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March 26, 2010

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

10 CFR 50.82(b)

Subject: REQUEST FOR ADDITIONAL INFORMATION REGARDING DECOMMISSIONING OF THE UNIVERSITY OF ARIZONA NUCLEAR REACTOR LABORATORY, FACILITY LICENSE NO. R-52, DOCKET NO. 50-113

This letter responds to the NRC's letter of February 25, 2010, requesting additional information regarding the University of Arizona's nuclear reactor decommissioning.

The University of Arizona's current reactor operating license expires on May 22, 2010. On or before midnight on May 22 we will:

- Cease reactor operations
- Partially unload fuel from the University of Arizona Research Reactor so that it contains insufficient fissile material present in the reactor to attain criticality under optimum available conditions of moderation and reflection.
- Maintain the reactor in a "secured" condition per the definition of Reactor Secured, part (a), of our technical specifications
- Continue our possession of the nuclear fuel
- Maintain our surveillance activities, and
- Maintain the facility, including, where applicable, the storage, control and maintenance of the spent fuel, in a safe condition until the defueling is completed.

By prior agreement, the DOE through its Reactor Fuel Assistance Program will assist in defueling our nuclear reactor following the end of operations.

Sincerely,

John G. Williams, Ph. D.
Director, Nuclear Reactor Laboratory

State of Arizona
County of Pima
Signed before me this twenty-sixth day of March, 2010, subscribed and sworn before me.

Deborah Pemberton
Notary Public

DEBORAH PEMBERTON
Notary Public - Arizona
Pima County
My Comm. Expires May 23, 2012

A020
NRR

Attachment
University of Arizona Response to the NRC's REQUEST FOR ADDITIONAL INFORMATION UNIVERSITY OF ARIZONA NUCLEAR REACTOR LABORATORY DECOMMISSIONING PLAN DOCKET NO. 50-113

Copy to:

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Test, Research and Training Reactor Newsletter
202 Nuclear Sciences Center
University of Florida
Gainesville, FL 32611

U.S. NRC Region IV
Texas Health Resources Tower
612 East Lamar Blvd.
Arlington, TX 76011-4005.

University of Arizona Response to the NRC's REQUEST FOR ADDITIONAL INFORMATION UNIVERSITY OF ARIZONA NUCLEAR REACTOR LABORATORY DECOMMISSIONING PLAN DOCKET NO. 50-113

1. The Decommissioning Plan (DP) needs to be submitted with a license amendment request to incorporate approval of the DP with associated license conditions as discussed below and in questions 2, 3, 4, and 6.

A license condition is required to document approval of the DP. A sample is provided below:

Decommissioning

a. The license is amended to approve the decommissioning plan described in the licensee's application dated Month Date, 2009, as supplemented on Month Date, 2009, and authorizes inclusion of the decommissioning plan as a supplement to the Safety Analysis Report pursuant to 10 CFR 50.82(b)(5).

University of Arizona response:

The University of Arizona will submit, in a revision of its Technical Specifications: "The license is amended to approve the decommissioning plan described in the licensee's application dated May 22, 2009, as supplemented by our letter of March 26, 2010, and authorizes inclusion of the decommissioning plan as a supplement to the Safety Analysis Report pursuant to 10 CFR 50.82(b)(5)."

2. Provide Method of Approving Changes to the DP

Background:
Section 2.4 of the DP, page 26, cites one of the functions of the Reactor Committee as: "Review and approval of all proposed changes to the facility, procedures and Technical Specifications, and Decommissioning Plan." Section 9.0 of the DP discusses the application of the Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.59 review process with respect to changes to the DP but does not provide sufficient specific criteria for when prior U.S. Nuclear Regulatory Commission (NRC) approval would be required.

The NRC staff has additional guidance on changes to DPs in NUREG-1757, Vol. 1, Chapter 18 (the licensee should note that Volume 1 is generally applicable to materials licensees, but may provide helpful information for reactor licensees).

Information Required:
A typical license condition used for DPs is included below:

A license condition will be required to document the change control criteria.

