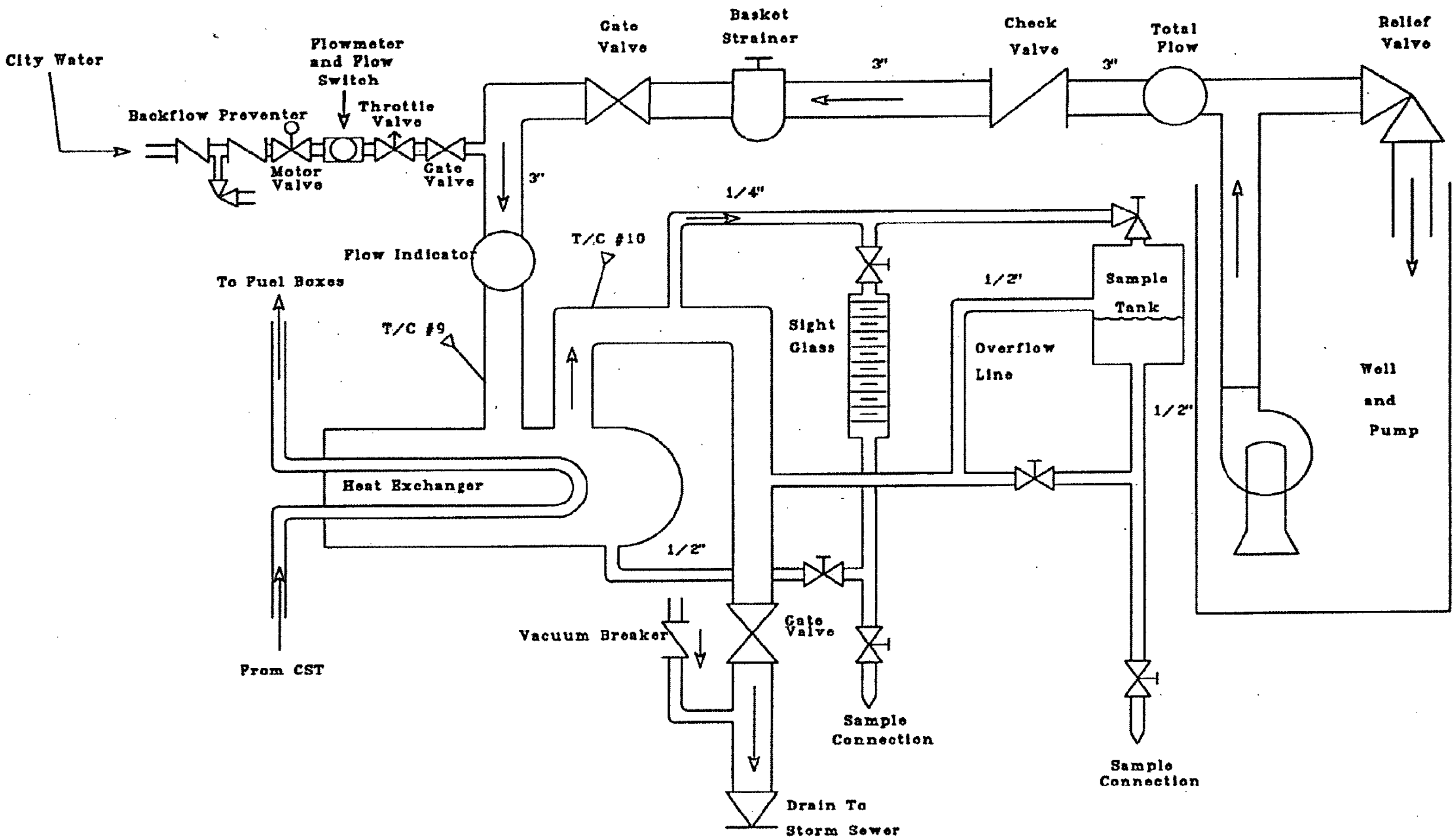
Response 2d:
The statement is based on the analysis (See the answers to Question 1) of the pressure drop in the heat exchanger for the primary and secondary sides.

References

1. *Kern, D.Q., Process Heat Transfer, McGraw-Hill, New York 1950.*

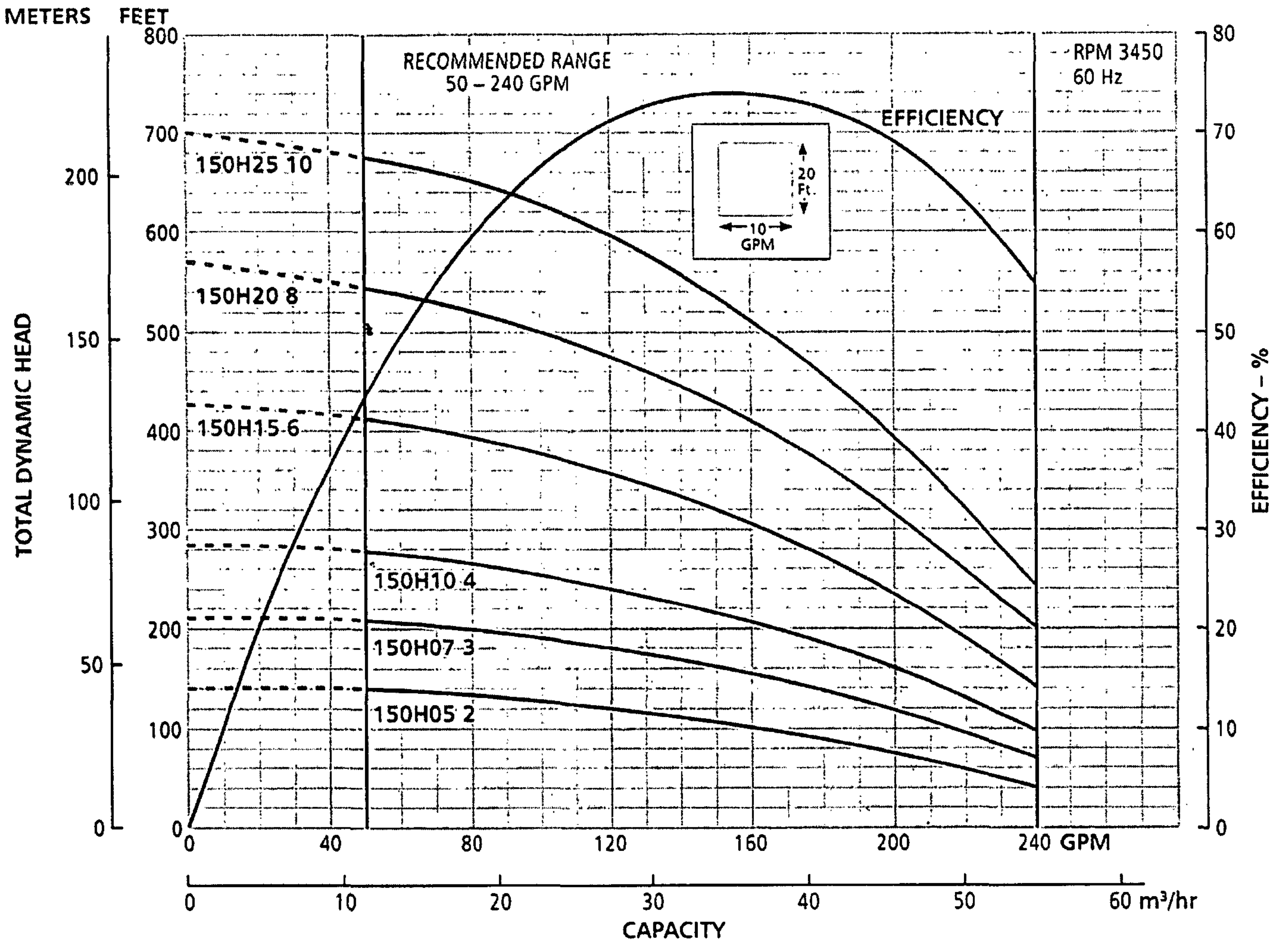
2. *Kakac, Sadik and Liu, Hongtan, Heat Exchanger Selection, Rating and Thermal Design, CRC Press, Boca Raton, Florida, 2002*

Appendix A - Schematic of UFTR secondary coolant system (From SAR Figure 5-5)



