

Group B

FOIA/PA NO: 2014-0013

RECORDS BEING RELEASED IN THEIR ENTIRETY

- 1) The license amendment request proposes the delay of the decommissioning plan submittal until the university is able to move the museum or a condition arise that would warrant notifying the NRC.
 - a. Provide a length of postponement requested as described in Section 2.6.4 of NUREG-1757, Volume 3.
 - b. Provide a description of how the university will begin planning for and proposed schedule for the movement of the artifacts located within museum that would allow for the beginning of decommissioning.
 - c. Provide a description of the conditions described in the request at which the university would notify the NRC, and would then begin decommissioning.
- 2) The decommission timeliness rule of 10 CFR 30.36 call out separate building and outdoor areas separately. Justification provided in the request is based on the building, and not outdoor areas. Provide further justification for the alternative schedule to include the outdoor areas surrounding the building, including the steam feeder tunnel, or provide a plan to decommission outdoor areas.
- 3) Provide justification that residual radioactivity in outdoor areas, including the steam tunnel or buried pipes, will not migrate during the timeframe requested in the extension or means to ensure survey for potential migration.
- 4) Section 6 of the request states that the building is listed on the National Register for historic buildings as justification for the postponement of decommissioning. Provide a description of why the listing of building on the National Register for Historic Buildings affects the effective conduct of decommissioning operations and how this effect will be changed if the postponement is granted.
- 5) Section 6 of the request gives examples that provide proposed justification to the educational, cultural, and historical value of the museum and the building. Describe how the conduct of decommissioning operations would affect these examples, including operation of the museum; undergraduate, graduate, and other instructional programs instructions; current and future museum contracts; and museum artifacts both in the basement and upper floors storage areas. Additionally, provide an estimated timeline for the length of disruption during decommissioning activities.

Health and Safety plan has not undergone a complete review. However, some questions I had begun to formulate on that plan include.

1. Section 3.5 of the request states building occupants are trained as occupational radiation workers. Provide a detailed description of the workers in the building who will occupational radiation workers prior to the building beginning decommissioning.
2. Sections 4.0 and 4.2.5 of the request states that MU is controlling invasive activities inside and outside Pickard. Provide a description of what is meant by invasive activities and how the university plans to control them in accordance with 10 CFR 30.36.
3. Section 4.1.1 of the request states that the radiation safety staff will inspect encapsulant integrity. Provide a description of:
 - a. How the staff will inspect the integrity.
 - b. Actions staff will take if the epoxy covering is determined to be compromised.
4. Section 4.2.4 of the request states residual radioactivity will be monitor by a routine surveillance program.
 - a. Describe locations and periodicity of the routine surveillance that will be used in the building.
 - b. Provide the type of instruments that will be used to monitor the building.

University of Missouri Pickard Hall Decommissioning

Pickard Hall Overview

- In early 1900s to approximately 1930, faculty researcher extracted radium-226 from uranium ores and conducted research on Th-232 daughters in the basement of Pickard Hall
- University of Missouri notified Region III of contamination at Pickard Hall and their intent to decommission on November 16, 2009
- Characterization Survey begin December 2009

Area (above background)	Average Dose Rate ($\mu\text{R/hr}$)	Maximum Dose Rate ($\mu\text{R/hr}$)
Basement	20	112
1 st and 2 nd Floor	7	12
Attic	3	17

- No areas exceed 2 mrem in any 1 hour
- Elevated exposure rates identified in Museum storage area and office room 27 in the basement that exceed 100 mrem if present for greater than 2500 hours
 - Lead slates placed in room 27 reduced exposure rates
 - Administrative controls in place for museum storage area.
- Removable alpha contamination identified in Mechanical Room, Attic, and historic brick ducts
 - Epoxy placed in mechanical room to limit the spread of contamination
 - Administrative controls in attic
 - Brick ducts are no longer in use since ventilation system was updated in the 70's
- Elevated radium and thorium identified in soil samples identified beneath drain gutters and in steam tunnel
 - Outdoor soil was remediated
 - Limited remediation was tried in the steam tunnel, but dose rates were identified to be increasing at depth and licensee stopped.
- NRC performed inspection in January 2010 to confirm preliminary characterization results
- University requested 3 month extension for submitted of decommissioning plan in November 2010
- University requested alternative schedule for decommissioning dated February 17, 2011

Regulations

10 CFR 30.36(g)(2): The Commission may approve an alternate schedule for submittal of a decommissioning plan required pursuant to paragraph (d) of this section if the Commission determines that the alternative schedule is necessary to:

- a) The effective conduct of decommissioning operations,
- b) Presents no undue risk from radiation to the public health and safety, and
- c) Is otherwise in the public interest.

10 CFR 30.36(d): Submit within 12 months of notification a decommissioning plan and begin decommissioning upon approval of that plan if-- (2) The licensee has decided to permanently cease principal activities, as defined in this part, at the entire site or in any separate building or outdoor area that contains residual radioactivity such that the building or outdoor area is unsuitable for release in accordance with NRC requirements.

University's Request

Delay submittal of a decommissioning plan for Pickard Hall indefinitely subject to periodic review by the NRC during license renewal time period with use of engineering and administrative controls to ensure adequate protection of public health and safety.

University's Justification

- A) Effective conduct of decommissioning operations
 - a. Building is listed on the National Register of Historic Places
 - b. Decommissioning would require closing of the museum
 - c. Decommissioning would result in risks to museum artifacts
 - d. Moving artifacts cost in excess of 1 million dollars
- B) Presents no undue risk from radiation to the public health and safety
 - a. All workers in the basement are trained, monitored occupational workers with ALARA yearly limit of 100 mrem
 - b. All non-restricted areas meet public dose limit as demonstrated through characterization survey
 - c. No airborne concentration identified
 - d. Perform surveys under current occupational program
 - e. No aggressive activities will be performed
 - f. NRC will be notified of any degrading trends
- C) Is otherwise in the public interest
 - a. Educational, cultural, and historical value of the building

Review

Standard Review Plan: NUREG-1757, Volume 3

- 1) Federal Register Notice with opportunity for comment [MCID]
- 2) Notify State (Keith Henke, John Langston, & Historic Society) [MCID w/state liaison support]
- 3) Public Meeting [MCID] (optional per NUREG-1757)
- 4) Technical Review
 - a. Review proposed dose model [MCID]
 - b. Review characterization study, including radon and air samples [MCID]
 - c. Review controls to ensure adequate protection [MLB/MCID]
 - d. Ensure environmental factors will not spread contamination [MCID]
 - e. Ensure all areas included in alternative schedule are justified [MCID]
 - f. Financial Assurance [MLB]
- 5) Safety Evaluation Report [MCID]
- 6) Environmental Assessment [MCID]
- 7) License Amendment or require submittal of a decommissioning plan [MLB]

Reason for Meeting

To discuss University of
Missouri's license application
request for an alternative
schedule for decommissioning
of Pickard Hall



Who is the NRC?



- Independent Federal Agency
- Regulates civilian use of nuclear material
- Regulatory Responsibility
 - Licensing
 - Safety
 - Security
 - Environmental
 - Inspection
 - Enforcement



NRC's Mission



To regulate the nation's civilian use of **byproduct**, source, and special nuclear materials to ensure adequate protection of public health and safety, promote the common defense and security, and to protect the environment.

Protection
of Public
Health and
Safety



Byproduct Material



- Energy Policy Act of 2005 expanded NRC regulatory jurisdiction to include discrete sources of Radium-226, a Naturally Occurring Radioactive Material (NORM)
- Transition Phase (72 FR 59157)
 - NRC gained authority of NORM in the state of Missouri after September 30, 2008
 - 1 year transitional period



Pickard Hall



- NRC received notification on November 17, 2009 that Naturally Occurring Radioactive Material had been identified in Pickard Hall in excess of NRC release criteria
- Characterization Survey results showed localized areas that required radiological controls
 - Attic, Steam Feeder Tunnel, behind walls, and under floor tiles



Decommissioning



- *Decommissioning* means to remove a facility safely from service and reduce residual radioactivity to a level that permits release of property
- Release removes the facility from a NRC license and can allow licensee's to release the property from their control



Timeliness Rule

10 CFR 30.36



Within 1 year of Notification,
Decommissioning Timeliness Rule
Requires Submittal of:

A Decommissioning Plan

- OR -

An Alternative Schedule

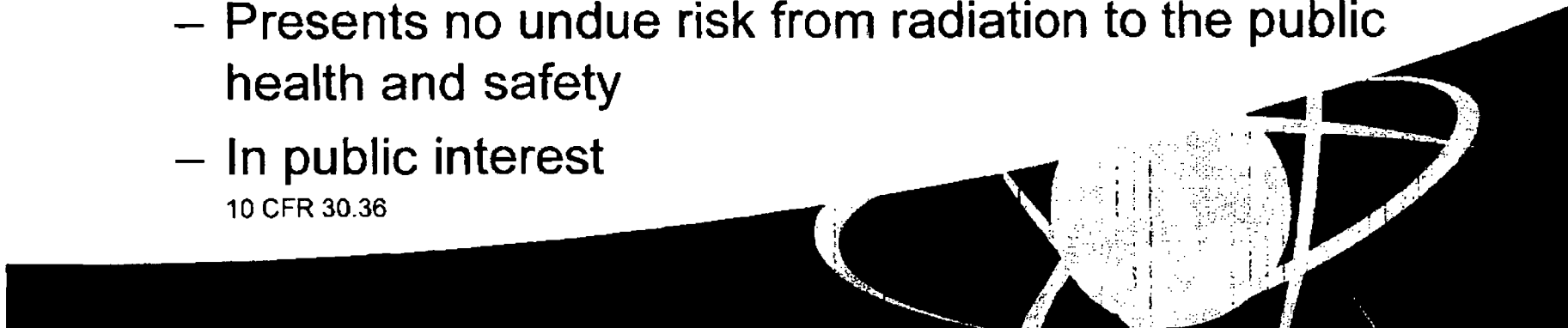


Alternative Schedule Requirements



- All regulations and licensee conditions continue to apply until site is fully decommissioned and site is released
- Alternative Schedule Requirement
 - Necessary for the effective conduct of decommissioning operations
 - Presents no undue risk from radiation to the public health and safety
 - In public interest