The licensee may make changes to the decommissioning plan without prior approval provided the proposed changes do not:

(i) Require Commission approval pursuant to 10 CFR 50.59;

(ii) Use a statistical test other than the Sign test or Wilcoxon Rank Sum test for evaluation of the final status survey;

(iii) Increase the radioactivity level, relative to the applicable derived concentration guideline level, at which an investigation occurs;

(iv) Reduce the coverage requirements for scan measurements;

(v) Decrease an area classification (i.e., impacted to unimpacted; Class 1 to Class 2; Class 2 to Class 3; or Class 1 to Class 3);

(vi) Increase the Type I decision error;

(vii) Increase the derived concentration guideline levels and related minimum detectable concentrations (for both scan and fixed measurement methods); and

(viii) Result in significant environmental impacts not previously reviewed.

University of Arizona response:
The University will submit these as license conditions in a revision of its Technical Specifications.

3. Clarify additional characterization needed

Background:
Radiological characterization has not been performed on the reactor tank, storage pits, reactor internals, and underlying site soils. Section 2.2.2 of the DP, page 15, states: "Prior to commencement of D&D activities, a limited characterization and review of facility documents pertaining to the period from the end of the characterization until removal of the fuel will be conducted to validate that radiological conditions at the facility have not changed" ... and "...characterization of the reactor tank, internals and underlying soil sites should be conducted"..."

Based on these statements, it appears that the licensee intends to perform additional characterization of the site following the end of reactor operations. However, this is not explicitly stated in the DP.

Information Required:
The licensee should provide a detailed radiological characterization plan, or commitment by license condition to submit a complete radiological characterization report for NRC to review prior to performing decommissioning activities at the University of Arizona Research Reactor (UARR). The licensee should refer to the applicable guidance documents (NUREG-1575, Sections 2.4 and 5.3; and NUREG-1757, Volume 2, Section 4.2) to determine the information that should be supplied by the licensee to allow NRC staff to verify that the licensee has adequately characterized the radiological condition of the site.

University of Arizona response:

The University will incorporate a commitment via license condition to submit a completed radiological characterization report to NRC review and approval prior to initiating decommissioning activities. The characterization report will include information required in NUREG-1575, Sections 2.4 and 5.3; and NUREG-1757, Volume 2, Section 4.2) to allow NRC staff to verify that the University has adequately characterized the radiological condition of the site.

4. Provide a Detailed Final Status Survey Plan

Background:
The DP does not contain a proposed Final Status Survey (FSS) Plan with adequate detail, as recommended by NUREG-1537, Part I, Appendix 17.1, section 4. Section 4.1 of the DP, page 41, states: "The FSS will be developed following the guidance provided in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)"..."

Based on the above it appears that the intent of the licensee is to submit a FSS Plan to the NRC for review and approval at a later date. However, this is not explicitly stated in the DP.

Information Required:
The licensee should provide a complete, detailed plan or an appropriate commitment, by license condition, to submit a complete, detailed plan for NRC review and approval prior to conduct of the surveys. The licensee should refer to the applicable guidance documents (NUREG-1537, Part I, Appendix 17.1, Section 4; and NUREG-1757, Volume 2, Chapter 4) to determine the information that should be supplied by the licensee to allow the NRC staff to determine that the FSS design or design process is adequate to demonstrate compliance with the radiological criteria for license termination.

University of Arizona response:

The University will incorporate a commitment via license condition to provide NRC with a Final Status Survey Plan prior to conduct of license termination surveys. The Plan will be developed in accordance requirements in NUREG 1575 (MARSSIM); NUREG-1537, Part 1, Appendix 17.1, Section A; and NUREG-1757, Volume 2, Chapter 4.

5. The DP included insufficient information on the qualifications and experience of senior staff as detailed below:

Background:
Section 2.4 of Appendix 17.1 in NUREG-1537, states that qualification and experience for key positions should be described.

Information Required:
Please provide the minimum qualifications for the Nuclear Reactor Lab (NRL) Director. Include specifics on education, licenses held and experience.

Please provide the minimum qualifications for the University Project Manager. Include specifics on education, project and task experience and specific University of Arizona (UA) experience.

Please provide details on the Reactor Supervisor's area of responsibility.

Please provide the minimum qualifications for the Reactor Supervisor. Include specifics on education, reactor experience and UA experience.

Please provide the minimum qualifications for the Radiation Control Office staff. Include specifics on education and experience.