Appendix B - UFTR Secondary Coolant Pump (well pump) Specifications

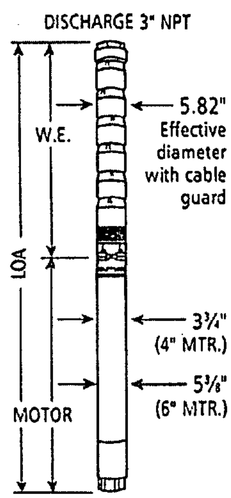
Model 150H



Curve Reference SU 507

DIMENSIONS AND WEIGHTS

HP	Stages	W.E. Order No.	Motor Order No.	PH	Motor Volts	Motor Lgth.	W.E. Lgth.	LOA	Wt. (lbs.)
5	2	150H05 2	S10940	1	230	28.2	18.0	46.2	95
			S10978 S10970 S10975 S10979	3	200 230 460 575	22.2	18.0	40.2	95
7.5	3	150H07 3	S11970	1	230	28.0	24.3	52.3	185
			S11978 S11971 S11972 *S11979	3	200 230 460 575	24.2	24.3	48.5	160
10	4	150H10 4	S12970	1	230	30.6	29.3	59.9	215
			S12978 S12971 S12972 *S12979	3	200 230 460 575	25.5	29.3	54.8	185
15	6	150H15 6	S13970	1	230	33.1	39.3	72.4	255
			S13978 S13971 S13972 *S13979	3	200 230 460 575	28.0	39.3	67.3	229
20	8	150H20 8	S14978 S14971 S14972 *S14979	3	200 230 460 575	30.6	49.3	79.9	274
25	10	150H25 10	S15978 S15971 S15972 *S15979	3	200 230 460 575	33.2	59.3	92.5	316



(All dimensions are in inches and weights in lbs. Do not use for construction purposes.)
*Non-stock motors have a six (6) week lead time.

Water end and motor must be ordered separately and are packaged separately.

SELECTION CHART

Horsepower Range 5 – 25, Recommended Range 50 – 240 GPM, 60 Hz, 3450 RPM

Pump Model	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																
	HP	PSI	25	50	75	100	125	150	175	200	250	300	350	400	450	500	600
150H05 2 2 Stages	5	0	254	230	200	164	102										
		20	206	172	120												
		30	174	122													
		40	126														
		50															
		60															
150H07 3 3 Stages	7.5	0		250	234	215	192	164	126								
		20	237	220	194	170	130	78									
		30	220	197	174	134	78										
		40	200	174	140	84											
		50	176	142	90												
		60	144	100													
150H10 4 4 Stages	10	0			251	238	223	205	186	163	92						
		20	253	240	225	210	190	168	140	104							
		30	240	226	210	190	170	140	104								
		40	228	212	193	172	146	108									
		50	213	193	172	147	111										
		60	194	176	148	116											
150H15 6 6 Stages	15	0				255	246	236	226	216	192	164	122				
		20		257	248	238	228	218	206	194	167	128					
		30	258	248	238	228	218	206	194	181	150	100					
		40	248	240	230	220	208	196	184	168	130						
		50	240	230	220	209	196	184	170	154	107						
		60	234	220	210	198	185	172	154	136	78						
150H20 8 8 Stages	20	0					259	252	244	237	221	204	183	163	134	95	
		20			260	253	246	238	230	223	206	187	166	138	100		
		30		260	253	246	239	231	223	214	197	177	154	120			
		40		254	247	240	232	224	216	208	188	168	140	102			
		50	255	247	240	232	224	216	208	199	180	156	125	80			
		60	247	240	232	225	216	209	199	190	170	142	106				
150H25 10 10 Stages	25	0							258	252	240	226	212	198	182	165	113
		20					259	253	247	240	227	213	199	183	166	144	78
		30				260	253	247	240	234	220	207	192	175	156	132	100
		40			260	254	247	241	234	228	214	200	184	168	146	118	
		50		260	254	248	242	235	229	222	208	193	177	158	134	104	
		60	260	254	248	242	235	230	222	216	201	186	169	148	120	84	

Appendix C – UFTR Coolant Sample Test Results

Sample number : CW1 - unfiltered (city water)

Sample number : DI1 - filtered (primary coolant)

UF UNIVERSITY of FLORIDA IFAS

UF/IFAS Analytical Services Laboratories
Extension Soil Testing Laboratory

Wallace Building 631 PO Box 110740 Gainesville, FL 32611-0740

Email: soilslab@mail.ifas.ufl.edu Web: soilslab.ifas.ufl.edu Phone #:352-392-1950

Water Test

To: Nuclear Engineering/Berglund, Matt
PO Box 118300
Gainesville, FL 32611
Tel: 352-392-1429 x318

Set: 1852
Report Date: 18-Nov-08

For further information contact:
Sanders, Cynthia B. & Wilber, Wendy
Alachua County Coop Extn Service
2800 NE 39th Ave
Gainesville, FL 32609-2658
Tel: 352-955-2402
Email: sanders1@ufl.edu

Lab No	Sample Identification	Parts per million (ppm or mg/L) Calcium Ca	Magnesium Mg	Hardness	Iron Fe	Manganese Mn	Sodium Na	Chloride Cl	Suspended Solids	pH	Electrical Conductivity in mmho/om or dS/m	Total carbonates in meq/liter
22987	CW 1	30.1	21.5	163.4	0.00	0.00	10.5	27.6	0.0	7.60	0.35	0.80
22988	DI 1	0.0	0.0	0.0	0.00	0.00	0.7	-0.3	0.0	5.70	0.00	N/A

REPORT OF WATER TEST RESULTS

The reported values have different meanings depending upon the planned uses of the water. The following interpretations are divided into Household Uses and Irrigation sections. Please read the applicable section to better understand these water test results.

HOUSEHOLD USES INTERPRETATIONS

The physical and chemical determinations made by the Extension Soil Testing Laboratory can be effectively used to diagnose potential problems in water. However the lab does not test a water's suitability for human consumption. Bacteriological tests may be available from the County Health Department or from selected commercial laboratories.

Hardness is calculated according to the following equation:

Hardness = (ppm Ca x 2.5) + (ppm Mg x 4.1)
(parts per million, ppm)

The following table will assist in classification of water hardness:

Interpretation	Hardness ppm	grains per gallon
soft	0 to 17	0 to 1
relatively soft	17 to 50	1 to 3
moderately hard	50 to 120	3 to 7
hard	120 to 170	7 to 10
vary hard	> 170	>10

Iron and **Mn** can impart a metallic taste to water as well as stain clothes and plumbing fixtures. Staining can be caused by as little as 0.3 ppm Fe or Mn.

Electrical Conductivity of water is related to the amount of dissolved salts in the water. Higher salinity results in higher electrical conductivity. Increases in electrical conductivity with time may mean that the aquifer is turning brackish or that salt water intrusion is occuring.

This data report has been issued on the authority of
Dr. Rao Mylavarapu, Laboratory Director, and Mr. Pete Straub, QA Officer,
in support of Florida Cooperative Extension Services.

Sodium and **Chloride** levels are used to define the type of salts contributing to the electrical conductivity of the water. Electrical conductivity measures the presence of all dissolved salts. If the electrical conductivity reading is elevated, the presence of sodium and chloride indicatethat the water source is a brackish or that saltwater may have intruded into the water source.

pH is a measurement which determines the level of acidity of the water. The pH of water can change rapidly for a number of reasons. If the reading is lower than 6.5, treatement of water may be necessary to preclude damage to metallic plumbing.

Additional information on interpretation of these results can be found in IFAS Circular 703, "Home Water Quality and Safety."

IRRIGATION AND MICROIRRIGATION INTERPRETATIONS

Interpretation of water quality for irrigation purposes must be crop specific. Crops respond differently to the quality of water with which they are irrigated. Use the following information as a guideline to determine if a possible problem exists. If there is a possible problem indicated, consult with your county extension agent and/or refer to the additional publications cited in the following text.

Electrical conductivity of water is related to the amount of dissolved salts in the water. Higher salinity results in higher electrical conductivity. As the electrical conductivity increases, the plant must expend more energy to take in nutrients dissolved in the water from fertilizer and the soil. Some plants are very sensitive to salinity, while others can tolerate a wide range. Use the following table to make general interpretations. Refer to IFAS Circular 817, "Soil, Container Media, and Water Testing Interpretations and IFAS Standardized Fertilization Recommendations." A reference copy of the circular is maintained at your county extension office.

Class of water	Electrical conductivity dS/m or mmhos/om*
Excellent	0.25
Good	0.25 to 0.75
Permissible	0.75 to 2.00
Doubtful	2.00 to 3:00
Unsuitable	> 3.00

*Conversion
ppm soluble salts = EC x 700

pH is a measurement which derminnes made the level of the acidity or alkalinity of the water. Much of the Florida's well waters are alkaline (pH 7.6 to 6.5). The high pH results from the calcium carbonate aquifer in which the water has been in contact. Use of such water in effect causes liming of the crop. Some crops, blueberry or pine seedings will grow poorly if exposed to water containing appreciable amounts of lime. Surface waters are usually lower in pH.

