

# UNIVERSITY *of* MISSOURI

ENVIRONMENTAL HEALTH AND SAFETY

**TO:** Ms. Katie Streit  
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Materials Control, ISFSI, and Decommissioning Branch  
Division of Nuclear Materials and Safety  
Region III  
U.S. Nuclear Regulatory Commission  
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**FROM:** Mr. Jack Crawford  
Radiation Safety Officer / Assistant Director  
Environmental Health & Safety  
University of Missouri – Columbia  
Columbia, MO 65211-3050

**DATE:** February 17, 2011

**SUBJECT:** Request for Pickard Hall Alternate Decommissioning Schedule

Dear Ms. Streit:

Pickard Hall, located at 405 S. Ninth Street on the University of Missouri (MU) campus in Columbia, MO, contains residual radioactivity in some lightly occupied areas. Residual materials originated from operations performed in the early 1900's involving extraction of radium-226 from uranium ores and research involving Th-232 daughters. Initial characterization results indicate that the facility does not meet NRC screening values for unrestricted release in some areas and a formal NRC-approved Decommissioning Plan (DP) will be required. Originally the Chemistry Building, Pickard is currently being used as the Museum of Art and Archaeology, and houses the Department of Art History and Archaeology. The building is listed on the National Register of Historic Places.

Considering the educational, cultural, and historical value of the museum and building, it is in the best interest of the public to delay initiation of remediation. As you can see from the attached documentation, MU is confident that residual materials can be safely managed in place under the existing broad scope NRC license, and requests approval of alternate schedule for submittal of a DP per 10 CFR 30.36 (g) (2).

MU requests that the submittal of a DP be delayed until MU is able to move the museum or conditions arise that would warrant notifying the NRC. The attached documentation describes examples of such conditions. To ensure that Pickard Hall receives continued attention, we will review the status of Pickard Hall as well as other Decommissioning activities as part of MU's radiation safety's program annual internal audit. In addition, we propose that the status of



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*Missouri's Flagship University*

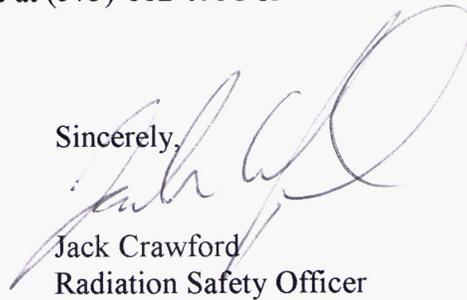
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Pickard Hall can also be reviewed each time our broad scope license is renewed. Our next renewal is scheduled for 2014.

We feel this request for an indefinite alternate schedule for submitting a DP is necessary to the effective conduct of decommissioning operations, would allow a more comprehensive characterization of Pickard over time, presents no undue risk from radiation to the public health and safety, and is in the public interest.

If you have any questions or concerns please contact me at (573)-882-0931 or [crawfordw@missouri.edu](mailto:crawfordw@missouri.edu).

Sincerely,



Jack Crawford  
Radiation Safety Officer

Attachments

cc: J. Jones  
S. Jurisson  
P. Ashbrook  
RSO File



# **Alternate Decommissioning Schedule Justification**

**Pickard Hall  
405 S. Ninth Street  
Columbia, MO 65211-1420**

**February 17, 2010**

**Submitted by:**

**University of Missouri  
Environmental Health and Safety  
# 8 Research Park Development Building  
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## TABLE OF CONTENTS

<b>1.0</b>	<b>INTRODUCTION .....</b>	<b>1</b>
<b>2.0</b>	<b>SITE DESCRIPTION.....</b>	<b>2</b>
<b>3.0</b>	<b>RADIOLOGICAL STATUS.....</b>	<b>3</b>
3.1	Surface Contamination .....	4
3.2	Airborne Radioactivity .....	5
3.3	Indoor Radon .....	5
3.4	External Dose Rates.....	6
3.5	Personnel External Dosimetry .....	6
3.6	Outdoor Areas.....	6
<b>4.0</b>	<b>HEALTH AND SAFETY PROGRAM.....</b>	<b>7</b>
4.1	Engineering Controls .....	8
4.1.1	Encapsulation.....	8
4.1.2	Soil Removal.....	8
4.1.3	Shielding .....	8
4.2	Administrative Controls.....	9
4.2.1	Training and Communications.....	9
4.2.2	Posting and Labeling .....	9
4.2.3	Area Security and Access Controls.....	9
4.2.4	Inspections and Surveillance.....	9
4.2.5	Operations and Maintenance Procedures.....	9
4.2.6	Dosimetry Monitoring .....	10
4.2.7	Radon Monitoring.....	10
4.2.8	ALARA Limit.....	10
4.3	Periodic Reviews .....	10
4.4	Changing Conditions .....	10
<b>5.0</b>	<b>FINANCIAL ASSURANCE .....</b>	<b>10</b>
<b>6.0</b>	<b>PUBLIC INTEREST .....</b>	<b>11</b>
<b>7.0</b>	<b>COMPLIANCE HISTORY .....</b>	<b>12</b>
<b>8.0</b>	<b>REFERENCES.....</b>	<b>13</b>

## ATTACHMENTS

- Attachment 1 – Pickard Hall Radon Monitoring Results
- Attachment 2 – Pickard Hall TLD Monitoring Results

## 1.0 INTRODUCTION

Pickard Hall, located at 405 S. Ninth Street on the University of Missouri (MU) campus in Columbia, MO, contains residual radioactivity above NRC screening values in some lightly occupied areas. Residual materials originated from operations performed in the early 1900's involving extraction of radium-226 from uranium ores and research involving Th-232 daughters. Originally the Chemistry Building, Pickard is currently being used as the Museum of Art and Archaeology, and houses the Department of Art History and Archaeology. The building is listed on the National Register of Historic Places.

