Dr. Sean M. McDeavitt
Director, TEES Nuclear Science Center
Texas A&M University
Texas A&M Engineering Experiment Station
1095 Nuclear Science Road, 3575 TAMU
College Station, TX 77843-3575

November 21, 2016 2016-0059
Docket Number 50-59 / License No. R-23

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555
Ref: 10 CFR 50.90

SUBJECT: License Amendment Request for the Approval of the Unrestricted Release of the Zachry Engineering Center and Changes to the AGN-201M Facility License No. R-23, Docket 50-59, Technical Specification Sections 5.2 and 5.3

Attn: Mr. Alexander Adams Jr., Chief,
Research and Test Reactors Branch
Office of Nuclear Reactor Regulation

Mr. Patrick M. Boyle, Project Manager,
Research and Test Reactors Branch
Office of Nuclear Reactor Regulation

Texas A&M University (TAMU) is proposing this license amendment request (LAR) to Operating License No. R-23, Docket 50-59 seeking U.S. Nuclear Regulatory Commission (U.S. NRC) approval for the unrestricted release of the Zachry Engineering Center located on the TAMU Campus. The Zachry Engineering Center is a currently-licensed location for the AGN-201M reactor. The approval of this LAR will result in the removal of the Zachry site from the R-23 license.

Further, TAMU proposes to remove the requirement to maintain an Emergency Plan and Physical Security Plan as a license condition from the R-23 license. The material possession levels at the AGN-201M site have been and will be below the regulatory requirements for having a Physical Security Plan.

For clarity, let me state that there are two license holders involved in recent relevant licensing actions preceding this current request. The first is TAMU, the licensee for the AGN-201M reactor that is the subject of this present LAR (Facility License No. R-23, Docket 50-59). The second is the Texas A&M Engineering Experiment Station (TEES), the licensee for the TEES Nuclear Science Center (NSC) 1 MW TRIGA reactor (Facility License No. R-83, Docket 50-128). Both TAMU and TEES are members of the Texas A&M University System (TAMUS), but TAMU is one of eleven academic members and TEES is one of seven state agency members; they have distinct legal standing within

Nuclear Science Center
1095 Nuclear Science Road, 3575 TAMU
College Station, TX 77843-3575
Tel. (979) 845-7551

the TAMUS.

On October 14, 2015, an LAR was submitted by TEES (U.S. NRC ADAMS Accession No. ML15287A148) to modify license R-83 to enable the relocation and safe storage of the AGN-201M special nuclear material on the NSC site; this LAR was approved by the U.S. NRC on August 31, 2016 (ADAMS Accession No. ML16109A153). Following this approval, the AGN-201M SNM was packaged, transported, and placed into storage under the conditions outlined in the amended Facility License No. R-83. All SNM was removed from the Facility License No. R-23 at that point.

On November 11, 2015, an LAR was submitted by TAMU (U.S. NRC ADAMS Accession No. ML15315A027) to modify license R-23 to enable to storage of the AGN-201M reactor tank, control console, and associated components either at the current Zachry Engineering Center location or at the TEES NSC site in designated storage areas; this LAR was approved by the U.S. NRC on October 14, 2016 (ADAMS Accession No. ML16278A497). Following this approval, the AGN-201M reactor tank and associated components were packaged, transported and placed into their proper storage locations at the NSC facility where they will be stored for up to 5 years. In that time, TAMU and TEES will work toward the establishment of a new AGN facility to enable the reassembly and operation of the AGN-201M reactor. The reactor tank and associated components are now stored at the NSC under the conditions outlined in the amended Facility License No. R-23.

The following are the enclosures and attachment accompanying this letter:

- Enclosure 1 contains the justification for unrestricted release of the Zachry Engineering Center; the "*no significant hazards consideration*" determination and the "*environmental consideration*" associated with the unrestricted release of the Zachry Engineering Center.
- Attachment 1 (attached to Enclosure 1) contains proposed modifications to page 3 of Facility License No. R-23 and the Technical Specifications (TSs) associated with license R-23. The modification to TS Page 15 removes all reference to the SNM storage location and various rooms within the Zachry Engineering Center. (Specifically, TSs 5.2 and 5.3 will be deleted to reflect that the AGN-201M SNM, the reactor, and all associated reactor components have been packaged, transported to, and stored at the NSC.) The modified TS Pages 20 and 21 and modified license page remove all references to the AGN-201M Emergency Plan and Physical Security Plan. (Specifically, license page 3, TSs 6.4.3(b) and 6.6(f) will be changed to remove reference to the AGN-201M Emergency Plan and Physical Security Plan.)
- Enclosure 2 contains the TAMU *Final Status Survey Plan, Revision 1* that is to be implemented in support of the unrestricted release of the Zachry Engineering Center. This LAR will be supplemented with the final survey results once they have been completed. It is anticipated that these results will be submitted in December 2016.

Should you have any questions regarding the LAR, please contact me or Mr. Jerry Newhouse at (979) 845-7551 or via email at mcdeavitt@tamu.edu or newhouse@tamu.edu.

Nuclear Science Center
1095 Nuclear Science Road, 3575 TAMU
College Station, TX 77843-3575
Tel. (979) 845-7551

Oath of Affirmation
I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Sincerely,

Sean M. McDeavitt, PhD
Director, TEES Nuclear Science Center
Submitted with Level 2 Delegate Authorization from Dr. Yassin Hassan in letter dated February 8, 2016 (ADAMS Accession No. ML16043A048)

Enclosure 1:	Justification for Unrestricted Release of the Zachry Engineering Center
Attachment 1:	Proposed Modifications to AGN-201M License Page 3 and Technical Specification Pages 15, 20, and 21 (Attached to Enclosure 1)
Enclosure 2:	Final Status Survey Plan, Revision 1 (previously submitted, included for clarity)

CC: next page

Nuclear Science Center
1095 Nuclear Science Road, 3575 TAMU
College Station, TX 77843-3575
Tel. (979) 845-7551

cc:

William Dean, Office Director
United States Nuclear Reactor Commission
Office of Nuclear Reactor Regulation

Michael Young, President
Texas A&M University 1246 TAMU
College Station, TX 77843-1246

Dr. M. Katherine Banks, Vice Chancellor and Dean
Dwight Look College of Engineering
3126 TAMU
College Station, TX 77843-3126

Dr. Yassin Hassan, Department Head, Nuclear Engineering
Texas A&M University
Nuclear Engineering Department
3133 TAMU
College Station, TX 77843-3133

Dr. John Hardy
Reactor Safety Board Chairman Texas A&M University
3255 TAMU
College Station, TX 77843-3255

Dr. Latha Vasudevan
Radiological Safety Officer, Texas A&M University
Environmental Health and Safety
1111 Research Parkway
College Station, TX 77843-4472

Jerry Newhouse
NSC Assistant Director
Texas A&M Engineering Experiment Station
3575 TAMU
College Station, TX 77843-3575

Scott Miller
NSC Manager of Reactor Operations
Texas A&M Engineering Experiment Station
3575 TAMU
College Station, TX 77843-3575

Jeremy Osborn
AGN-201M Reactor Supervisor
Texas A&M University
Nuclear Engineering Department
3133 TAMU
College Station, TX 77843-3133

Nuclear Science Center
1095 Nuclear Science Road, 3575 TAMU
College Station, TX 77843-3575
Tel. (979) 845-7551

ENCLOSURE 1

TEXAS A&M UNIVERSITY

FACILITY LICENSE R-23, DOCKET NO. 50-59

AMENDED FACILITY OPERATING LICENSE

AGN-201M REACTOR

JUSTIFICATION FOR THE UNRESTRICTED RELEASE OF THE ZACHRY ENGINEERING CENTER

1.0 ABBREVIATIONS AND SYMBOLS

The following is a list of abbreviations, symbols, and units used in Enclosure 1:

ABBREVIATIONS:

ADAMS	Agencywide Documents Access and Management System
AEC	Atomic Energy Commission
AGN-201M	Aerojet General Nucleonics Model 201-Modified
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
DQOs	Data Quality Objectives
FSS	Final Status Survey
LAR	License Amendment Request
MARSSIM	"Multi-Agency Radiation Survey and Site Investigation Manual"
MDC	Minimum Detectable Concentrations
NSC	Texas A&M Engineering Experiment Station Nuclear Science Center
NUREG	US Nuclear Regulatory Commission Regulation
SNM	Special Nuclear Material
TAMU	Texas A&M University
TEDE	Total Effective Dose Equivalent
TEES	Texas A&M Engineering Experiment Station
TRIGA	Training, Research, and Isotope Production, General Atomics
TS	Technical Specification
U.S. NRC	United States Nuclear Regulatory Commission

SYMBOLS:

α	Alpha
β	Beta
γ	Gamma
μ	Micro
$<$	Less than
%	Percent
$\Delta k/k$	Reactivity
°C	Celsius
^{14}C	Carbon 14
^{41}Ar	Argon 41
UO_2	Uranium Dioxide
PuBe	Plutonium-Beryllium

UNITS:

s	Second
h	Hour
y	Year
cm	Centimeter
dpm	Disintegrations Per Minute
Ci	Curie
R	Roentgen
rem	Roentgen Equivalent Man
mrem	Millirem
μrem	Microrem
rad	A Unit of Absorbed Radiation Dose
mSv	Millisieverts

2.0 INTRODUCTION

Texas A&M University (TAMU) owns and operates the AGN-201M reactor (Facility License No. R-23, Docket No. 50-59). Per the recent license amemndment to Facility License No. R-23 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16278A497), the licensed locations for the AGN-201M are in the Zachry Engineering Center and the TEES Nuclear Science Center (NSC); the NSC site is approved for storage only. On October 15, 2016, TAMU completed a project to defuel, disassemble, package, and transport the AGN-201M SNM, reactor, and associated components from the Zachry Engineering Center to the NSC site and the Zachry site is now empty.

There are two license holders involved in recent relevant licensing actions preceding this document. The first is TAMU, the licensee for the AGN-210M reactor that is the subject of this present LAR (Facility License No. R-23, Docket 50-59). The second is TEES, the licensee for the NSC 1 MW TRIGA reactor (Facility License No. R-83, Docket 50-128).

On October 14, 2015, an LAR was submitted by TEES (ADAMS Accession No. ML15287A148) to modify license R-83 to enable the relocation and safe storage of the AGN-201M SNM on the NSC site; this LAR was approved by the U.S. NRC on August 31, 2016 (ADAMS Accession No. ML16109A153). On November 11, 2015, an LAR was submitted by TAMU (U.S. NRC ADAMS Accession No. ML15315A027) to modify license R-23 to enable to storage of the AGN-201M reactor tank, control console, and associated components at the TEES NSC facility in designated storage areas; this LAR was approved by the U.S. NRC on October 14, 2016 (ADAMS Accession No. ML16278A497). These approvals enabled TAMU to transport and store the AGN-201M SNM, reactor, and associated components at the NSC facility.

The AGN-201M SNM is now stored in the NSC fuel storage vault. The reactor tank and components are stored in the accelerator building and a cargo container on the NSC site. The reactor tank is stored in a defueled and drained condition and all associated components are stored in secured locations. The NSC license was amended to allow temporary storage for a period not to exceed 5 years to enable TAMU to establish a new site in which to operate the reassembled AGN-201M reactor.

The purpose of this LAR is threefold: First, TAMU requests approval from the U.S. NRC for the unrestricted release of the Zachry Engineering Center. TAMU has prepared this LAR in accordance with Chapter 17 of the NUREG-1537 Part 1, “Guidelines for Preparing and Reviewing Applications for Licensing of Non-Power Reactors.” The AGN-201M license and applicable TSs will remain active while the AGN-201M SNM, reactor, and associated components are stored at the NSC facility.

Second, as part of the unrestricted release, TAMU proposes the deletion of TS Sections 5.2 and 5.3 to reflect that the AGN-201M SNM, reactor, and all associated reactor components have been packaged, transported and stored at the NSC site. The AGN-201M SNM, reactor, and associated components no longer exist in the Zachry Engineering Center. Justification for the proposed TS changes is in Enclosure 1 (this document). Attachment 1 to this enclosure contains the new proposed TS page 15.

Third, TAMU requests the AGN-201M license reference to the Physical Security Plan and associated TSs reference to the AGN-201M Physical Security Plan and Emergency Plan be removed from the AGN-201M TSs. The material possession levels at the AGN-201M site have been and will be below the regulatory requirements for having a Physical Security Plan and Emergency Plan. Attachment 1 contains the new proposed TS pages and license page 3. (See Section 5.13 for details on this matter.)

Currently, all SNM formerly associated with license R-23 has been transferred to license R-83 and is now protected under the Physical Security Plan for R-83. The Physical Security Plan for R-83 was approved by the U.S. NRC as part of the license renewal process completed in October 2015. Since the R-83 Physical Security Plan has been approved by the U.S. NRC, this SNM transfer does not decrease the effectiveness of the protection of the SNM as described in 10 CFR 50.54(p).

3.0 BACKGROUND

On August 26, 1957, the Atomic Energy Commission (AEC) issued an operating license to TAMU for the operation of the AGN-201M reactor. The original location of the AGN-201M Reactor was in the Mechanical Engineering Shops in Thompson Hall on the TAMU campus. On November 3, 1970, TAMU submitted a LAR to the AEC requesting approval to disassemble, package, transport, and reassemble the AGN-201M reactor in the newly constructed Zachry Engineering Center. The AEC approved this LAR and issued Amendment 9 to the AGN-201M License on February 4, 1972. The Zachry Engineering Center became the licensed location of the AGN-201M reactor at TAMU.

Radiological surveys performed over the operating history of the AGN-201M reactor have identified no contamination over release limits in the reactor areas of Zachry Engineering Center. In addition, recent surveys conducted during reactor disassembly and in support of the removal, packaging, and transport of the SNM have identified no contamination over release limits on the reactor external surfaces or on reactor internal component surfaces (e.g., in the core tank, on control rod drive thimbles that pass through the unclad fuel disks, and on the lower core plate). (Enclosure 2 of this document contains the Final Status Survey (FSS) Plan, Revision 1 associated with the unrestricted release of the Zachry Engineering Center; it describes the procedures to be followed to certify the Zachry site is not measurably contaminated.) This LAR will be supplemented with the final radiological survey results once they are collected. It is anticipated that the final survey results will be submitted in December 2016. Successful results from the FSS will demonstrate compliance with U.S. NRC regulations and guidance in support of the unrestricted release of the Zachry Engineering Center.

As a final point of background for this LAR, it is notable that TAMU instigated the relocation of the AGN-201M reactor as part of a much larger-scale project wherein the Zachry Engineering Center is being completely renovated and repurposed. The expansion project required the transport and temporary storage of the AGN-201M SNM, reactor, and associated components from the Zachry Engineering Center to the NSC site. By letter dated April 15, 2015 (ADAMS Accession No. ML15183A462), TAMU provided an overview of the entire project to the U.S. NRC. In the letter, TAMU specifically committed to operating the AGN-201M reactor in the future, and as such, committed to construct or modify a facility to house the AGN-201M reactor within or adjacent to the NSC site. In the near future, TAMU anticipates submitting a construction permit application to the U.S. NRC requesting approval to proceed.

As noted briefly in Section 2.0, the relocation project required two LARs be submitted to the U.S. NRC for approval in order to relocate the AGN-201M SNM, reactor, and associated components. The first LAR was submitted from TEES to the U.S. NRC by letter dated October 14, 2015

(ADAMS Accession No. ML15287A148), as supplemented. The October 14, 2015 LAR and supplements requested U.S. NRC approval of changes to the TEES License and TSs (Facility License No. R-83, Docket No. 50-128) to receive and possess the AGN-201M fuel and SNM in the NSC fuel storage vault for a period of up to 5 years. On August 31, 2016 (ADAMS Accession No. ML16109A153), the U.S. NRC issued Amendment 18 to the NSC operating license approving the changes to the NSC License and TSs. The AGN-201 M fuel and SNM have been transported and stored at the NSC facility.