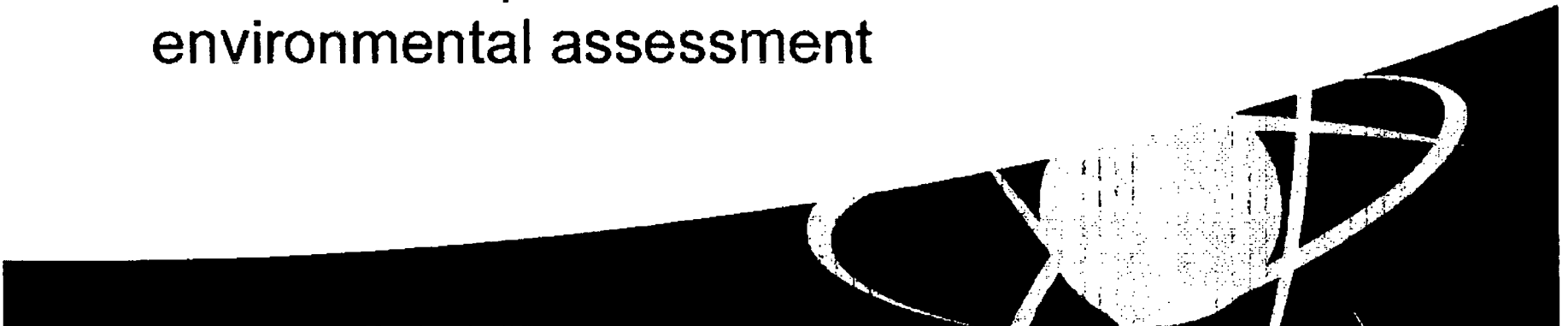
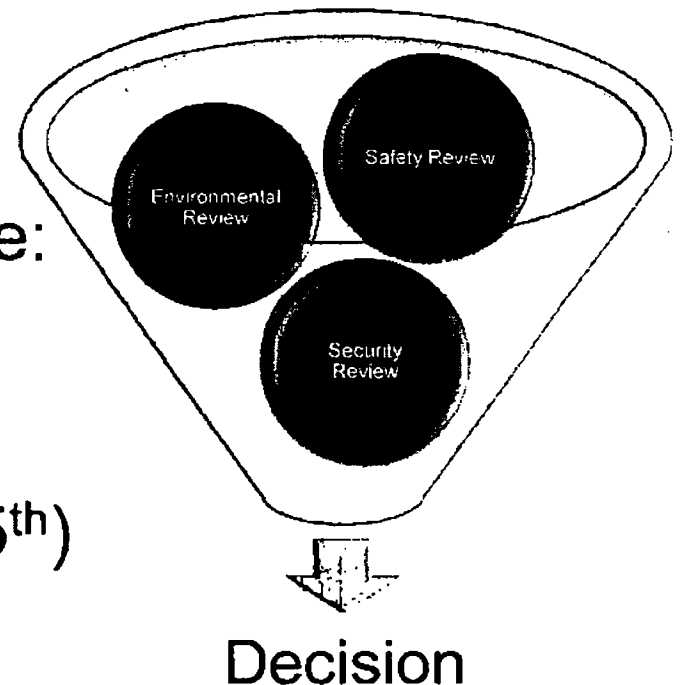
10 CFR 30.36



NRC's Review Process



- Technical Review of the amendment request will include:
 - Safety Review
 - Security Review
 - Environmental Review
- Public Comment Period (July 5th)
- Documented in a safety evaluation report and environmental assessment



Public Involvement



- Comment Period
- Public Meetings
- Opportunity for an Atomic Safety & Licensing Board Hearing

We want
Your
Insights,
Input,
Perspective



NRC Review Status



- NRC is currently performing the Technical Review of the Request, No decision has been Made
- NRC began reviewing application March 21, 2011 and expect the review to take 1 year
- July 5th is due date for comments and request of a hearing



NRC Inspection Activities



- NRC Began a Reactive Inspection on January 26, 2010
- If amendment is approved, periodic inspections will be conducted to verify compliance with commitments, regulatory requirements, and University procedures



Contact Information



- Christine Lipa, Branch Chief
 - Christine.Lipa@NRC.gov
 - 630-829-9834
- Mike LaFranzo, Senior Health Physicist
 - Michael.LaFranzo@NRC.gov
 - 630-829-9865
- Katie Streit, Project Manager
 - Katherine.Streit@NRC.gov
 - 630-829-9621
- Prema Chandrathil, Public Affairs Officer
 - Prema.Chandrathil@NRC.gov
 - 630-829-9663



For More Information



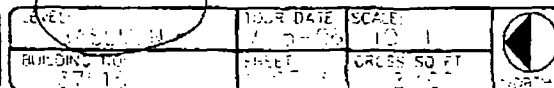
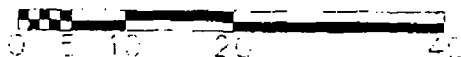
- For more information regarding Decommissioning, see:
<http://www.nrc.gov/about-nrc/regulatory/decommissioning.html>
- For more information regarding Naturally Occurring Radioactive Material, see: <http://nrc-stp.ornl.gov/narmtoolbox.html>
- For the NUREG-1757 documents, see:
<http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1757/>
- For 10 CFR 30.36, see: <http://www.nrc.gov/reading-rm/doc-collections/cfr/part030/part030-0036.html>

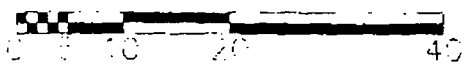
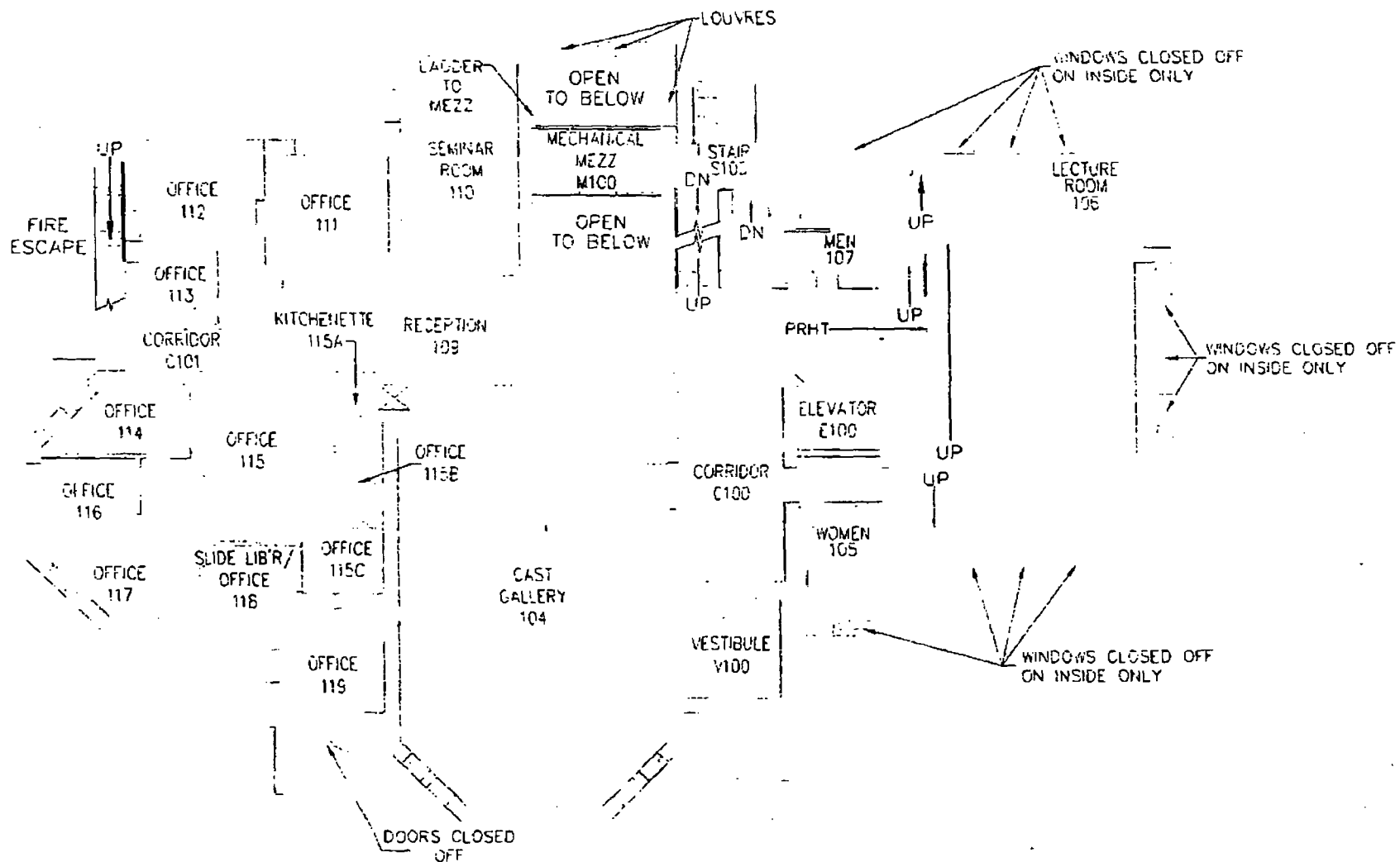


U of Missai

Pickard Hall







1st fl.

REVISED: 5-7-67 D.B.



CAMPUS FACILITIES
SPACE PLANNING & MANAGEMENT
(374) FEB 1968

POKACHUK

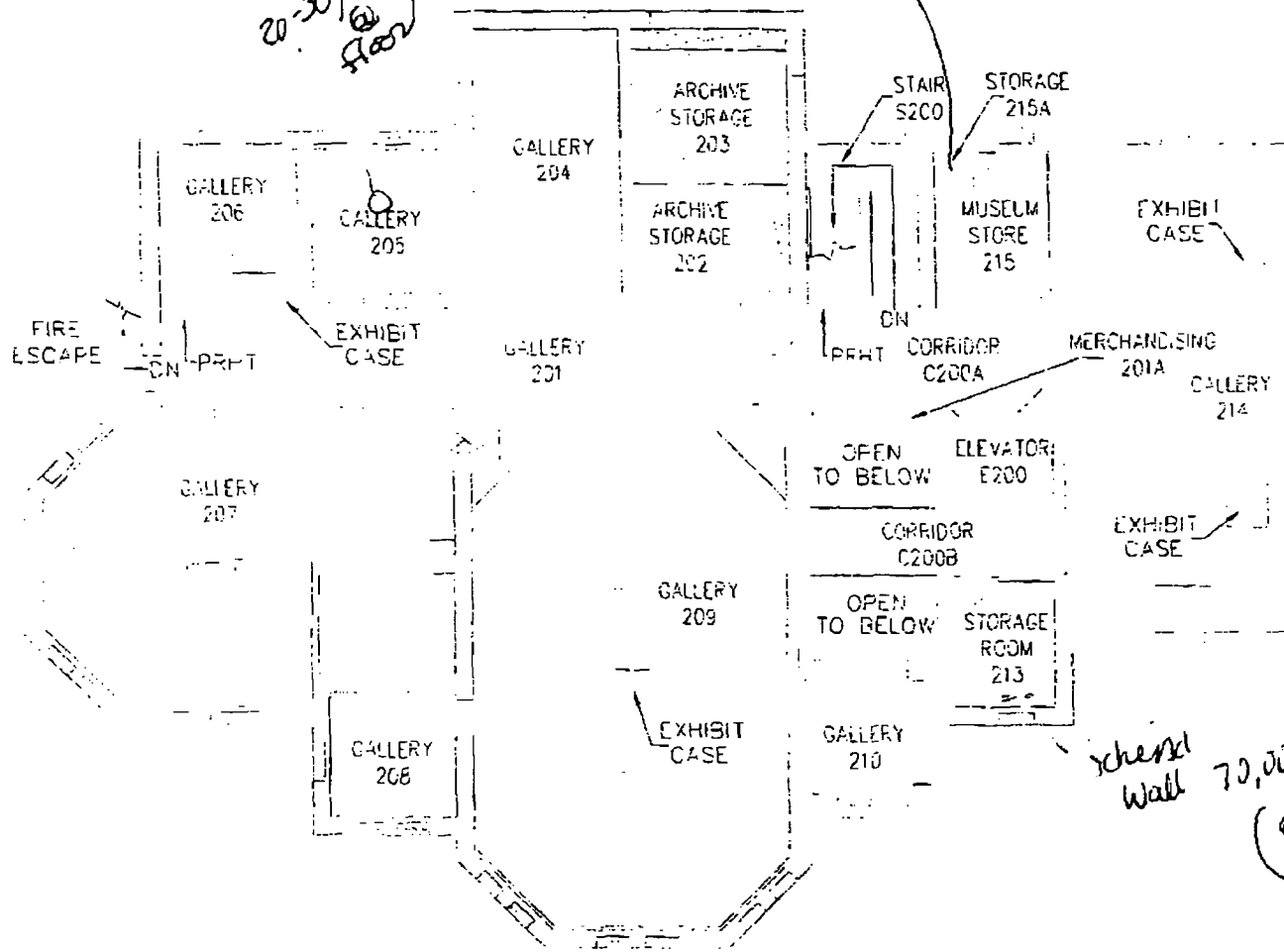
DATE 1-1-68	TITLE BUILDING	TOUR DATE 7-1-68	SCALE 1" = 10'
		SHEET 1	FOOTING BY 10-1-68



20-30 yr/m
floor

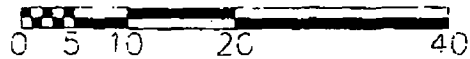
Calm had to
access attic
ladder going
up.