These materials recently became licensed by the US Nuclear Regulatory Commission (NRC) under broad scope license number 24-00513-32 as a result of implementation of the NRC's expanded definition of byproduct material (NARM Rule). NRC guidance documents (including timeliness) are written from the perspective that materials were initially licensed by the NRC and facilities are operated according to NRC guidance, including decommissioning recordkeeping and financial assurance. With the sudden placement of materials in NRC jurisdiction, MU found itself in a position of impossibility to meet NRC requirements for decommissioning timeliness. Because materials were used over a century ago and activities ceased in the 1930s, records were not kept according to NRC decommissioning recordkeeping requirements, and the materials were not included in MU's broad scope license decommissioning funding plan (DFP), therefore the University did not have adequate information to plan decommissioning of Pickard.

MU submitted notification of their intent to decommission Pickard on November 16, 2009, indicating that the schedule for commencement of decommissioning activities was not certain due to the complexity of the project, and that MU would conduct additional assessments and keep the NRC informed of progress. Radiological characterization activities commenced in December 2009. The NRC inspected Pickard on January 26 and 27, 2010, reviewed preliminary characterization survey results, and performed confirmatory radiological measurements. Inspection results are contained in "NRC Reactive Inspection Report 030-02278/10-01(DNMS) – University Of Missouri" dated February 24, 2010. In the report, the NRC noted that MU had taken appropriate actions to control restricted areas, and that the licensee's and NRC's survey results indicated no person or area had exceeded public dose limits.

MU has spent more than the past year characterizing Pickard Hall to collect information important to decommissioning and updating their DFP to include Pickard Hall. Initial characterization results indicate that the facility does not meet NRC screening values for unrestricted release in some areas and a formal NRC-approved Decommissioning Plan (DP) will be required. MU is monitoring and controlling impacted areas to comply with occupational and public dose limits. Most of the activity is contained in basement

mechanical rooms and storage areas, in the unfinished attic, inside unused brick ducts, and in drain piping under the basement floor.

The Museum of Art and Archaeology has a growing collection and is extensively used for educational and research purposes by MU students, faculty and staff. Discussions about finding a location with more space have begun. Remediation and decommissioning of Pickard Hall at the time of the Museum's move to a new building would minimize risk to the collections and significantly reduce the costs. Meeting the decommissioning timeliness requirements would require closing of the museum (either permanently or temporarily), and either selling the artifacts, or exposing them to considerable risk of damage during movement and in interim storage at a location not specifically designed to meet the stringent environmental conditions necessary to assure their protection and preservation. Moving the artifacts is estimated to cost in excess of one million dollars and take several months to complete. Moving the artifacts to interim storage during a temporary closure of the museum would require artifacts to be relocated at least two times, and subject these unique and valuable items to unnecessary risk of damage.

Considering the educational, cultural, and historical value of the museum and building, it is in the best interest of the public to delay initiation of remediation. MU is confident that residual materials can be safely managed in place under the existing broad scope NRC license, and requests approval of alternate schedule for submittal of a DP per 10 CFR 30.36 (g) (2) until the building no longer houses the museum, or there is significant change in the radiological conditions, upon which MU will provide notice to the NRC within 60 days of occurrence. MU cannot definitively estimate how long it will take to identify a new location for the museum, perform the necessary building preparations, and move the museum out of Pickard Hall. Therefore, MU requests that submittal of a DP be delayed indefinitely subject to periodic review by the NRC to coincide with broad scope license renewal. This alternate schedule is necessary to the effective conduct of decommissioning operations, presents no undue risk from radiation to the public health and safety, and is in the public interest.

## **2.0 SITE DESCRIPTION**

Pickard Hall, built in 1892 as the Chemistry Building, is located on Ninth Street in the Francis Quadrangle area of the MU campus. The building has a footprint of 8,400 square feet with approximately 24,600 gross square feet of floor area over three elevations (not including the attic). In the early 1900s, a faculty researcher extracted and purified salts of radioactive elements from ores (extracted radium-226 from uranium ores), and conducted research involving Th-232 daughters in basement laboratories until the 1930's. The processes and areas of usage are generally known to MU staff. Other areas of the building were also laboratories. A major renovation was conducted in 1974 and the Museum of Art and Archaeology moved to Pickard in 1976.

The museum is located on the first and second floors, and the basement is used for storage of museum artifacts. Additionally, faculty offices are located on the first floor and in the basement. The brick building sits on a stone and mortar foundation. Originally, the building had wooden floors throughout, including the basement. The current basement floor is poured concrete with tile and carpet coverings. It is suspected, but not known for certain, that the concrete floor is original to the building and that the wooden floors were installed on top of the concrete. Floors on the first and second elevations are primarily carpeted with stone/ceramic tiled foyers and restrooms. Interior walls are plaster and sheetrock. The interior of the facility underwent a major renovation in 1974 that resulted in minor changes to the layout of the basement. Some windows on the basement and first floors and all windows on the second floor have been covered on the inside to prevent ultraviolet damage to artifacts. The entire ventilation system has been upgraded since the cessation of use of licensed materials; some original ventilation ducts remain, but are not in use. Original drains were terminated at floor level and grouted or re-used.