The second LAR was submitted to the U.S. NRC on November 11, 2015 (ADAMS Accession No. ML15315AA027). This LAR and supplements requested U.S. NRC approval to transport and store the AGN-201M reactor and associated components in secured locations at the NSC facility for a period up to 5 years. On October 14, 2016 (ADAMS Accession No. ML16278A497), the U.S. NRC issued Amendment 15 to the AGN-201M operating license approving the changes to the AGN-201M License and TSs. The AGN-201M reactor and associated components have been transported and stored at the NSC site.

This LAR represents the final step in the regulatory process associated with the AGN-201M relocation project. In short, TAMU is requesting approval from the U.S. NRC for the unrestricted release of the Zachry Engineering Center. The substance of this LAR is focused on detailed activities to be undertaken by TAMU to accomplish this unrestricted release.

4.0 REGULATORY EVALUATION

The AGN-201M SNM, reactor, and components have been moved to and stored at the NSC. No contamination was identified during the move. The licensed site at the Zachry Engineering Center is now being controlled until the FSS plan is implemented and this LAR is approved. TAMU is now seeking U.S. NRC approval for the unrestricted release of the Zachry Engineering Center. TAMU developed an FSS plan (Enclosure 2) which details the process to be implemented to meet the criteria required to achieve the unrestricted release of the Zachry Engineering Center. It is expected that this LAR will be supplemented in December 2016 with the FSS results to justify the unrestricted release of the Zachry Engineering Center.

This LAR and the FSS plan were prepared using the guidance and format specified in Chapter 17 of NUREG-1537. The radiological criteria for the unrestricted release of the Zachry Engineering Center is set forth in 10 CFR 20.1401. The FSS plan was developed and will be administered per the applicable sections of the following regulations and regulatory guidance documents:

Code of Federal Regulations

10 CFR 19	Notices, Instructions and Reports to Workers
10 CFR 20	Standards for Protection Against Radiation
10 CFR 30	Rules of General Applicability to Domestic Licensing of Byproduct Material 10
10 CFR 50	Domestic Licensing of Production and Utilization Facilities
10 CFR 51	Licensing and Regulatory Policy and Procedures for Environmental Protection

U.S. NRC Regulatory Guides

1.86 “Termination of Operating Licenses for Nuclear Reactors” (Withdrawn)
(Note: this withdrawn Guide is referenced because it contains a table of surface contamination values that is still contained in 25 Texas Administrative Code §289.202(ggg)(6), “Acceptable Surface Contamination Levels” and are applicable to State-licensed activities at TAMU.)

8.21 "Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants"
8.30 "Health Physics Surveys in Uranium Recovery Facilities"

NUREG – Publications
1505 "A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys"
1507 "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions"
1537 "Guidelines for Preparing and Reviewing Applications for Licensing of Non-Power Reactors"
1575 "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Facilities"
1757 "Consolidated Decommissioning Guidance"

The FSS Plan, Revision 1 was developed in accordance with appropriate sections of above NRC guidance documents. The primary purpose of conducting surveys is to demonstrate that the former AGN-201M site within the Zachry Engineering Center satisfies U.S. NRC criteria for unrestricted release. Also, satisfying U.S. NRC criteria will assist the State of Texas Department of State Health Services, and Texas A&M University Radiological Safety, Environmental Health and Safety in supporting the unrestricted release. By satisfying these criteria, the remaining structure can be reused without radiological restrictions. The design of the AGN-201M reactor precludes the possibility of groundwater or soil contamination as there are no external cooling loops, coolant cleanup systems, or irradiation loops. Further, there are no radioactive waste processing systems (e.g., waste compaction, liquid waste treatment, or contaminated off gas treatment systems). Accordingly, the FSS (Enclosure 2) does not address soil or groundwater sampling.

Texas A&M University will comply with the requirements of 10 CFR 20.1402 for the radiological criteria for the unrestricted release of the Zachry Engineering Center. In accordance with this rule, the site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the public that does not exceed 25 mrem (0.25 mSv) per year. Although no contamination has been detected on any surfaces or components during extensive surveys conducted in support of defueling and during earlier scoping surveys, TAMU commits to using the default screening values for surface contamination as presented in Appendix H to NUREG-1757, Volume 2, Revision 1, as upper limits for the project. Site characteristics support the use of these values as only superficial surface contamination is expected. There are no buried pipes or potentially contaminated structures, and no unusual radionuclides are anticipated. The screening values have been determined by the U.S. NRC to be ALARA and no further analyses are required (Appendix N to NUREG-1757). TAMU's self-imposed release criteria are more limiting (contamination is not to exceed twice background, using appropriate instrumentation) and determined by the TAMU radiological safety program.

NUREG-1537 Section 17.1.4 will be used by TAMU. The following are the criteria to be used to release the Zachry Engineering Center for unrestricted use:

1. a) No more than 5 μrem per hour above background at 1 meter from the surface measured for indoor gamma radiation fields from concrete, components, and structures, or,

b) No more than 10 mrem per year for gamma emitters above background absorbed dose to any person, considering reasonable occupancy and proximity.

2. Residual surface contamination limitations consistent with Regulatory Guide 1.86.

Regulatory Guide 1.86 was withdrawn by U.S. NRC, effective August 12, 2016, although similar numerical guidance remains in Regulatory Guides 8.21, and 8.30. The table of surface contamination values in RG 1.86 has been retained for this project as these values are also contained in 25 Texas Administrative Code §289.202(ggg)(6) "Acceptable Surface Contamination Levels" and are applicable to State-licensed activities at TAMU.

The TAMU radiological safety program has a policy of "no detectable activity" for unrestricted use and release. "No detectable activity" is interpreted by TAMU as not exceeding twice the background level. For direct radiation levels, the TAMU EHS criteria of "less than twice background" will be established by confirming that dose rates from any residual licensed material are no more than twice background levels at 1 meter from the surface consistent with the previously noted guidance from NUREG-1537. Surface contamination levels will be evaluated relative to background data presented in instrument manufacturers' technical literature and using field measurements. Meeting the TAMU Radiological Safety criteria for release will also satisfy U.S. NRC requirements. This demonstrates conservatism in the TAMU program for unrestricted release.

NUREG-1575 defines impacted areas as those with a possibility of residual radioactivity in excess of background levels. Radiological surveys of impacted areas are required to demonstrate that established criteria have been satisfied. Non-impacted areas are those with no reasonable expectation of residual contamination; no surveys of non-impacted areas are required. Impacted areas are classified by contamination potential as follows:

- Class 1: Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on radiological surveys) expected to be in excess of established unrestricted release criteria.
- Class 2: Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed established criteria.
- Class 3: Areas that are potentially impacted but are not expected to contain any residual radioactivity, or are expected to contain levels of residual activity at a small fraction of the established criteria, based on site operating history and previous radiological surveys.

Based upon extensive survey experience in the building and due to the acceptance criteria being very close to background, TAMU finds it is appropriate to use the Scenario B Null Hypothesis, as presented in NUREG-1505. This scenario assumes the facility is acceptable for release if the alternative hypothesis (i.e., it is contaminated) is rejected. All static survey points and scans must not exceed twice background to pass. No statistical treatment of the survey data is required.

Implementing the FSS plan, developed in accordance with NRC regulatory guidance will demonstrate conditions for the unrestricted release of the Zachry Engineering Center in accordance with Subpart E of 10 CFR 20, "Radiological Criteria for License Termination," thus allowing building renovations to proceed without radiological safety constraints.

5.0 TECHNICAL EVALUATION

5.1 FSS Plan Synopsis

Texas A&M University prepared a comprehensive FSS plan which is presented in Enclosure 2. With the removal of the reactor and any known radioactive materials and components associated with AGN-201M reactor operations from the Zachry Engineering Center, the FSS plan may now be implemented to demonstrate that residual radiological conditions satisfy U.S. NRC criteria for future unrestricted uses of the facility. This FSS plan will be implemented in accordance with U.S. NRC recommended guidance as presented in NUREG-1575, and NUREG-1757. The process emphasizes the use of Data Quality Objectives and Data Quality Assessment. The graded approach methodology will be followed to ensure survey efforts are maximized in those areas having the greatest potential for residual contamination.

Based upon the self-contained design of the AGN-201M reactor, TAMU operating procedures, and thorough survey work performed in preparation for and during reactor disassembly and defueling work, the Zachry Engineering Center meets the NUREG-1757, Vol 1 description of a Group 2 decommissioning. Screening values are applicable (no surface contamination or activation of structures has been identified), no liquid, solid, or particulate effluents were routinely generated, and there are no pathways for soil or groundwater contamination.

The radiological dose criterion of <25 mrem/y specified in 10 CFR 20.1402 will be the basis for unrestricted release. To date, no surface contamination has been identified in the facility and no activation products have been identified in volumetric sampling of reactor shielding and the building structure and only trace levels of contamination have been found on reactor internals (including components in contact with the reactor fuel). The lack of detectable surface contamination prevents selection of a default radionuclide of concern. However, the selected survey instruments exhibit MDCs for commonly encountered radionuclides that are well below the Default Screening Values presented in Table 1 of Appendix H to NUREG 1757, Volume 2, Revision 1. The screening values are upper limits for the project, and are based upon conservative exposure pathway considerations and have been determined by the U.S. NRC to meet the ALARA criteria for release. No further ALARA analysis is required. It was determined by ongoing site surveys that no specific radionuclide contamination can be identified and there is no potential for fission product contamination. Therefore, the conservative screening value for ^{60}Co has been chosen as the upper limit for release surveys.

Impacted surfaces have been classified (Class 1, 2, or 3) by contamination potential and those surfaces further subdivided into survey units. The process for classification and survey unit identification is described in NUREG-1575, Sections 4.4 and 4.6. Because each survey point must not exceed the screening values (and the more limiting TAMU constraint of not exceeding twice the background levels), no statistical tests are required.

The FSS plan presents the applicable release criteria, categorization of areas for survey work, survey methodology and instrumentation, and survey data evaluation. The FSS plan will be implemented, the results will be analyzed, and a summary submitted to the U.S. NRC.

5.2 Facility Description

The AGN-201M reactor is an educational research reactor formerly located on the TAMU campus in the Zachry Engineering Center (Fig. 1). The reactor was first assembled in 1957 and began operation in Thompson Hall before it was relocated to the Zachry site in 1972. As noted above, the AGN-201M reactor has been dismantled and the SNM, reactor tank and all related components have been relocated to the NSC facility according to the provisions in the amended R-23 and R83 Facility Operating Licenses. The Zachry site described here is the location to be surveyed for unrestricted release under this LAR.

The location in the Zachry Engineering Center allowed for the complete isolation of the reactor room from the remainder of the building. Also, the AGN reactor room was designed with approximately 3-foot thick reinforced concrete walls, ceilings and floors. Floor areas were covered with tile identified to be asbestos containing material.

Over the past 59 years TAMU students in the Department of Nuclear Engineering used the reactor for educational experiments and applications and graduate students occasionally used the reactor for research purposes. The reactor has not been operated since 2014. The AGN-201M reactor area on the former Ground Floor is divided into 3 rooms (Fig. 2):

1. Room 60C Office/Control point area with minimal potential for contamination.
2. Room 61A Safeguards Laboratory, a small laboratory used for research.
3. Room 61B Reactor Room, housing the reactor, shielded control area, and storage.

The First Floor area (Room 135 in Fig. 3) is a single large room designed with removable concrete shield plugs in the floor to allow access to the top of the reactor. This room was used extensively for unrelated ion beam accelerator work, which limited access to the top (thermal column) of the reactor.

5.3 Operating History

Over the past 59 years the AGN-201M reactor has experienced numerous intermittent periods in which the reactor was not operational. It is noteworthy that the reactor was relocated in the early 1970’s to the Zachry Engineering Center and began operation in 1972 with a maximum thermal power rating of 5 watts.

From 1957 to the present, based upon its documented power history and using estimated data, a total of approximately 2×10^{17} fissions have occurred in the AGN-201M fuel. Accordingly, the fuel has not been significantly depleted and fission product content is negligible.

From 1972 through to the present, power operation of the AGN-201M reactor has produced approximately 1.3 kilowatt-hours of energy. Logs document approximately 1,400 total operating hours with an average power level of approximately 0.93 watts. The reactor has not operated since 2014 and has only logged 142 operating hours since the 1999. The very low fission product content was confirmed during the recent defueling work; measured levels close to contact with the fuel disks were <2 mrem/h gamma dose rate and approximately 60 mrad/h beta dose rate. As noted above, all SNM has been packaged, transported, and stored at the NSC facility.

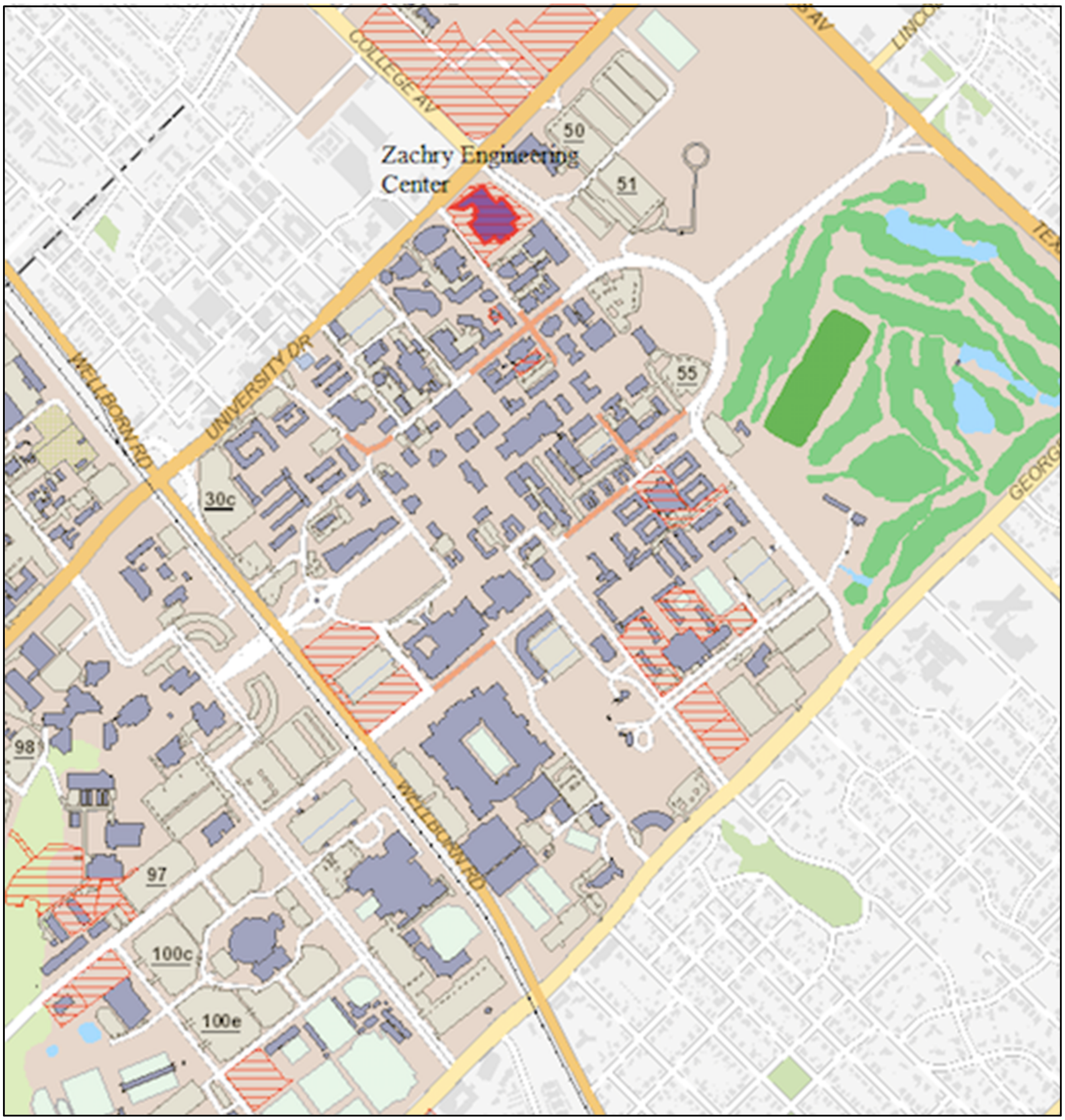


Figure 1. Map of Texas A&M Campus, indicating location of Zachry Engineering Center.