Total Carbonates and Bicarbonates are a direct measure of the liming potential of the water. For many crops, use of water with an appreciable liming potential is not of concern and may lower the need for agricultural lime additions. However, as noted above, some crops will be adversely affected. Neutralization of the liming potential can be economically accomplished in some situations by treatement of water with acid. Refer to Notes in Soil Science No. 18, "Neutralizing excess bicarbonates from irrigation water" and Notes in Soil Science No. 25, Quick-test method for pH and bicarbonates in water."

Ca and **Mg** are used to calculate **Hardness** described in the Hosehold Uses described above.

Na and **Cl** can be used to determine the type of salts present and to diagnose the possibility of saltwater intrusion.

Fe and **Mn** can cause plant tissue staining. Overhead irrigation with water containing levels above 0.3 ppm may cause staining to foliage. Additionally such levels indicate that the water should be treated to prevent microirrigation plugging due to enhanced microbial growth or iron encrustations.

Suspended solids are used to predict the amount of undissolved material that is in the water. High suspended solids indicate that plugging problems are likely to occur if the water is used for microirrigation without adequate filtration.

Criteria for estimating plugging potential of microirrigation water sources.

Factor	Units	-----------Plugging potential------------------- Sight	Moderate	Severe
pH		7.0	7.0 to 7.5	7.5
Suspended solids	ppm	50	50 to 100	100
Mn, Fe	ppm	0.1	0.1 to 1.5	1.5
Hardness	ppm	150	150 to 300	300
Electrical conductivity	dS/m	0.7	0.7 to 2.9	2.9

Adopted from IFAS Bulletin 258, "Causes and prevention of emitter plugging in microirrigation systems"

Attachment 3

Response to RAI on Ar-41 Release

<u>Response to NRC RAI No.7</u>

Prepared by: Glenn Sjoden
Reviewed and revised by: Alireza Haghighat

The following response is in reference to questions surrounding calculations used to compare EPI code 7.0 with STAC2.1 as outlined in Item #7 of the RAI document.

The parameters used for annual averages as noted in the item were, in general, reasonable averages and best representative estimates, as applicable, collected from various sources as noted. However, with regard to previously cited calculation parameters, these did indeed default to "most conservative" positions that do not necessarily reflect "true" average conditions. Therefore, based on discussions regarding this matter, it is more appropriate to assign across the board average conditions for ultimate assessment of the environmental burden of Ar-41. To elaborate on this point further, the following apply:

- The velocity of the wind at the stack height is interpolated from the classification of land use based on standard profiles for frictional (drag) effects on wind speed in STAC2.1; these are based on velocity profile fits for "URBAN", "SUBURBAN", or "RURAL" from *Smith, M.E. Recommended Guide for the Prediction of the Dispersion of Airborne Effluents, 3rd ed. New York: The American Society for Mechanical Engineers, 1979.* Use of "URBAN" was used for the discussion in Item #7 (which gives the most conservative (lowest) answer for wind speed at stack discharge of 3.99 m/s at the stack based on a ground speed average of 2.42 m/s measured from a data station located 3.56 m off of the ground). Therefore, the URBAN model yields the lowest wind speed and assumes tall buildings surround the stack; since this is not the case, a better more representative value for the wind profile land use is a "SUBURBAN" terrain category, which is clearly more representative of the University of Florida campus.
- The Pasquill stability class noted in Item #7 is stability class "A", the most conservative value. A more correct value based on seasonally averaged daytime weather data for the University of Florida campus is stability class "B".
- The (computed) "effective height of effluent release" from the stack is directly affected by the exhaust velocity, local temperature, stack effluent temperature, etc, since the effluent acts as a "buoyant plume" at discharge. Again, the effective release height of 12.3 m noted in Item #7 reflects the effective stack height based on the most conservative value; based on average ambient conditions, this value will fluctuate based on exhaust velocity; at this time, with equipment changes, the best estimate for mean stack exhaust speed is 6.4 m/s (equal to 7882.2 cfm) .
- If we assume universally average conditions for all parameters, as follows:

  - Ground Altitude ZALT : 42. m
  - Effluent Half Life THALFH : 1.8300E+00 Hrs

- Effluent gmol Weight MOLWT : 4.0960E+01 gmol
- Global Center XGLOB : .00 m YGLOB : .00 m
- Stack Location XSTAK : .00 m YSTAK : .00 m
- Wind Direction FROM Vector (0 to 360) WINDIR : 167.1 deg
- Source Release Strength (Ci/s or g/s) QSC : 9.2280E-05
- Phys Stack Height SHSTAK : 9.0 M
- Stack Diameter DISTAK : .860 M
- Effluent Exit Velocity VSTAK : 6.4 M/S
- Effluent Exit Temperature TSTAK : 29.23 C
- Ambient Air Temperature TAMB : 29.23 C
- Effluent Specific Heat CPEFF : 1.009E+03 J/KG-C
- Density of Effluent / Density of Air EDF : 1.40
- Ground Wind Velocity UGND : 2.4 M/S
- Height of ground velocity Measurement SMEAS : 3.6 M
- Air Density at 29.23 C Est= 1.22 KG/M3
- Mass Flow Rate Out Stack SMDOT : 12.75 KG/S
- Heat Emission Out Stack QHEFF : 0.000E+00 CAL/S
- Terrain is SUBURB - Velocity at Stack USTAK : 4.25 M/S
- Effective Stack Height : 12.9 M
- Pasquill Condition : B - MODERATELY UNSTABLE; SUNNY AND WARM (2.0 M/S +- 20 deg)

The peak concentration from the universally averaged conditions is 3.157E-08 Ci/M^3 (or 158.6 mrem/yr assuming continuous reactor operation at 100% power) at a range located of 65 m down wind along a 167.1 wind vector. This is in the vicinity of Weil Hall, as shown on the map attached. The nearest occupied dormitory is East Hall, and based on the average conditions, the concentration at that location (at downwind 10 m, -200 m off plume centerline) is << 10 rem/yr, i.e., it is not measurable.

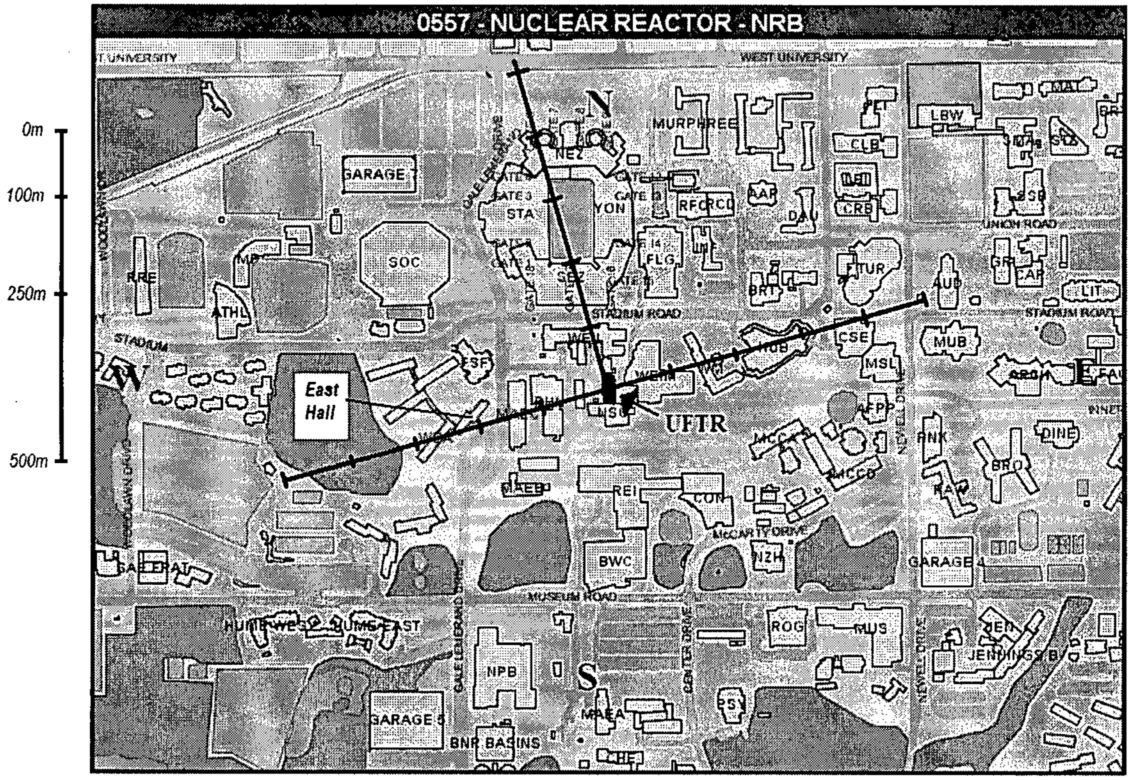


Figure depicting average wind vector from the UFTR stack along the UFTR campus. Tick marks indicate 100m intervals.