University of Arizona response:

Details of the Reactor Supervisor's area of responsibility were included in the previously submitted Decommissioning Plan, Section 2.4, page 25, and are repeated here:

- Overseeing all activities of contractor personnel on the licensed site (RS)
- Ensuring that all decommissioning activities are performed in compliance with applicable regulations and license conditions (RS)
- Review of all plans and procedures required for decommissioning (RS)
- Reviewing and submitting to the Reactor Committee all needed changes and subsequent plans and procedures that do not change the original intent or result in an unreviewed safety question (RS)
- Communicating with all appropriate regulatory agencies (RS)
- Communicating with the Nuclear Regulatory Agency, The University Administration, and the decommissioning contractor and sub-contractors (RS)

Minimum required qualifications and experience requirements for the following positions are:

- Nuclear Reactor Laboratory (NRL) Director.
  Advanced degree (MS or PhD) in Nuclear Engineering or related discipline and five (5) years experience in nuclear reactor operations and/or decommissioning.

Familiarity with the UARR NRC License, the Decommissioning Plan, the UARR Radiation Protection Program and with applicable federal and state regulations.

Trained at the level required by the UA Radiation Protection Program for a permit holder to be in possession of radioactive materials of the types known to be present at the licensed reactor site.

- University Project Manager

  Bachelor's degree in Architecture, Civil, Electrical, Mechanical or Structural Engineering or related field AND five years of construction experience which included one year of construction supervisory experience; OR, nine years of progressively responsible construction experience which included one year of construction supervisory experience; OR, any equivalent combination of experience, training and/or education approved by the University Human Resources department.

- Reactor Supervisor.

  Bachelor's degree in Engineering or science field AND completion of an approved training program in nuclear reactor maintenance AND three years of nuclear reactor operation and maintenance experience; OR, Completion of an approved training program in nuclear reactor maintenance AND seven years of nuclear reactor operation and maintenance experience; OR, Any equivalent combination of experience, training and/or education approved by Human Resources.

  Familiarity with all physical plant and equipment at the UA reactor at a level equivalent to that required for an SRO license at an operating reactor of the same type

  Knowledge of the UARR license conditions, Safety Analysis Report and Decommissioning Plan and procedures as approved by the Reactor Committee

  Knowledge of security requirements at the site and ability to meet the requirements for unescorted access to it.

  Trained at the level required by the UA Radiation Protection Program for worker with radioactive materials of the types known to be present at the reactor licensed site

  Knowledge of Federal regulations applicable to the possession, transport and use of radioactive materials

- Radiation Control Office.

  Radiation Control Office directorate. Two, or more, individuals with advanced degrees (MS or PhD) certified in Health Physics and Diagnostic Radiological Physics, each with 10 years experience in radiation safety and health physics.

  Radiation Control Office staff. Associate's degree or equivalent certification in Radiation or Physical Sciences AND two years of radiation monitoring experience; OR, four years of radiation monitoring experience; OR, any equivalent combination of experience, training and/or education approved by the University Human Resources department.

6. Release Criteria

Background:
Section 2.2.3 of the DP discusses release criteria for the remaining equipment and surfaces. Currently the licensee proposes to us the NRC screening values but discusses the possibility of using alternative site-specific release criteria developed using a dose modeling software code such as the RESRAD family of codes.

Information Required:
A license condition is needed to require NRC review and approval if the licensee decides to use alternative site-specific release criteria.

University of Arizona response:

The University will use the release criteria specified in the DP and as amended in the letter dated March 26, 2010. The University will submit a revised license condition for review and approval by the NRC if alternative release criteria are developed for release of the NRL.

7. Provide evaluation of hot particles

Background:
A number of reactor facilities have discovered hot particles in various locations during decommissioning. Origins of hot particles have included particles of failed fuel and particles of activated materials. The DP does not discuss the possibility of hot particles at the NRL facility.

Information Required:
UA should evaluate the possibility of hot particles at the NRL facility. The DP should either justify that significant hot particles do not exist at the facility or demonstrate that characterization and final status surveys will detect such hot particles if they do exist.

University of Arizona response:

Our only fuel failure occurred to fuel element # 4058 in November 1974 and involved release only of gases. Post-incident radiation surveys showed no facility contamination. Since then the University experienced no additional fuel failures, and our routine monthly radiation surveys have never detected hot particles. If present, hot particles would be limited to the reactor tank. Prior to tank concrete demolition activities, the reactor components and gunite liner will be removed. This would remove any potential hot particles present within the reactor tank. Survey instrumentation used during the tank remediation will have MDCs low enough to detect hot particles. In addition, final status survey instrumentation will have MDCs at a small fraction (typically 10-50%) of the release levels, and thus will also be capable of finding hot particles if missed during D&D activities.