### 3.0 RADIOLOGICAL STATUS

MU procured Chase Environmental Group, Inc. (Chase) to conduct an initial characterization of accessible surfaces of the facility to the extent possible without interfering with museum operations (without moving artifacts, causing excess vibration, etc.). Characterization was performed to determine the extent and magnitude of residual radioactivity to support decommissioning planning, and to evaluate radiological exposures to building occupants and visitors. Characterization was an iterative process that was performed from December 2009 to June 2010 over five separate mobilizations.

Chase surveyed accessible portions of the entire facility including all elevations, the attic, the roof, steam tunnel feeder, and outside grounds. Characterization consisted of the following types of measurements:

- Indoor surface scans for alpha and beta emissions using gas flow proportional detectors (100% of accessible surfaces < 2m height)
- Indoor surface scans for gamma emissions using a 2" x 2" sodium iodide detector at a distance of 10 cm (100% of accessible surfaces < 2m height)
- Indoor large area wipes for alpha and beta removable activity (100% of accessible floor surfaces)
- At locations of elevated activity identified during indoor scans:
  - Static measurements for alpha and beta total surface activity
  - Static measurements for gamma emissions at a distance of 10 cm
  - External dose rate measurements at a 1 meter distance
  - Disc smears for alpha and beta removable activity
- Solid samples of concrete surfaces for gamma spectroscopy analysis (a subset of samples was also analyzed by alpha spectroscopy analysis)

- Solid samples of contaminated brick ducts and wood flooring in the attic.
- GPS-correlated gamma scans of outdoor areas
- Surface soil samples for gamma spectroscopy analysis (a subset of samples was also analyzed by alpha spectroscopy analysis)
- Sampling for airborne radioactivity

Based on gamma spectroscopy and alpha spectroscopy analysis of soil and concrete samples collected during characterization, the nuclides of concern are U-238, Th-232 and their progeny, particularly Ra-226.

Residual radioactivity in the building is contained primarily in two locations with limited occupancy – in the attic and in the basement storage and mechanical rooms. In the basement, there is likely distributed surface contamination on floor surfaces as well as buried drain lines with residual radioactivity, based on surface measurements and the linear geometry of elevated gamma measurements. The attic has residual radioactivity on surfaces and in open brick ducts. These ducts are within walls and likely extend to the basement, and may be a source of slightly elevated dose rates in limited areas on all elevations.

There were two small areas of residual radioactivity in surface soils of outside grounds that were remediated and the buried sewer discharge from the building appears to contain elevated activity. There may also be subsurface soil contamination under the basement floor.

Residual materials are effectively encapsulated based on removable contamination measurements. Low levels of detectable removable contamination were found in the attic and mechanical areas in the basement where there is low occupancy. Some areas of the building do not meet the decommissioning criteria for unrestricted use (based solely on external dose rates and the occupancy assumption of the building occupancy scenario of 2340 hrs). Occupied areas meet the public dose limits based on removable contamination results, dose rates and conservative occupancy assumptions, except Room 27 (office) and Room 12 (storage). However, MU is controlling access to these areas, and providing radon and external dosimetry monitoring sufficient to ensure public dose limits are met in unrestricted areas.

The “Pickard Hall Characterization Survey Report” dated July 16, 2010 was submitted to NRC Region III. A summary of the results is provided below.

### **3.1 Surface Contamination**

Elevated residual surface activity exists in infrequently occupied basement storage and mechanical rooms, a basement office, on attic floors and on brick duct internals. Very low levels of removable activity are present in the building. All routinely occupied areas have non-detectable levels of removable surface activity. Removable alpha activity was

only detected in a basement mechanical room, inside brick ducts in the attic, and at two locations on attic wooden floors.

Total surface activity (fixed + removable) exists up to 4.7K dpm/100cm<sup>2</sup> alpha and 14K dpm/100cm<sup>2</sup> beta-gamma on attic wooden floors, and up to 1.4K dpm/100cm<sup>2</sup> alpha and 145K dpm/100cm<sup>2</sup> beta-gamma in basement areas. Many beta gamma surface activity results are biased high due to the influence of emissions from residual activity below the surface being measured. Many areas had elevated beta-gamma activity during scans, but no detectable alpha activity, indicating that residual radioactivity is covered (most areas of elevated activity are covered by vinyl floor tiles and are effectively encapsulated).

All of the removable radioactivity measurements collected on building structural surfaces were less than the analysis MDC (20 dpm/100cm<sup>2</sup> alpha and 122 dpm/100cm<sup>2</sup> beta-gamma), except:

- 29 dpm/100cm<sup>2</sup> alpha in a basement mechanical room that was subsequently encapsulated
- Up to 251 dpm/100cm<sup>2</sup> alpha and 524 dpm/100cm<sup>2</sup> beta-gamma inside two adjacent brick ducts in the attic (Note: Attic is Restricted Access)
- Up to 24 dpm/100cm<sup>2</sup> alpha on two locations on the attic wooden floor (Note: Attic is Restricted Access)

### 3.2 Airborne Radioactivity

Surface contamination measurements indicate that materials are tightly bound and are not available to become airborne in occupied areas under normal conditions. Air sample results in the attic and basement were less than the MDC of 2.3E-14 µCi/ml gross alpha (more than four orders of magnitude less than the Ra-226 DAC of 3E-10 µCi/ml). Concrete sample analysis indicates that the sum of the U-238 and Th-232 activity concentrations is about an order of magnitude less than the Ra-226 activity concentration.