Attachment 4

UFTR Annual Report 2005-2006

Attachment #4

2005-06 Annual Report

Introduction

As stated in the University of Florida Training Reactor (UFTR) Technical Specifications, Section 6.6.1 Operating Report, routine annual reports covering the activities of the reactor facility during the previous calendar year shall be submitted to the Commission within nine (6) months following the end of each prescribed year. The prescribed year ends August 31 for the UFTR. This annual operating report includes 7 sections:

(1) a narrative summary of reactor operating experience including the energy produced by the reactor and the hours the reactor was critical;

(2) the unscheduled shutdowns including, where applicable, corrective actions taken to preclude recurrence;

(3) tabulation of major preventive and corrective maintenance operations having safety significance;

(4) tabulation of major changes in the reactor facility and procedures, and a tabulation of new tests or experiments, that are significantly different from those performed previously and are not described in the Safety Analysis Report, including conclusions that no unreviewed safety questions were involved;

(5) A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the facility operators as determined at or before the point of such release or discharge. (The summary shall include to the extent practicable an estimate of individual radionuclides present in the effluent. If the estimated average release after dilution or diffusion is less than 25% of the concentration allowed, a statement to this effect is sufficient.);

(6) A summarized result of environmental surveys performed outside the facility;

(7) A summary of exposure received by facility personnel and visitors where such exposures are greater than 25% of that allowed.

The following discussion on the above seven sections covers the period from September 1, 2005 to August 31, 2006, except as noted otherwise.

1. Summary of Operation Experience

In the past reporting year, UFTR continues to function as a reliable and productive facility with a broad range of research and educational utilizations by users within University of Florida as well as researchers and educators around the State of Florida. In the summer of 2005, the UFTR facility has started the HEU to LEU fuel conversion project.

The generated energy and operation hours in this year are given as follows:

Energy generated: 6852.360 KWH

Reactor Run Time: 168.53 hrs

2. Unscheduled Shutdowns

From September 1, 2005 to August 31, 2006 there were 5 unplanned shutdowns, each one summarized in the table below.

Reason	Corrective Action
*9/6/05: Fuel Box temperature indicated above 155 °F, about 921.9 °F. (Occurred 2 times, 9/30/05) **	*Reset temperature indicator back to normal in about 6 minutes. Assured that is was not likely to trip again, experimented with limiting power level to see if it affected trip.*
1/27/06: Extended Range indicator came on and loud buzzing came from the wide range board array. Extended range light indicated the extended circuit was energized at an incorrect power level.	*Relays were cleaned and replaced. Verified power supply voltages. Continued to operate at power to monitor switching circuit in the indicated noise levels.*
*2/27/06: Overpower trip caused by overcompensation of AFC in Auto, resulting in safety 2 trip. **	*Validated DCO. Reviewed and approved of restart to complete A-2 surveillance by RSRS Executive Committee.*

*4/5/06: Trip initiated by rising trip set point on A9 High Volts Bistable card. **	*Valid DCO/Alignment check of HV trip.*

**Note: Filed as an Unscheduled Reactor Trip*

3. Safety Related Maintenance Operations

1) *5/06 – 8/06: the Safety Channel 1 High Voltage trip is investigated. And it is due to the safety channel 1 high voltage drifts out of the spec. Related electrical components are replaced or repaired. The system has been tested according to SOP and it is operational.*

4. Major Changes in Reactor Facility, Procedures and Experiments

UFTR facility completes the HEU to LEU fuel conversion. Corresponding changes on reactor facility, procedures and experiments can be found in the UFTR HEU to LEU fuel conversion report.

5. Radioactive Effluents

Liquid release:

UFTR is equipped with a waste water holdup tank. The tank is released two or three times per year. The radioactivity in the released water is measured. Wastewater shall be sampled and monitored prior to tank discharge. No isotopic analysis is required if the estimated average release concentration is less than 25% of the concentration limit allowed in 10CFR20, Appendix B, Table 2. The current limit is 5.0E-9 uCi/mL for releases to the sanitary sewer.

Time period (mm.dd.yyyy)	*Water released (Gallon)*	*Activity released (uCi/mL)*
06.10.2005 – 09.07.2005	*895.9*	*5.48E-010*
09.07.2005 – 08.21.2006	*929.8*	*< Lower Limit of Detection*

Argon-41 Release:

The Argon-41 release concentration is measured about every six months. The annual Argon-41 release is estimated by the measurement and operation hours. Discharge concentrations of Ar-41 shall not exceed 1.0E-8 uCi/mL per 10CFR20 Appendix B, Table II when averaged over 30 days.

UFTR Gaseous Release Data Table

Month(s)	**Releases per Unit Energy Generation (uCi/kW-hr)**	**Instantaneous Ar-41 Conc. at Full Power (uCi/mL)**
Sep. 2005 - Dec. 2005	*3736.34*	*9.32E-008*
Dec. 2005 - Aug. 2006	*3520.06*	*8.70E-008*

UFTR Gaseous Release Summary

Month	**Release (uCi/month)**	**Monthly Average Concentration (uCi/mL)**
September 2005	0.4117×10^{6}	1.4258×10^{-10}
October 2005	*0*	*0*
November 2005	*0*	*0*
December 2005	2.7740×10^{6}	9.5224×10^{-10}
January 2006	7.2705×10^{6}	2.4957×10^{-9}
February 2006	5.4143×10^{6}	1.8586×10^{-9}
March 2006	3.1937×10^{6}	1.0963×10^{-9}
April 2006	5.0805×10^{6}	1.7440×10^{-9}
May 2006	*0*	*0*
June 2006	*0*	*0*
July 2006	*0*	*0*
August 2006	*0*	*0*

TOTAL ARGON - 41 Releases for the reporting year: 24.14 Ci

YEARLY AVERAGE ARGON - 41 Release Concentration: 6.9078 x 10^{-10} uCi/mL

6. Environmental Surveys

The firm maintaining radiation records for the University of Florida keeps a year to date record, therefore it is easier to report radiation exposure by the nearest completed calendar year. The following film badge exposures are for the period January 1, 2005 to December 31, 2005. Thirteen areas (Numbered from 1 to 13) were monitored for the entire calendar year. A list of these numbered areas can be found in UFTR SOP. Reactor cell is separately monitored during the same time period. The area radiation exposures are tabulated below. All doses are in unit of mrem.

Area No.	TEDE
1	15
2	5
3	3
4	1
5	8
6	1
7	6
8	4
9	2
10	4
11	1
12	2
13	3

Area	DDE	LDE	SDE, WB	TEDE
Reactor C	8	7	8	8

7. Radiation Exposures

Note that UFTR Tech Specs requires only a summary of exposure received by facility personnel and visitors where such exposures are greater than 25% of that allowed. Since all personnel exposures during this period are below the limits, we provide an exposure summary for the UFTR staff.

The following table illustrates the radiation dosages of 4 workers for the period January 1, 2005 to December 31, 2005. All the dosages are in mrem.

Individual	DDE	LDE	SDE
Berglund, M.	*28*	*29*	*31*
Holman, M.	*10*	*9*	*7*
Vernetson, W.	*12*	*11*	*16*
Yenatskyy, M.	*9*	*9*	*6*
Shea, B	*7*	*5*	*3*

Attachment 5

UFTR Annual Report 2006-2007

<u>**Attachment #5**</u>

2006-07 Annual Report

Introduction

As stated in the University of Florida Training Reactor (UFTR) Technical Specifications, Section 6.6.1 Operating Report, routine annual reports covering the activities of the reactor facility during the previous calendar year shall be submitted to the Commission within nine (6) months following the end of each prescribed year. The prescribed year ends August 31 for the UFTR. This annual operating report includes 7 sections:

(1) a narrative summary of reactor operating experience including the energy produced by the reactor and the hours the reactor was critical;

(2) the unscheduled shutdowns including, where applicable, corrective actions taken to preclude recurrence;

(3) tabulation of major preventive and corrective maintenance operations having safety significance;

(4) tabulation of major changes in the reactor facility and procedures, and a tabulation of new tests or experiments, that are significantly different from those performed previously and are not described in the Safety Analysis Report, including conclusions that no unreviewed safety questions were involved;

(5) A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the facility operators as determined at or before the point of such release or discharge. (The summary shall include to the extent practicable an estimate of individual radionuclides present in the effluent. If the estimated average release after dilution or diffusion is less than 25% of the concentration allowed, a statement to this effect is sufficient.);

(6) A summarized result of environmental surveys performed outside the facility;

(7) A summary of exposure received by facility personnel and visitors where such exposures are greater than 25% of that allowed.

The following discussion on the above seven sections covers the period from September 1, 2006 to August 31, 2007, except as noted otherwise.