8. Technical Specifications

Background:
The DP should describe the applicable decommissioning technical specifications (TS) to include the safety precautions necessary during the decommissioning phase (refer to NUREG-1537, Part I, Appendix 17.1, Section 5).

Section 5.0, page 48, states that: "After the reactor ceases operation, most of the technical specifications will no longer be applicable. Additionally, other technical specifications that apply to non-operating conditions will be amended at the time of reactor shutdown and fuel removal. If additional changes to the technical specifications are necessary prior to D&D operations, the University will request that changes be approved by the NRC through a license amendment." Based on this statement, the NRC staff concludes that the licensee intends to submit the decommissioning technical specifications to the NRC for review and approval prior to the start of decommissioning work.

Information Required:
The DP should include the commitment by the licensee to include the information described in NUREG-1537, Part I, Appendix 17.1, Section 5, in the revisions to the TS. The revised TS should include the four sections described in Section 5 of Appendix 17.1: 1) a section imposing limiting decommissioning conditions at the facility that is comparable to the limiting conditions for operation for required equipment and conditions; 2) a section providing for surveillance of the required equipment and conditions for decommissioning; 3) a section describing the residual facility and site to which the DP applies, and; 4) an administrative section that outlines the management structure, provides for review and audit functions, provides for development and use of the necessary procedures, and contains reporting and record-retention requirements.

University of Arizona response:

The University will commit to revise our technical specifications (TS) to support decommissioning activities. The TS revisions will be submitted for review and approval prior to reactor shutdown and will include information described in the four sections described in NUREG-1537, Part 1, Appendix 17.1, Section 5.

9. Decommissioning Contractor

Background:
The specific qualifications and experience of the Decommissioning Contractor (DC) are not specified in the DP as recommended in section 2.6 of Appendix 17.1 of NUREG-1537.

Information Required:
Please specify the qualifications and experience requirements that will be used to evaluate the DC and what are the minimum expectations. Include specifics on: Task Experience, QA Program and Personnel Experience.

University of Arizona response:

Qualifications and experience requirements that will be used to evaluate the DC will be the following:

- Task experience: the University will require the selected DC to have at least 5 years prior experience in radiological site decommissioning. Specific experience in decommissioning test reactors, power reactors, and/or materials licensed sites will be required. DC submittals of project descriptions, references, and other supporting information will be required prior to contract award. Specific DC project management documentation will be required in the areas of work plan development, training, QA, work management, reactor dismantlement and decontamination, waste packaging, waste shipping, work documentation, radiation protection, final status surveys, regulatory interface, and supporting the preparation of the final decommissioning project report. The minimum expectation of the University for a DC contractor is verification of company experience in these tasks plus proof of financial viability.

- QA program: the University will require the selected DC to have an existing QA program that was used to support decommissioning projects and final status surveys. The minimum expectation of the University for a DC contractor is verification of company QA experience in these tasks.

- Personnel experience: the University will require the selected DC to support the project with an experienced work force with at least 5 years prior experience in radiological site decommissioning. Specific individual experience will be required in the areas of work plan development, training, QA, work management, reactor dismantlement and decontamination, waste packaging, waste shipping, work documentation, radiation protection, final status surveys, regulatory interface, and supporting the preparation of the final decommissioning project report. The minimum expectation of the University for a DC contractor is verification of personnel experience in these tasks plus a commitment to provide experienced personnel for the duration of the project.

10. Training Program

Background:
The Training Program section of the DP, Section 2.5, lacks some of the information recommended by NUREG-1537, Part I, Appendix 17.1, Section 2.5. The items not described include:

- The required frequency for refresher training
- A statement that contractors will receive training on the DP and the site

Information Required:
The licensee should provide additional information in Section 2.5 of the DP, and the licensee's training program modified accordingly.

University of Arizona response:

No modification to the university-wide Radiation Protection Program, administered by the University's Radiation Control Office, will be required. The University of Arizona Research Reactor will submit a revised biennial operator requalification program before reactor shutdown on May 22, 2010. The revision will extend its applicability to include some staff in addition to former operators.

The DC and any subcontractor(s) will be required to meet the training requirements specified by the University. Initial training will be required for all personnel directly involved with the accomplishment of D&D activities prior to work and will be formally administered to all DC and subcontractors at the initiation of site D&D activities. Contractors will also receive training on the DP and the site. Refresher training will be conducted informally throughout the project during project tail-gate and safety meetings. Formal refresher training will be administered annually, if applicable. The DC and any subcontractor(s) will be required to submit proof of prior training (such as radiation worker or HAZWOPER certification) as required by the University. All training certifications will be maintained in the project record.