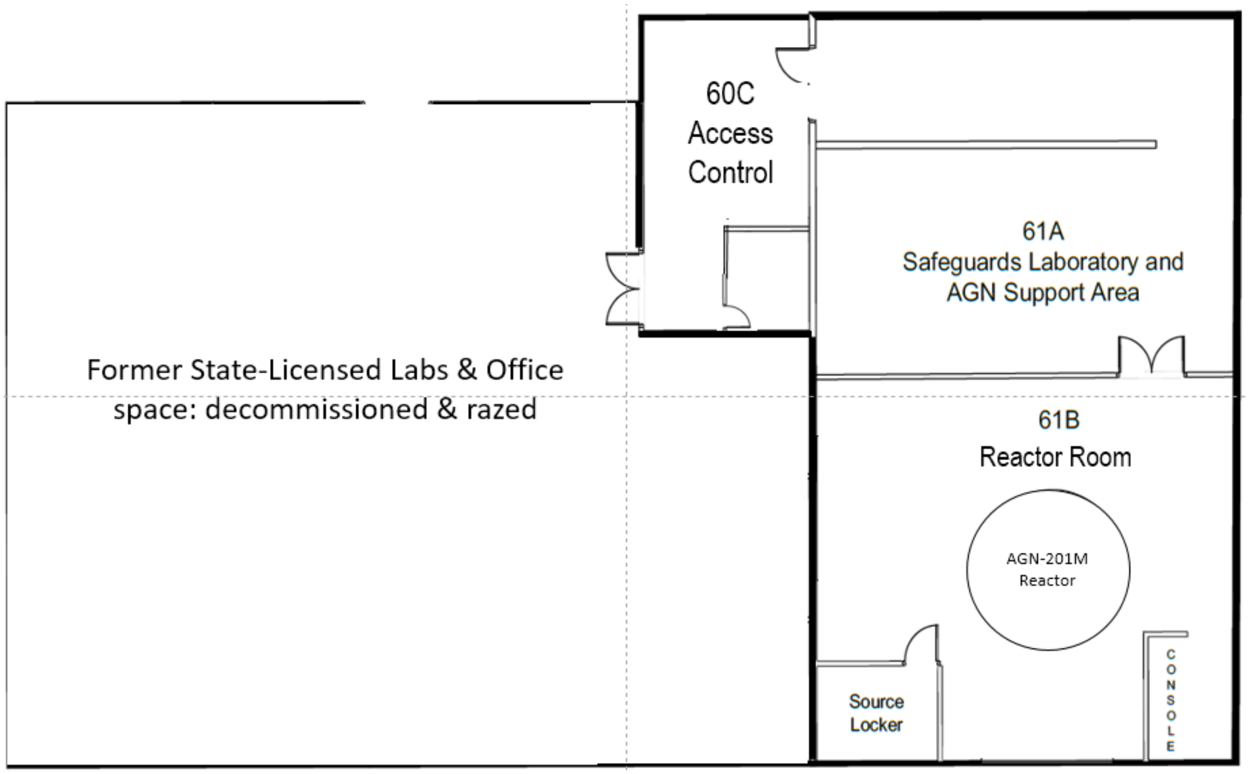


Figure 2. Ground Floor Layout. (Main 61 Area Rooms: ~27 ft by ~48 ft)

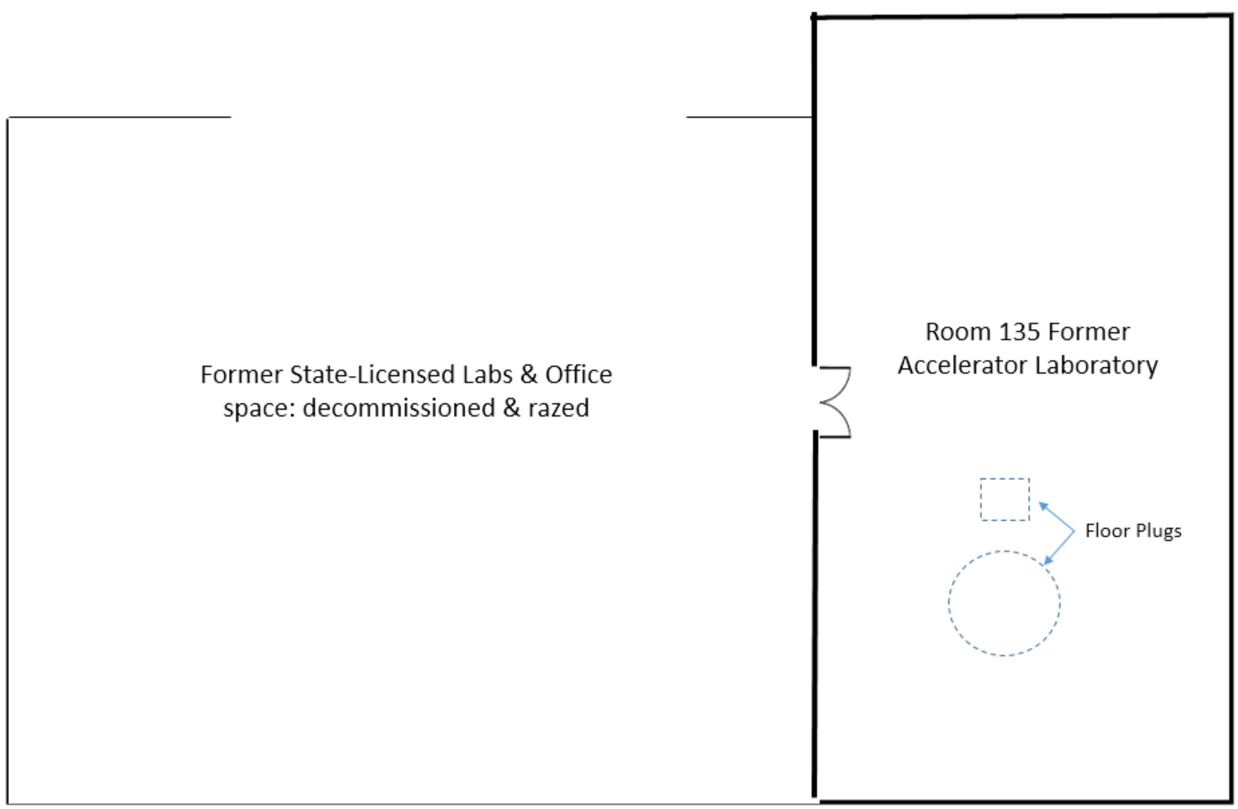


Figure 3. First Floor Layout. (Room135: ~27 ft by ~48 ft)

5.4 Reactor Description (When Assembled)

TAMU's AGN-201M and all other AGN-201M reactors are described by the reactor description given in the original Aerojet-General Nucleonics AGN-201M reactor report (Hazard Report and Preliminary Design Report by Aerojet-General Nucleonics, Docket F-40). The reactor is a free standing unit as depicted in Fig. 4.

Figure 5 presents a cutaway schematic of the AGN-201M design. Key components and safety features are identified. The AGN-201M reactor is designed to use homogenous polyethylene-UO_2 fuel plates with graphite reflectors. The reactor is equipped with one thermal column, eight access ports, and one glory hole through the core tank. The reactor fuel is sealed in a gas-tight aluminum tank surrounded by a graphite reflector, lead shield, and large water shield tank. The water shield is designed to eliminate fast neutron release from the system. During operation, heat flows from the core through the graphite reflector and the lead shield into the tank of water that surrounds the reactor core. An external heat sink is not required since the reactor power level is so low.

The maximum neutron fluence rate is 2.4×10^8 n/cm^2-s at 5 watts. This power level was approved by the AEC in Amendment No. 10 to License R-23 issued on January 18, 1973. Excess reactivity is approximately 0.137% $\Delta k/k$ (empty glory hole), and the design has a temperature coefficient of -0.024% $\Delta k/k$ per degree C.

Ventilation for power operation was provided by a roof-mounted blower connected to a high efficiency particulate filter box in the accelerator room above the reactor room (Fig. 3). A grate in the floor of the accelerator room provided a flow path for air from the reactor room. All airflow from the reactor room was dispersed in the accelerator room before discharge via the filtered collector inlet in a corner of the accelerator room. No real-time stack monitoring equipment was provided, as effluents (e.g., ^{41}Ar) were negligible.

5.5 Planned Activities for the Unrestricted Release of the Zachry Engineering Center

Important basic tasks to support TAMU's efforts in achieving unrestricted release of the Zachry Engineering Center included 1) removal of the AGN-201M SNM, reactor, and associated components in preparation for general cleanup of the facility and 2) development and continued implementation of the FSS Plan. The project is not a decommissioning project since the AGN-201M reactor and associated components have been placed in temporary storage with no disposal of reactor equipment or SNM. No contamination has been identified in the facility. No significant radioactive waste volumes have been generated to date. Significant contamination is not anticipated as building clean-up progresses. Contamination surveys and core sampling to date show no detectible surface contamination over background, and no activation products detected in core samples.

Since the AGN-201M SNM, reactor tank, associated components, and all floor tiles have now been removed, initial floor surveys were completed. Concrete cores were extracted from the floor directly under the former site of the reactor pedestal and laboratory analysis did not detect the presence of activation products. Calculations based upon power history and observed neutron dose rate along with sample data from concrete shield blocks removed from around the reactor skirt also support the conclusion that there has been no detectable activation of the concrete building structure.

Figure 4. AGN-201M Reactor.

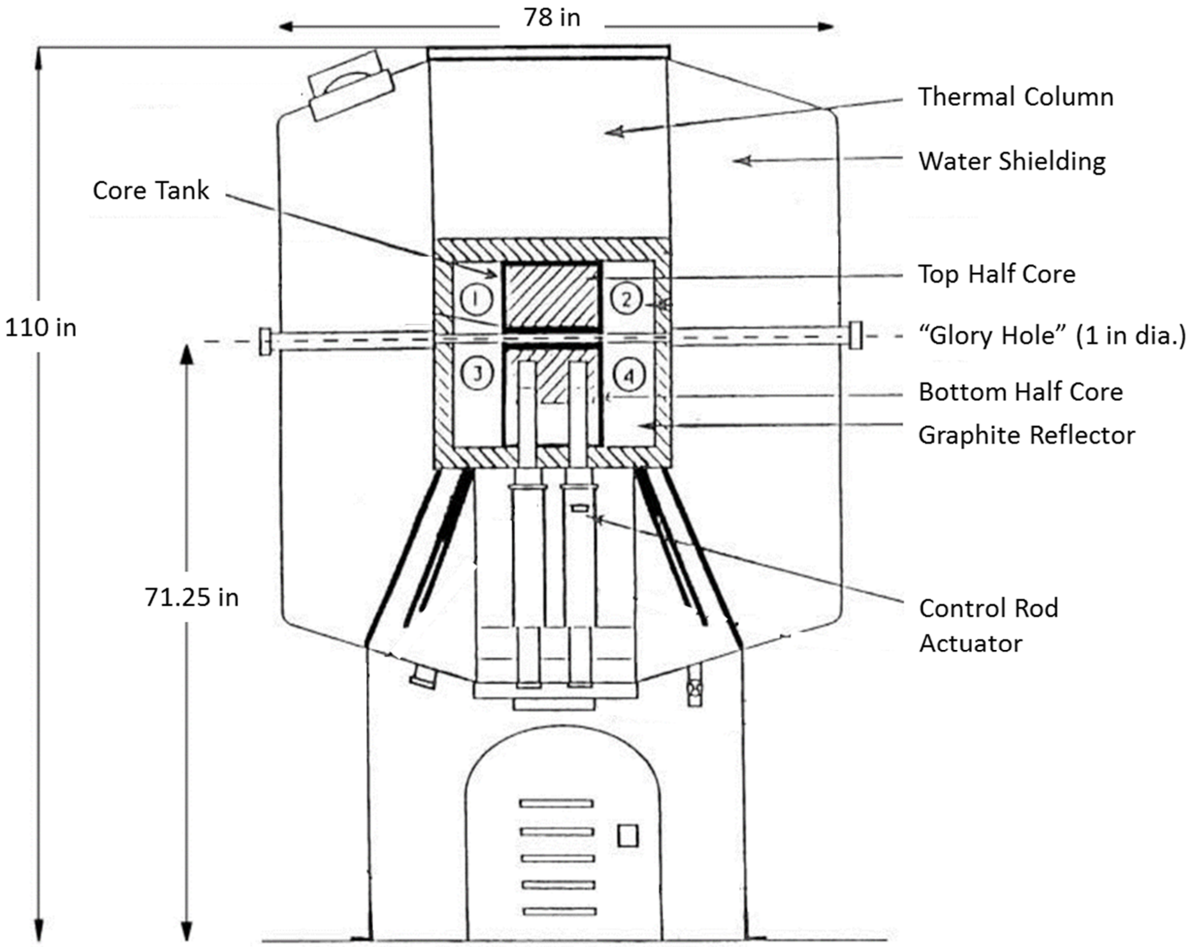


Figure 5. Cut-away View of AGN-201M Reactor

5.6 Organization and Roles and Responsibilities

The TAMU senior (Level 2) manager for oversite of the entire AGN-201M relocation project is Dr. Sean M. McDeavitt, Director of the TEES Nuclear Science Center, as delegated by the Department Head of Nuclear Engineering, Dr. Yassin Hassan (see Table 1). Dr. McDeavitt holds level 2 management authority for the TEES NSC Facility License No. R-83 and delegated level 2 management authority for the TAMU AGN-201M Facility License No. R-23.

Dr. McDeavitt ultimately reports to Dr. M. Katherine Banks, Vice Chancellor and Dean of Engineering for the Texas A&M University System (TAMUS), Dean of the TAMU College of Engineering, and the Director of TEES. Dr. Banks holds Level 1 management authority for the TEES NSC Facility License No. R-83 and shares level 1 management authority for the TAMU AGN-201M Facility License No. R-23 with the President of Texas A&M University, Michael K. Young.

Table 1 presents additional information describing the list of responsible individuals or groups and their respective roles within the project:

Table 1. Responsible Individuals/Groups and Roles in the AGN-201M Relocation Project

	Role
Michael Young, TAMU President	• "Level 1" management authority over the AGN-201M operating license (R-23). • Regulatory responsibility for the AGN-201M
Dr. M. Katherine Banks, TAMUS Vice Chancellor and Dean of Engineering, TAMU Dean, College of Engineering, and Director of TEES	• Shared "Level 1" management authority over the AGN-201M operating license (R-23).
Dr. Stuart Anderson, Assistant Vice Chancellor for Facilities Planning and Management	• Direct leadership of the Zachry renovation project, AGN relocation project for TEES. • Reports to Level 1 management for both operating licenses (R-23 and R-83).
Dr. Yassin Hassan, Head, Nuclear Engineering Department	• "Level 2" management authority on the AGN-201M operating license (R-23)
Dr. Sean M. McDeavitt, Director, TEES Nuclear Science Center	• AGN Relocation Activity Coordinator for TAMU and TEES (April 2015). • Delegated "Level 2" management authority on the AGN-201M operating license (R-23) from Dr. Y. Hassan. (Delegation letter dated Jan. 22, 2016 - *NRC ADAMS No. ML16043A048*) • "Level 2" management authority for the NSC TRIGA operating license (R-83).
TEES Reactor Safety Board (Dr. John Hardy, Chair)	• The Reactor Safety Board (RSB) has internal oversight and regulatory compliance authority over both the NSC TRIGA and AGN-201M reactors, per provisions within the NRC licensing documents (i.e., TRIGA and AGN technical specifications). • The RSB has jurisdiction for the technical review or concurrence approval for primary communications with the Nuclear Regulatory Commission regarding the licensing, technical, and safety issues for the NSC TRIGA and AGN-201M reactors. • When needed, the RSB relies on the expertise of the Radiological Safety Committee (RSC) or external consultants to provide expert review of matters under its jurisdiction.