1. Summary of Operation Experience

In the past reporting year, UFTR continues to function as a reliable and productive facility with a broad range of research and educational utilizations by users within University of Florida as well as researchers and educators around the State of Florida. And as a milestone year, the UFTR facility has completed the HEU to LEU fuel conversion project.

The generated energy and operation hours in this year are given as follows:

Energy generated: 4801.040 KWH

Reactor Run Time : 202.50 hrs

2. Unscheduled Shutdowns

From September 1, 2006 to August 31, 2007 there were 5 unplanned shutdowns, each one summarized in the table below.

Reason	Corrective Action
11/21/06: Coolant flow trip, accidental due to nitrogen insertion. *	*Performed ½ hour of nitrogen flow without trip indication at shutdown, and performed daily satisfactory checks.*
5/30/07: Safety 2 power channel – apparent high voltage trip, S2 HV apparent drop below 10% set point (Occurred 3 times, 6/8/07 and 7/26/07). *	*Troubleshoot, repaired safety 2 HV system.*
8/13/07: NE Fuel box high temperature. *	*Completed successful daily checks.*

**NOTE: Filed as an Unscheduled Reactor Trip*

3. Safety Related Maintenance Operations

1) *6/07: Dilution fan motor is replaced and the dilution fan is cleaned upon observing reduced dilution fan RPM*

2) *7/07: Troubleshoot and repair Safety 2 High Voltage*

4. Major Changes in Reactor Facility, Procedures and Experiments

None

5. Radioactive Effluents

Liquid release:

UFTR is equipped with a waste water holdup tank. The tank is released two or three times per year. The radioactivity in the released water is measured. Wastewater shall be sampled and monitored prior to tank discharge. No isotopic analysis is required if the estimated average release concentration is less than 25% of the concentration limit allowed in 10CFR20, Appendix B, Table 2. The current limit is 5.0E-9 uCi/mL for releases to the sanitary sewer.

Time period (mm.dd.yyyy)	*Water released (Gallon)*	*Activity released (uCi/mL)*
08.21.2006– 05.18.2007	*816.2*	*< Lower Limit of Detection*

Argon-41 Release:

The Argon-41 release concentration is measured about every six months. The annual Argon-41 release is estimated by the measurement and operation hours. Discharge concentrations of Ar-41 shall not exceed 1.0E-8 uCi/mL per 10CFR20 Appendix B, Table II when averaged over 30 days.

UFTR Gaseous Release Data Table

Month(s)	**Releases per Unit Energy Generation (uCi/kW-hr)**	**Instantaneous Ar-41 Conc. at Full Power (uCi/mL)**
Sep. 2006 - Feb. 2007	*3520.06*	*8.70E-008*
Mar. 2007 - Aug. 2007	*3787.94*	*9.59E-008*

UFTR Gaseous Release Summary

Month	Release (uCi/month)	Monthly Average Concentration (uCi/mL)
September 2006	*0*	*0*
October 2006	*0*	*0*
November 2006	*0*	*0*
December 2006	0.0002×10^{6}	5.1958×10^{-14}
January 2007	*0*	*0*
February 2007	2.5267×10^{6}	8.6736×10^{-10}
March 2007	7.3762×10^{6}	2.5937×10^{-9}
April 2007	2.6621×10^{6}	9.3601×10^{-10}
May 2007	0.0257×10^{6}	9.0519×10^{-12}
June 2007	0.0019×10^{6}	6.5665×10^{-13}
July 2007	0.0033×10^{6}	1.1441×10^{-12}
August 2007	5.3977×10^{6}	1.8980×10^{-9}

TOTAL ARGON - 41 Releases for the reporting year: 17.99 Ci

YEARLY AVERAGE ARGON - 41 Release Concentration: 5.2550×10^{-10} *uCi/mL*

6. Environmental Surveys

The firm maintaining radiation records for the University of Florida keeps a year to date record, therefore it is easier to report radiation exposure by the nearest completed calendar year. The following film badge exposures are for the period January 1, 2006 to

December 31, 2006. Thirteen areas (Numbered from 1 to 13) were monitored for the entire calendar year. A list of these numbered areas can be found in UFTR SOP. Reactor cell is separately monitored during the same time period. The area radiation exposures are tabulated below. All doses are in unit of mrem.

Area No.	**TEDE**
1	*2*
2	*6*
3	*< 1*
4	*< 1*
5	*< 1*
6	*< 1*
7	*1*
8	*< 1*
9	*< 1*
10	*< 1*
11	*< 1*
12	*< 1*
13	*< 1*

Area	**DDE**	**LDE**	**SDE, WB**	**TEDE**
Reactor C	*< 1 mrem*	*<1 mrem*	*2*	*< 1 mrem*

7. Radiation Exposures

Note that UFTR TechSpecs requires only a summary of exposure received by facility personnel and visitors where such exposures are greater than 25% of that allowed. Since all personnel exposures during this period are below the limits, we provide an exposure summary for the UFTR staff.

The following table illustrates the radiation dosages of 4 workers for the period January 1, 2006 to December 31, 2006. All the dosages are in mrem.

Individual	**DDE**	**LDE**	**SDE**
Berglund, M.	*75*	*103*	*157*
Holman, M.	*< 1 mrem*	*< 1 mrem*	*< 1 mrem*
Vernetson, W.	*70*	*74*	*101*
Yenatskyy, M.	*< 1 mrem*	*< 1 mrem*	*4*

Attachment 6

UFTR Annual Report 2007-2008

Attachment #6

2007-08 Annual Report

Introduction

As stated in the University of Florida Training Reactor (UFTR) Technical Specifications, Section 6.6.1 Operating Report, routine annual reports covering the activities of the reactor facility during the previous calendar year shall be submitted to the Commission within nine (6) months following the end of each prescribed year. The prescribed year ends August 31 for the UFTR. This annual operating report includes 7 sections:

(1) a narrative summary of reactor operating experience including the energy produced by the reactor and the hours the reactor was critical;

(2) the unscheduled shutdowns including, where applicable, corrective actions taken to preclude recurrence;

(3) tabulation of major preventive and corrective maintenance operations having safety significance;

(4) tabulation of major changes in the reactor facility and procedures, and a tabulation of new tests or experiments, that are significantly different from those performed previously and are not described in the Safety Analysis Report, including conclusions that no unreviewed safety questions were involved;

(5) A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the facility operators as determined at or before the point of such release or discharge. (The summary shall include to the extent practicable an estimate of individual radionuclides present in the effluent. If the estimated average release after dilution or diffusion is less than 25% of the concentration allowed, a statement to this effect is sufficient.);

(6) A summarized result of environmental surveys performed outside the facility;

(7) A summary of exposure received by facility personnel and visitors where such exposures are greater than 25% of that allowed.

The following discussion on the above seven sections covers the period from September 1, 2007 to August 31, 2008, except as noted otherwise.

1. Summary of Operation Experience

In the past reporting year, UFTR continues to function as a reliable and productive facility with a broad range of research and educational utilizations by users within University of Florida as well as researchers and educators around the State of Florida.

The generated energy and operation hours in this year are given as follows:

Energy generated: 8726.214 KWH

Reactor Run Time: 197.63 hrs

2. Unscheduled Shutdowns

From September 1, 2007 to August 31, 2008 there were 5 unplanned shutdowns, each one summarized in the table below.

Reason	Corrective Action
*10/5/07: Coolant level trip, coolant pump trip.**	*Completed form O.6A and successful daily pre-operational checks.*
11/14/07: Critical position on Reg. Blade at 368 versus the expected 300 – 305 range.	*Provided reliable indication on S-1. Assured applicable surveillances affected by maintenance were completed satisfactorily.*
4/29/08: HV indicator required trip.	*Checked SC1 high voltage, and performed daily operational check.*
6/27/08: Pit alarm went off and SRO noted A/C waste water line came loose and was dripping water on the floor.	*Cleaned water from pit (< 300ml). Performed DCO – SAT.*
8/7/08: Sporadic dilute fan RPM indicator; drop from 561 to 553 with momentary drop to 484.	*Posted sign. Performed satisfactory daily pre-operational check, and check room at open and close.*

**NOTE: Filed as an Unscheduled Reactor Trip*

3. Safety Related Maintenance Operations

1) *12/07 – 05/08: safety blade 2 is repaired, due to failure to drop during drop test surveillance.*

4. Major Changes in Reactor Facility, Procedures and Experiments

None

5. Radioactive Effluents

Liquid release:

UFTR is equipped with a waste water holdup tank. The tank is released two or three times per year. The radioactivity in the released water is measured. Wastewater shall be sampled and monitored prior to tank discharge. No isotopic analysis is required if the estimated average release concentration is less than 25% of the concentration limit allowed in 10CFR20, Appendix B, Table 2. The current limit is 5.0E-9 uCi/mL for releases to the sanitary sewer.