11. Waste Disposal

Background:
The DP states: "Based on the site characterization and reactor activation analysis, Class B and C LLRW are not expected at the UARR."

Information Required:
What if any contingencies, does the licensee have if Class B or C waste is identified at the NRL during decommissioning? Where would the licensee plan on shipping such waste?

University of Arizona response:

Results from the activation analysis performed on the reactor and associated comments show an extreme low probability of encountering class "B" and "C" waste during decommissioning of the UARR. In the event class "B" and "C" waste is identified, the University acknowledges that no commercial option for either disposal or long term offsite storage of class "B" and "C" wastes is currently available to the University.

12. Radiation Protection

Background:
The DP refers to the D&D project Radiation Protection (RP) Program, a RP and ALARA Plan to be prepared by the DC, and a project Health Physics Program. It is unclear how these "new" programs are related to the existing RP program.

Information Required:
Please describe if and how the current RP Program is utilized and/or incorporated into the decommissioning RP programs.

University of Arizona response:

No modification to the university-wide Radiation Protection Program, administered by the University's Radiation Control Office, will be required. The University RCO will augment the Decommissioning Contractor's Health Physics staff in providing radiation safety oversight. The University RCO will continue independent monitoring and sample analysis.

13. Soil / Groundwater Contamination

Background:
Both the DP and the Environmental Report state that there have not been any non-routine events such as accidents, spills, unplanned releases.

Information Required:
Please confirm that there is no record of any unexplained loss of pool inventory.

University of Arizona response:
The University has no record or knowledge of any unexplained loss of pool water inventory.

14. Provide Instrument Scan MDCs

Background:
Section 3.6, page 7, of the UA NRL Characterization Report listed the minimum detectable concentrations (MDCs) for static (direct) surface measurements. Scan measurements will be made as part of the decommissioning project. Therefore scan MDCs need to be performed for the survey instruments used to conduct scan measurements.

Since scan survey measurements appear to be needed for site characterization, the licensee should provide the minimum detectable concentrations for radiological measurement instrumentation.

Information Required:
The licensee should provide a description and justification for survey measurements and instrumentation, including sensitivities for NRC to review prior to performing decommissioning activities at the UARR. The licensee should refer to the applicable guidance documents (NUREG-1575, Sections 6.4 and 6.5; NUREG-1757, Volume 2, Section 4.2) to provide the information that should be supplied by the licensee to allow NRC staff to verify that the licensee has adequately developed scan minimum detectable concentrations for instrumentation used to perform radiological scan surveys.

University of Arizona response:

The University concurs that scan measurements should be included in the additional characterization that will occur after the cessation of activities at NRL. As described in the response to RAI#3 above, the University will provide a Final Characterization Report to the NRC for review before decommissioning activities begin on the UARR. During this additional characterization, *a priori* MDCs for scan measurement will be calculated per guidance from NUREG-1575 (MARSSIM) and NUREG-1757.

The MDC_{scan} for beta-gamma measurements will be calculated by determining the Minimum Detectable Count Rate (MDCR). The MDCR is determined by first determining the minimum detectable net source counts using Formula 6-8 in the MARSSIM as shown below.

Minimum number of detectable source counts: $$s_i = d'\sqrt{b_i}$$

where:

d′ = Value taken from Table 6.5 in the MARSSIM for applicable true and false positive rates

b_i = Number of background counts in a given time interval

The MDCR is then calculated from Formula 6-9 in the MARSSIM:

Minimum detectable count rate: $$MDCR = s_i * \frac{60}{i}$$

where:

i = Observed time interval

Finally, applying the detection efficiency correction resulted in an MDC_{scan} in standardized units (DPM/100cm^2) from this formula:

$$\text{Scan MDC:} \quad MDC_{scan} = \frac{MDCR}{\sqrt{\rho} * \varepsilon_i * \varepsilon_s * \frac{probearea}{100cm^2}}$$

where:

ρ = Surveyor efficiency (value from a range between 0.5 and 0.75)
ε_i = Instrument efficiency (based on 2-π (two-pi) emission rate)
ε_s = Surface efficiency (typically 50% for beta/gamma radionuclides)
probearea = Total area of the detector face in cm^2

The value for ρ was developed in Draft NUREG/CR-6364 and NUREG-1507. It is a percentage estimate of the likelihood a surveyor will reliably detect an elevated count rate.