NOTE: ALL EXTERIOR WINDOWS ON THIS
LEVEL ARE COVERED ON THE
INSIDE ONLY.



25 yr/m.
schem wall 70,000 cpm
(8-10,000 is
back of)

2nd.



CAMPUS FACILITIES
SPACE PLANNING & MANAGEMENT
(573) 882-4608

OXARD INN

REVISED: 3-7-07 J.B.

LEVEL 2ND	TOUR DATE 7-2-07	SCALE 1"=30'
BUILDING NO. 7701	SHEET 3-1-3	GROSS SQ. FT. 2,100



1/22/09

The Curators of the University of Missouri
Pickard Hall Building Contamination
Docket Number: 030-02278

- ~1892 Building Constructed and used for Chemistry Department
- ~1890s -1930s Expected research using uranium and radium ores
- ~1976 Ventilation system replaced
- 3/12/2007 Broadscope initiative inspection conducted
- 9/30/2008 NRC gained authority for NARM in Missouri
- 3/30/2009 Licensee's deadline to submit license amendment adding NARM
- 11/17/2009 Letter notifying NRC that they had determined that Pickard Hall is subject to NRC decommissioning regulations (10 CFR 30.36) under "TENORM" and intends to permanently decommissioning Pickard Hall for unrestricted use.

- 12/1/09 Chase Environmental, Kentucky agreement state licensee, files for reciprocity to conduct characterization survey of Pickard Hall
- 12/7 - 11/09 Chase Environmental conducts characterization survey
- 12/21- 22/09 NRC contacted licensee for characterization survey results

- Preliminary Characterization Results
 - Radionuclides of Concern – Ra-226, Th-232 and daughters
 - Areas of contamination found in:
 - Attic
 - Mechanical Room in Basement
 - Room 12, adjacent to Mechanical Room in Basement
 - Room 27, previously occupied room in Basement
 - Brick "fume hood" chases believed not to be conducted with modern ventilation
 - Dose rate area surveys highest reading was 120 microR/hr in basement. 27 microR/hr readings found in upstairs area, but not unexpected readings for the type of building.
 - Concrete samples indicate Ra-226 at 2000 pCi/L and Th-232 at 19.9 pCi/L.
 - Soil samples indicate Ra-226 at 71 pCi/L and Th-232 at 21 pCi/L.

- Licensee's Actions
 - Licensee restricted access to Attic and basement rooms. Work continues in room 12, however workers were trained as radiation workers and are required to sign in and out.
 - Licensee committed to submit characterization report as soon as possible
 - Licensee committed to notify NRC prior to conducting any decommissioning work.

- Future Actions
 - License amendment to add possession only until remediation course of action is determined
 - Potential need for Decommissioning Plan

→ Sweetser Hall (was location of use)

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TELEPHONE CONVERSATION RECORD
NRC Region RIII
Materials Control, ISFSI, and Decommissioning Branch

Person Called: Jack Crawford, MS, CNMT
Radiation Safety Officer, Assistant Director
Office of Radiation Safety (RS)
Environmental Health and Safety (E H&S)

Mary Aldrich, Health Physicist, E H&S, RS

Telephone No.: (573) 882-0931

Licensee: The Curators of the University of Missouri
Columbia, Missouri

License No: 24-00513-32
Docket No.: 030-02278

Callers: George M. McCann, Senior Health Physicist
NRC Region III, Division of Nuclear Materials Safety
Materials Control, ISFSI, and Decommissioning Branch

Darrel Wiedeman, Senior Materials Inspector
NRC Region III, Division of Nuclear Materials Safety
Materials Inspection Branch

Katherine Strelt, Health Physicist
NRC Region III, Division of Nuclear Materials Safety
Materials Control, ISFSI, and Decommissioning Branch

Lionel Rodriguez, Reactor Engineer
NRC Region III, Division of Nuclear Materials Safety
Materials Control, ISFSI, and Decommissioning Branch

Dates of Calls: December 22, 2009

**SUBJECT: DISCUSSION OF LICENSEE ACTIONS TAKEN RELATING TO
CHARACTERIZATION SURVEY RESULTS OF PICKARD HALL**

On the above date, the RIII NRC staff and the University of Missouri Radiation Safety staff discussed the preliminary results of characterization surveys conducted on the week of December 7th, 2009 in the Pickard Hall property. As discussed in a previous telephone conversation (ML093560017), the characterization surveys were performed by an agreement state licensed contractor, Chase Environmental group, under a reciprocity agreement with the NRC.

A brief history of the site was given by the licensee. Pickard hall dates back to the early 1900's and was originally the university's Chemistry building. There are records that indicate that there was possible radium and uranium separation work conducted by Herman Schmudt in the building during the early 1900's. The licensee is in the pursuit of finding some of the original

B/5

construction plans for the building. The building, including the ventilation system, was believed to be remodeled around 1976. Currently, Pickard Hall is home to the university's Museum of Art and Archeology.

The preliminary results of the characterization surveys performed by the contractor indicate that there is contamination possibly above the NRC regulatory limits for unrestricted release. All accessible building floors and lower wall areas were scanned for alpha and beta contamination and gross floor swipes were taken. Additionally, the contractor performed surveys to characterize the attic and old "fume hood" chases. Areas of identified contamination were further investigated with swipe samples and static measurements. Soil and concrete scarifier samples were taken for further analysis. The initial results of the surveys conducted in the museum gallery, which is open to members of the public, indicated no elevated levels of contamination. The greatest exposure reading was located in the basement of the building with a value of 120 microR/hr. Areas where contamination was identified or the preliminary results indicate there exists the potential for contamination were the mechanical room (room 13) in the basement, a storage room adjacent to the mechanical room (room 12), a room which contained an office space (room 27), the attic of the building, and historic "fume hood" chases. The contamination is believed to be radium contamination, but the licensee is awaiting the contractor's final analysis to determine the final radionuclide makeup of the contamination.

The licensee indicated that the mechanical room is normally not occupied and access to the room is now restricted with a requirement for basic personnel protective equipment. No removable contamination was identified in the readily accessible areas of the storage room adjacent to the mechanical room, but access has been restricted to authorized persons only and sign in requirements put in place. The occupant of Room 27 had previously been monitored with a TLD, with results indicating no elevated dose. However, as a result of the initial information from the surveys, access has been restricted to this room and the person normally occupying the room moved to another location. The attic space is difficult to access, but the licensee also restricted access and building workers have been notified to notify radiation safety staff if entry is necessary since limited surveys and swipes of the attic identified removable contamination. The licensee has identified 6 brick fume hood chases in the attic with contamination. These chases were most likely connected to historic laboratory fume hoods when the building was used as the chemistry building of the university. There is a possibility that there are more of these. However, these seem to be inactive and not tied to the current ventilation system in use for the building.

The licensee agreed to provide the characterization survey results to the NRC staff as soon as they receive them from the decommissioning contractor. The results are expected to be received by the NRC staff within a week, by December 29, 2009.

End of conversation Record. No further discussion.

University of Missouri

Inspection Plan

Reactive Inspection

Inspection Report No.: 03002278/10-01

Site: Curators of the University of Missouri – Pickard Hall

License #: 24-00513-32

Docket #: 030-02278

Dates of Inspection: ~~July 26-27, 2009~~ Jan 26-28, 2010

Inspectors (s): Peter Lee, Health Physicist
Katie Streit, Health Physicist
Mike McCann - HP lead inspector.

Planned Inspection Activities

The purpose of this inspection is to verify the licensee's assessment of the radiological conditions at Pickard Hall. The inspectors will conduct a confirmatory survey of unrestricted floors 1 and 2 to verify licensee's characterization survey results. Focus areas of the survey will be around access points to the basement and attic, the student auditorium, and walls containing old ventilation system piping. Additional confirmatory readings will be taken to verify preliminary characterization survey results. The inspectors will review and verify the licensee's control of the attic and basement restricted areas. The inspectors will review the building ventilation system. The inspectors will interview licensee personal to determine the historical type of research conducted in the building; the rooms where research was believed to be conducted; if similar work was conducted in other buildings; and the timeframe when the licensee became aware of the contamination, designation of workers as radiation workers, the delay time and reason for delay in notification of the NRC and the licensee's justification for no building air sampling.

The inspectors will not enter the attic unless air sampling results have been obtained. Sensitivity to students and the public will be taken during the inspector's confirmatory survey.

- 1) IP 83890 Closeout Inspection Survey
- 2) IP 83822 Radiation Protection

Projected Onsite Inspection Hours: 2-4 days
18 hours Peter and Katie + Mike

Total Inspection Charged Hours: 32 hours est. 72 hrs.

State Notified of Inspection: Yes (Keith Henke, Tel.: 573-751-6112)

Branch Chief Review:

personal safety

test for alpha

radium, thorium, amer? others?

plans for both bldgs Sweitzer hall + pickard Hall

soil contamination + downspouts

piping outside bldg

change in work location - why

Brief Tues afternoon for Steve

Christine Lipa

Date:

1-25-10

B/b

Region III Regional Issues
Decommissioning Counterpart Meeting - June 2010
Materials Control, ISFSI, and Decommissioning Branch

University of Missouri's Naturally Occurring Radioactive Material Legacy Contamination



- On November 17, 2009, Region III was informed by letter that University of Missouri had identified radium contamination in Pickard Hall.
- Pickard Hall is currently houses the Art History and Archaeology Departments.
- The second floor contains the University's Museum of Art and Archaeology.
- The basement contains the museum storage areas in addition to departmental office space.
- Pickard Hall is on the National Register of Historical Places.



How did Pickard Hall Become Contaminated?