TAMU Radiological Safety Committee (Dr. John Poston, Chair)	• The RSC advises the TAMU administration on matters related to radiological safety and recommends policies and procedures to ensure an adequate radiological safety program. • The RSB will rely on the RSC for review of matters related to radiological safety as part of this relocation project; this includes the review of site decontamination plan.
ReNuke Services, Inc. (Oak Ridge, TN) Rich Werdann, Project Manager	• ReNuke Services (renuke.com) is an external contractor tasked with managing the relocation project to move the AGN-201M to the NSC site. • ReNuke will work with the Director of the Nuclear Science Center, RSB, RSC, and other necessary individuals and groups to achieve the successful relocation of the AGN-201M to the NSC site. • Reports to Stuart Anderson and coordinates activity with Sean McDeavitt

5.7 Dose Estimate

All project personnel frequently accessing the reactor rooms or engaged in the direct handling of radioactive material have been and will continue to be monitored under the TAMU personnel monitoring program (Landauer Luxel dosimeters as the dosimeter of record). General area exposure rates in the reactor room were approximately 10 to 15 μR/h near the defueled reactor. Maximum exposure rates of up to 50 mrem/h were observed during removal and leak testing of the 1 Ci ^{239}PuBe neutron start-up source. This was a brief task (15 minutes) and effectively removed the largest exposure potential from the project. The source is now in shielded storage at the TEES NSC along with all of the AGN-201M SNM. Total project occupational collective dose is expected to be <120 mrem TEDE. The maximum occupational dose to any project employee is not expected to exceed approximately 50 mrem over the duration of planned activities. This very low dose value represents a small fraction of the 620 mrem National Council on Radiation Protection and Measurements estimated average U.S. annual radiation dose per person.

5.8 Data Collection and Data Evaluation

Extensive facility radiological surveys were conducted in preparation for defueling, and reactor disassembly. No surface contamination in excess of twice background has been identified on facility equipment removed or disposed, building surfaces, reactor external surfaces, or on laboratory equipment and furniture. In addition, surveys were conducted in the only floor drain in the reactor site (in the reactor room to capture potential leakage of radiologically uncontaminated chromated water), in the floor electrical penetrations opened to verify status, and on piping penetrations through the walls and floor of the facility used to provide utility services (e.g., gas, compressed air, and water). Two small glass drain lines from laboratory sinks were surveyed and removed with no detectable contamination in or on the glass surfaces or in the associated traps. No contamination in excess of twice background was detected in any of these areas.

Particularly noteworthy is contamination survey data from reactor internals obtained during reactor defueling. All surfaces monitored were <<100 dpm/100 cm^2 α, and <<1,000 dpm/100 cm^2 β–γ. These surfaces included the graphite reflectors that were in direct contact with the polyethylene fuel plates, the core tank internal surfaces, control rod drive guide thimbles, and the glory hole tube.

Volumetric samples were collected and analyzed, as follows:

- Four concrete cores from reactor pedestal shield blocks at maximally-exposed surfaces.
- Four concrete cores: two obtained from the concrete reactor pedestal and two from the floor under it.
- Three concrete cores from the building wall that was cut out to facilitate removal of the reactor tank (including samples collected in line with the reactor glory hole).
- One aqueous liquid sample from the reactor shield tank (chromated water).
- One aqueous liquid sample from the sink trap in room 61B.

The samples were submitted to General Engineering Laboratories (Charleston, South Carolina) for analysis. No activation product activity was detected in the concrete samples when analyzed by gamma spectroscopy. Aliquots from all liquid samples were also analyzed by liquid scintillation counting for tritium and ^{14}C, with no activity detected. The sampling data supports the initial assessment that any activation of the building structure is negligible. Data are presented in the FSS Plan, Revision 1 (Enclosure 2).

Removal of all reactor components has been completed and the rooms in Zachry Engineering Center emptied in preparation for the FSS work. The tile floors, identified by the renovation contractor as potentially asbestos-bearing material, were confirmed to meet surface contamination limits and asbestos abatement work was completed. The exposed concrete floor has been surveyed and determined to be free of detectable surface contamination, allowing preparations for Final Survey Status work to continue. An additional survey of the floors will be conducted as part of the Final Survey Status.

Data evaluation will be performed on Final Survey Status results for individual survey units to determine whether the survey unit meets the release criteria. Static and scan surveys must individually pass the ^{60}Co screening value release criteria (and the TAMU requirement that no survey point exceed twice background) for the survey unit to pass. Instrument count rates are necessarily the measurements of record and will be recorded as such. No statistical tests are required. Sample data will be summarized and presented in the final survey report.

5.9 Survey Instruments

Based on guidance from the referenced NUREG documents (Section 2.0), TAMU has selected instrumentation that provides the accuracy and reliability required for the surveys to be undertaken accurately and thoroughly. Given the relatively low instrument background count rates and high counting efficiencies, 100 cm^2 dual phosphor detectors (Ludlum Instruments Model 43-93) have been used with dual channel scaler/ratemeters (Ludlum Instruments Model 2360) for radiological surveys conducted in support of defueling and cleanup work. These were augmented with thin-window "pancake" Geiger-Mueller detectors with scaler/ratemeters (Ludlum Instruments Model 43-9 detectors with Model 3 scaler/ratemeters) to access smaller diameter penetrations (e.g., for electric cables, water supply lines, natural gas lines, and the drain piping).

For direct comparison with proposed confirmatory surveys, the Final Survey Status Plan for contamination is being implemented using large area gas proportional detectors (Ludlum Instruments, handheld 126 cm^2 model 43-68, and a cart-mounted 580 cm^2 model 43-37 floor monitor). These detectors have been extensively evaluated and the data published in a variety of documents, including Decommissioning Health Physics (Ablequist, 2001), and NUREG-1507.

Operational surveys include swipes for removable contamination. Swipes are counted using a dual channel scaler (Ludlum Instruments 2929 with a 43-10 dual phosphor detector).

5.10 Release Criteria

Since no detectable contamination has been identified in the facility or on associated equipment, no specific radionuclides of concern have been identified. Cobalt-60 (^{60}Co) has been conservatively selected as the possible radionuclide of concern, and its corresponding screening value for surface contamination, as presented in NUREG 1757 (Table H.1 of volume 2), is the applicable regulatory limit for the project.

The TAMU requirements for unrestricted release are specified in the Radiological Safety Program, Section 7, paragraph B, "Limits", paragraph 2.

"*Contamination levels on laboratory surfaces (removable) as determined by either wipe survey or instrument survey:*

a. *no detectable contamination above background, i.e., not more than twice background levels*
b. *the determination of "no detectable contamination above background" must be made with a detector which has been response checked within the past 12 months and which is suitable for measuring the type(s) of radiation expected*."

Although specifically noted as applicable to removable surface contamination, it is also being applied to directly measured total contamination (i.e., fixed + removable). These criteria for removable and total contamination are well within the screening values presented in Appendix H to NUREG-1757 for typically encountered radionuclides (including ^{60}Co, the limiting value in the table H.1) as well as current State of Texas limits that remain applicable to State-licensed activities at TAMU.

5.11 Protection of Workers and the Public

Industrial safety specialists, such as experienced health physics staff, professional staff, along with management personnel, will be responsible for ensuring that the project complies with applicable federal safety requirements and general safe work practices.

All personnel working on the project have received appropriate training to recognize and understand potential hazards and risks. Training requirements for subcontractors will be determined based on the specific task the subcontractor is performing.

The Project Coordinator or his/her designee (through the TAMU EHS personnel) will direct site activities necessary for ensuring that the project meets occupational safety and health requirements for protection of project personnel and the public. The functional responsibility will be to ensure compliance with the Occupational Safety and Health Act of 1973.

As a minimum, the management on-site shall implement the following:

- General site safety procedures
- A requirement for a daily site safety meeting
- TAMU emergency contact telephone numbers
- Local emergency medical responders (as required)

5.12 Data Collection Quality Assurance

Measurements will be performed in accordance with the Final Survey Status Plan by qualified personnel following written instrument operating procedures. Instrument calibration practices meet ANSI standards and daily background and source response checks of instruments will be performed. For quality control purposes, static and removable activity measurements will be obtained at 2 locations in each survey unit.

5.13 Security Plan and Emergency Plan

The AGN-201M SNM, reactor and associated components have been removed from the Zachry Engineering Center. TAMU will follow 10 CFR 50.54(p) for changes to the Security Plan. TAMU is modifying the Security Plan, as appropriate, during the removal of the AGN-201M reactor and associated components, and the decontamination of the Zachry Engineering Center. TAMU will continue to monitor and restrict access to Zachry Engineering Center until it achieves unrestricted release. TAMU has no intention of reducing the safeguard effectiveness for the AGN-201M Security Plan for the Zachry Engineering Center until the unrestricted release is approved by the NRC.

Once the FSS results have been shown to meet 10 CFR 20.1401 criteria for unrestricted release for the Zachry Engineering Center, the material possession will be less than regulatory requirement for having a Physical Security Plan (Category 3). Therefore, TAMU is requesting to eliminate the AGN-201M Physical Security Plan.

The AGN-201M fuel, SNM, reactor and associated components have been removed from the Zachry Engineering Center. TAMU will follow 10 CFR 50.54(q)(iv)(3) in evaluating changes to the current AGN-201M Emergency Plan. TAMU will maintain all records of the proposed changes in accordance with 10 CFR 50.54(q)(iv)(5). Residual radioactivity levels, if any, remaining in Zachry Engineering Center do not approach the emergency planning thresholds of 10 CFR 30.72, Schedule C. Therefore, TAMU is requesting to eliminate the AGN-201M Emergency Plan.

5.14 Schedule

The following are proposed milestones to achieve the unrestricted release of the Zachry Engineering Center:

- Reactor and Associated Components Removed and Transported to the NSC (Complete);
- Cleanup and Decontamination (if needed) of the Zachry Engineering Center (Complete);
- Final Survey Results Completed (11/18/2016);
- Submit Survey Results to U.S. NRC (12/09/2016);
- U.S. NRC Completes Inspection of the Zachry Engineering Center (12/16/2016); and
- U.S. NRC Issues Unrestricted Release Amendment (12/30/2016).

5.15 FSS Plan Changes

Any changes to the Final Survey Status Plan will be conducted in accordance with 10 CFR 50.59.

5.16 Conclusion

The AGN-201M SNM, reactor, and associated components have been relocated to the NSC facility for temporary storage. TAMU will comply with 10 CFR 20.1402 criteria for unrestricted release of the Zachry Engineering Center.

In the future, the AGN-201M reactor will be reconstructed and ultimately brought back to an operational status. This project is taking all steps deemed necessary to retain the integrity of this reactor and associated components. While the AGN-201M reactor and associated components are stored at the NSC facility the AGN-201M license and applicable TSs will remain active.

Once the FSS results have been shown to meet 10 CFR 20.1401 criteria for unrestricted release for the Zachry Engineering Center, the NRC regulatory requirements for the Emergency Plan and the Physical Security Plan no longer exist for the AGN-201M reactor. Therefore, reference to the plans can be eliminated from the AGN-201M License and TSs.

Technical Specification Sections 5.2 and 5.3 contain terminology specifically identifying Fuel Storage and the Zachry Engineering Center. Now that the successful removal of the reactor and associated components has occurred, the TSs are no longer applicable as the building will be empty. Thus, these TSs can be eliminated.

Following the comprehensive surveys as described in the FSS plan, TAMU will provide the U.S. NRC with the results of the surveys to justify the unrestricted release the Zachry Engineering Center. The survey results are intended to demonstrate that areas of the Zachry Engineering Center that previously housed the AGN-201M reactor satisfy the unrestricted release criteria of the U.S. NRC. The Zachry Engineering Center can then be reused without radiological restrictions.

TAMU has concluded, based on the considerations above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed activities, (2) there is reasonable assurance that such activities will be conducted in compliance with U.S. NRC regulations, and (3) the issuance of this amendment will not be inimical to the common defense and security or the health and safety of the public.

6.0 CHANGES TO THE AGN-201M LICENSE AND TECHNICAL SPECIFICATIONS

Once the FSS results have been shown to meet 10 CFR 20.1401 criteria for unrestricted release for the Zachry Engineering Center, the NRC regulatory requirements for the AGN-201M Emergency Plan and Physical Security Plan no longer exist for the AGN-201M reactor. Therefore, reference to the plans can be eliminated from the AGN-201M License and TSs. Specifically, references to the plans on page 3 of the AGN-201M license and TSs 6.4.3(c) and TS 6.6(f)are being eliminated.

Technical Specification Sections 5.2 and 5.3 are also being eliminated as the AGN-201M SNM, reactor, and associated components have been disassembled, transported, and placed into storage at the NSC facility for a period up to five years. These TSs specify the fuel storage location and various rooms within Zachry Engineering Center. Once unrestricted release is achieved, the AGN-201M site will be turned over for complete renovation and the former Zachry Engineering Center will no longer exist; the building is being completely renovated and transformed into the Zachry Engineering Education Complex. Therefore, deleting TSs 5.2 and 5.3 is warranted.

Attachment 1 to Enclosure 1 contains proposed TSs and license page changes.

7.0 ENVIRONMENTAL CONSIDERATION

7.1 Proposed Action:

Issuance of the proposed LAR for the AGN-201M reactor (Facility License No. R-23, Docket No. 50-59) for the unrestricted release of the Zachry Engineering Center.

Following the relocation and storage of the AGN-201M SNM, reactor and associated components to the NSC facility, the Zachry Engineering Center is ready for final surveys and any decontamination (as necessary). This LAR proposes that the U.S. NRC approve the unrestricted release of the Zachry Engineering Center and deletion of TS Sections 5.2 and 5.3.

7.2 Environmental Impacts of the Proposed Action

Surveys over the operating history of the AGN-201M reactor indicate very little, if any, contamination in the Zachry Engineering Center. The procedures used will control radiation exposure to the workers, public, and environment. TAMU will follow the FSS plan to support the unrestricted release of the Zachry Engineering Center. This LAR will be supplemented with the final radiological survey results, once they have been completed. TAMU anticipates submitting the survey results in December 2016. Implementation of the FSS plan will demonstrate compliance with U.S. NRC regulations and guidance in support of the unrestricted release of the Zachry Engineering Center.

Texas A&M University will comply with the requirements of 10 CFR 20.1402 radiological criteria for the unrestricted release of the Zachry Engineering Center. In accordance with this rule, the Zachry Engineering Center will be considered acceptable for unrestricted release if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group does not exceed 25 mrem (0.25 mSv) per year.

The FSS plan requires that the release surveys demonstrate that the former AGN-201M site within the Zachry Engineering Center has been certified clean and satisfies unrestricted release criteria for 1) the U.S. NRC, 2) the state of Texas Department of State Health Services, and 3) Texas A&M University Radiological Safety, Environmental Health and Safety. If these criteria are satisfied, then the remaining structure can be reused without radiological restrictions.

7.3 Environmental Impacts of the Alternatives to the Proposed Action

As an alternative to the proposed unrestricted release of the subject area within the Zachry Engineering Center, the potentially-contaminated site would remain in possession-only status under Facility Operation License No. R-23. It would also eventually be subject to the U.S. NRC rule "Timeliness in Decommissioning of Material Facilities" (*59 FR 36026-36040*). This would eliminate the benefits of incorporating the subject area into the ongoing expansion of the Zachry Engineering Center for increasing the engineering education activities at TAMU.

7.4 Finding of No Significant Impact

Based on the above, TAMU finds that issuing the proposed LAR for the unrestricted release of the Zachry Engineering Center and the modifications to TS Section 5.2 and 5.3 will have no significant impact on the environment. TAMU is committed to following U.S. NRC rules and regulations to achieve the unrestricted release of the Zachry Engineering Center. The implementation of the FSS plan will demonstrate compliance with U.S. NRC regulations and guidance in support of the unrestricted release of the Zachry Engineering Center. Therefore, TAMU finds that issuing the proposed LAR will have no significant environmental impacts.