15. Calculate DCGLs for Activated Concrete or Volumetrically Contaminated Bulk Materials

Background:
There are NRC license termination screening values associated with surface and soil concentrations presented in the UARR DP, Section 2.2.2, page 19. However, Derived Concentration Guideline Levels (DCGLs) need to be determined for activated concrete or volumetrically contaminated bulk materials which will be encountered during the decommissioning process.

Section 2.2.3, page 19, of the DP states that "Residual concrete and steel from the reactor tank will also be sampled to ensure that residual radioactivity meets the following NRC screening values for soils".

Information Required:
The licensee should provide a description and calculation of the DCGLs for activated concrete or volumetrically contaminated bulk materials for NRC to review prior to performing decommissioning activities at the UARR. The licensee should refer to the applicable guidance documents (NUREG-1575, Sections 4.3 and NUREG-1757, Volume 2, Section 4.2) to provide the information that should be supplied by the licensee to allow NRC staff to verify that the licensee has adequately developed DCGLs for activated concrete or volumetrically contaminated bulk materials.

University of Arizona response:

The University revises the statement referenced above in Section 2.2.3, page 19, to read: "Residual concrete and steel from the reactor tank will be sampled to ensure that all residual radioactivity associated with reactor operations has been removed to background levels".

16. Incomplete List of Radionuclides of Concern

Background:
The UA NRL Characterization Report, Section 3.1, page 4, has identified the radionuclides of concern as tritium and beta/gamma emitting isotopes. No specific beta/gamma radionuclides were identified other than tritium. The UA Activation Analysis and Component Characterization Report provided results for several radionuclides that are not included in the radionuclide screening levels in the UARR DP.

The DP included the following screening levels for surfaces:

H-3	Fe-55	Tc-99
C-14	Co-60	Cs-137
Mn-54	Ni-63	

The DP included the following screening levels for soils:

Co-60	Fe-55	Eu-152
H-3	Ni-63	Eu-154
C-14	Cs-137	

The UA Activation Analysis and Component Characterization Report included the following radionuclides not included above:

Ca-45	Co-58	Zn-65
Cr-51	Ni-59	Nb-94
Fe-59		

Information Required:
The licensee should identify the radionuclides of concern by isotope and include radionuclides associated with activation of concrete, volumetrically contaminated materials, and buried or embedded piping, if applicable. NUREG-1757, Volume 1, and NUREG-1757, Volume 2, Sections 4, 5 and Section I.2 discusses information the licensee is expected to provide regarding the existing radiological characterization of the site. Specifically, the licensee should identify all radionuclides of concern potentially present at the site. Ensure that any new radionuclides identified by characterization activities following reactor shutdown are included.

University of Arizona response:

Owing to the fact that the nuclear reactor is still operating, a complete site characterization has not been conducted. A limited characterization was conducted to validate routine surveys results and to verify the clean operating history of the site. This characterization data will provide the statistical data necessary to conduct a proper final status survey. Specifically, the standard deviation of measurements in the areas is needed, in conjunction with the release criteria, for the design of the FSS. Because locations measured less than MDC on the characterization measurements, typical Radionuclides of Concern (ROC) for a reactor with no fuel cladding failures were chosen as a conservative approach.

The following table provides a comprehensive list of the radionuclides of concern for the UARR and a matrix of the applicable area/media of where the radionuclide is of concern.

Radionuclide	Half-life	Building Surfaces	Soils	Activated Concrete/Metal
Tritium (H-3)	12.32 years	x	x	x
Carbon-14	5715 years	x	x	x
Manganese-54	312.1 days	x	x	x
Iron-55	2.73 years	x	x	x
Cobalt-60	5.271 years	x	x	x
Nickel-63	100 years	x	x	x
Technitium-99	2.13E+05 years	x	x	x
Cesium-137	30.07 years	x	x	
Europium-152	13.54 years		x	x
Europium-154	8.593 years		x	
Ca-45	162.7 days		x	x
Cr-51	27.702 days		x	x
Fe-59	44.51 days		x	x
Co-58	70.88 days		x	x
Ni-59	7.60E+04 years		x	x
Zn-65	243.8 days		x	x
Nb-94	2.00E+04 years		x	x

If additional radionuclides are identified in the characterization of the subsurface soils under the reactor, they will be added to the list identified in the DP and submitted for NRC review.