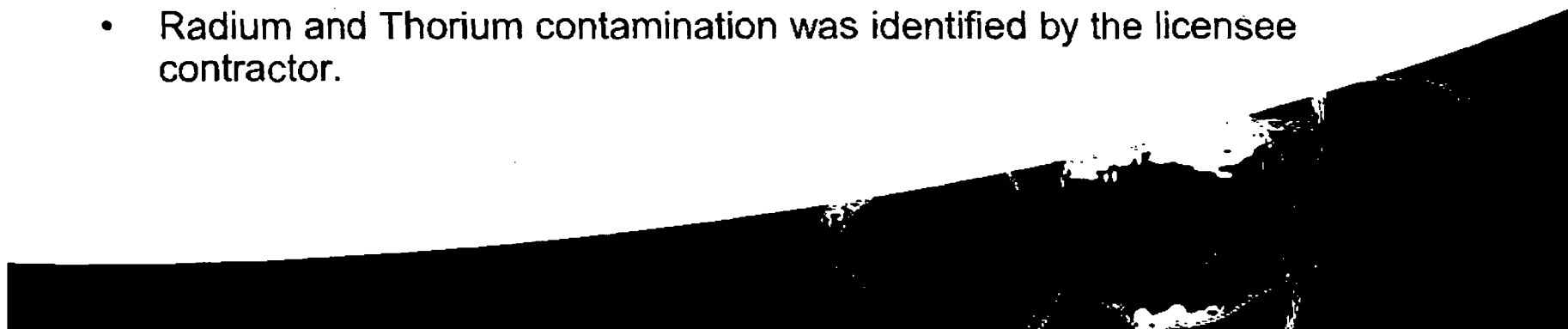
- Pickard Hall was the University's Original Chemistry Building
- Professor Herman Schlundt separated Radium in the basement of Pickard Hall in the early 1900's.
- Thorium-232 contamination has additionally been identified and believed to have been used and stored in the building by Professor Schlundt.



How was the Contamination Identified?



- The university was inspected as part of the decommissioning broadscope initiative in 2008.
- In response to IN2009-30, Findings from the NRC Initiative to Assess Materials Licensees' Compliance with the NRC Decommissioning Requirements, an university health physicist began reviewing historical university records to identify any buildings with possible historical contamination.
- The university conducted a scoping survey in Fall of 2009 after records indicated potential historical contamination.
- Radium and Thorium contamination was identified by the licensee contractor.



University's Response



- Hired an agreement state contractor to perform a characterization survey
- Performed a dose assessment of the expected highest impacted member of the public.
- Restricted access to the attic and two basement rooms.
- Trained and began monitoring university employees working in Pickard Hall's basement.
- Performed remediation on two small areas of soil found to have elevated measurements.
- Notified the NRC per requirements of 10 CFR 30.36.

NRC Response



- Performed a reactive inspection to verify the adequacy of the radiation protection mechanisms and dose estimate
- Performed a confirmatory survey to verify preliminary characterization survey results
- Notified the regional public affairs official
- Conducts bi-weekly calls with the university's RSO to discuss the progress and results of the on-going characterization survey.
- Added radium contamination to the university's license.

Preliminary Characterization Survey Results (approximate values)



Area	Average Dose Rate (μ R/hr)	Maximum Dose Rate (μ R/hr)
Basement	20	120
1 st and 2 nd Floor	15	35
Attic	15	100
Outside	10	25 (prior to remediation)

Schweitzer Hall



- Professor Schlundt moved to Schweitzer Hall after Pickard Hall.
- University performed remediation of Schweitzer Hall in the 1960 and 1982 before NRC regulated NORM.
- University identified radium and thorium contamination on the roof and undeveloped portions of the attic and restricted access.
- Currently the building houses several biochemistry laboratories that perform radiological principle activities and therefore not subject to 10 CFR 30.36 requirements at this time.



Future Actions



- Characterization survey is expected to be completed in July 2010.
- Licensee intends to epoxy floor in mechanical room in June 2010.

Any Questions or Comments?



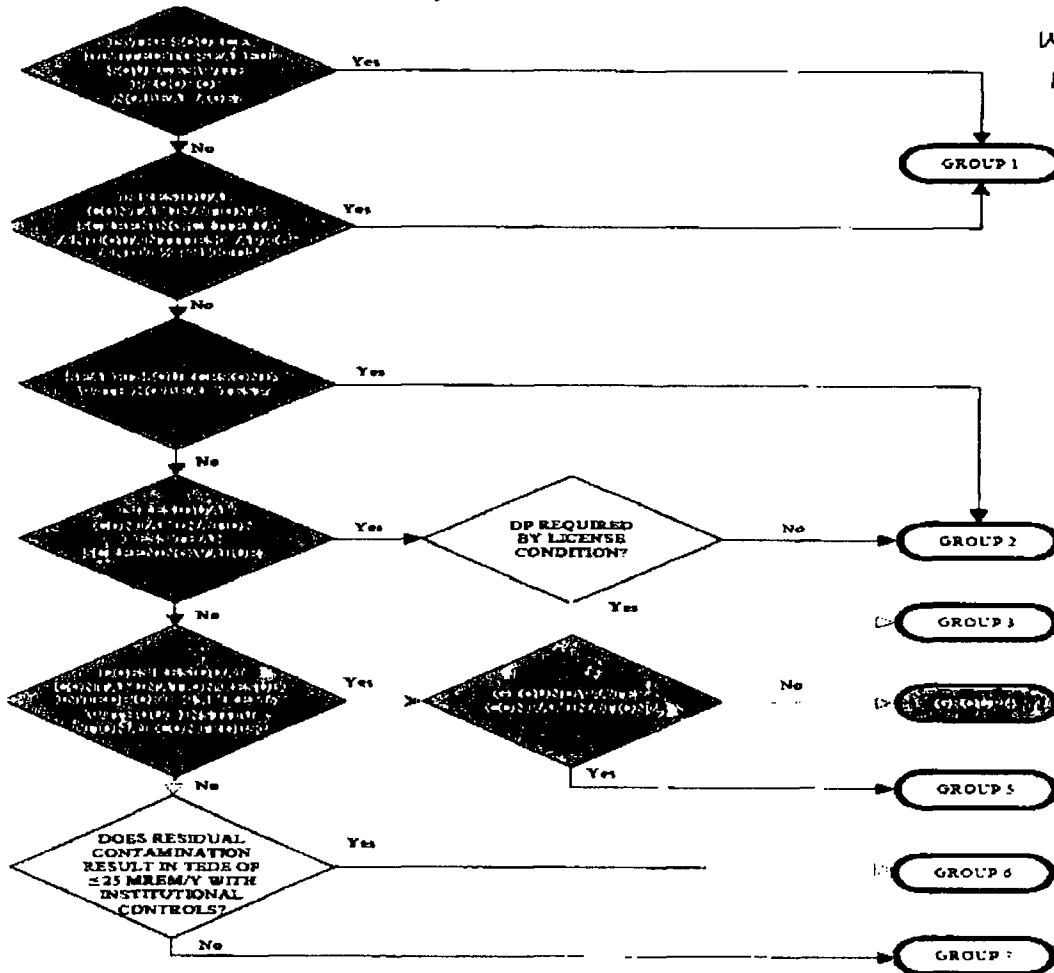
11/18/10

University of Missouri Project Management Determination Briefing

Purpose: To discuss whether headquarters or the region should maintain decommissioning project management and licensing authority over the partial decommissioning release of Pickard Hall at University of Missouri at Columbia, Missouri.

Site Notes:

- The University of Missouri identified Pickard Hall contained radium-226 and thorium-232 contamination in 2009 due to research conducted between 1890 to 1930s.
- Building houses the University of Missouri's Art History and Archeology departments, a public museum of Art and Archeology, and is listed on the National Registry of Historic Places.
- Licensee plans to request alternative decommissioning schedule.
- Restricted Area Maximum dose rate: 112 μ Rem/hr above background.
- Unrestricted area maximum dose rate: 15 μ Rem/hr above background.
- Basement office workers are aware of the situation and have been trained as radiation workers and have dosimetry.



Timeline:

- 11/17/2009: Licensee notified the NRC per 30.36(d) that it identified that Pickard Hall contained residual radium-226 contamination such that the building was unsuitable for release in accordance with NRC requirements.
- 12/7/2009: Licensee begins full characterization of Pickard Hall.
- 1/26/2009: NRC performs reactive inspection to verify licensee characterization results.
- 6/21-23/2010: Licensee encapsulates floor and wall surfaces in two basement mechanical room to prevent the spread of removable contamination. NRC performed an inspection onsite.
- 10/25/2010: Licensee requests extension submittal date Decommissioning Plan (DP) submittal from November 17, 2010 to February 17, 2010. 10 CFR 30.36(d) requires a submittal of a DP 12 months from the date of the notification without an alternative schedule approved from the NRC.

Future Expected Timeline

- 2/17/2010: Licensee expected to request for an alternative schedule for decommissioning per 10 CFR 30.36(f) and 10 CFR 30.36(h)(2)(i).
- Spring 2010: Licensee request to place permanent shielding in office room to reduce the source term for public occupancy.
- Spring 2010: Performance of steam feeder tunnel remediation and/or encapsulation to prevent the spread of radium contamination in the steam tunnel. *Chase*
- TBD Decommissioning Plan submittal. (several years)

Expected Project Management Review Process

Alternative Schedule Licensing Review Process – FY11 (Projected ~10 weeks)

Guidance provided in NUREG-1757, Volume 3, section 2.6.

- Acceptance Review (2 weeks)
- Federal Register Notice with opportunity to request a hearing and provide public comments (1 week)
- Public Meetings (within the comment period) (TBD)
- Safety Evaluation Report (4 weeks)
- Environmental Assessment (2 weeks)
- License Amendment (1 day)

Decommissioning Plan Licensing Review Process – FY12+ (Projected ~ 15 weeks)

- Acceptance Review (4 weeks)
- Federal Register Notice with opportunity to request a hearing and provide public comments (1 week)
- Public Meeting (TBD)
- Safety Evaluation Report (8 weeks)
- Environmental Assessment (2 week)
- License Amendment (1 day)

Building License Removal – FY14+ (Projected ~11 weeks)

- Final Status survey review (10 weeks)
- Potential need for public meetings and Federal Register Notice (1 week)
- License Amendment

Regional Interest

- Regional licensee since only a partial site release.
- Characterization results show that majority of the contamination on the inside of the building and soil contamination is not a large concern.

Potential Impacts

- Large public interest or outrage requiring numerous public meetings.
- Potentially a several year project that will need continual project management.
- Large alpha contamination
- Radon (may set precedence)
- Legal Issues on NRC jurisdiction on discrete Radium.
- Potential for the licensee to request unique or complex dose modeling or restricted release.

NRC Region III Decommissioning Branch

Project Management Determination Criteria

Providing regulatory oversight of decommissioning activities conducted by NRC licensees and former licensees is a joint effort shared by Headquarters and the Regions. In meeting this effort, Headquarters and the Regions share management responsibilities based on the complexity of the decommissioning activities.

NUREG-1757, *Consolidated Decommissioning Guidance*, states that the Regions normally have the lead for Group 1 and 2 sites and Headquarters has the lead for Group 4 to 7 sites. However, before assigning regulatory oversight for Group 3 sites, the Regions and Headquarters will discuss and agree on the appropriate lead office. Although very few sites fall into the Group 3 category, many sites are classified as a Group 4, and the Regions do occasionally project manage these sites. When these decisions are made for the Region to project manage a Group 3 or 4 decommissioning site, the decision is normally based on an ad hoc discussion between the Regional and Headquarters Branch Chiefs with input from staff and Division Directors.

To ensure a thorough and consistent approach when determining whether the Region should assume project management for a Group 3 or 4 decommissioning site, the following criteria should be considered in making that decision.

- Is this an active NRC Region III licensee requesting a partial site release that intends to retain its license? If so, the Region would normally project manage the decommissioning activities.