Time period (mm.dd.yyyy)	*Water released (Gallon)*	*Activity released (uCi/mL)*
05.18.2007 – 04.15.2008	*907.7*	*< Lower Limit of Detection*

Argon-41 Release:

The Argon-41 release concentration is measured about every six months. The annual Argon-41 release is estimated by the measurement and operation hours. Discharge concentrations of Ar-41 shall not exceed 1.0E-8 uCi/mL per 10CFR20 Appendix B, Table II when averaged over 30 days.

UFTR Gaseous Release Data Table

Month(s)	**Releases per Unit Energy Generation (uCi/kW-hr)**	**Instantaneous Ar-41 Conc. at Full Power (uCi/mL)**
Sep. 2007 - Oct. 2007	*3787.94*	*9.59E-008*
Nov. 2007 - Apr. 2007	*3272.26*	*6.20E-008*
May 2007 – Aug. 2007	*4756.73*	*9.77E-008*

UFTR Gaseous Release Summary

Month	Release (uCi/month)	Monthly Average Concentration (uCi/mL)
September 2005	3.9666×10^{6}	1.3948×10^{-9}
October 2005	0.9528×10^{6}	3.3502×10^{-10}
November 2005	1.8955×10^{6}	4.9880×10^{-10}
December 2005	*0*	*0*
January 2006	*0*	*0*
February 2006	*0*	*0*
March 2006	*0*	*0*
April 2006	6.2525×10^{6}	1.6454×10^{-9}
May 2006	16.6721×10^{6}	4.7560×10^{-9}
June 2006	2.3422×10^{6}	6.6817×10^{-10}
July 2006	1.7109×10^{6}	4.8805×10^{-10}
August 2006	2.7611×10^{6}	7.8767×10^{-10}

TOTAL ARGON - 41 Releases for the reporting year: 36.55 Ci

YEARLY AVERAGE ARGON - 41 Release Concentration: 8.8116×10^{-10} *uCi/mL*

6. Environmental Surveys

The firm maintaining radiation records for the University of Florida keeps a year to date record, therefore it is easier to report radiation exposure by the nearest completed calendar year. The following film badge exposures are for the period January 1, 2007 to December 31, 2007. Thirteen areas (Numbered from 1 to 13) were monitored for the entire calendar year. A list of these numbered areas can be found in UFTR SOP. Reactor cell is separately monitored during the same time period. The area radiation exposures are tabulated below. All doses are in unit of mrem.

Area No.	TEDE
1	*2*
2	*< 1*
3	*< 1*
4	*< 1*
5	*< 1*
6	*< 1*
7	*3*
8	*< 1*
9	*< 1*
10	*< 1*
11	*< 1*
12	*< 1*
13	*< 1*

Area	DDE	LDE	SDE, WB	TEDE
Reactor C	*< 1 mrem*	*< 1 mrem*	*< 1 mrem*	*< 1 mrem*

7. Radiation Exposures

Note that UFTR TechSpecs requires only a summary of exposure received by facility personnel and visitors where such exposures are greater than 25% of that allowed. Since all personnel exposures during this period are below the limits, we provide an exposure summary for the UFTR staff.

The following table illustrates the radiation dosages of 3 workers for the period January 1, 2007 to December 31, 2007. All the dosages are in mrem.

Individual	DDE	LDE	SDE
Berglund, M.	*< 1 mrem*	*< 1 mrem*	*40*
Vernetson, W.	*< 1 mrem*	*16*	*41*
Yenatskyy, M.	*< 1 mrem*	*< 1 mrem*	*2*

Attachment 7

UFTR Decommission Report

UF | UNIVERSITY of FLORIDA

College of Engineering
Department of Nuclear & Radiological Engineering
UFTR Nuclear Facilities

202 Nuclear Sciences Bldg.
PO Box 118300
Gainesville, FL 32611-8300
352-392-1401
352-392-3380 Fax
www.nre.ufl.edu

January 4, 2010

MEMORANDUM

TO Decommissioning File

FROM: Brian Shea, Reactor Manager

SUBJECT: Annual Estimate of UFTR Decommissioning Cost per 10 CFR 50.75

The estimated cost for the complete decommissioning of the University of Florida Training Reactor (UFTR) as of December 2009 is $3.28 million. To meet the requirements of 10 CFR 30.3 and 50.75 the decommissioning cost estimate is updated to reflect any changes in pertinent new information. No significant facility modifications or unusual occurrences took place from the previous cost update. The cost update was adjusted based on the Consumer Price Index (CPI) and Low Level Waste Disposal Adjustment Factor. The decommissioning cost estimate is being kept on file as the current cost estimate per NRC requirements.

Consumer Price Index Adjustment Factor (F_{CPI})
Consumer Price Index historical data can be found from Department of Labor, Bureau of Labor Statistics: *CPI for all urban consumers, US city average, all items* (Base 1982)
ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt (See Appendix A at the end of this attachment)

The adjustment factor of $F_{CPI,x}$ will be updated annually by finding the ratio of the current year CPI to the above CPI for December 1982. For example, to calculate F_{CPI} for year 1986:

$$F_{CPI,x} = \frac{CPI_x}{CPI_{1982}} = \frac{110.5}{97.6} = 1.132 ,$$

where, x corresponds to the year when the factor being calculated.

Waste Burial Adjustment Factor (F_B)
Waste Burial Adjustment is evaluated using the 1986 data as base cost. The 1986 base cost can be found at U.S. Nuclear Regulatory Commission: *Report on Waste Burial Charges* (NUREG-1307, Rev.13) (Base 1986) http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/ (See Appendix A at the end of this attachment)

First we adjuste the base from 1986 to 1982:

$$B_{1982} = \frac{B_{1986}}{1.132} = 0.883 \ ,$$

Then the waste burial adjustment factor for a given year can be evaluated by:

$$F_{B,x} = \frac{B_x}{B_{1982}} = \frac{B_x}{0.883} \ ,$$

where, *x* corresponds to the year when the factor being calculated.

Note that BWR values for B_x are used as they are more conservative than PWR values

2009 Decommissioning Cost = *F_B *(1982 Cost of Radioactive Waste disposal) +*

F_{CPI} *(1982 Total Cost Estimate – 1982 Cost of Rad Waste Disposal)

$$= \frac{11.198}{0.883} \times (199{,}000) + \frac{210.2}{97.6}(541{,}000 - 199{,}000) = 3.28 million$$

Attachments

cc: Facility Director (memo only)
RSRS Members (memo only)

Introduction

All reactor facilities, licensed by U.S. Nuclear Regulatory Commission, are required to ensure that decommissioning funds will be available when the facility ceases licensed activities. The University of Florida Training Reactor (UFTR) is owned and operated by a public educational institution in the State of Florida and its decommissioning funds are guaranteed through the State of Florida statement of intent to budget the cost.

To meet the requirements in 10CFR50.82 (b)(1)(ii) and (b)(1)(iii), DECON alternative will be adopted. Decommissioning activities will be completed without significant delay unless prevented by factors beyond the licensee's control (NUREG-1537). The UFTR decommissioning goal would be to safely remove licensed and neutron-activated material from the facility and to remove as much residual radioactivity as reasonably achievable, ensuring that residual radioactivity levels would permit the release of the property for unrestricted use, as defined in NUREG 1757 Vol 1. Residual radioactivity, distinguishable from background, would result in a calculated dose from all pathways to the average member of the critical group not in excess of 0.25 mSv/yr (25 mrem/yr).

The decommissioning cost estimate for UFTR is based on actual vendor price quotes (Coughlin, 2009), prior experience with reactor disassembly, NRC Decommissioning Guidance (NUREG-1757, 2006), and decommissioning experience of other research reactors (Marske & Hertel, 2001). The cost estimate takes no credit for salvage value of any reactor components.

Facility Description Summary

NRC License Numbers and Types
License No. R-56, Argonaut-type Reactor

Types and Quantities of Materials Authorized Under the Licenses Listed Above

Authorized to possess up to 5.2kg of contained Uranium-235, 1 curie sealed plutonium-beryllium neutron source, 25-curie antimony-beryllium neutron source, possess but not separate byproduct material and special nuclear materials as may have been produced by the operation of the facility.