### 3.3 Indoor Radon

The presence of licensed radium as a building contaminant is a potential (albeit small) source of radon and radon progeny. MU conducted radon analysis in representative areas of Pickard Hall and the results indicate that radon exposures originating from licensed materials are *de minimus*.<sup>1</sup> It is not practical or even possible at this time to model the radon concentration (from licensed sources) in Pickard Hall. However, MU collected 19 long term radon tests throughout Pickard Hall during 2008 and 2009 utilizing Landauer RadTrak alpha track detectors. The tests were a mixture of 90 day and year-long tests; with the 90 day tests taken over the winter months, adding additional conservatism.

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<sup>1</sup> The NRC's position on this subject is illustrated in a letter from the Director of the Division of Radiation Protection and Emergency Preparedness (Frank J. Congel) to the Directors of each of the NRC Regions dated November 26, 1990. (ML 103470215)

Comparing these test results with the predicted average radon concentration for Boone County, MO provides reasonable assurance that radon and radon progeny from licensed sources are negligible. The EPA classifies Boone County as Zone 2 with respect to radon, with a predicted average indoor radon levels of between 2 and 4 pCi/L.<sup>2</sup>

The mean for radon test results evaluated by Landauer is 2.2 pCi/L with a maximum value of 7.3 pCi/L, a minimum of 0.3 pCi/L, and a standard deviation of 1.6 pCi/L. The 7.3 pCi/L result was from a mechanical space that is managed as a restricted area and has exceedingly low occupancy. Eliminating this outlier from the data set results in a mean of 1.9 pCi/L, maximum of 4.0 pCi/L, and a standard deviation of 1.0 pCi/L. While conceding that the EPA's predicted average indoor radon concentrations for Boone County, MO are just predictions; it is clear from empirical, long-term testing that the average radon concentrations in Pickard Hall are at or below the bottom of this predicted range and any licensed material in Pickard Hall is an insignificant contributor to indoor radon and radon progeny.

### 3.4 External Dose Rates

Dose rate measurements were performed with a tissue equivalent Bicron MicroRem meter. Dose rates were performed at each static measurement<sup>3</sup> location at a distance of one meter from the source (midpoint of a receptor). Additionally, the occupancy required at each location to achieve external doses of 100 mrem/yr was calculated. Room 27 (office) and Room 12 (storage room) in the basement are the only rooms that would result in an external dose of 100 mrem/yr or more with less than 2500 hours per year of occupancy. This is based on measurements at the highest areas of residual radioactivity, so they are conservative in that an occupant would not spend all of their time in one location. MU controls both of these rooms as restricted areas and occupants of the building are trained as occupational radiation workers and are monitored with thermoluminescent dosimeters (TLDs). Additionally, MU has installed permanent shielding on a portion of the floor over a suspected contaminated drain pipe in Room 27 to further reduce dose rates.

### 3.5 Personnel External Dosimetry

Building occupants are trained as occupational radiation workers and are monitored with TLDs on a quarterly basis. All deep dose equivalent (DDE) results for 2010 were non-detectable except that one quarterly DDE result for one occupant was 10 mrem.

### 3.6 Outdoor Areas

Initially, surface soil samples were collected at four discreet locations in outside grounds surrounding the building. Two of the samples were at small (up to a few square feet) areas of elevated activity detected by a sustained increase in the count rate during gamma scans. Six background surface soil samples were collected in the Quadrangle. Gamma

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<sup>2</sup> <http://www.epa.gov/radon/zonemap.html>, and <http://epa.gov/radon.states/images/missouri.gif>.

<sup>3</sup> Static measurement locations were primarily at areas of elevated activity identified during scans.

spectroscopy results were used to select a subset of three background samples and three soil samples for uranium and thorium isotopic analysis by alpha spectroscopy.

The two small areas of elevated activity were directly under the roof gutter at the corner of the building and are assumed to have become contaminated by water dripping from the gutter seam many decades ago. The areas were removed to a one foot depth and a sample was collected at the bottom of each excavation. Radium-226 concentrations dropped about a factor of three or more based on soil sample results, indicating that residual radioactivity is not mobile in the environment.

Subsequently, and after removal of the two small areas of surface soil with elevated activity, outdoor gamma scans were performed using GPS mapping to provide visualization of surface gamma radiation levels. Several areas of elevated activity were identified on the GPS Map, all of which were attributed to granite markers and brick pavers, except for in the northwest corner of Pickard where elevated activity had previously been identified. It should be noted that, even though elevated radiation levels were identified, all of the more than 13,000 measurements were less than twice the background rate.

The information provided by the GPS survey provided input to the design of additional surface soil sampling locations. Nineteen additional samples were collected (two of the samples were a composite of four locations in the Quadrangle). Results were similar to background results. The highest result was 3.2 pCi/g Ra-226 and 1.4 pCi/g Th-232, U-238 was less than the MDC. The highest results for the background sample set was 3.27 pCi/g Ra-226 and 1.17 pCi/g Th-232.

Considering that residual materials are a result of operations that ceased in the early 1900's and there is no evidence of significant migration of contaminants in the environment, it can be safely concluded that materials can be managed under the broad scope license within the time scales associated with an alternate decommissioning schedule with no additional impact to the environment. Additionally, the area is comprised of clayey soils and a deep<sup>4</sup> groundwater aquifer such that groundwater is not impacted by residual radioactivity that may be immediately under the basement floor slab.