This is a partial site release.

- Have any EPA NRC MOU issues been identified? If so, Headquarters would normally project manage the decommissioning action.

Building-surface contamination is the major concern of this project and therefore not subject to the EPA MOU.

Building is on the National Historic Place list, which will require coordination with other agencies and require Environmental Assessment.

- Does the site contain buried or mixed waste that will make remediation and disposal particularly challenging? If so, the site may be better project managed by Headquarters, depending on the type and quantity of contamination and/or mixed waste.

No buried waste is expected.

- Is the company financially viable; does the Company have any financial instruments in-place; will a revised decommissioning funding plan be needed? If any outstanding financial issues exist that may impact the completion of the decommissioning, then the activities would normally be project managed by Headquarters.

Yes, financially viable. No outstanding financial issues.

Side: All DPs require revision of DP funding plans. Therefore, a revision of the DP funding plan will be required.

- Is groundwater contamination an issue? Due to the potential complexity in assessing and modeling radioactive contaminants in groundwater, these sites would normally be project managed by Headquarters.

No

- Is the decommissioning action expected to be completed in a reasonable timeframe, e.g., less than 1-1½ years? Decommissioning activities that can be completed in a timely manner, including the time for Decommissioning Plan (DP) review and approval, through the review and approval of the Final Status Survey, could reasonably be expected to be project managed by the Region.

No. Licensee intends to ask for alternative schedule and intends to leave the site in a safe store condition for several years. However, once decommissioning is initiated, decommissioning should be able to be completed in 24 months.

- Is this a site with a significant level of public or congressional interest? Sites that may require a high level of public outreach should normally be project managed by Headquarters.

Significant public interest is expected since the building is a public building with classrooms located at a large University which has been contaminated since the 1890s.

- Does this site have any unique disposal issues? For example, is onsite mixing going to be employed, or is there a request for an optional disposal method under CFR 20.2002? If retained by Region, appropriate TARS and QA of Regional work will be coordinated with HQ.

No

- Are site specific DCGLs being generated or are the default screening values being used? If site specific DCGLs are derived, are the pathway analyses limited, e.g. direct exposure and or inhalation that have no groundwater impacts. If the screening values are selected for the DCGLs, or if simplistic modeling is used to develop site specific DCGLs, and the decommissioning action is for the release for unrestricted use, the Region would normally project manage the action.

TBD. However, site specific dose model with revised re-suspension values and radon pathways are expected.

Current Region Decommissioning Projects (expected completion dates)

- Sigma –FY11 (June 2011)
 - DP amendment
 - Final Status survey report review
- ABC Lagoon – FY11 (August 2011)
 - Decommissioning Plan
 - Remediation
 - Final Status Survey Report
- Breckenridge – FY11 (September 2011)
 - Remediation
 - Final Status Survey Report
- LCAAP - FY11 (April 2011)
 - Final Status Survey Report review for Area 10
 - Continued oversight.
- Potential Group 3+ sites
 - NASA Glenn – In formal characterization phase
 - Cyclotron
 - Licensee in characterization phase
 - DP may not be required
 - University of Missouri, Sin Claire Farm's Lagoons and Buildings
 - Carbon-14 and Hydrogen-3 potential contamination
 - Licensee in characterization phase
 - SEMO outside area
 - Am-241 soil contamination
 - ABC Historic Lagoons and Lysemeter fields
 - Potential Carbon-14 and Hydrogen-3 contamination

good afternoon
 my name is Christine Lipa and I work for the U.S. NRC
 Thank you for coming to our meeting. ①

this is a public meeting and there will be time for questions at the end of our presentation.



I'd like to walk thru several handouts that you may have collected on your way in.

your way in

① copy of these items

② copy of press release

③ copy of Federal Register describing how public can submit comments to NRC

Public mtg

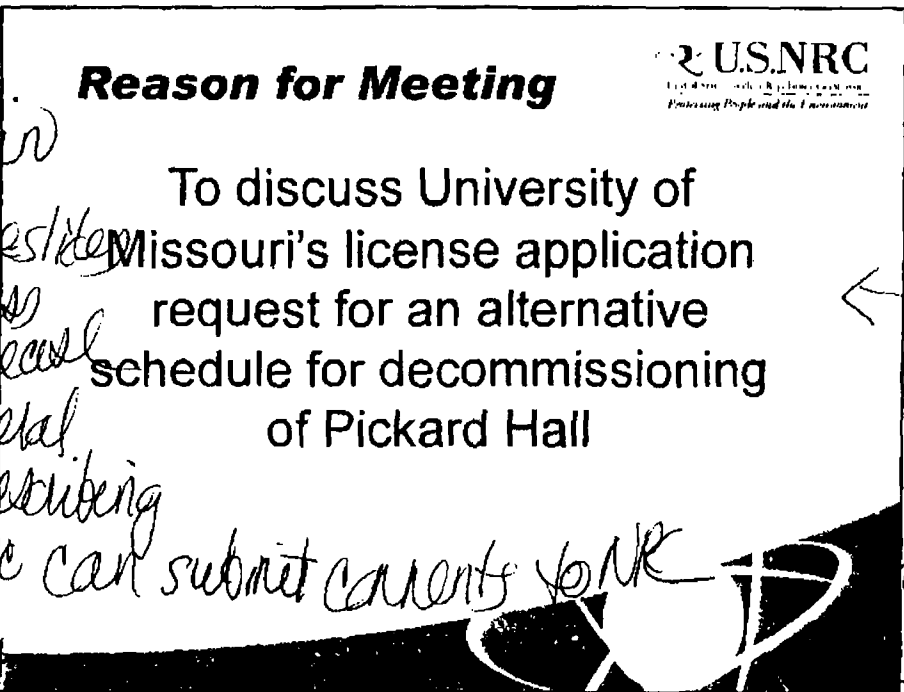
Feedback form - can fill out & leave here for us @ back table

④ copy of safety inspection report we did in Jan 2010

⑤ sheet w/ OR codes

⑥ Copy of sheet on how to use our document system - ADAMS

⑦ This card for any questions



we will go through the back of site - main purpose



① discuss our process

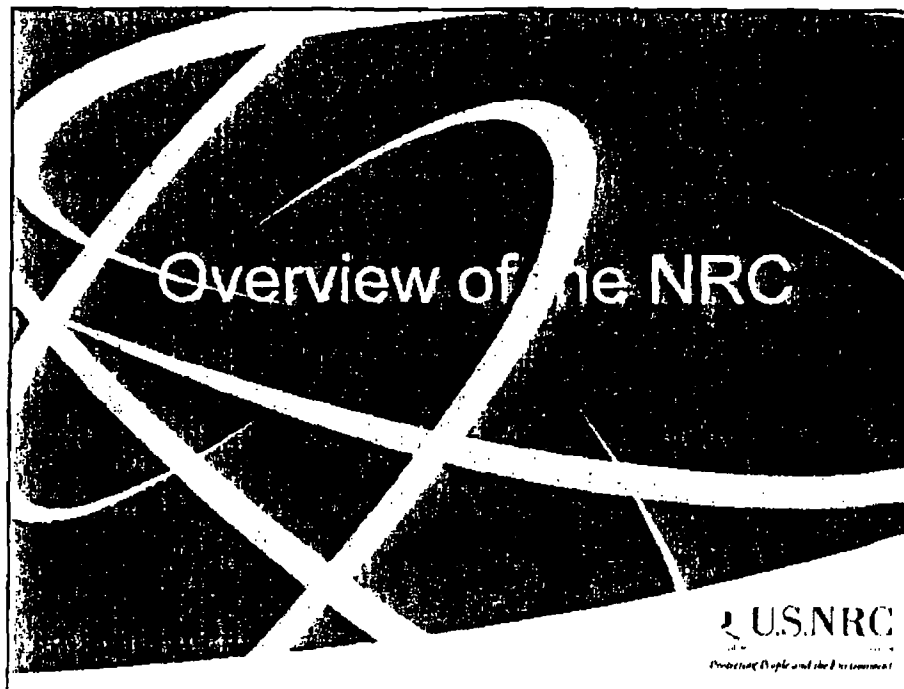
② discuss specific license req

③ be avail to public for Q's

NRC Presenters



- **Christine Lipa**
 - Branch Chief; Materials Control, ISFSI, and Decommissioning Branch; RIII, NRC
- **Katie Streit**
 - Health Physicist; Materials Control, ISFSI, and Decommissioning Branch; RIII, NRC
- **Mike LaFranzo**
 - Senior Health Physicist; Materials Control, ISFSI, and Decommissioning Branch; RIII, NRC

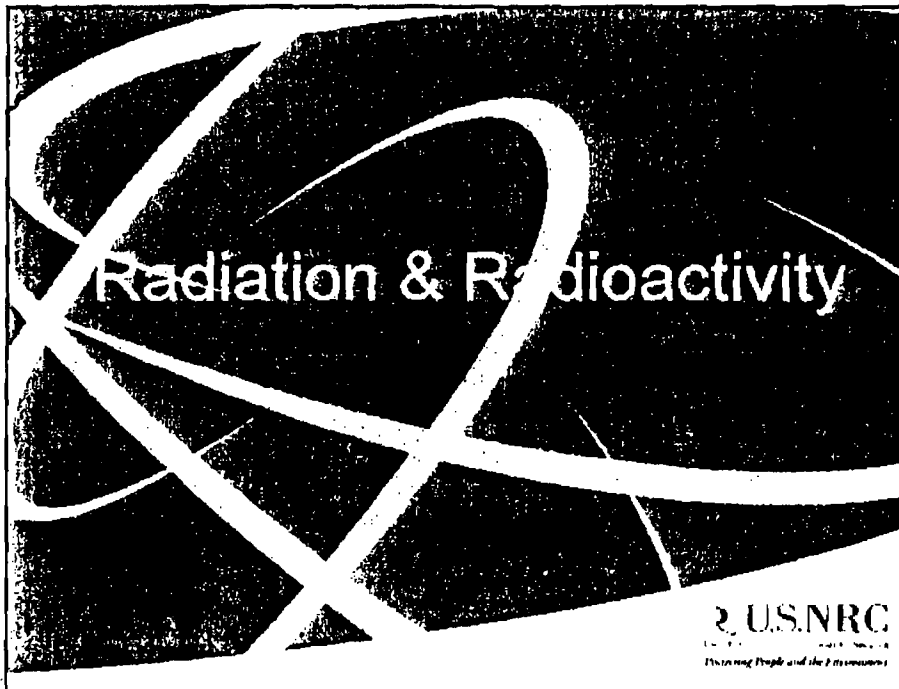


Katie —

Byproduct Material



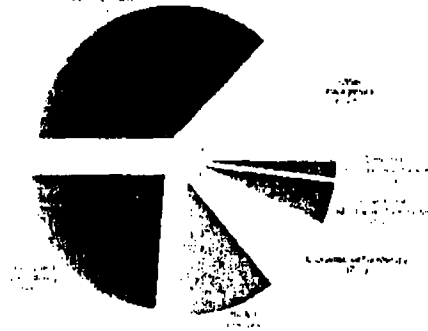
- Energy Policy Act of 2005 expanded NRC regulatory jurisdiction to include discrete sources of Radium-226, a Naturally Occurring Radioactive Material (NORM)
- Transition Phase (72 FR 59157)
 - NRC gained authority of NORM in the state of Missouri after September 30, 2008
 - 1 year transitional period