University of Florida Training Reactor

The University of Florida Training Reactor (UFTR) is located on University of Florida campus at Gainesville, Florida. The UFTR is a modified Argonaut type reactor, a light water and graphite moderated, graphite reflected, light water cooled reactor. The UFTR originally operated from December 1959 at power levels up to the maximum of 10kW. In 1964 the reactor license was amended to allow operation at power levels up to the current 100kW rating. In 2006 the original HEU fuel was replaced by LEU fuel. The reactor core is heterogeneous in design with 19.75% enriched uranium silicide-aluminum (U_3Si_2-Al) fuel contained in aluminum cladding. Water is used as the coolant and also as the moderator. Graphite blocks surround the boxes containing the fuel plates and water moderator. Graphite serves as a moderator and reflector. An isomeric sketch of the reactor is presented in Figure 1.1 of the UFTR Emergency Plan. The reactor is used for various types of nuclear research (e.g. Nuclear Activation Analysis) and educational programs. The reactor building, which was built in 1958, is a "vault-type" building as defined in 10 CFR 73.2(o). The building is divided into five segments, including the reactor cell, staff offices, classroom, and two rooms dedicated for Nuclear Activation Analysis. The current floor plan is shown in Figures 1.2 and 1.3 of the UFTR Emergency Plan.

General Description of Rooms

Reactor Cell

A 2000-square foot reactor cell encompasses the reactor structure and the reactor control room. The biological shield around the reactor core is made of cast-in-place concrete 1 to 2 meters thick. A three-ton monorail crane traverses the reactor cell from north to south wall. All of the potentially contaminated equipment is stored in the fenced-off low-level storage area within the reactor cell. Potentially contaminated waste (personal protective clothing and small common items) is kept within the reactor cell boundary in trash bins. Liquid reactor effluents, including primary/secondary coolants as well as the air conditioning condensate, are stored in a tank, which is also located within the reactor cell. The tank contents are checked for contamination prior to being transferred to an external holdup tank. The low-level storage area in is the only commonly utilized area in UFTR that is not surveyed weekly for radiological contamination and thus the only area where surface contamination may exist during everyday facility operation.

A qualitative and quantitative analysis of all potentially contaminated (non-SNM) reactor components was performed in February 2009, when the entire reactor was disassembled. The main radionuclides present in the analyzed samples were europium-152, barium-133, cobalt-60 and zinc-65 with half-lives 13.33, 10.51, 5.27, 0.675 years respectively, see **Table 1**. Specific Activity listed in **Table 1** for *Rx Graphite Stringers* and *Rx Concrete* is based on gamma emission analysis using a High Purity Germanium Detection system. The analyzed samples were collected from areas that were exposed to the highest neutron flux.

Structural reactor concrete and reactor graphite combined make up 99% of reactor waste. Given the half-lives of main radioisotopes and 50 years of reactor operation, the current radionuclide concentrations in graphite and concrete are near their equilibrium concentrations, and therefore do not need to be adjusted in the future. For the purposes of the decommissioning cost estimate, it was assumed that all concrete from 0.5 meters under the floor to two meters above the floor, as well as all of the reactor graphite, would be contaminated. Based on decommissioning experience of comparable facilities, this estimate is conservative because two-meter thick reactor walls are expected to be contaminated to the depth of fewer than 0.5 meters.

Table I Quantities of Accumulated Materials and Their Levels of Radiological Contamination

Contaminated Material/Component	Weight (kg)	Specific Activity (nCi/g)	Actual/Shipping Volume (m^3)	Contact Radiation Level (mR/hr)
Rx Graphite Stringers	13000	Co-60: <0.95 Eu-152: <0.1 Zn-65: <0.85	7.1/8.5	<7
Rx Steel (I-beams, shafts, fasteners)	900	Co-60: 550	0.1/5.6	800
Rx Sand	1900	Co-60: 0.30 Eu-152: 4.6	1/1.5	<10
Rx Concrete	290000	Co-60: <1.3 Eu-152: <2.0 Ba-133: <0.6	90/180	N/A
Rx Aluminum (shield tank, primary piping)	805	Zn-65: <80	0.3/10	10
Combustibles	50	N/A	1./2	<2

Nuclear Activation Laboratory

The Nuclear Activation Analysis Laboratory (NAAL) is used for processing small batches of activated samples. NAAL is the only location at UFTR, other than the reactor cell, where radioactivity is used and stored. The south NAAL room is used for handling and analyzing sealed radioactive samples and sealed commercial radioactive sources. The north room of the NAAL is used for insertion and removal of samples from the reactor via a pneumatic rapid sample transfer (RABBIT) system. The RABBIT system is used for short neutron irradiation of samples. It is mostly used for generating short-lived radioisotopes with half-lives of less than a day. An 8'x8'x10' hot cave is located within the north room of the NAAL. It is used for storing and remote handling of highly radioactive items such as thermocouples and steel nuts/bolts that were removed from the reactor core. The RABBIT system glove box and the hot cave are not contaminated as indicated by the swipe survey conducted on March 4, 2009.

Table II Manpower requirements, occupational radiation doses and costs for decommissioning UFTR

Operation or category	Time (days)	Person days: Supervisor	Foreman	Craftsman	H.P. Tech	Tech	Clerk	Total person -days	Person -mrem	1982 Costs (Thousands of $)
Planning & preparation										
Prepare documentation*	25	10	25	0	0	0	10	45	0	12.2
Perform radiological survey*	5	0	5	0	10	0	0	15	4	4.3
Develop work plan*	30	20	30	0	20	30	30	130	0	33.0
Subtotals:	**60**	**30**	**60**	**0**	**30**	**30**	**40**	**190**	**4**	**50**
Decommissioning										
Rx Concrete Slabs**	3	1	2	3	1	0	0	7	20	2.2
Rx Graphite**	5	5	5	10	5	10	0	35	1500	10.7
Rx piping and shield tank**	5	2	4	5	5	5	0	21	1000	6.3
Rx Sand**	4	1	3	4	3	4	0	15	1000	4.5
Rx Structure*	50	30	50	100	25	100	30	335	1000	94.9
Rabbit System**	0.4	0.2	0.4	0.1	0.2	0.7	0	1.6	5	0.5
Workbenches*	0.4	0.1	0	0	0.1	0.2	0	0.4	1	0.1
Rx Vent System*	2.6	1.3	1.9	0.9	1.3	3.9	0	9.3	5	2.8
Washing Machine*	0.2	0.1	0	0	0.1	0.2	0	0.4	0	0.1
Filters*	0.4	0.2	0.4	0	0.2	0.8	0	1.6	0	0.5
Ceiling*	2.2	1.1	2.2	0.5	1.1	4.4	0	9.3	1	2.8
Walls*	4.4	2.2	4.4	0	2.2	8.8	0	17.6	2	5.3
Floors*	2.9	1.5	2.9	0	1.5	5.8	0	11.7	10	3.5
Soil and Concrete Analyses*	10	3	0	0	8	10	5	26	5	6.5
Site Restoration	20	10	20	60	10	40	0	140	2	42.5
Documentation and Reports*	25	10	25	0	10	0	25	45	0	16.1
Subtotals:	**136**	**69**	**121**	**184**	**74**	**194**	**60**	**676**	**4551**	**199**
Power, Equipment and Material										
Small tools and materials*										4.1
Protective equipment**										2.4
Commercial Vacuum Cleaner*										2.4
Electric Power										3.5
Heavy equipment rent*										48.6
Subtotals:										**61.0**
Waste management costs										
Packaging materials*										8.1
Transportation & disposal***										105.7
Subtotals:										**113.8**
Final Radiological survey*	**8**	**4**	**8**		**16**		**8**	**36**	**0**	**9.0**
Totals	**204**	**103**	**189**	**184**	**120**	**224**	**108**	**902**	**4555**	**433**
25% Cost contingency										108
Total cost with contingency										**541**

* Values based on NUREG/CR-6477

** Values based on reactor disassembly experience

*** Value based on 3/9/2009 BIONOMICS radioactive waste disposal price quote

The estimated cost for decommissioning the UFTR is $3.28 million (**Table II**). The decommissioning is expected to take 1-2 years, and require 5 person-rem to complete. The cost estimate assumes most of the decommissioning work will be performed by contractors. The cost estimate for decommissioning the UFTR reactor facility for years 2009 and beyond will be adjusted for inflation by the consumer price index and the waste burial factor. The cost estimate will be annually adjusted to reflect any changes in pertinent new information such as changes in labor, burial, energy and material costs, recent unusual occurrences and facility modifications. If and when a decision to decommission the UFTR is made, the funds needed for decommissioning will be requested from the State of Florida Legislature as per 10 CFR 50.75(e)(2)(iv).

References

U.S. Nuclear Regulatory Commission (2006). *Consolidated Decommissioning Guidance - Decommissioning Process for Materials Licensees* (NUREG-1757 Vol.1, Rev2). Washington, DC.

U.S. Nuclear Regulatory Commission (1996). *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors – Standard Review Plan and Acceptance Criteria* (NUREG-1537 Vol.1, Rev2). Washington, DC.

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Coughlin, W. (bcoughl@ehs.ufl.edu) (9 March 2009). *RE: Reactor rad waste disposal quote status.* Email to: Yenatskyy, M. (yenmike@ufl.edu).