8.0 NO SIGNIFICANT HAZARDS CONSIDERATION

The LAR will allow TAMU to delete TS Sections 5.2 and 5.3 associated with fuel storage and the term "Zachry Engineering Center" as well as justify the unrestricted release of the Zachry Engineering Center. Discussion of the expansion of Zachry Engineering Center has been presented to the U.S. NRC in several correspondences from TAMU. The guidance was followed to achieve the goal of unrestricted release, as allowed by 10 CFR 20.1401. The FSS plan will be followed to ensure the Zachry Engineering Center attains unrestricted release in accordance with the U.S. NRC regulations.

The AGN-201M SNM, reactor, and associated components have been removed from the Zachry Engineering Center. All potential hazards related to the previously-installed reactor have been eliminated. TAMU has evaluated the potential for significant hazards associated with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, as presented below:

1. Does the proposed amendment involve a significant increase in the probability or consequences of an accident previously evaluated?
   Response: No.

The transport of the AGN-201M SNM, reactor, and associated support equipment renders the area within the Zachry Engineering Center empty. Once empty and the FSS results have been shown to meet 10 CFR 20.1401 criteria for unrestricted release for the Zachry Engineering Center, the NRC regulatory requirements for the Emergency Plan and Physical Security Plan no longer exist for the AGN-201M reactor. Therefore, reference to the plans can be eliminated from the AGN-201M License and TSs. In addition, TS Sections 5.2 and 5.3 are no longer applicable and can be deleted from the AGN-201M TSs. The empty room, following comprehensive cleaning and surveys, will meet the criteria to be released for unrestricted use. Therefore, this TS change and compliance with the governing rules and regulations fulfills the goals and objectives required to support unrestricted release of the Zachry Engineering Center. The proposed changes do not involve a significant increase in the probability or consequences of an accident previously evaluated. The Technical Evaluation describes the methodology and requirements TAMU intends to meet to achieve unrestricted release of the Zachry Engineering Center.

2. Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?
   Response: No.

The AGN-201M SNM, reactor, and associated components have been transported to and are now stored at the TEES NSC. Once empty and the FSS results have been shown to meet 10 CFR 20.1401 criteria for unrestricted release for the Zachry Engineering Center the NRC regulatory requirements for the Emergency Plan and Physical Security Plan no longer exist for the AGN-201M reactor. Therefore, reference to the plans can be eliminated from the AGN-201M License and TSs. In addition, TS Sections 5.2 and 5.3 are no longer requiredsince the surveillance would be applied to empty rooms. As such, it is not credible to postulate the possibility of a new or different kind of accident from any accident previously evaluated. The AGN-201M reactor license and applicable TSs will remain in effect while the AGN-201M SNM, reactor, and associated components are stored at the NSC, thus eliminating any association with the Zachry Engineering Center. There are no new accidents or unevaluated scenarios associated with preparing the Zachry Engineering Center for unrestricted release.

3. Does the proposed amendment involve a significant reduction in a margin of safety? Response: No.

There are no activities to be undertaken associated with the AGN-201M, as all work is to be performed in the empty Zachry Engineering Center. Noting the work to be performed, the existing margin of safety is greatly enhanced relative to conditions at the start of the project, when all the AGN-201M equipment was in the building. Removal of all equipment demonstrates that there will be no reduction in the margin of safety and no adverse consequences to the staff and surrounding areas.

9.0 CONCLUSION

The AGN-201M SNM, reactor, and associated components have been relocated to the TEES NSC for temporary storage. TAMU will comply with 10 CFR 20.1402 criteria for unrestricted release of the Zachry Engineering Center.

The FSS plan will be implemented to provide the basis for the unrestricted release of the Zachry Engineering Center. This project is taking all steps deemed necessary to retain the integrity of this reactor and associated components while stored at the NSC facility. While the AGN-210M reactor and associated components are stored at the NSC facility the AGN-201M license and applicable TSs will remain active.

Once the FSS results have been shown to meet 10 CFR 20.1401 criteria for unrestricted release for the Zachry Engineering Center, the NRC regulatory requirements for the Emergency Plan and Physical Security Plan no longer exist for the AGN-201M reactor. Therefore, reference to plans can be eliminated from the AGN-201M License and TSs.

Technical Specification Sections 5.2 and 5.3 contain terminology specifically identifying Fuel Storage and the Zachry Engineering Center. Having successfully removed the AGN-201M SNM, reactor, and associated components from the Zachry Engineering Center, these TSs can be deleted.

Texas A&M University will provide the U.S. NRC with the results of the FSS to justify the unrestricted release the Zachry Engineering Center. The survey results are intended to demonstrate that areas of the Zachry Engineering Center that previously housed the AGN-201M reactor satisfy the unrestricted release criteria of the U.S. NRC. The Zachry Engineering Center can then be reused without radiological restrictions.

TAMU has concluded, based on the considerations above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed activities, (2) there is reasonable assurance that such activities will be conducted in compliance with the U.S. NRC regulations, and (3) the issuance of this amendment will not be inimical to the common defense and security or the health and safety of the public.

ATTACHMENT 1

TEXAS A&M UNIVERSITY

FACILITY LICENSE R-23, DOCKET NO. 50-59

AMENDED FACILITY OPERATING LICENSE

AGN-201M REACTOR

PROPOSED PAGES:

TECHNICAL SPECIFICATION PAGES 15, 20, and 21

FACILITY LICENSE NO. R-23 PAGE 3

c. The core, reflector, and lead shielding are enclosed in and supported by a fluid-tight steel reactor tank. An upper or "thermal column tank" may serve as a shield tank when filled with water or a thermal column when filled with graphite.

d. The 6 ½ foot diameter, fluid-tight shield tank is filled with water constituting a 55 cm thick fast neutron shield. The fast neutron shield is formed by filling the tank with approximately 1000 gallons of water. The complete reactor shield shall limit doses to personnel in unrestricted areas to levels less than permitted by 10 CFR 20 under operating conditions.

e. Two safety rods and one control rod (identical in size) contain less than 15 grams of U-235 each in the same form as the core material. These rods are lifted into the core by electromagnets, driven by reversible DC motors through lead screw assemblies. De-energizing the magnets causes a spring-driven, gravity-assisted scram. The fourth rod or fine control rod (approximately one-half the diameter of the other rods) is driven directly by a lead screw. This rod may contain fueled or unfueled polyethylene.

5.2 Fuel Storage

DELETED

5.3 Reactor Room, Reactor Control Room, Accelerator Room

DELETED

6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

The administrative organization for control of the reactor facility and its operation shall be as set forth in Figure 1 attached hereto. The authorities and responsibilities set forth below are designed to comply with the intent and requirements for administrative controls of the reactor facility as set forth by the Nuclear Regulatory Commission.

c. Proposed tests or experiments which are significantly different from previous approved tests or experiments, or those that involve an unreviewed safety question as defined in 10 CFR 50 paragraph 50.59.

d. Proposed changes in Technical Specifications or licenses.

e. Violations of applicable statues, codes, regulations, orders, Technical Specifications, license requirements, or of internal procedures or instructions having nuclear safety significance.

f. Significant operating abnormalities or deviations from normal and expected performance of facility equipment that affect nuclear safety.

g. Reportable occurrences.

h. Audit reports.

6.4.3 Audits

Audits of facility activities shall be performed at least quarterly under the cognizance of the Reactor Safety Board but in no case by the personnel responsible for the item audited. These audits shall examine the operating records and encompass but shall not be limited to the following:

a. The conformance of the facility operation to the Technical Specifications and applicable license conditions, at least annually.

b. DELETED

c. DELETED

6.4.4 Authority

The Reactor Safety Board shall report to the President and shall advise the Head of the Department of Nuclear Engineering on those areas of responsibility outlined in section 6.1.6 of these Technical Specifications.

6.4.5 Minutes of the Reactor Safety Board

The Chairman of the Reactor Safety Board shall direct the preparation, maintenance, and distribution of minutes of its activities. These minutes shall include a summary of all meetings, actions taken, audits, and reviews.

6.5 Approvals

The procedure for obtaining approval for any change, modification, or procedure which requires approval of the Reactor Safety Board shall be as follows:

a. The Reactor Supervisor shall prepare the proposal for review and approval by the Head of the Department of Nuclear Engineering.

b. The Head of the Department of Nuclear Engineering shall submit the proposal to the Chairman of the Reactor Safety Board.

c. The Chairman of the Reactor Safety Board shall submit the proposal to the Reactor Safety Board members for review and comment.

d. The Reactor Safety Board can approve the proposal by majority vote.

6.6 Procedures

There shall be written procedures that cover the following activities:

a. Startup, operation, and shutdown of the reactor.

b. Fuel movement and changes to the core and experiments that could affect reactivity.

c. Conduct of irradiation and experiments that could affect the operation or safety of the reactor.

d. Preventative or corrective maintenance which could affect the safety of the reactor.

e. Surveillance, testing, and calibration of instruments, components, and systems as specified in section 4.0 of these Technical Specifications.

f. DELETED

The above listed procedures shall be approved by the Head of the Department of Nuclear Engineering and the Reactor Safety Board. Temporary procedures which do not change the intent of previously approved procedures and which do not involve any unreviewed safety question may be employed on approval by the Reactor Supervisor.

6.7 Experiments

a. Prior to initiating any new reactor experiment and experiment procedures shall be prepared by the Reactor Supervisor and reviewed and approved by the Head of the Department of Nuclear Engineering and the Reactor Safety Board

b. Approved experiments shall only be performed under the cognizance of the Head of the Department of Nuclear Engineering and the Reactor Supervisor.

2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment xx, are hereby incorporated in their entirety in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

(3) Physical Security Plan

DELETED

D.

DELETED

E. This license is effective as of the date of issuance and shall expire at midnight, August 26, 1997.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Brian K. Grimes, Assistant Director
For Engineering & Projects
Division of Operating Reactors

Attachment:
Appendix A, Technical
Specifications dated

Date of Issuance: April 25, 1979

ENCLOSURE 2

TEXAS A&M UNIVERSITY

FACILITY LICENSE R-23, DOCKET NO. 50-59

AMENDED FACILITY OPERATING LICENSE

AGN-201M REACTOR

FINAL STATUS SURVEY PLAN, REVISION 1

SURVEY PLAN FOR THE
UNRESTRICTED RADIOLOGICAL RELEASE OF THE
AGN-201M RESEARCH REACTOR FACILITY
ZACHRY ENGINEERING CENTER
TEXAS A&M UNIVERSITY
COLLEGE STATION, TEXAS

Revision 1
November 10, 2016

Contents

ACRONYMS, ABBREVIATIONS, AND UNITS

C	carbon
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
Cs	cesium
dpm	disintegrations per minute
Eu	europium
^3H	tritium
hr	hour
keV	kiloelectron volt
m	meter
m^2	square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation
Manual MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MeV	million electron volts
NRC	Nuclear Regulatory Commission
pCi	picocurie
pCi/g	picocurie per gram
PuBe	plutonium-beryllium (neutron source)
RSSI	Radiation Site Survey and Investigation
TAMU	Texas A&M University
TDSHS	Texas Department of State Health Services
U	uranium
µCi	microcurie

UNRESTRICTED RADIOLOGICAL RELEASE SURVEY PLAN
AGN-201M RESEARCH REACTOR FACILITY
ZACHRY ENGINEERING CENTER
TEXAS A&M UNIVERSITY, COLLEGE STATION, TX

1.0 INTRODUCTION

Texas A&M University (TAMU) is renovating the Zachry Engineering Center. This Center housed the AGN-201M reactor, licensed by the Nuclear Regulatory Commission (Facility License R-23). It also contained offices and laboratories in which radiological materials were used in support of reactor operations and other activities, as authorized under Texas Department of State Health Services (TDSHS) license L00448. Furnishings, materials and equipment were surveyed and removed from the State-licensed areas of the facility. Building surfaces in those non-reactor areas were surveyed and demonstrated to satisfy the TAMU criterion for demolition without need for radiological restrictions. These areas have been razed in preparation for renovation.

The reactor and associated components have been packaged and placed in secure offsite storage, awaiting reinstallation in a new facility (note that the Part 50 license is not being terminated). Remaining materials and equipment in the reactor facility have been surveyed, removed, and dispositioned in accordance with the TAMU criteria. Radiological surveys performed over the operating history of the AGN-201M reactor have identified no contamination over TAMU release limits in the reactor areas of Zachry Engineering Center. In addition, recent surveys conducted during reactor disassembly and in support of the removal, packaging and transport of the reactor fuel and SNM have not identified contamination over TAMU release limits on the reactor external surfaces or on reactor internal component surfaces (e.g., in the core tank, on control rod drive thimbles that pass through the unclad fuel disks, and on the lower core plate).

ReNuke Services, Inc., of Oak Ridge, TN, has been contracted by TAMU to remove and relocate the reactor, develop a survey plan, and conduct unrestricted release surveys of the building. The final results will be submitted as a supplement to a license amendment request for the unrestricted release of the Zachry Engineering Center.

Office furnishings, miscellaneous materials and non-reactor equipment have been surveyed in accordance with the TAMU Radiological Safety Program and removed from the facility. No contaminated items were identified. Screening surveys of the reactor facility surfaces have been performed, with no contamination detected and no need for decontamination identified. Based upon reactor power history and neutron surveys during power operation, activation of the building structure is considered very unlikely. Concrete samples from shield blocks around the reactor support skirt and from walls in the reactor room have been analyzed by an offsite laboratory for the presence of neutron activation products, and support this assessment; no activation products were detected. Based upon these surveys, the AGN-201M design characteristics, and the facility historical uses, the areas have been classified as to contamination potential. Radiological surveys of the impacted areas will be conducted to demonstrate that the facility conditions satisfy requirements for unrestricted future use and thus enable building renovations to proceed without radiological safety constraints.

2.0 PURPOSE AND SCOPE

The purpose of the release surveys is to demonstrate that areas of the Texas A&M University Zachry Engineering Center, which houses the AGN-201M reactor facility, satisfy criteria of the Nuclear Regulatory Commission, Texas Department of State Health Services, and Texas A&M University Radiological Safety, Environmental Health and Safety for unrestricted release. By satisfying these criteria, the remaining structure can be demolished or reused without radiological restrictions.

Texas A&M University will comply with the requirements of 10 CFR 20.1402, radiological criteria for the unrestricted release of the Zachry Engineering Center. In accordance with this rule, the site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the public does not exceed 25 mrem (0.25 mSv) per year. No contamination has been detected on any surfaces or components during extensive surveys conducted in support of defueling and during earlier scoping surveys, and TAMU commits to using the default screening values for surface contamination as presented in Appendix H to NUREG -1757, Volume 2, Revision 1 as upper limits for the project. Site characteristics support the use of these values, as only superficial surface contamination is expected. There are no buried pipes or potentially contaminated structures, and no unusual radionuclides are anticipated. The screening values have been determined by the NRC to be ALARA; no further pathways evaluations are required (Appendix N to NUREG – 1757, Volume 2). TAMU's self-imposed release criteria are more limiting (contamination is not to exceed twice background, using appropriate instrumentation), as explained below.

3.0 SITE DESCRIPTION

Figure 1 is a site map of the Texas A&M campus, indicating the location of the Zachry Engineering Center, on Bizzell Street near University Drive. This Center was home to Engineering Student Services and Academic Programs Office, as well as the Department of Nuclear Engineering and the Department of Electrical and Computer Engineering. The building is a large concrete structure and consists of a basement level, a ground level, and three additional floors. As depicted in Figure 3, the AGN-201M reactor was located in Room 61B on the ground floor, in the southwest portion of the building. It is a fully self-contained unit, with no external coolant or irradiation systems. The reactor core is a right cylinder, approximately 26 cm diameter by 24 cm high consisting of nine fuel discs and fueled control rods containing nominally 665 grams of U-235 at an enrichment of just less than 20%. The fuel is a mixture of UO_2 microspheres in a polyethylene matrix. The core and the control and safety rods are surrounded by a leak tight, 95 cm diameter by 148 cm high core-tank.