Average Exposure



Average Exposure in the United States is
620 mrem per year



Source: National Council on Radiation Protection and Measurements, Report 180, 2009

Examples of Average Exposures



Source	Amount (mrem/yr)
Air (natural Radon)	200
Terrestrial Radiation	46
Food and Drinks (e.g., potassium)	40
Medical X-Ray	40
Cosmic Radiation at Columbia, MO elevation	28

Source: U.S. EPA "Calculate your Radiation Dose" at
<http://www.epa.gov/radiation/understand/calculate.html>

NRC Verified Building Status



- Building is safe for use
- Radiological controls are adequate to ensure building occupants and public safety
- No NRC dose limits have been exceeded

NRC verified the building status during a reactive inspection and confirmatory survey conducted in January 2010

Doses at Pickard Hall



- Dosimetry Monitoring Results
 - Highest quarterly result was 13 mrem, or approximately the same as an average person receives from consuming natural radioactive material found in food and drinks
 - Provided as an attachment to the licensee's request
- NRC has verified licensee performed dose assessment which concluded no dose limits have been exceeded in the buildings current configuration

Decommissioning



- *Decommissioning* means to remove a facility safely from service and reduce residual radioactivity to a level that permits release of property
- Release removes the facility from a NRC license and can allow licensee's to release the property from their control

Decommissioning Plan



- Is necessary when new procedures are needed for the decommissioning of the facility
- Decommissioning Plans Include
 - Planned Decommissioning Activities
 - Health and Safety Procedures
 - Decommissioning Schedule
 - Final Status Survey Design
 - Building Release Limits

10 CFR 30.36

University's Alternative Schedule Request

U.S. NRC
U.S. Nuclear Regulatory Commission
Protecting People and the Environment

- Justification Provided in University's Request
 - Building listed on the National Register of Historic Places and houses the Museum of Art and Archaeology and its artifacts
 - Safe & Stable Condition
 - Operational controls & Periodic Surveys
 - Characterization Survey Results
 - Public Interest
 - Building and Museum provide educational, cultural, and historic value

NRC is
reviewing
the
University's
request.

NRC License Review

U.S. NRC
U.S. Nuclear Regulatory Commission
Protecting People and the Environment

NRC Review of the Request



- **Ensure public health and safety**
 - Verify the facility will remain in a safe configuration
 - Verify controls are in place to quickly identify if conditions change
 - Verify licensee's characterization survey results
 - As Low As Reasonably Achievable (ALARA)
 - Findings will be documented in a Safety Evaluation Report
- **Ensure Necessity and Public Interest**
- Application will be reviewed using NUREG-1757, "Consolidated Decommissioning Guidance"

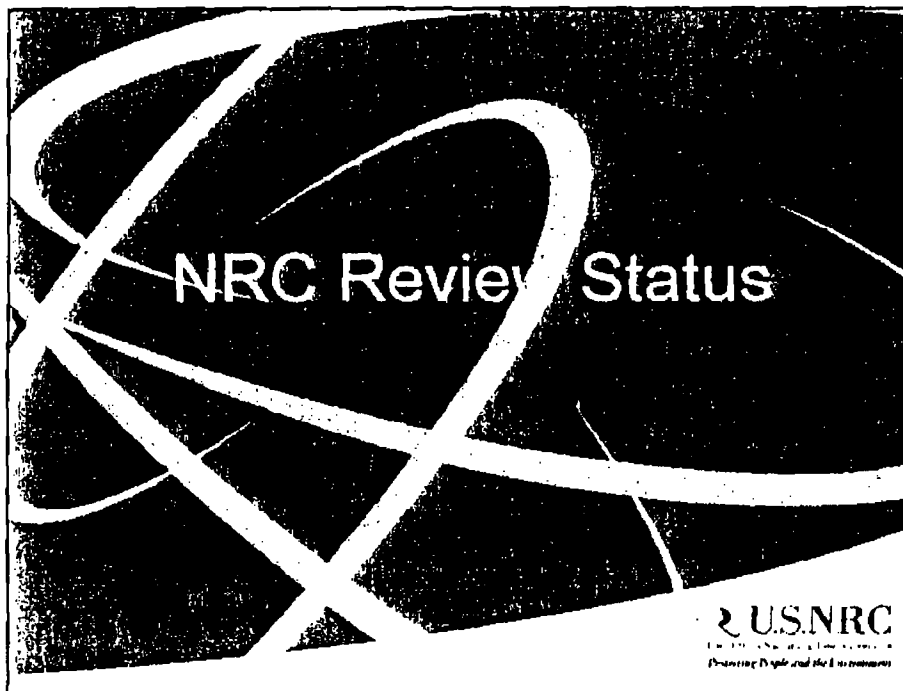


Public Involvement



- Comments will be posted on NRC web and will not be edited to remove personal information
- Request a hearing by July 5, 2011, as described in *Federal Register* notice (76 FR 26322)

NRC strives
to maintain
openness
in license
review



NRC Inspection Activities



- NRC Began a Reactive Inspection on January 26, 2010
- If amendment is approved, periodic inspections will be conducted to verify compliance with commitments, regulatory requirements, and University procedures

Inspections Scope



- Review public and occupational exposures
- Operational Controls
- Removal or Remediation Activities
- Confirmatory Surveys

Contact Information



- Christine Lipa, Branch Chief
 - Christine.Lipa@NRC.gov
 - 630-829-9834
- Mike LaFranzo, Senior Health Physicist
 - Michael.LaFranzo@NRC.gov
 - 630-829-9865
- Katie Streit, Project Manager
 - Katherine.Streit@NRC.gov
 - 630-829-9621
- Prema Chandrathil, Public Affairs Officer
 - Prema.Chandrathil@NRC.gov
 - 630-829-9663



For More Information



- For more information regarding Decommissioning, see:
<http://www.nrc.gov/about-nrc/regulatory/decommissioning.html>
- For more information regarding Naturally Occurring Radioactive Material, see: <http://nrc.stp.ornl.gov/narmtoolbox.html>
- For the NUREG-1757 documents, see:
<http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1757/>
- For 10 CFR 30.36, see: http://www.nrc.gov/reading-rm/doc-collections/cfr/part030/part030_36.html



Lipa, Christine

From: Logaras, Harral
Sent: Thursday, June 23, 2011 5:27 PM
To: Heck, Jared
Cc: Pederson, Cynthia; Lipa, Christine; Streit, Katherine; Weil, Jenny; Barker, Allan
Subject: Missouri G2G

Today we (Katie Streit, Mike LaFranzo, Christine Lipa, Mike McAnn, Nick Hansing and I) met with Jane Beetem, Brandon Doster and Ben Overby of the State of Missouri; Dan Schneiderjohn of Boone County Health; and Mitch Erdel of U. S. Senator Blunt's office..

We presented a synopsis of the public meeting slides (University of Missouri Pickard Hall Decommissioning Plan) and took questions with discussion in the following areas: Has a DP actually been submitted? Is the characterization submitted last July accurate as of today? Will there be a schedule for decommissioning in the DP? What is the goal of the DP?

The team addressed these fully and answered all questions to the satisfaction of the attendees within the planned 1 hour agenda.

Mitch Erdel thanked us for the briefing and the State appreciated the opportunity to interact on technical issues separate from the public meeting.

Harral

INSPECTION RECORD

Region III

License No. 24-00513-32

Inspection Report No. 030-02278/2011-002

Docket No. 030-02278

Licensee (Name and Address):

The Curators of the University of Missouri

311 Jesse Hall

Columbia, Missouri 65211

Licensee Contact: Jack Crawford – RSO Telephone No. 573-882-0931

Date of This Decommissioning Inspection: August 25-16, 2011

Type of Inspection: ☐ Initial ☒ Announced ☐ Unannounced
 ☒ Routine ☐ Special

Summary of Findings and Actions:

- ☐ No violations cited, clear U.S. Nuclear Regulatory Commission (NRC) Form 591 or regional letter issued
- ☐ Non-cited violations (NCVs)
- ☐ Violation(s), Form 591 issued
- ☒ Violation(s), regional letter issued
- ☐ Followup on previous violations

Inspector

Michael LaFranzo
Michael LaFranzo, Senior Health Physicist

Date 9/13/11

Approved

Christine A. Lipa
Christine A. Lipa, Chief, MCID

Date 9-16-11

B/12

(B)

PART I-LICENSE, INSPECTION, INCIDENT/EVENT, AND ENFORCEMENT HISTORY

1. AMENDMENTS AND PROGRAM CHANGES:

In a letter dated February 17, 2011, the licensee requested an Alternate Decommissioning Schedule for the decommissioning of Pickard Hall.

2. DECOMMISSIONING INSPECTION AND HISTORY:

On January 26 and 27, 2010, the U.S. Nuclear Regulatory Commission (NRC) conducted a reactive inspection at the University of Missouri, Columbia, Missouri Campus. The purpose of this inspection was to assess the University's actions to address radiological contamination identified in two Academic Halls, Pickard Hall and Schweitzer Hall. During the inspection, the NRC determined that radiological contamination was located in Pickard Hall and decommissioning was required for that building pursuant to 10 CFR 30.36. No cited violations of NRC requirements were identified during the inspection (IR 030-02278/10-01(DNMS).

On June 23, 2011, representatives of the U.S. Nuclear Regulatory Commission (NRC) held a public meeting in Columbia, Missouri regarding the University of Missouri, Columbia's license amendment request for an alternative schedule for decommissioning of Pickard Hall. The Public Meeting Summary can be found at NRC public web site (Accession Number: ML11194A073). Prior to the public meeting, representatives of NRC also performed a non-inspection related site tour of Pickard Hall.

3. INCIDENT/EVENT HISTORY:

No incidents or events were noted since the last decommissioning inspection.

PART II - INSPECTION DOCUMENTATION

1. ORGANIZATION AND SCOPE OF PROGRAM:

Ms. Jackie Jones, Vice Chancellor of Administrative Services
Maureen Kotlas, Director of Environmental Health and Safety
Silvia Jurisson, Chairperson, Radiation Safety Committee
Jack Crawford, Radiation Safety Officer

On August 25-26, 2011, NRC performed a decommissioning inspection of Pickard Hall relating to radiological surveys thereof to support the licensee's Alternative Decommissioning Schedule. During the inspection, the licensee had two health physicists accompany the inspector during the inspection. The licensee has not used radioactive material in this building since the 1930s. The licensee believes and has documentation to support that the radiological contamination is Radium-226.

2. SCOPE OF INSPECTION:

The inspection focused on NRC independent radiological surveys to support the licensee's request for an Alternate Work Schedule. The Alternate Work Schedule concerning the decommissioning rule requests NRC approval to delay work such that the licensee would not start decommissioning activities of Pickard Hall immediately and that further evaluation of a decommissioning plan and schedule would occur in 2014.

NRC also performed interviews of licensee staff and reviewed records associated with radiological surveys of Pickard Hall.