Marske, S., Hertel, N. (2001). *Decommissioning Of The Georgia Tech Research Reactor.* WM'01 Conference, Tucson, AZ

Attachment 7-Appendix A: CPI data

U.S. Department Of Labor
Bureau of Labor Statistics
Washington, D.C. 20212

Consumer Price Index

All Urban Consumers - (CPI-U)

U.S. city average

All items

1982-84=100

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1982	94.3	94.6	94.5	94.9	95.8	97.0	97.5	97.7	97.9	98.2	98.0	97.6
1983	97.8	97.9	97.9	98.6	99.2	99.5	99.9	100.2	100.7	101.0	101.2	101.3
1984	101.9	102.4	102.6	103.1	103.4	103.7	104.1	104.5	105.0	105.3	105.3	105.3
1985	105.5	106.0	106.4	106.9	107.3	107.6	107.8	108.0	108.3	108.7	109.0	109.3
1986	109.6	109.3	108.8	108.6	108.9	109.5	109.5	109.7	110.2	110.3	110.4	110.5
1987	111.2	111.6	112.1	112.7	113.1	113.5	113.8	114.4	115.0	115.3	115.4	115.4
1988	115.7	116.0	116.5	117.1	117.5	118.0	118.5	119.0	119.8	120.2	120.3	120.5
1989	121.1	121.6	122.3	123.1	123.8	124.1	124.4	124.6	125.0	125.6	125.9	126.1
1990	127.4	128.0	128.7	128.9	129.2	129.9	130.4	131.6	132.7	133.5	133.8	133.8
1991	134.6	134.8	135.0	135.2	135.6	136.0	136.2	136.6	137.2	137.4	137.8	137.9
1992	138.1	138.6	139.3	139.5	139.7	140.2	140.5	140.9	141.3	141.8	142.0	141.9
1993	142.6	143.1	143.6	144.0	144.2	144.4	144.4	144.8	145.1	145.7	145.8	145.8
1994	146.2	146.7	147.2	147.4	147.5	148.0	148.4	149.0	149.4	149.5	149.7	149.7
1995	150.3	150.9	151.4	151.9	152.2	152.5	152.5	152.9	153.2	153.7	153.6	153.5
1996	154.4	154.9	155.7	156.3	156.6	156.7	157.0	157.3	157.8	158.3	158.6	158.6
1997	159.1	159.6	160.0	160.2	160.1	160.3	160.5	160.8	161.2	161.6	161.5	161.3
1998	161.6	161.9	162.2	162.5	162.8	163.0	163.2	163.4	163.6	164.0	164.0	163.9
1999	164.3	164.5	165.0	166.2	166.2	166.2	166.7	167.1	167.9	168.2	168.3	168.3
2000	168.8	169.8	171.2	171.3	171.5	172.4	172.8	172.8	173.7	174.0	174.1	174.0
2001	175.1	175.8	176.2	176.9	177.7	178.0	177.5	177.5	178.3	177.7	177.4	176.7
2002	177.1	177.8	178.8	179.8	179.8	179.9	180.1	180.7	181.0	181.3	181.3	180.9
2003	181.7	183.1	184.2	183.8	183.5	183.7	183.9	184.6	185.2	185.0	184.5	184.3
2004	185.2	186.2	187.4	188.0	189.1	189.7	189.4	189.5	189.9	190.9	191.0	190.3
2005	190.7	191.8	193.3	194.6	194.4	194.5	195.4	196.4	198.8	199.2	197.6	196.8
2006	198.3	198.7	199.8	201.5	202.5	202.9	203.5	203.9	202.9	201.8	201.5	201.8
2007	202.416	203.499	205.352	206.686	207.949	208.352	208.299	207.917	208.490	208.936	210.177	210.036
2008	211.080	211.693	213.528	214.823	216.632	218.815	219.964	219.086	218.783	216.573	212.425	210.228
2009	211.143	212.193	212.709	213.240	213.856	215.693	215.351	215.834	215.969	216.177	216.330	215.949

2 Summary

The elements of decommissioning cost, per 10 CFR 50.75(c)(2), are assigned to three categories: those that are proportional to labor costs, L_x; those that are proportional to energy costs, E_x; and those that are proportional to burial costs, B_x. The adjustment of the total decommissioning cost estimate can be expressed by

Estimated Cost (Year X)

$$= [1986\ \$\ \text{Cost}]\ [A\ L_x - B\ E_x + C\ B_x]$$

where A, B, and C are the fractions of the total 1986 dollar costs that are attributable to labor (0.65), energy (0.13), and burial (0.22), respectively, and sum to 1.0. The factors L_x, E_x, and B_x are defined by

L_x = labor cost adjustment, January of 1986 to January of Year X.

E_x = energy cost adjustment, January of 1986 to January of Year X, and

B_x= LLW burial/disposition cost adjustment, January of 1986 to January of Year X (i.e., burial/disposition cost in January of Year X divided by burial cost in January of 1986).

Licensees are to evaluate L_x and E_x for the years subsequent to 1986 based on the national producer price indexes, national consumer price indexes, and local conditions for a given site (see Chapter 3).

B_x is evaluated by recalculating the costs of burial/disposition of the radioactive wastes from the reference PWR (Ref. 1) and the reference BWR (Ref. 2) based on the price schedules provided by the available burial sites/waste vendors for the year of interest. The results of these recalculations are presented in Table 2.1, by site and by year. Effective July 1, 2000, different price schedules at the South Carolina burial site applied for states within and outside the newly created Atlantic Compact, comprised of South Carolina, Connecticut, and New Jersey (see footnote (c) in Table 2.1). Effective July 1, 2008, waste from states that are not members of the Atlantic Compact will not be accepted at the South Carolina disposal site. Licensees not located in either the Northwest or Atlantic Compacts should use the B_x values for the Generic LLW Disposal Site. Issues of this report prior to 1998 considered direct disposal of LLW at an available LLW disposal site as the only LLW disposition option. This report includes the additional LLW disposition option of turning over the majority of the LLW generated during decommissioning to waste vendors for disposition. The B_x values for this option are also provided in Table 2.1 for the years 1998 through 2008 (see footnote (d) in Table 2.1). It is left to the licensees to determine whether direct disposal or disposition using waste vendors best represents their particular situation.

Table 2.1 Values of B_x as a Function of LLW Burial Site, Waste Vendor, and Year[(a)]

	B_x Values for Washington Site[(b)]				B_x Values for South Carolina Site								B_x Values for Generic LLW Disposal Site[(e)]			
					Atlantic Compact[(c)]				Non-Atlantic Compact[(d)]							
	Direct Disposal		Direct Disposal with Vendors[(f)]		Direct Disposal		Direct Disposal with Vendors[(f)]		Direct Disposal		Direct Disposal with Vendors[(f)]		Direct Disposal		Direct Disposal with Vendors[(f)]	
Year	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR
2008	8.283	23.185	5.153	20.889	25.231	22.504	9.872	11.198	NA	NA	NA	NA	25.231	22.504	9.872	11.198
2006	6.829	11.702	3.855	9.008	22.933	20.451	8.600	9.345	23.030	20.813	8.683	10.206	NA	NA	NA	NA
2004	5.374	13.157	3.846	11.755	19.500	17.389	7.790	8.347	21.937[(g)]	17.970	7.934	8.863	NA	NA	NA	NA
2002	3.634	14.549	5.748	15.571	17.922	15.988	9.273	8.626	18.732	16.705	9.467	8.860	NA	NA	NA	NA
2000	2.223	3.375	4.060	4.379	17.922	15.987	7.878	7.943	18.129	16.244	8.052	8.189	NA	NA	NA	NA
1998	3.165	14.403	4.538	15.203	15.886	13.948	7.173	6.968	NA	NA	NA	NA	NA	NA	NA	NA

(a) The values shown in this table are developed in Appendix B, with all values normalized to the 1986 Washington PWR/BWR values by dividing the calculated burial costs for each site and year by the Washington site burial costs calculated for the year 1986.
(b) Effective 1/1/93, the Washington site is not accepting waste from outside the Northwest and Rocky Mountain Compacts.
(c) Effective 7/1/2000, rates are based on whether a waste generator is or is not a member of the Atlantic Compact.
(d) Effective 7/1/2008, the South Carolina site is not accepting waste from outside the Atlantic Compact.
(e) B_x values for the Generic site are assumed to be the same at that provided for the Atlantic Compact, for lack of a better alternative at this time.
(f) Effective with NUREG-1307, Rev. 8 (Ref. 3), turning over the majority of LLW to waste vendors for disposition is considered a possibility.
(g) Calculated using the "flat rate" cost method. See Sections B.2 and B.3.