#### **4.0 HEALTH AND SAFETY PROGRAM**

MU has an extensive radiation protection program associated with the existing broad scope license that will continue during the extension period to ensure health and safety for employees, the public, and the environment. Considering the scope of MU's existing program, a separate Health and Safety Program (HASP) is not needed to safely manage

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<sup>4</sup> According to US Geological Survey (USGS) monthly groundwater aquifer level measurements over the past ten years in a nearby well, groundwater in the area is 140 ft or more below land surface.

materials at Pickard. MU is controlling invasive activities inside and outside Pickard, and conducting routine monitoring of the building and occupants to continually assess the potential spread of materials and doses to occupants. MU license procedures do not support aggressive remediation activities that may arise as a matter of necessity to support future operations. If aggressive actions involving residual radioactivity are needed to support ongoing operations, MU will amend their license to include such activities, or contract a properly licensed contractor to perform the work.

## **4.1 Engineering Controls**

### **4.1.1 Encapsulation**

During initial characterization surveys, low levels of removable activity were identified on bare concrete floors in basement mechanical rooms 13 and 15. Subsequently, MU encapsulated floor and wall surfaces in these rooms to provide a protective barrier from radioactive materials, and to ensure residual radioactivity would not become removable or become airborne. Wall surfaces were covered with an encapsulant product typically used to encapsulate asbestos. Floor surfaces were encapsulated with an epoxy floor coating that is commonly used for garage floors. A second layer of epoxy with a contrasting color was applied over floor surfaces to provide visual indication of wear. The encapsulant integrity is inspected by MU radiation safety staff concurrently with routine radiological surveys required by the radiation protection program.

### **4.1.2 Soil Removal**

MU had Chase Environmental remove some surface soils in outside grounds and in the steam tunnel feeder. The two small elevated areas of surface soil activity identified during initial characterization were remediated to a depth of approximately one foot. Each excavation was surveyed and sampled after remediation, covered with a geotextile fabric to provide a clear interface, and then backfilled with clean soils provided by MU. The purpose of this remediation was to ensure normal landscaping activities such as thatching and aerating do not disturb soils with residual radioactivity. The steam tunnel feeder floor was removed to a one-foot depth and then covered with geotextile fabric and concrete pavers to allow access for piping inspections without directly contacting radioactive materials.

### **4.1.3 Shielding**

MU has installed permanent shielding in Room 27 on a portion of the floor along the north wall in the form of lead sheets  $\sim\frac{3}{4}$  inch thick by  $\sim 12$  feet long and 4 feet wide to reduce exposure (shine) from a suspected contaminated drain pipe underneath. This  $\frac{3}{4}$  inch of lead shielding has significantly reduce ( $\sim \frac{1}{2}$ ) the external dose rates in the room from the floor.

## **4.2 Administrative Controls**

### **4.2.1 Training and Communications**

Building occupants that require access to restricted areas are provided occupational radiation worker training and are monitored by dosimetry. Non-occupants, such as facilities and maintenance personnel, that require access to restricted areas are briefed and accompanied by radiation safety personnel. The characterization report was provided to building occupants and routine survey results are provided to the Building Coordinator, Chair of Art History and Archaeology, and the Director of the Museum for their review and dissemination as needed.

### **4.2.2 Posting and Labeling**

Areas with residual radioactivity are controlled as restricted areas and occupants are provided occupational radiation worker training. Room 27, basement storage rooms, the steam tunnel feeder, and the attic are controlled as restricted areas and posted as such.

### **4.2.3 Area Security and Access Controls**

Restricted areas remain locked when not in use. The attic, the only location with removable radioactivity, is controlled by a locked access hatch. In order to access the attic, a display case and ceiling tiles in the museum gift shop must be removed to access a ladder that leads to the attic via the hatch. These areas are also posted with "Restricted Access" signs.

### **4.2.4 Inspections and Surveillance**

Residual radioactivity is routinely monitored by MU to ensure personnel exposures from the residual materials do not exceed applicable dose limits. The routine surveillance program involves visual inspections, radioactivity measurements, TLD monitoring of building occupants, and will involve yearly radon testing to ensure residual radioactivity does not become a public or occupant health and safety issue. MU conducts routine surveys and inspections of Pickard Hall on a quarterly frequency. Surveys consist of dose rate measurements, total surface activity measurements and wipe tests. Additionally, the integrity of the building structure, floor tiles and surface coatings are inspected to ensure materials will be contained.

### **4.2.5 Operations and Maintenance Procedures**

To prevent the possibility of the spread of contamination from soils with elevated activity, facilities personnel must contact the radiation safety office and gain approval prior to conducting any excavation of more than 6" deep. Landscaping activities that require disturbance of the soils surrounding Pickard, other than thatching or aerating, are controlled and requires communication and coordination with the radiation safety office for review and health physics coverage if deemed appropriate. In addition to access controls, the radiation safety office must evaluate and approve any invasive activity in indoor restricted areas.

#### **4.2.6 Dosimetry Monitoring**

All building occupants that require access to restricted areas are monitored with TLDs which are read on a quarterly basis. See attachment 2.

#### **4.2.7 Radon Monitoring**

MU has periodically monitored the radon concentration in air for representative areas of Pickard Hall using alpha track detectors (see attachment 1) and will continue to do so on a yearly cycle.

#### **4.2.8 ALARA Limit**

Even though building occupants having access to restricted areas are considered occupational radiation workers, MU has established an administrative ALARA limit of 100 mrem/yr to meet the limit for members of the public.