A 10 cm thick lead shield surrounds the core-tank and 20 cm thick graphite reflectors. A 198 cm diameter by 213 cm height water shield tank surrounds the reactor core assembly (Figure 2). The maximum authorized steady state operating power level is 5 watts, thermal. The reactor has not operated for several years. The design of the AGN-201M reactor precludes the possibility of groundwater or soil contamination, as there are no external coolant pumps, heat exchangers, or coolant makeup/cleanup systems, and no external irradiation loops. In addition, the basic design precludes the need for radioactive waste processing systems (e.g., no waste compaction, liquid waste treatment, or contaminated off gas treatment systems). Accordingly, the FSS does not address soil or groundwater sampling.

Room 60C was primarily used for office space and access control. Room 61A was used in support of reactor operations (e.g., safeguards laboratory work, experiment preparation). Room 61B contains the reactor control console and a small inner room where radioactive sources were stored. Access to the top of the reactor is through Room 135 on the 1st floor level, directly above the reactor room. Rooms 60C, 61A, 61B, and 135 (which also previously contained an ion-implant particle accelerator) constitute the primary site security boundaries for the reactor. These rooms occupy approximately 170 m2 on each level. They have 1-m reinforced concrete walls; the accelerator room ceiling is also 1-m thick concrete and a steel plate liner. Figures 3 and 4 show the layouts of the reactor facility; bolded outlines indicate Primary Reactor Site boundaries.

A polyethylene tank was located in the Basement directly beneath the primary reactor facility and was connected to a floor drain in Room 61B to allow collection of water in the unlikely event of leakage from the reactor shield tank (radiologically uncontaminated chromated water). This capability was not used, and the tank remained empty until its survey and removal. The single PVC drain line did not contain detectable radioactivity when examined during scoping surveys. It was removed and all sections surveyed, along with the polyethylene tank. Rooms 135 and 61A were also equipped with sink drains previously connected to a sump in the State-licensed area of the building. No contamination was detected in the glass drain line or the in-line trap in the reactor areas, and no contamination was identified during sampling of the sump or the State-licensed laboratory drains. These drains were terminated and the sump released as part of the laboratory decommissioning.

The facility shares electric power and air supply with the remainder of Zachry Engineering Center building. During normal power operation, ventilation for the reactor area was provided by a ventilation fan in Room 135, which pulled air through a grated opening in the Room 61B ceiling. Portions of the ventilation system were surveyed in early 2016 during laboratory facility surveys, and found to meet the applicable release criteria.

Figure 1 – Map of Texas A&M Campus, indicating location of Zachry Engineering

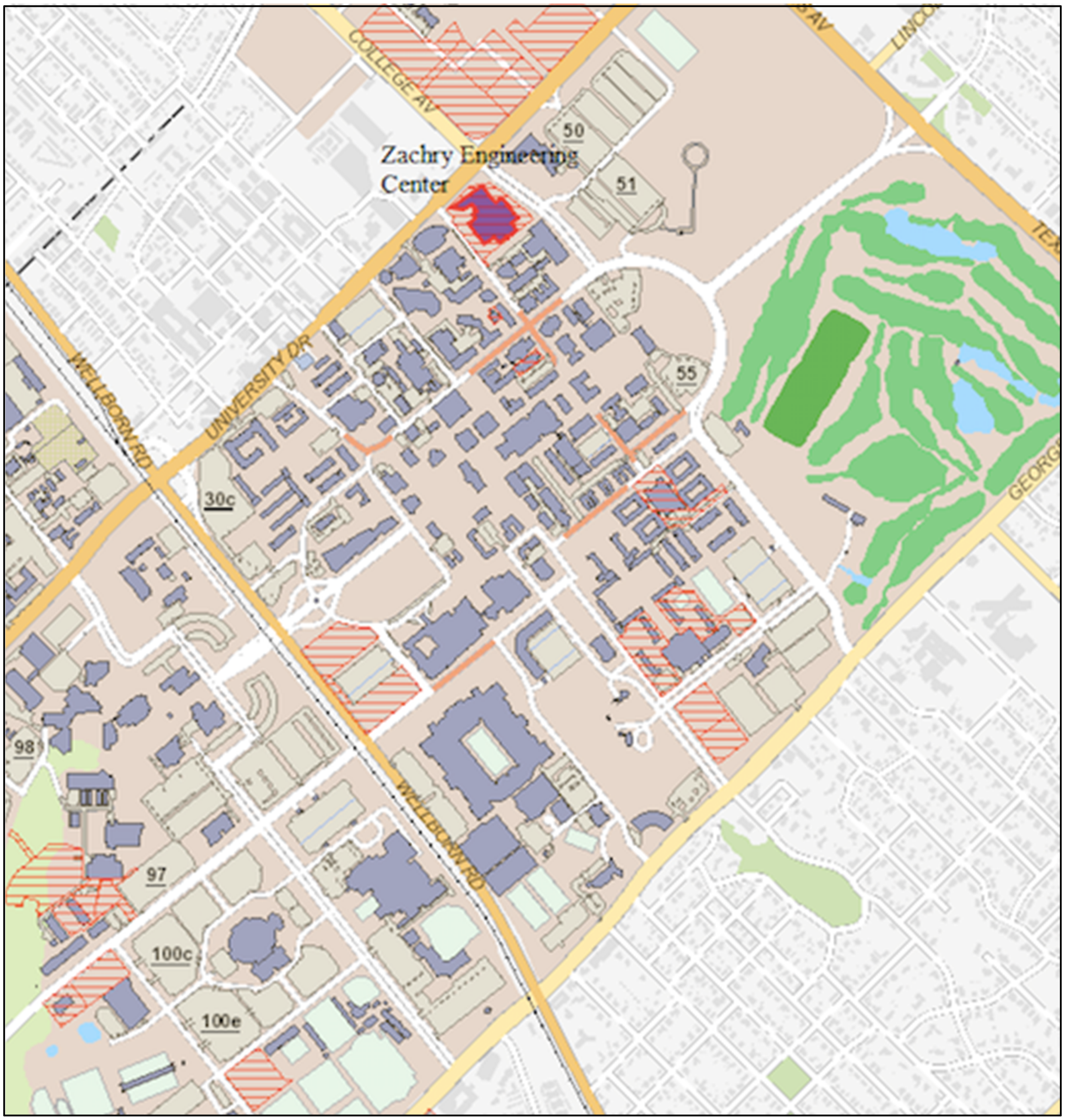


Figure 2 – Cut-away View of AGN-201M Reactor

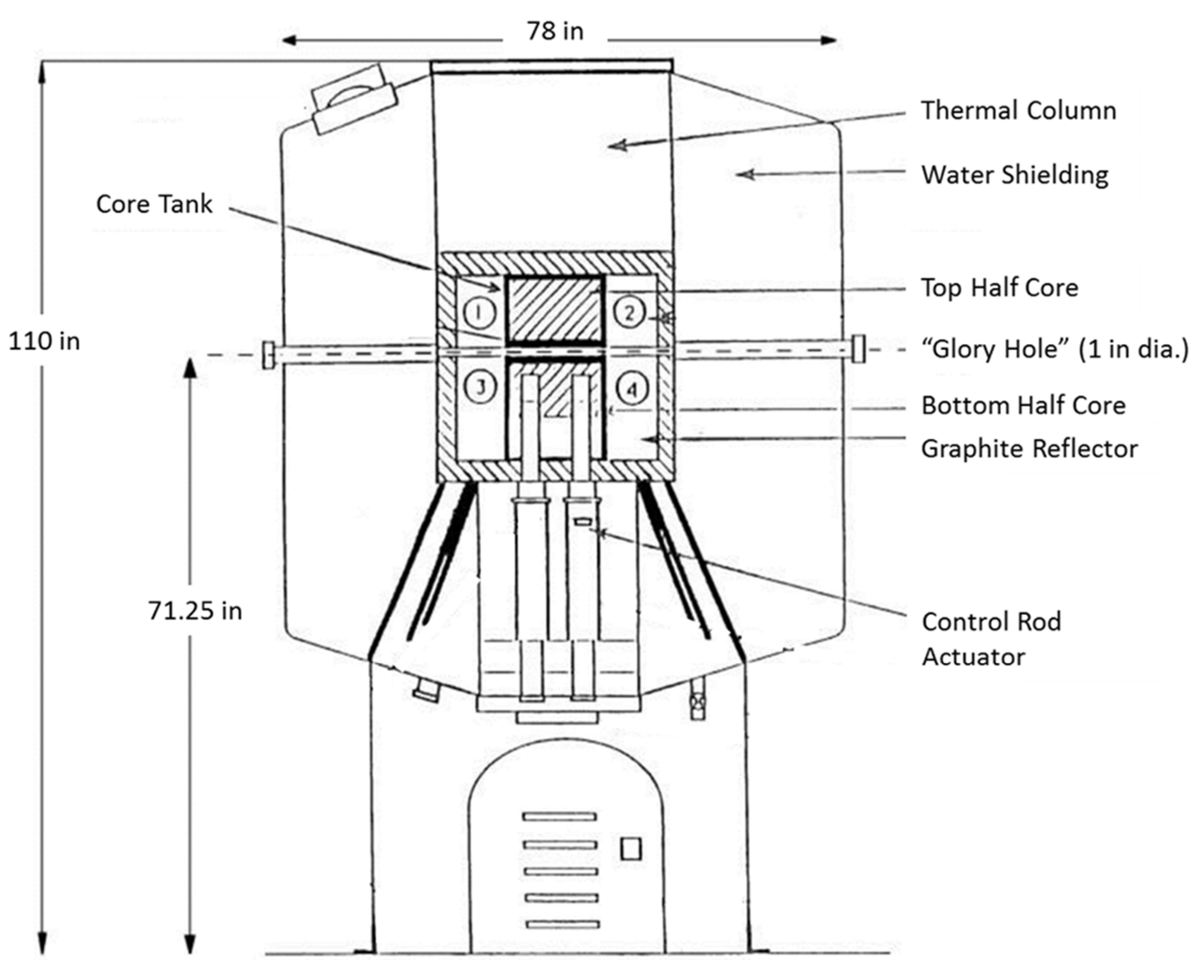


Figure 2a – AGN-201M Reactor without block shielding, as currently located in Zachry Engineering Center

Figure 3 - Reactor Facility Ground Floor; Bolded outline indicates Security Boundary

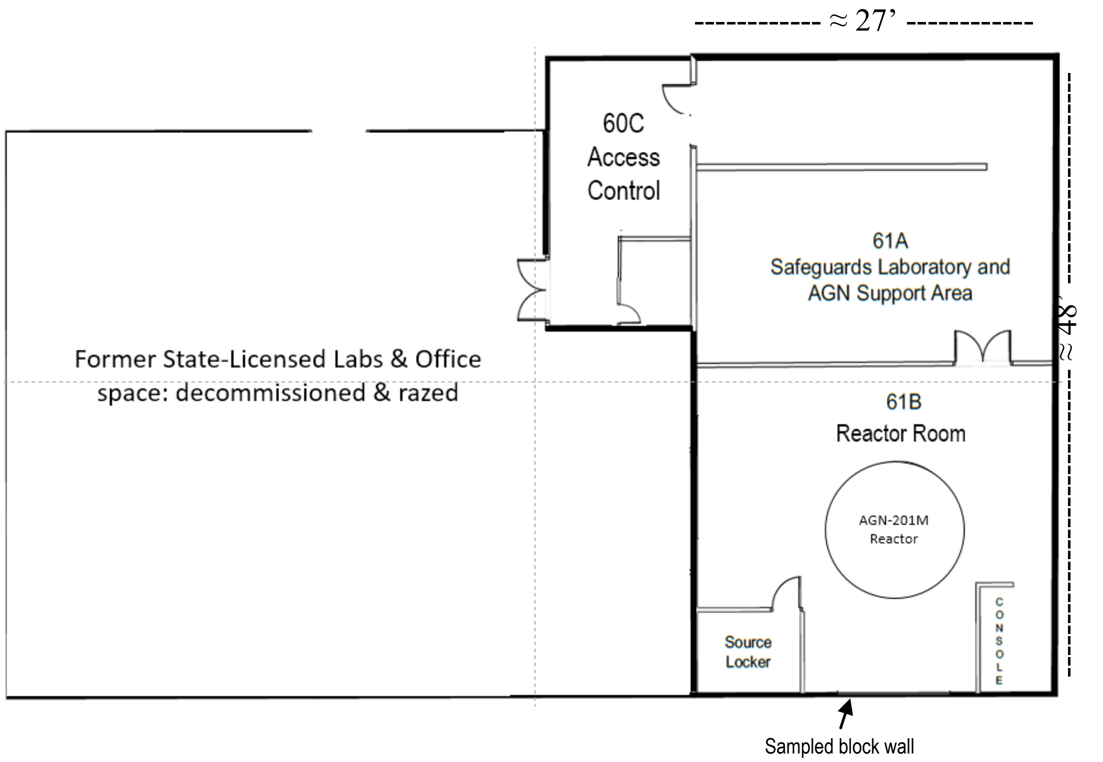
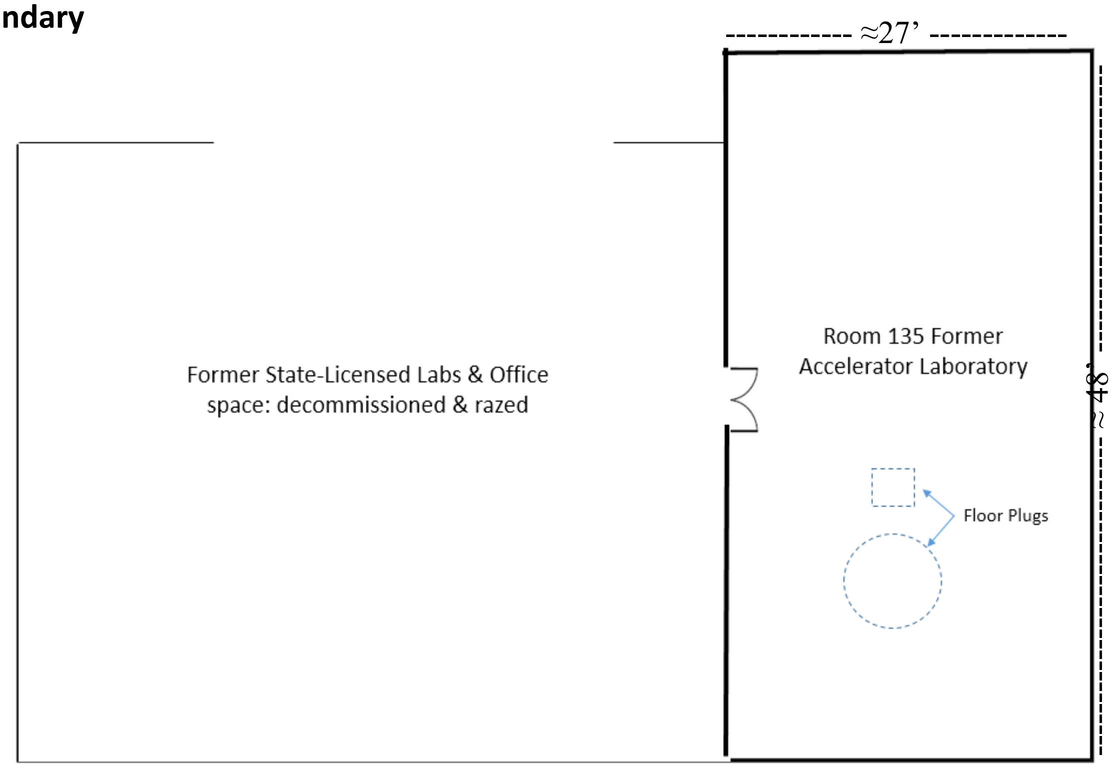


Figure 4 – Reactor Facility First Floor; Bolded outline indicates primary Reactor Site Boundary



4.0 RADIONUCLIDE CONTAMINANTS AND CRITERIA

AGN-201M reactor operations in the Zachry Engineering Center began in 1972 and concluded in 2014. During the school years of 1999/2000 through 2009/2010, the reactor was not operated. In other years, annual operating watt- hours ranged from 4.32 to 82.36. Since the 2009/2010 school year, the total operating time has been approximately 138 watt-hours. There has been no reactor operation since 2014. Records and anecdotal information from the previous Senior Reactor Operator have not revealed any reactor incidents or occurrences which may have resulted in contamination of surfaces external to the reactor shield tank. Results of surveys performed by the TAMU Radiological Safety staff did not identify any detectable removable contamination on reactor components or reactor room surfaces. Recent scoping surveys did not detect any fixed or removable contamination on surfaces in rooms 61A and 61B. Considering the low power level and limited operating time, low neutron fluence rate (1.5 x 10^8 n/cm^2-sec, average at the 5 watts maximum licensed power), inherent shielding provided by the reactor components and containment tank, and the decay time since last operation, the likelihood of detectable activity in facility structural media is considered to be negligible.