3. INDEPENDENT AND CONFIRMATORY MEASUREMENTS:

The inspector performed independent radiological surveys with a NaI (2x2) detector. The inspector visited all major rooms and areas and performed selected independent surveys of the ceiling, walls and floor. The inspector verified radiological contamination where the licensee had indicated such contamination would be located. The inspector also identified several areas where the licensee either did or did not identify radiological contamination that were not posted nor were security measures in place. The NRC has cited the licensee for failure to make or cause to be made surveys that may be necessary for the licensee to comply with the regulations in Part 20 related to security and posting of areas that possess licensed material (see section 4 for details). The locations identified were in McLorn Gallery (room 205), wall of the storage room on the second floor (room 213). Research Laboratory 17, the Lecture Hall (room 106), outside of Staff Office 9 in the corridor, above the 9 foot level of Offices 111

and 112 and the Julius Carlebach Gallery (room 206). Background radiation levels were between 10 Kilocounts per minute (KCPM) and 15 KCPM. The NRC did not identify any removeable contamination but radiation levels with the radiation detector ranged from 30KCPM to 60 KCPM on contact. In Offices 111 and 112, the inspector's survey instrument did not exceed 9 feet above the floor and it is anticipated radiation levels on the ceiling of the room (ceiling is approximately 15 feet) could be much higher.

4. VIOLATIONS, NCVs, AND OTHER SAFETY ISSUES:

During the decommissioning inspection, the inspector was performing independent radiological surveys of areas within Pickard Hall. During radiological surveys, the inspector identified numerous areas that possessed elevated radiation levels but the licensee had not performed adequate surveys, in accordance with 10 CFR 20.1501, to determine if such areas required security measures to be implemented in accordance with 10 CFR 20.1801 or whether those areas required posting in accordance with 10 CFR 20.1902(e). The specific citation and locations where elevated radiation levels were located are below:

Title 10 Code of Federal Regulations (CFR) 20.1501 requires that each licensee make or cause to be made surveys that may be necessary for the licensee to comply with the regulations in Part 20 and that are reasonable under the circumstances to evaluate the extent of radiation levels, concentrations or quantities of radioactive materials, and the potential radiological hazards that could be present.

Contrary to the above, as of August 25, 2011, the licensee did not make surveys to assure compliance with:

- A. 10 CFR 20.1801, which requires the securing from unauthorized removal or access to licensed material that are stored in controlled or unrestricted areas. Specifically, elevated radiation levels were identified in McLorn Gallery (room 205), wall of the storage room on the second floor (room 213). Research Laboratory 17, the Lecture Hall (room 106), outside of Staff Office 9 in the corridor, above the 9 foot level of Offices 111 and 112 and the Julius Carlebach Gallery (room 206) and the licensee did not make surveys to determine the quantity of licensed material which could affect the determination of security of those areas.
- B. 10 CFR 20.1902(e), which requires posting of areas or room in which licensed material is used or stored. Specifically, elevated radiation levels were identified in McLorn Gallery (room 205), wall of the storage room on the second floor (room 213). Research Laboratory 17, the Lecture Hall (room

106), outside of Staff Office 9 in the corridor, above the 9 foot level of Offices 111 and 112 and the Julius Carlebach Gallery (room 206) and the licensee did not make surveys to determine the quantity of licensed material which could affect the whether posting in those areas are required.

The licensee verbally committed to re-evaluate those areas and determine if additional regulatory measures are required. The Notice of Violation requires a response from the licensee which will provide additional details of the additional evaluations or surveys to ensure compliance with NRC regulations.

5. PARITIAL LIST OF PERSONNEL CONTACTED:

- #* Maureen Kotlas, Director of Environmental Health and Safety
- #* Silvia Jurisson, Chairperson, Radiation Safety Committee
- #* Jack Crawford, Radiation Safety Officer

Use the following identification symbols:

- # Individuals present at entrance meeting – August 25, 2011
- * Individuals present at exit meeting – August 26, 2011

-END-

September 16, 2011

Ms. Jackie Jones, Vice Chancellor
Administrative Services
The Curators of the University of Missouri
319 Jesse Hall
Columbia, Missouri 65211-1250

SUBJECT: NRC INSPECTION REPORT 030-02278/11-02(DNMS) AND NOTICE OF
VIOLATION – THE CURATORS OF THE UNIVERSITY OF MISSOURI

Dear Ms. Jones:

This refers to a decommissioning inspection conducted on August 25 and 26, 2011 at the Curators of the University of Missouri, Pickard Hall facility located in Columbia, Missouri. The purpose of the inspection was for the U.S. Nuclear Regulatory Commission (NRC) to conduct independent radiological surveys of Pickard Hall in support of the licensee's proposed decommissioning of the facility. An exit meeting was conducted between members of your staff and Michael LaFranzo of my staff on August 26, 2011.

During this inspection, the NRC staff examined activities conducted under your license as they relate to public health and safety to confirm compliance with the Commission's rules and regulations and with the conditions of your license. Within these areas, the inspection consisted of selected examination of procedures and representative records, observations of activities, and interviews with personnel.

Based on the results of this inspection, the NRC has determined that a Severity Level IV violation of NRC requirements occurred. The violation was evaluated in accordance with the NRC Enforcement Policy. The current Enforcement Policy is included on the NRC's Web site at (<http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html>). The violation involved the failure to make or cause to be made surveys that may be necessary for the licensee to comply with the regulations in Part 20 related to security and posting of areas that possess licensed material. The violation is being cited in the Notice because it was identified by the NRC. You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response. The guidance in NRC Information Notice 98-28, "Suggested Guidance Relating to Development and Implementation of Corrective Action," may be helpful. You can find the Information Notice on the NRC website at: <http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1998/in98028.html>. The NRC will use your response, in part, to determine whether further enforcement action is necessary to ensure compliance with regulatory requirements.

ENCLOSURE 2

B/13 (14)

J. Jones

-2-

In accordance with Title 10 of the Code of Federal Regulations (CFR) 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response, will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>. To the extent possible, your response should not include any personal privacy or proprietary, information so that it can be made available to the Public without redaction.

We will gladly discuss any questions you have concerning this inspection.

Sincerely,

/RA/

Christine A. Lipa, Chief
Materials Control, ISFSI and
Decommissioning Branch
Division of Nuclear Materials Safety

Docket No. 030-02278
License No. 24-00513-32

Enclosure:
Notice of Violation

cc w/encl: Maureen Kotlas, Director of Environmental Health and Safety
Silvia Jurisson, Chairperson, Radiation Safety Committee
Jack Crawford, Radiation Safety Officer
State of Missouri

J. Jones

-2-

In accordance with Title 10 of the Code of Federal Regulations (CFR) 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response, will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>. To the extent possible, your response should not include any personal privacy or proprietary information so that it can be made available to the Public without redaction.

We will gladly discuss any questions you have concerning this inspection.

Sincerely,

/RA/

Christine A. Lipa, Chief
Materials Control, ISFSI and
Decommissioning Branch
Division of Nuclear Materials Safety

Docket No. 030-02278
License No. 24-00513-32

Enclosure:
Notice of Violation

cc w/encl: Maureen Kotlas, Director of Environmental Health and Safety
Silvia Jurisson, Chairperson, Radiation Safety Committee
Jack Crawford, Radiation Safety Officer
State of Missouri

DISTRIBUTION:
Cynthia Pederson
Anne Boland
Patrick Loudon
Steven Orth
Carole Ariano
Paul Pelke
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MIB Inspectors

*See previous concurrence

DOCUMENT NAME: G:\DNMS\I\Work in progress\IR- University of Missouri 030-02278 2011-001 Letter.docx

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OFFICE	RIII DNMS	C	RIII DNMS	RIII	RIII
NAME	MLLaFranzo: jm MLL		CALipa CAL		
DATE	09/18/11		09/16/11		

OFFICIAL RECORD COPY

NOTICE OF VIOLATION

The Curators of the University of Missouri
Columbia, Missouri

Docket No.: 030-02278
License No.: 24-00513-32

During a U.S. Nuclear Regulatory Commission (NRC) inspection conducted on August 25 and 26, 2011 one violation of NRC requirements was identified. In accordance with the NRC Enforcement Policy, the violation is listed below:

Title 10 Code of Federal Regulations (CFR) 20.1501 requires that each licensee make or cause to be made surveys that may be necessary for the licensee to comply with the regulations in Part 20 and that are reasonable under the circumstances to evaluate the extent of radiation levels, concentrations or quantities of radioactive materials, and the potential radiological hazards that could be present.

Contrary to the above, as of August 25, 2011, the licensee did not make surveys to assure compliance with:

- A. 10 CFR 20.1801, which requires the securing from unauthorized removal or access to licensed material that are stored controlled or unrestricted areas. Specifically, elevated radiation levels were identified in McLom Gallery (room 205), wall of the storage room on the second floor (room 213). Research Laboratory 17, the Lecture Hall (room 106), outside of Staff Office 9 in the corridor, above the 9 foot level of Offices 111 and 112 and the Julius Carlebach Gallery (room 206) and the licensee did not make surveys to determine the quantity of licensed material which could affect the determination of security of those areas.
- B. 10 CFR 20.1902(e), which requires posting of areas or room in which licensed material is used or stored. Specifically, elevated radiation levels were identified in McLom Gallery (room 205), wall of the storage room on the second floor (room 213). Research Laboratory 17, the Lecture Hall (room 106), outside of Staff Office 9 in the corridor, above the 9 foot level of Offices 111 and 112 and the Julius Carlebach Gallery (room 206) and the licensee did not make surveys to determine the quantity of licensed material which could affect the whether posting in those areas are required.

This is a Severity Level IV violation (Section 6.3).

Pursuant to the provisions of 10 CFR 2.201, The Curators of the University of Missouri is hereby required to submit a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with a copy to the Regional Administrator, Region III, within 30 days of the date of the letter transmitting this Notice of Violation (Notice). This reply should be clearly marked as a "Reply to a Notice of Violation" and should include for each violation: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken, and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate reply is not received within the time specified in this Notice, an order or a Demand for

B/14

Notice of Violation

-2-

Information may be issued as to why the license should not be modified, suspended, or revoked, or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

Because your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> to the extent possible, it should not include any personal privacy, proprietary or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information).

In accordance with 10 CFR 19.11, you may be required to post this Notice within two working days of receipt.

Dated this 16th day of September 2011.

TELEPHONE CONVERSATION RECORD

DATE OF CALL: September 16, 2011

LICENSEE: Curators of the University of Missouri – Columbia Campus

LICENSE NO.: 24-00513-32
DOCKET NO. 030-02278

PERSON CALLED: Jack Crawford
Assistant Director EHS
Radiation Safety Officer
Laser Safety Officer
Adjunct Instructor NSEI
University of Missouri
Phone: 573-882-0931

CALLER: Mike McCann, Senior Health Physicist
Materials Control, ISSFI, and Decommissioning Branch

SUBJECT: CLARIFICATION OF LICENSEE'S "REQUEST FOR PICKARD HALL
ALTERNATIVE DECOMMISSIONING SCHEDULE," DATED FEBRUARY 17,
2011 (ML110540477)

Mr. Crawford (Radiation Safety Officer (RSO)) was contacted to clarify some points regarding the February 17, 2011, submittal that requested an alternative decommissioning schedule. Specifically, the RSO was asked about the finality of the characterization data, and the Statement that a decommissioning plan would be submitted at some point in the future pursuant to 10 CFR 30.36(g).

Mr. Crawford indicated that Pickard Hall contains residual radium-226 contamination in some lightly occupied areas, and that initial characterization results indicate that the facility does not meet NRC screening values for unrestricted release in some areas. Mr. Crawford indicated that a final characterization and dose analysis cannot be completed until the museum is closed and moved to another location as outlined in the February 17 alternative decommissioning schedule request. The RSO indicated that he had just completed a MARSSIM training course and is now more aware of the survey and facility release requirements. We also discussed that the NRC screening values are a guidance tool, and does not preclude the use of other modeling approaches and establishment of site specific criteria to demonstrate compliance with 10 CFR 20.1402. He further indicated that he was initially confused in that he thought the submission of a DP was automatically required.