### **4.3 Periodic Reviews**

The radiological status of Pickard Hall will be evaluated during routine monitoring by radiation safety personnel. Annually, as part of the radiation protection program review, MU will review radiological data collected at Pickard and perform trending analysis to ensure radiological conditions are not degrading, that there is not migration of radioactive materials, and controls continue to be effective in limiting doses to occupants and members of the public.

### **4.4 Changing Conditions**

If there becomes a trend of degrading radiological conditions, MU will notify the NRC within 60 days and implement additional controls as necessary to limit exposure potential. Additionally, if an unexpected event occurs that disturbs radioactive material, such as fire or flooding, or there is a need to intentionally disturb materials for building maintenance, such as excavating an embedded drain line in the basement, MU will notify the NRC and take appropriate actions to control the spread of radioactive materials and limit exposures.

## **5.0 FINANCIAL ASSURANCE**

The University is in the process of updating the broad scope license decommissioning funding plan (DFP) to include Pickard Hall. The updated DFP will be submitted to the NRC later this year but in parallel with the evaluation of this request for alternate decommissioning schedule. The total estimated decommissioning cost allocated to Pickard Hall is about \$3M including a contingency of 25%. The decommissioning cost estimate was developed using the guidance contained in NUREG-1757 "Consolidated NMSS Decommissioning Guidance," Volume 3, Appendix A.3. Remediation is assumed to proceed to unrestricted levels with an endpoint criterion of 25 mrem/yr based on the building occupancy scenario of NUREG/CR-5512 for building structures or the residential scenario of NUREG/CR-5512 for outdoor areas.

Because MU is a government entity, financial assurance is provided in the form of a Statement of Intent. Therefore, this alternate schedule request does not increase the probability that decommissioning will be complicated by insolvency or other unforeseen economic or financial factors that are normally of concern to private entities.

There is a possibility that decommissioning costs will increase as a result of the requested alternate schedule. Labor and material costs are expected to increase, but keep pace with inflation. A major cost of decommissioning is waste disposal that has historically been unstable, and at times, hyperinflationary. However, the trend over the past decade has been that more disposal options are available for NORM waste. Higher concentrations are being accepted at unlicensed facilities (EPA Subtitle C landfills) and there is increasing acceptance of very low level NORM waste at EPA Subtitle D landfills. Decommissioning will not be more complex as a result of building deterioration during the extension period because proper maintenance of the building is assured to protect museum artifacts.

## **6.0 PUBLIC INTEREST**

Pickard Hall has significant educational, cultural, and historical value. Additionally, MU is a state university, so economic factors are also relevant to assessment of the public interest.

Pickard Hall houses the MU's Museum of Art and Archaeology and is listed on the National Register for historic buildings. The facility serves the campus and community as a cultural destination and is integrally involved in the teaching and educational mandate of the University. The Museum works closely with the Department of Art History and Archaeology (also located in Pickard Hall), which intensively uses the Museum and its holdings for undergraduate and graduate instruction (BA through PhD); the Museum is also used for graduate Museum Studies classes and undergraduate classes specifically about the Museum, its history, and its role. Other academic units (such as the Honors College) have also embedded the Museum into their instructional programs, and interruption or temporary suspension of museum operations would have a significant adverse effect on these academic programs. Interruption would also seriously impact the Museum's research mandate, and interfere with its charge to make the collections freely available to visiting researchers and to the public. The Museum's planning horizon for exhibitions is 36 months, and contracts for upcoming public exhibitions are already in place. Their cancellation would entail significant and unbudgeted expense and disruption.

The Museum serves the community of Columbia and mid-Missouri as the only accredited museum in the region; interruption of museum operations would have significant impact on K-12 programming in the area, as schools, teachers, and classes regularly use the Museum and its facilities.

The Museum currently holds more than 15,000 objects in its permanent catalogued collections, plus research collections from excavated sites in Israel, Cyprus, and other areas of the Mediterranean. Pickard Hall also houses an important collection of rare and fragile plaster casts of Greek, Roman, and medieval sculpture collected over the past century, which now forms one of a small number of collections (only three of which are in the U.S.). Moving these collections using appropriate fine arts techniques/movers would be extremely expensive while still placing the collections themselves at considerable risk, both because adequate storage spaces are not available elsewhere and these collections would need to move from Pickard to a temporary storage facility, possibly back to Pickard, then subsequently move once again when a permanent facility for the Museum is constructed.

Costs to move collections would be in excess of one million dollars; additional costs associated with cancellation of exhibit contracts and lost revenue from retail operations are not included in that figure. Costs for visitorship loss, arrangements for alternate instructional venues, and access to necessary physical resources are difficult to calculate. Costs for relocation of both Museum staff and the Department of Art History and Archaeology would include both physical moving costs and costs for relocating and reorganizing the more than 136,000 slides and photographs required for teaching. Further costs include the relocation of the documentary and library resources supporting departmental programs currently housed in Pickard Hall, as well as alternate arrangements to access museum objects required for undergraduate and graduate instruction. The need for proximity of classroom space to the museum collections, as well as a location that would allow faculty physical access to departmental research resources, adds to the difficulty of finding space in the current campus environment. Dislocation and interruption of instructional activities would result in both immediate direct costs to meet current class obligations and longer-term revenue loss from reduced credit hours in affected programs.