Conservative, bounding calculations estimate ^{152}Eu (likely the predominant activation product in concrete) specific activity in the range of 10^{-3} pCi/g in concrete shield blocks that were located around the reactor support skirt. Sampling and analyses was conducted to validate the calculation-based conclusion that no activation products are present at detectable levels. Candidate radionuclides for concrete activation include ^{152}Eu, ^{154}Eu, ^{60}Co, ^{134}Cs, ^{3}H, and ^{14}C. Laboratory analyses (gamma spectrometry and liquid scintillation counting) of core samples are summarized below. Samples included cores from 4 innermost shield blocks previously around the reactor skirt (shielding subject to the highest neutron dose), 1 core from the North room wall, collected directly across from the glory hole, 3 cores from the South block wall in line with the glory hole, 2 cores from the nominal 3 ½” concrete reactor pad, 2 cores from the concrete floor directly under the reactor pad, and 1 core from the wall in the access hallway, an area with no significant neutron exposure. None of the samples were found to contain detectable activation products, with minimum detectable concentrations for the radionuclides of interest less than 10% of the NUREG 1757 soil screening values. Europium MDC’s were also < 10% of the EPA values for residential soils. These screening values are directly applicable as a portion of the South wall was opened for removal of the reactor shield tank. Exposure rate surveys 1 meter over the reactor pad were not different than the nominal 5 microR/h ambient exposure rates throughout the facility. Sample results are presented in Table 1.

Table 1. Volumetric sample data

No activation products detected	134Cs MDC, pCi/g	60C MDC, pCi/g	152Eu MDC, pCi/g	154Eu MDC, pCi/g	3H MDC, pCi/g	14C MDC, pCi/g
Wall: hallway (no neutron irradiation)	5.82E-02	7.23E-02	1.12E-01	1.73E-01	5.43E+00	1.41E+00
Wall: N side, opposite glory hole	8.97E-02	9.91E-02	1.90E-01	2.97E-01	5.44E+00	1.37E+00
S. Wall 1: IW-1 (wall removed)	4.77E-02	4.30E-02	1.09E-01	1.01E-01	7.63E+00	6.26E-01
S. Wall 2: IW-2 (wall removed)	4.52E-02	4.11E-02	1.40E-01	1.30E-01	7.85E+00	6.01E-02
S. Wall 3: IW-3 (wall removed)	7.01E-02	6.72E-02	1.29E-01	2.26E-01	8.08E+00	6.21E-01
Reactor shield block: E1	7.87E-02	7.69E-02	1.31E-01	2.17E-01	7.96E+00	5.98E-01
Reactor shield block: S1	8.06E-02	7.64E-02	1.70E-01	1.86E-01	8.07E+00	6.14E-01
Reactor shield block: N1	5.54E-02	7.87E-02	1.64E-01	1.99E-01	7.88E+00	6.07E-01
Reactor shield block: W1	6.01E-02	5.80E-02	1.30E-01	1.84E-01	8.06E+00	1.00E+00
Reactor pad concrete 1	5.89E-02	5.19E-02	1.26E-01	1.55E-01	6.85E+00	6.34E-01
Reactor pad concrete 2	5.59E-02	5.20E-02	1.14E-01	1.41E-01	6.30E+00	6.35E-01
Floor under reactor pad, 1	9.17E-02	6.72E-02	1.77E-01	2.07E-01	6.27E+00	6.51E-01
Floor under reactor pad, 2	6.87E-02	5.17E-02	1.69E-01	1.98E-01	6.58E+00	6.30E-01

South Wall (IW-1 to IW-3)

Shield Block Wall (4 Samples)

Reactor Pad Concrete (4 samples)

Coverings have not been applied over any known location of contamination. The location in the facility considered most likely to have been impacted by reactor operations is the concrete floor directly beneath the reactor shield tank. Potential activation radionuclides include the same radionuclides in the above table. The core assembly contains enriched uranium fuel and (likely) very small quantities of longer-half-life fission products including ^{137}Cs, ^{90}Sr, ^{144}Ce, and ^{95}Zr and activation products such as ^{60}Co in components; however, there is no history of contamination by these radionuclides on surfaces external to the reactor.

The NRC reactor license includes a ^{239}PuBe special-form neutron source containing up to 16 grams of ^{239}Pu for use in reactor operation. This source was leak tested (no contamination was detected), removed from the AGN-201M reactor, and transported to offsite storage

Section 17.1.4 of NUREG-1537 establishes the following criteria to release non-power reactor facilities for unrestricted use

1. a) no more than 5 microrem per hour above background at 1 meter from the surface measured for indoor gamma radiation fields from concrete, components, and structures, or

   b) no more than 10 millirem per year for gamma emitters above background absorbed dose to any person, considering reasonable occupancy and proximity (NRC letters dated March 17, 1981 and April 21, 1982).

2. residual surface contamination consistent with Regulatory Guide 1.86.

Regulatory Guide 1.86 was withdrawn by NRC, effective August 12, 2016, although similar numerical guidance remains in Regulatory Guides 8.21, "Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants", and 8.30, "Health Physics Surveys in Uranium Recovery Facilities". The table of surface contamination values has been retained (see Table 2) for the project as these values are also in Texas Regulation 25 TAC §289.202(ggg)(6), Acceptable surface contamination levels (Ref 2), and are applicable to State-licensed activities at TAMU.

Table 2. Acceptable Surface Contamination Levels based on Detectability

Nuclide[a]	**Total**	**Removable**
U-nat, U-235, U-238, and associated decay products	5000 dpm/100 cm^2	1000 dpm/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5000 dpm/100 cm^2	1000 dpm/100 cm^2

a. Where surface contamination by both alpha- and beta-gamma emitting radionuclides exist, the limits established for alpha- and beta-gamma-emitting radionuclides apply independently.

The TAMU radiation safety program has a policy of "no detectable activity" for unrestricted use and release. "No detectable activity" is interpreted by TAMU as not exceeding twice the background level (Ref 1).

Due to other Zachry Engineering Center renovation work starting prior to the reactor relocation project, suitable concrete surfaces outside the reactor complex were not available for reference background measurements. Background measurements were performed in a Class 3 area (Room 60C) on a section of poured concrete floor unlikely to have been impacted by reactor operations. This area, as with the other floor areas, was covered with floor tile since the start of reactor operations. The tile has since been removed from all areas. The poured concrete background levels for the 126 cm^2 gas-flow proportional detectors are effectively the observed ambient background levels of 3 alpha cpm and 250 beta cpm. As expected, the larger (nominally 580 cm^2) gas-flow proportional floor monitor exhibits higher ambient background levels of approximately 9 alpha cpm and

300 beta cpm. Initial survey work supports the conservative use of ambient background levels for scanning surveys of the floors and the remainder of the facility surfaces (primarily poured concrete walls, steel and glass). The ambient background values will also be conservatively applied to surveys of two higher density block shield walls in Room 61B. Laboratory analysis demonstrates a higher concentration of the ^{232}Th-series radionuclides relative to other block and concrete used in facility construction, and the impact on surveys is an increased background count rate of 100 cpm on these blocks. This material-specific background will not, however, be applied. The ambient background will also be used for scanning surveys of these walls. To summarize, no materials-specific background count rates will be subtracted from scanning surveys of facility surfaces. Note that 2-step surveys will be used for static measurements, as described in section 6.3, Integrated Survey Strategy.

The nominal ambient background values are used to calculate the sensitivity of the scanning surveys to ensure they are adequate relative to the surface contamination Screening Values presented NUREG 1757, Appendix H. Because no residual radioactivity has been identified during extensive surveys of the reactor, associated components, and the facility, no specific radionuclides of interest have been identified. The NUREG 1757, Appendix H surface contamination screening value for ^{60}Co (7,100 dpm/100 cm^2) has been conservatively chosen for evaluation of potential building contamination. Table 3 presents a summary of the minimum detectable surface contamination, the NRC screening value, and the surface contamination levels corresponding to twice the background levels (the TAMU constraint).

During scanning surveys, net count rates exceeding 450 cpm beta when using the 126 cm^2 detectors, or 800 cpm beta for the 580 cm^2 detector, will be indicative of contamination exceeding the screening value for ^{60}Co.

The assumption that the removable activity fraction does not exceed 10% will be evaluated if contaminated areas are identified. Table 3 clearly demonstrates that meeting the TAMU Radiological Safety criteria for release will also satisfy the NRC requirements. As noted, no contamination has been detected and no specific radionuclides have been identified during extensive scoping surveys; ^{60}Co has been conservatively selected as a possible radionuclide of concern. Gross alpha and beta-gamma surveys limits will be applied (i.e., not to exceed twice background, alpha and beta-gamma activity evaluated independently). Also note that net count rates exceeding 3 cpm alpha or 250 cpm beta when using the 126 cm^2 detectors, or 9 cpm alpha or 300 cpm beta for the 580 cm^2 detector, will be indicative of contamination exceeding the TAMU criteria (twice background) and will require further investigation.

Table 3. Summary Data

Detector/Application	MDA ($dpm/100\ cm^2$)	NRC Co-60 Default Screening Value ($dpm/100\ cm^2$)	TAMU twice background equivalent (net $dpm/100\ cm^2$)
126 cm^2 gas proportional/scan	Alpha - N/A * 1500 beta	Alpha - N/A* 7100	N/A 3000
126 cm^2 gas proportional/static	63 alpha 470 beta	Alpha - N/A* 7100	26 alpha (< MDC) 2200 beta
580 cm^2 gas proportional/scan	Alpha - N/A* 2280 beta (for a 100 cm^2 spot)	Alpha - N/A* 7100	A > 2 x background reading will be investigated with a 126 cm^2 detector
Laboratory counter/removable activity	19 alpha 90 beta	Alpha - N/A* 710	4 alpha 500 beta

*No potential alpha-emitting contaminants have been identified

Measured background exposure rates within the Zachry Engineering Center are 5 to 8 microR/hr. The TAMU "less than twice background" criterion will be met by confirming that dose rates from background plus residual licensed material are no more than 10 microR/h, measured at 1 meter from building surfaces. This is consistent with the previously noted guidance from NUREG 1537.

5.0 IMPACTED AREAS AND SURVEY UNITS

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (Ref 3) defines impacted areas as those with a possibility of residual radioactivity in excess of background levels. Radiological surveys of impacted areas are required to demonstrate that established criteria have been satisfied. Non-impacted areas are those with no reasonable expectation of residual contamination; no surveys of non-impacted areas are required. Impacted areas are classified as to contamination potential as follows:

- Class 1: Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on radiological surveys) expected to be in excess of established unrestricted release criteria.
- Class 2: Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed established criteria.
- Class 3: Areas that are potentially impacted but are not expected to contain any residual radioactivity, or are expected to contain levels of residual activity at a small fraction of the established criteria, based on site operating history and previous radiological surveys.

The rigor of a release survey is based on these contamination potential classifications. Structure survey units are established with size limitations presented in Table 4.

Table 4. Survey Unit Area by Classification

Classification	Maximum Area(m^2)
Class 1	**100 (floor surface)**
Class 2	**100 to 1000**
Class 3	**No limit**

Table 5 contains a preliminary list of AGN-201M reactor facility impacted areas and survey units. This list is based on use history and previous monitoring records. Screening surveys, conducted during removal of furnishings, materials, and equipment from the facility support the recommended classifications.

Table 5. Impacted Areas and Survey Units

Class	Level	Room(s)	Surfaces	Number of Survey Units
Class 1	Ground	61A	Floor and lower walls	1
	Ground	61B	Floor and lower walls	1
	First	135	Floor and lower walls	2
Class 2	Ground	61A and 61B	Upper walls and ceiling	1
Class 2	First	135	Upper walls and ceiling	1
Class 3	Ground	60C	All	1

6.0 SURVEY APPROACH

6.1 General

This survey plan was prepared in accordance with guidelines and recommendations, presented in the Multi-Agency Radiation Survey and Site Investigation Manual. The process described in this reference emphasizes and incorporates the use of Data Quality Objectives and Data Quality Assessment, along with a quality assurance/quality control program. A quality assurance program for survey activities will be implemented. The graded approach is followed to assure that survey efforts are maximized in those areas having the greatest potential for residual contamination or the highest potential for adverse impacts of residual contamination.

Trained and qualified radiological technicians will conduct field measurements, following standard procedures and using calibrated instruments, sensitive to the potential contaminants. Professional health physics personnel will assess and evaluate the survey data and prepare a report of the findings.

6.2 Site Preparation

Furnishings, materials and equipment have been removed from the facility in accordance with TAMU Radiation Safety Program procedures. Following removal and transfer of the reactor and associated components, drains, ducts, diffusers, grates, cable trays, etc., were accessed and surveyed. Nominal 100 cm^2 dual phosphor detectors (Ludlum Instruments Model 43-93) have been used with dual channel scaler/ratemeters (Ludlum Instruments Model 2360) for health physics surveys conducted in support of defueling and cleanup work. Note that background and efficiencies for these scintillation detectors are identical to the gas flow proportional detectors selected for final status surveys. Use of the model 43-93 scintillation detectors was augmented with thin-window “pancake” Geiger-Mueller detectors with scaler/ratemeters (Ludlum Instruments Model 43-9 detectors with Model 3 scaler/ratemeters) to access smaller diameter penetrations (e.g., used for electric cables, water supply lines, natural gas lines, etc). To date, no building surfaces have been found to contain detectable residual activity, with MDC’s well below the NRC and TAMU release criteria as presented in Table 2 and no remediation has been required. Building surfaces have been appropriately gridded to provide a means for referencing survey locations. Measurements will be identified by grid coordinate or, if not practical, by referencing to building features or by photograph. Surfaces where contamination was deemed likely (Class 1) or possible (Class 2) have been gridded at 1-meter intervals, as is practical for the conditions. Grid origins are in the southwest corner of the room. If, during the survey, contamination above limits is identified in Class 2 or Class 3 areas, the rigor of the survey unit will be increased to that of Class 1 areas.

6.3 Integrated Survey Strategy

Radiological surveys will consist of:

- surface scans for elevated levels of gross alpha, beta, and gamma radiation levels,
- static measurements of gross alpha and gross beta activity,
- smears for removable gross alpha and gross beta activity, and
- sampling for laboratory analysis of specific radionuclide contaminants, if net activity is found

Based upon facility history and surveys performed in support of reactor disassembly and removal of the shield tank, the rigor of surveys will follow a graded approach based on the likelihood of contamination. Table 6 indicates the survey rigor for various contamination classifications.

Table 6. Survey Rigor for Each Survey Unit

Contamination Class	Alpha, Beta, and Gamma Scan	Static Alpha and Beta	Removable Alpha and Beta
1	100% - all structure surfaces	Systematic static measurement at a minimum of 18 locations and at additional locations of highest potential contamination, based on professional judgment and scan results	At each static measurement location
2	50% - floor and lower walls; 10% upper walls and ceiling surfaces	Systematic static measurement at a minimum of 18 locations and at additional locations of highest potential contamination, based on professional judgment and scan results	At each static measurement location
3	10 % - floor and 1 m^2 around each static measurement location on lower walls	One floor measurement and 1 lower wall measurement per 10 m^2 of floor area in each room, and measurements and at additional locations of potential contamination, based on professional judgment and scan results (minimum of 18 data points per survey unit).	At each static measurement location

Because the acceptable release criterion of twice background is low, Scenario B, as recommended by NUREG-1505 (Ref 4), is the basis for the survey design. The Null Hypothesis for that Scenario is:

"The survey unit meets the release criterion."

The objective of the release survey is to accept this Null Hypotheses, by demonstrating at a Type I (α) decision error level of 0.05 and a Type II (β) decision error level of 0.025 that residual contamination is less than twice background. There are multiple building surface types (concrete, metal, wood, glass, etc.) in most survey units and, background levels will likely vary, by instrument, material, time of day, and location within the facility. To facilitate adjusting measurements for appropriate localized background contributions, a paired measurement approach will be used. To perform paired measurements, a measurement is first performed by placing a piece of nominal ¼-inch plastic or metal shield material, between the surface and the Ludlum 43-68 detector face. The static measurement is repeated without the intervening shield material, and the difference between the second and first measurement indicates the net contamination level.

Each measurement will be individually evaluated and no individual measurement may indicate detectable activity in excess of the project limits (e.g., all net measurements must be less than the 3 alpha and 250 beta cpm nominal count rates as measured with the 43-68 detectors the more restrictive TAMU limits). No statistical test will be required to demonstrate compliance with release criteria.

To establish the number of measurements needed to demonstrate that residual contamination criteria have been satisfied, a parameter known as the "relative shift", which effectively describes the distribution of final sample data, is calculated, as follows:

(1) Δ/σ = (DCGL-LBGR)/ σ

where:

Δ/σ	=	relative shift
DCGL Criteria	=	cleanup criteria
LBGR	=	lower bound of the gray region and is defined in the DQOs as 50 percent of the DCGL. Where final sample data are not yet available, MARSSIM guidance (Section 5.5.2.2) assigns a value of one-half of the DCGL for the LBGR.
σ	=	standard deviation of the sample concentrations in the survey unit. Where final sample data are not yet available, MARSSIM guidance (Section 5.5.2.2) recommends a value of 30 percent of the DCGL.

Using the equation for relative shift and MARSSIM guidance for situations where final sample data are not yet available, the relative shift for design purposes is (1 – 0.5)/0.3 for a value of1.67. Based on the relative shift of 1.67 and Type I and Type II decision errors of 0.05 and 0.025, respectively, the number of required data points from each survey unit to perform the evaluation, as obtained from MARSSIM guidance (Table 5.5) is 18.

For static measurement locations on Class 1 and Class 2 room surfaces, a random start point will be identified on the floor and additional measurement locations will be systematically selected on a triangular spacing from that start point. Spacing distance, L, is determined by

$$L= [(\text{Survey Unit Area})/0.866 \times \text{number of data points}]^{0.5}$$

Internal surfaces of ductwork and piping will be accessed, scanned, and static measurements performed at the entrance and discharge and additional points at a frequency of 1 measurement per 4 m^2 of internal surface area.

Static measurement locations on Class 3 room surfaces will be at locations of highest contamination potential, as selected by professional judgment.

6.4 FSS Survey Instrumentation

Table 7 is a list of radiological survey instrumentation that will be used to implement the AGN-201M reactor facility surveys. These instruments will be maintained, calibrated, and operated in accordance with written procedures. For application to unrestricted release, instrument response (efficiency) is based on NIST–traceable sources of Tc-99 (beta E_{MAX} = 292 keV) and Th- 230 (alpha E = 4.68 MeV). The energies of these radionuclides are representative of the dominant potential contaminants. Note that the 126 cm^2 43-68 gas flow proportional detectors have detector efficiencies and ambient background count rates that are identical to the 100 cm^2 43-93 dual phosphor scintillation detectors used for health physics surveys during facility preparations for release; survey data are directly comparable.

Table 7. Instrumentation for Release Surveys

Detector	Display	Application
Ludlum 43-37	Ludlum 2360	Alpha /beta scans
Ludlum 43-68	Ludlum 2360	Alpha/beta scans
Ludlum 43-68	Ludlum 2360	Alpha/beta static measurements
Ludlum 43-10	Ludlum 2929	Removable alpha/beta measurements (scaler)
Ludlum 19	N/A	Gamma scans/direct gamma measurements

For field measurement applications, calibration represents 2π response. Effects of surface conditions on measurements are integrated into the overall instrument response through use of a "source efficiency" factor, in accordance with the guidance in ISO-7503-1 (Ref 7) and NUREG/CR-1507 (Ref 8). Default surface efficiencies of 0.25 for alpha emitters and 0.25 for beta emitters will be used.

Detection sensitivities are estimated using the guidance in MARSSIM and NUREG/CR-1507. Instrumentation and survey techniques are chosen with the objective of achieving detection sensitivities of $\leq$50% of the criteria for structure surfaces, for both scanning and direct measurement. These detection sensitivities assure identification of areas potentially exceeding the established project criteria. Minimum detectable activity levels (refer to Appendix A) for this survey satisfy the Table 1 values.

6.5 Surface Scans

Scans of surfaces will be performed to identify locations of potential residual surface contamination and induced activity. Gas proportional detectors will be used for alpha and beta scans. A Ludlum Model 43-37 gas proportional detector (580 cm^2) will be used with a Ludlum Model 2360 scaler/ratemeter to scan the floor surfaces. Surfaces not accessible with this large detector will be scanned with the smaller Ludlum Model 43-68 gas proportional detectors (126 cm^2) used with Ludlum Model 2360 scaler/ratemeters. Alpha/beta scanning will be performed by maintaining the detector within ¼ inch of the surface and passing the detector over the surface at a rate of approximately ½ detector width per second, while monitoring the audible output of the scaler/ratemeter for immediate identification of increases in count rate. When 2 alpha counts are detected within approximately 2 seconds, the detector movement will be halted at the location for approximately 10 seconds to detect a possible elevated count rate. This is consistent with Appendix J guidance in the MARSSIM document (NUREG 1575).

A Ludlum Model 19 gamma scintillation detector will be used for gamma scans. General area gamma monitoring will be performed with the detector approximately 1 m above the floor.

6.6 Static Surface Activity Measurements

Static measurement of alpha and beta surface activity will be performed using Ludlum Model 43-68 gas proportional detectors with Ludlum Model 2360 scaler/ratemeters. Measurements will be conducted by holding the detector in position within ¼ inch of the surface and integrating the count over a 2-minute period. Two measurements, 1 shielded and 1 unshielded, will be performed at each static measurement location, with the net count rate being the difference between the two measurements, for alpha and beta detection.

6.7 Removable Contamination Measurements

A smear for removable activity will be performed at each static surface activity measurement location. A 100 cm^2 surface area will be wiped with a nominal 2-inch diameter cloth smear, using moderate pressure.

6.8 Samples and Analyses

Smears will be analyzed onsite for gross alpha and gross beta activity using a Ludlum Model 2929 scaler with a Model 43-10-1 dual scintillation detector (or equivalent instrumentation).

6.9 Quality Assurance/Quality Control

Measurements will be performed in accordance with the survey plan by qualified personnel following written instrument operating procedures. Instrument calibration practices meet ANSI standards and daily background and source response checks of instruments will be performed daily. For quality control purposes, replicate static and removable activity measurements were obtained at 2 locations in each survey unit.

7.0 DATA EVALUATION

Surface contamination measurement data will be adjusted for background contributions and converted to units of net counts per minute. Data will be assessed to verify that the type, quantity, and quality are consistent with the survey plan and design assumptions. Individual data values will be compared with the count rate limit derived from NUREG 1757 surface contamination screening values for ^{60}Co and the TAMU criteria of twice background. Residual contamination limits established for the project (see Section 4) are presented in Table 3, including a comparison of the TAMU limits and the NRC screening values.

Evaluation of volumetric sample data is discussed in Section 4, Radionuclide Contaminants and Criteria

8.0 ISOLATION AND CONTROL

Following completion of the release survey, the facility will be isolated and access controlled until NRC approval for unrestricted release is received. It is recognized that the NRC may choose to conduct independent surveys to confirm the findings of this survey. These areas will not be available for general access or work until NRC approval for unrestricted release is obtained.

9.0 REPORT

A draft report describing the survey procedures and findings will be prepared. This report will stand alone and provide a complete record, documenting the facility's radiological status satisfies established project criteria and that the facility is therefore ready for unrestricted release. Appendix B is a sample of the report content. The report will include all sample data supporting this determination. Comments on the draft report will be resolved and a final report prepared and submitted to the NRC for review and approval.

10.0 REFERENCES

1. Radiological Safety Program Manual, Radiological Safety Environmental Health and Safety Department, Texas A&M University, July 2004.
2. Texas Regulations for acceptable contamination levels for unrestricted use, 25 TAC§289.202(ggg)(6).
3. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575 (Rev. 1), U.S. Nuclear Regulatory Commission, 2000.
4. A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys, NUREG-1505 (Rev 1) U.S. Nuclear Regulatory Commission, 1998.
5. Evaluation of Surface Contamination – Part 1: Beta Emitters and Alpha Emitters, ISO- 7503-1, International Organization for Standardization, 1988.
6. Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, NUREG/CR-1507, U.S. Nuclear Regulatory Commission, 1997.
7. Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria, NUREG-1757, Vol. 2, Rev. 1, U.S. Nuclear Regulatory Commission, 2006.

Appendix A

Measurement/Detection Sensitivities of Survey Techniques

The methods for calculating survey detection sensitivities are presented in MARSSIM (Ref 1) and NUREG-1507(Ref 2). Detector parameters used in these calculation are background count rate, efficiency (instrument response and surface correction factors), and detector area. The following table presents typical values of these parameters for detectors used for surveys of concrete structure surfaces of the AGN reactor facility. Background levels for concrete are the highest for surface media remaining in this facility, and therefore direct measurements on other media will be more sensitive than those presented here for concrete.

Detector/ Instrument	Probe Area (cm^2)	Background (cpm)		Detector efficiency		Surface correction	
		alpha	beta	alpha	beta	alpha	beta
43-37	580	9	300	0.50	0.46	0.25	0.25
43-68	126	3	250	0.36	0.36	0.25	0.25
2929	N/A	1	25	0.25	0.20	N/A	N/A

Alpha Scans

Surface scans for alpha activity are conducted using Ludlum Model 43-37 and Model 43-68 gas proportional detectors, coupled with Ludlum Model 2360 scaler/ratemeters. MARSSIM recommends the use of Poisson summation statistics to estimate the probability of detecting a small number of counts that may indicate the possible presence of alpha contamination during a relatively short observation period. The equation for estimating the probability of detecting 1 or more counts is:

$$P(n\geq 1) = 1 - e^{-[((GE + B)t))/60]}$$

where:

$P(n\geq 1)$ = Probability of getting 1 or more counts during the time interval
$\underline{G}$ = Source activity (disintegrations per minute, dpm)
B = Background count rate (counts per minute, cpm)
E = Detector efficiency (counts/disintegration)
t = Dwell time over source (sec)

The probability of detecting 2 or more counts is given by:

$$P(n\geq 2) = 1 - (e^{-[((GE + B)t)]/60]} - ((GE+B)(t))/60).\ e^{-[((GE + B)t)]/60]}]$$

Using these parameters, detection probability calculations for a contamination level of 100 dpm/100 cm^2were performed for a scan rate of ½ detector width per second (i.e., dwell times of 2 seconds) The probabilities of detecting a single alpha count during a 2-second dwell time are approximately 33% for the 43-68 detector and 52% for the 43-37 detector. Because of the higher background count rate associated with the 43-37 floor monitor detector, MARSSIM (Appendix I) recommends using 2 counts as a screening value when scanning for alpha contamination. The probability of detecting 2 counts with the larger detector increases to approximately 82%. Whenever a count is detected, the detector is paused over the surface for 10 seconds to determine whether there is actually elevated alpha activity present, in which case, a static measurement is then performed. A 10 second pause results in a 90% or greater probability of identifying the presence of alpha activity exceeding 100 dpm/100 cm^2. Although the calculated scan detection probabilities may appear relatively low, it should be noted that historic records and characterization surveys have not identified any potential for alpha contamination in this facility.

Alpha Activity Static Measurements

Static measurements of alpha surface activity are performed using 43-68 detectors, with the same background and response characteristics as indicated above for alpha scanning. A static measurement is performed by placing the detector on the surface and allowed to integrate the count for a period of 2 minutes. The minimum detectable alpha contamination level (MDC) is calculated as follows:

MDC = $[3 + 4.65\ (BKGD)^{1/2}]$/(efficiency factors)(detector area/100)(count time)

The resulting value is approximately 63 dpm/100 cm^2.

Beta Scans

Surface scans for beta activity are conducted using Ludlum Model 43-37 and Model 43-68 gas proportional detectors, coupled with Ludlum Model 2360 scaler/ratemeters. The detector is passed over the surface at a rate of 1/2 detector width/sec, while maintaining the distance from the detector to the surface at approximately 0.5 cm. The audible signal from the instrument is monitored by the surveyor. Detectable changes in the count rate are noted, and the immediate area resurveyed at a reduced speed to confirm the change in audible signal and, if applicable, to identify the boundary of the impacted area. The minimum detectable count rate (MDCR) is a function of the background count rate (BKGD) in counts per minute (cpm) and the time (i) in seconds that the detector is within close proximity to the source of radiation. Equation 6-6 of NUREG-1507 provides the following relationship:

$$MDCR = d' [BKGD*i/60]^{1/2} * 60/i$$

A high probability (95%) of true detection is the objective, and the survey is willing to accept a high probability of false-positive detections (60%) with resulting investigations. The value of d' is selected from Table 6.1 in NUREG-1507 to be 1.38.

To account for less than ideal survey performance, a surveyor efficiency factor (p) of $(0.5)^{1/2}$ was also incorporated into the final calculation of beta scan sensitivity as follows:

$$\frac{\text{MDCR}}{(0.5)^{1/2} *(\text{cpm/dpm})(\text{probe area}/100)} \qquad \text{(B2)}$$

The resulting values are approximately 1500 dpm/100 cm^2 for the 43-68 detector and an average of 390 dpm/100 cm^2 for the 43-37 detector. If only a single 100 cm^2 area is present, the scan sensitivity for the 43-37 detector would be approximately 2280 dpm.

Beta Activity Static Measurements

Static measurements of beta surface activity are performed using 43-68 detectors. A static measurement is performed by placing the detector on the surface and allowing it to integrate the count for a period of 2 minutes. The minimum detectable beta contamination level (MDC) is calculated as follows:

$$\text{MDC} = [3 + 4.65\ (\text{BKGD})^{1/2}]/(\text{efficiency factors})(\text{detector area}/100)(\text{count time})$$

The resulting value is approximately 470 dpm/100 cm^2.

Removable Alpha and Beta Activity Measurements

Smears for removable activity are counted for 2 minutes in a Ludlum Model 2929 alpha/beta counter. The backgrounds are 1 alpha cpm and 25 beta cpm; 4π detection efficiencies are 0.25 alpha and 0.20 beta. Using the same equation (without probe area correction) as above for direct measurements yields removable activity MDCs of approximately 19 alpha dpm/100 cm^2 and 90 beta dpm/100 cm^2.

References

1. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575 (Rev. 1), US Nuclear Regulatory Commission, 2000.
2. Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, NUREG/CR-1507, US Nuclear Regulatory Commission, 1997.

APPENDIX B

Sample Outline of Release Survey Report

1.0 Executive Summary
2.0 Introduction
3.0 Purpose and Scope
4.0 Site Description
5.0 Radionuclide Contaminants and Criteria
6.0 Survey Approach
7.0 Survey Results Summary
8.0 Conclusion
9.0 References

Attachments

Field data (electronic)