## **7.0 COMPLIANCE HISTORY**

The NRC inspected Pickard on January 26 and 27, reviewed preliminary characterization survey results, and performed confirmatory radiological measurements. Inspection results are contained in "NRC Reactive Inspection Report 030-02278/10-01(DNMS) – University Of Missouri" dated February 24, 2010. In the report, the NRC noted that MU had taken appropriate actions to control restricted areas, and that the licensee's and NRC's survey results indicated no person or area had exceeded public dose limits.

## 8.0 REFERENCES

- NUREG 1757, "Consolidated NMSS Decommissioning Guidance"
- Pickard Hall Characterization Survey Report, July, 2010 (ML102800311, ML102800322, ML102800330, ML102800336, ML102800398, ML102800412, ML102800427, ML102800430, ML102800436, ML102800441, ML102800450, ML102800452, ML102800455, ML102800458, ML102800463, ML102800467, and ML102800563)
- University of Missouri – Columbia Decommissioning Funding Plan, Draft, Feb 2011 (final version estimated May, 2011)
- Letter dated November 26, 1990 from Director of the Division of Radiation Protection and Emergency Preparedness (Frank J. Congel) to the Directors of each of the NRC Regions (ML 103470215)
- Letter dated November 16, 2009 from MU RSO (Jack Crawford) to NRC Region III, "Notification of Intent to Decommission Pickard Hall" (ML093270544)
- Letter dated October 25, 2010 from MU RSO (Jack Crawford) to NRC Region III, "Extension Request for Submittal of Pickard Hall Decommissioning Plan" (ML103050161)
- "NRC Reactive Inspection Report 030-02278/10-01(DNMS) – University of Missouri," dated February 24, 2010. (ML100600810)
- <http://www.epa.gov/radon/zonemap.html>, and <http://epa.gov/radon.states/images/missouri.gif>.

# Attachment 1 – Pickard Hall Radon Monitoring Results

## Radon Monitoring Report

EMS UNIVERSITY OF MISSOURI  
 ATTN: ROSE LEVAMP  
 9 RESEARCH PARK BLDG BUILDING  
 COLUMBIA, MO 65211

**LANDAUER**

Landauer, Inc. 2 Science Road Glenwood, Illinois 60025  
 Telephone: (800) 528-8327 Fax: (708) 709-70

Acct. No. 0410211

PROGRAM NAME: PICKARD

Detector Number	Detector Type	Starting Date	Ending Date	Field Data - Comments	Exposure (pCi-hrs)	Avg. Radon Conc. (pCi/L)
4741886	DRN	21-NOV-08	24-FEB-09	RM 3	55.0 19.18	0.6 10.05
4741887	DRN	21-NOV-08	24-FEB-09	RM 26	104.8 18.3	1.1 10.09
4741896	DRN	19-NOV-08	24-FEB-09	RM 17A	204.0 112.8	2.1 10.13
4741904	DRN	21-NOV-08	24-FEB-09	RM 7	61.3 15.65	0.6 10.08
4741918	DRN	19-NOV-08	24-FEB-09	RM 17	227.4 113.7	2.3 10.14
4741929	DRN	19-NOV-08	24-FEB-09	RM 6	180.3 111.0	1.7 10.11
4741939	DRN	21-NOV-08	24-FEB-09	RM 12	292.3 115.9	3.1 10.17
4741974	DRN	19-NOV-08	24-FEB-09	RM 8	128.3 19.5	1.3 10.10
4741977	DRN	19-NOV-08	24-FEB-09	RM 15, 16A, 16	213.7 113.2	2.2 10.14
4741988	DRN	21-NOV-08	24-FEB-09	RM 27	380.1 118.6	4.0 10.20

RELATED ONLY TO MONITORS  
 VED BY LANDAUER.

QC Release	Process No	Report Date	Date Received
DRB	A21617	12-MAR-09	27-FEB-09

PAGE 1 OF 1

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 MAR 17 2009  
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# Radon Monitoring Report

THE UNIVERSITY OF MISSOURI  
 ATINI ROSE LEVKAFF  
 3 RESEARCH PARK DEV BUILDING  
 COLUMBIA, MO 65211

## LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60025  
 Telephone: (800) 533-8377 Fax: (708) 753-70

Acct. No. 0810211

PROGRAM NAME: PICKARD

Detector Number	Detector Type	Starting Date	Ending Date	Field Date / Comments	Exposure (Dh-Days)	Avg Radon Conc (pCi/l)
4741991	DRN	21-NOV-08	24-FEB-09	RM 2	124.6 19.3	1.3 10.10
4742006	DRN	19-NOV-08	24-FEB-09	RM 2B	246.3 119.4	2.3 10.15
4742007	DRN	19-JAN-09	24-FEB-09	RM 1A	107.7 18.4	0.3 10.02
4742019	DRN	21-NOV-08	24-FEB-09	RM 4	119.3 19.0	1.3 10.10
4742080	DRN	21-NOV-08	24-FEB-09	RM 9	97.1 17.85	1.0 10.08

RESULTS RELATED ONLY TO MONITORS  
 AS RECEIVED BY LANDAUER.

QC Release	Process No.	Report Date	Date Received
DRB	A21617	12-MAR-09	27-FEB-09

PAGE 2 OF 1

# Radon Monitoring Report

UW UNIVERSITY OF MD  
8 RESEARCH PK DEV BLDG  
COLUMBIA, MD 21046

## LANDAUER

Landauer, Inc. 2 Science Road Greenwood Illinois 60423-1586  
Telephone: (800) 524-6127 Facsimile: (708) 755-7348

Asst. No.

0410211

Detector Number	Detector Type	Starting Date	Ending Date	Rate Data / Comments	Exposure (24-hrs)	Avg. Radon Conc. (pCi/L)
4741889	DRN	17-JUL-09	07-DEC-09	PICKARD 13 MBAS	1009.1 231.9	7.2 20.22
4741900	DRN	21-NOV-08	07-DEC-09	PICKARD 12 ONE YEAR	1127.4 233.4	3.0 20.09
4741906	DRN	19-NOV-08	08-DEC-09	PICKARD 25 ONE YEAR	903.5 229.8	2.4 20.08
4741942	DRN	21-NOV-08	08-DEC-09	PICKARD-27-ONE YEAR	1193.7 234.8	3.1 20.09

RECEIVED  
DEC 27 2009

RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER.

QC Review	Process No.	Report Date	Date Received
DRB	A21798	15-DEC-09	09-DEC-09

PAGE 1 OF 1

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# Attachment 2 – Pickard Hall TLD Monitoring Results

## Personnel

Series Code	Participant	PartName	Location Description	DosePeriod	Deep	Lens	Shallow
PKD	54232	LANGDON, SUSAN		1Q10	M	M	2
PKD	54232	LANGDON, SUSAN		2Q10	10	10	9
PKD	56166	LEE, KRISTIE		1Q10	M	M	M
PKD	56166	LEE, KRISTIE		2Q10	M	M	M
PKD	56166	LEE, KRISTIE		3Q10	M	M	M
PKD	56167	KIDD, JOSEPH		1Q10	M	M	M
PKD	56167	KIDD, JOSEPH		2Q10	M	M	M
PKD	56167	KIDD, JOSEPH		3Q10	M	M	M
PKD	56168	LAND, NORMAN		1Q10	M	M	M
PKD	56168	LAND, NORMAN		2Q10	M	M	M
PKD	56168	LAND, NORMAN		3Q10	M	M	5
PKD	56169	SMITH, BARBARA		1Q10	M	M	M
PKD	56169	SMITH, BARBARA		2Q10	M	M	20
PKD	56169	SMITH, BARBARA		3Q10	M	M	2
PKD	56170	PIXLEY, MARY		1Q10	M	M	M
PKD	56170	PIXLEY, MARY		2Q10	M	M	M
PKD	56170	PIXLEY, MARY		3Q10	M	M	M
PKD	56171	WILCOX, JEFFREY		1Q10	M	M	2
PKD	56171	WILCOX, JEFFREY		2Q10	M	M	20
PKD	56171	WILCOX, JEFFREY		3Q10	M	M	M
PKD	56172	MEHRHOFF, WAYNE A		1Q10	M	M	M
PKD	56172	MEHRHOFF, WAYNE A		2Q10	M	M	2
PKD	56172	MEHRHOFF, WAYNE A		3Q10	M	M	M
PKD	56173	REED, KENYON L		1Q10	M	M	M
PKD	56173	REED, KENYON L		2Q10	M	M	M
PKD	56173	REED, KENYON L		3Q10	Lost	Lost	Lost
PKD	56174	DISALVO, LAUREN		1Q10	M	M	M
PKD	56174	DISALVO, LAUREN		2Q10	M	M	M
PKD	56174	DISALVO, LAUREN		3Q10	Lost	Lost	Lost
PKD	56175	NAVARRO, RACHEL		1Q10	M	M	M
PKD	56175	NAVARRO, RACHEL		2Q10	M	M	M
PKD	56175	NAVARRO, RACHEL		3Q10	M	M	M
PKD	56176	BARKER, ALEX		1Q10	M	M	M
PKD	56176	BARKER, ALEX		2Q10	Lost	Lost	Lost
PKD	56176	BARKER, ALEX		3Q10	M	M	M
PKD	56177	STEBBING, PAUL		1Q10	M	M	M
PKD	56177	STEBBING, PAUL		2Q10	M	M	M
PKD	56177	STEBBING, PAUL		3Q10	M	M	M
PKD	56178	COX, BRUCE		1Q10	M	M	M
PKD	56178	COX, BRUCE		2Q10	M	M	M
PKD	56178	COX, BRUCE		3Q10	Lost	Lost	Lost
PKD	56179	GEISLER, CAROL		1Q10	M	M	M
PKD	56179	GEISLER, CAROL		2Q10	M	M	M
PKD	56179	GEISLER, CAROL		3Q10	M	M	M
PKD	56181	CALLAWAY, CATHY L		1Q10	M	M	M
PKD	56181	CALLAWAY, CATHY L		2Q10	M	M	M
PKD	56181	CALLAWAY, CATHY L		3Q10	M	M	M
PKD	56182	KASPER, JANET		1Q10	M	M	M
PKD	56182	KASPER, JANET		2Q10	M	M	M
PKD	56183	SZABO, GEORGE		1Q10	M	M	M
PKD	56183	SZABO, GEORGE		2Q10	M	M	M
PKD	56183	SZABO, GEORGE		3Q10	Lost	Lost	Lost
PKD	56218	LAKE, SARAH		1Q10	M	M	M
PKD	56218	LAKE, SARAH		2Q10	M	M	M
PKD	56218	LAKE, SARAH		3Q10	M	M	M
PKD	56219	TATUM, AARON		1Q10	M	M	M
PKD	56219	TATUM, AARON		2Q10	M	M	M
PKD	56219	TATUM, AARON		3Q10	M	M	M