B/15

To clarify the DP requirements, the elements of 10 CFR 30.36(d) and 30.36(g) were also discussed. Mr. Crawford indicated that the final determination for the University to submit a DP will be made after full characterization of the Hall has been completed. Mr. Crawford indicated that he understood that the Alternative Schedule would be based on 10 CFR 30.36(f). In this case the University has initial data that infers that some areas of the Hall may be in excess of the screening values, but that in order to fully assess the Hall to demonstrate whether it meets the unrestricted use criteria of 10 CFR 20.1402, that further characterization will be needed.

We discussed the licensee's request to delay initiation of the decommissioning process and that the request must contain justification that supports the proposed delay. Pursuant to 10 CFR 30.36(f), NRC may grant a request to delay initiation of the decommissioning process. The decommissioning process does not start until NRC makes a determination on the request. Specifically, Mr. Crawford was advised that 30.36(d) requires after the University made the notification to the NRC that Pickard Hall may not be suitable for unrestricted use, that the University was to either begin immediately decommissioning the Hall so that the building or outdoor area is suitable for release in accordance with NRC requirements, or submit within 12 months of notification a decommissioning plan, if required by paragraph (g) (1). Thus, without the full characterization of the Hall, the University cannot make a final decision whether or not the decommissioning of the Hall can be done under the authority of the University's existing license or if a DP will be required.

Mr. Crawford was advised that the NRC would send a letter within the near future requesting additional information regarding the schedule extension and that if he has any additional questions to talk to Mr. Mike LaFranzo, Senior Health Physicist, 603-829-9865.

No further discussion.

Lipa, Christine

From: McCann, Mike
Sent: Monday, September 19, 2011 2:07 PM
To: LaFranzo, Michael
Cc: Lipa, Christine; Rodriguez, Lionel; Bonano, Eugenio; Lee, Peter; Tapp, Jeremy
Subject: September 20 2011 Checklist for the University of MissouriRecord.docx
Attachments: September 20 2011 Checklist for the University of MissouriRecord.docx

Mike

Attached is a draft checklist for the University of Missouri. It is a work in progress, but thought I would send around for FYI and training purposes.

I will work on the Attachment more tomorrow.

Any questions give me a holler.

Mike

**ff Materials Control, ISFSI and
Decommissioning Branch**

General License Review Checklist and Certification Document

Licensee: Curators of the University of Missouri
Address: 311 Jesse Hall, Office of Research, Safety, Columbia, MO 65211
Facility: Pickard Hall, located at 405 S. Ninth Street, University of Missouri
Campus (no principle licensed activities being performed.)

Contact: Jack Crawford
Title: Radiation Safety Officer
Telephone: (573) 882-0931
E-mail: crawfordw@missouri.edu

License No(s): 24-00513032
Docket No(s): 030-02278
Ref Numbers: NA
Expiration Date: January 31, 2014
Control Number: 574562
PP Code: 02110
Secondary PCode: added SPCode as follows: (03800 3 Byproduct Material Possession Only
- Permanent Shutdown Principle activities ceased, license termination
request pending; packaging and shipping operations authorized;
decontamination and decommissioning (D&D) not authorized) Checked
with Kevin Null, Senior License Reviewer prior to modification.

Reviewer: Mike LaFranzo, Senior Health Physicist
Mike McCann, Senior Health Physicist

License Action Type (Check one)

Decommissioning Plan ☐ Partial Site Release X ☐ From MLB ☐
Amend X ☐ Termination ☐ New License ☐ Renewal ☐

Decommissioning Group 2 ☐ 3 ☐ 4 ☐ Technical Review for MLB: X ☐

Decommissioning Other specify: Request for delay in complying with 10 CFR 30.36(d),
request to delay decommissioning schedule pursuant to 10 CFR 30.36(f).

Date action transferred from MLB to MCIDB: February 04, 2011

Date action received: March 23, 2011

Date due (if decommissioning, negotiate due date with Branch Chief): December 2011
(drop dead date February 04, 2012)

OMI Track Updated? Yes ☐ No ☐ <http://portal.nrc.gov/edo/r/iii/DNMS>

See Drive G: Decommissioning MCIDB Branch: Branch Guidance Procedures: Guidance: NRC
Region III, Division of Nuclear Materials Safety, Decommissioning Branch, Project Management
Procedure (PMP), July 15, 2008.

Staff General comments regarding license action: In University of Missouri letter dated February 17, 2011, (ML110540477), the University requests to delay the decommissioning of an academic Hall (Pickard Hall), which has low residual levels of Radium-226. In an attachment to its letter, "Alternative Decommissioning Schedule Justification, Pickard Hall, 405 South Ninth Street, Columbia, Missouri, "dated February 17, 2011, the licensee outlines the basis and justification for their scheduler delay request.

The MCIDB staff used the NRC guidance document " NUREG-1757, Vol. 3, Rev. 1, Consolidated Decommissioning Guidance, Financial Assurance, Recordkeeping, and Timeliness, " for the review of the licensee's request. The general sections addressing this review are discussed in Section 2.2 Extension or Alternative Schedule for Decommissioning," and Section 2.6, "Review Criteria for Extension or Alternative Time Schedule Requests." Attachment A, is the initial review checklist developed during the review of the University's request. The staff also called the licensee on September 16, 2011, to clarify the regulatory basis for the licensee's decommissioning schedule extension.

Staff License review observations and certification of compliance

1. NUREG 1757, vol 1, rev 2¹, Appendix C (pages C-1 to C-4) "Notification Checklist" items verified*? Yes ☒ No ☐ NA ☐ Comment:
2. NUREG 1757 Appendix L (page L-3 to L-8) "Decommissioning Process Checklists" items verified*? Yes ☐ No ☐ NA ☒ If Group 2 go to Item 3, if Group 3 or 4 go to Item 4,
Comment: This action is under continued assessment. A specific Group designation cannot be assigned until further characterization of the Hall and soils adjacent to Building. This will be done at some date in the future. This action is specific to a 10 CFR 30.36(f) exemption request. The Group 2 section will be completed for this action, since an Environmental Assessment and Finding of No Significant Impact will need to be made and published in the Federal Register announcing the decommissioning schedule extension if approved by the NRC.
3. Group 2 action (Does not require a Decommissioning Plan)
 - a. This action qualifies for a Categorical Exclusion (CATX)² pursuant to 10 CFR Part 51.22(c) (20)³. If the CATX is NOT specific to decommissioning (administrative, procedural, etc) change CATX reference to the appropriate CATX specified in 10 CFR 51⁴. Include in the license amendment cover letter the following sentence
"An environmental assessment for this action is not required; since this action is categorically excluded under 10 CFR 51.22(c) (licensing manager should fill in appropriate number)."

Yes ☐ No ☒ If NO go to step b. **Comment:** The 10 CFR 50.51(14) categorical exclusions do not apply to this action. There exist a significant potential public dose and public interest regarding this license amendment.

¹ NUREG-1757, vol 1 rev 2, is publicly accessible (ML063000243).

* Appendix not required to be put into ADAMS

² CATXs are not automatic and other parameters such as public or regulatory interest (see 10 CFR 5021) could lead to the need for an Environmental Assessment.

³ See NUREG-1748 "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs," Appendix B: CATX Checklist (ML032540811), and Federal Register / Vol. 75, No. 74 / Monday, April 19, 2010 / Rules and Regulations, pages 20248 – 20257.

⁴ See NUREG-1748, Section 2.1 "Documenting the CATX." (ML032540811)

b. The determination for an Environmental Assessment (EA) was verified⁵?
Yes ☒ No ☐ If EA required go to Step c. Comment:

c. Finding of No Significant Impact (FONSI) and EA were announced in a Federal Register Notice⁶: Yes ☐ No ☐
Branch approval Date: _____
OGC concurrence Date: _____
State Consult Date: _____
Date issued and Page Numbers: Comment:

d. Final status survey (FSS) report provided to the NRC adequate? Does it meet minimum criteria of 10 CFR 30.36(j), "Final Status Surveys."⁷
Yes ☒ No ☐ NA ☐
ML No. for FSS: _____ Comment:

e. NRC inspection and confirmatory survey was performed⁸?
Yes ☐ No ☐
ML No. and Date of Inspection Report: _____ Comment:

f. The proposed radiological release criteria are consistent with CFR Part 20, Subpart E, and NRC screening criteria⁹? If the licensee has a license commitment for a lower clean-up criteria tied down in license, then the licensee must meet that limit unless the screening criteria is requested to be incorporated as part of the current amendment.
Yes ☐ No ☐ Comment:

g. Records to be submitted by licensee or retained for historical purposes are on file or will be transferred to NRC verified¹⁰? Yes ☐ No ☐ Comment:

h. Does the licensee have a financial assurance document on file with NRC¹¹?
Yes ☐ No ☐ if licensee's request for release is acceptable and FA is no longer required, advise MLB so document can be returned to licensee.
License Reviewer Name: _____
Date informed: _____ Comment:

- i. License Termination or amendment issued? Amendment No: _____ Date: _____
- Place this checklist with Project Manager/reviewer's signature certification in pending folder. Done? Yes ☐ No ☐
 - Verify documents in ADAMS and profiled correctly. Done? Yes ☐ No ☐

⁵NUREG 1757, vol 1, Appendix E Checklist for Use of Generic Environmental Impact Statement for License Termination and Sample Environmental Assessment for Sites that Use Screening Criteria. (ML063000243)

⁶PMP Section 4.2.3 "Federal Register Notices" and "Federal Register Notice Drafting Tools for NRC-wide Use" (<http://www.internal.nrc.gov/ADM/DAS/cag/notices/nitems.html>).

⁷NUREG 1757, vol 1 Section 15.4.3 "Final Status Survey" (FSS) page 2-9; NUREG-1757, Chapter 2 Group 2 Decommissioning, Section 9.2, "Licensee Actions;" (ML063000243) and NUREG-1757 vol 2 Chapter 4, "Facility Radiation Surveys," (ML070390081)

⁸NUREG-1757 vol 1, Section 15.4.5 "Confirmatory Surveys;" NUREG-1757 vol 2, Chapter 4 "Confirmatory Surveys;" and IP 83890 A Closeout Inspection and Survey.e

⁹NUREG-1757 vol 1, Chapter 6, Radiological Criteria for Decommissioning, Section 6.6, Decommissioning Screening Criteria; and Appendix B, Table B.1 Acceptable License Termination Screening Values of Common Radionuclides for Building-Surface Contamination, and Table B.2 for surface soil release criteria. Also, see NUREG 5512 vol 3 (http://r3intra.nrc.gov/dnms2006/DNMS_WEB/index_files/nuregs.htm)

¹⁰NUREG-1757 Chapter 15, Section 15.51 Records; 10 CFR 30.35, 30.36, and 30.51; 40.36, 40.42, and 40.61; 70.25, 70.38, and 70.51; or 72.80, as appropriate, or the licensee has affirmed that these records are not required to be retained, or the records have been transferred to NRC

¹¹NUREG-1757, vol 3 and 10 CFR 30.35 for financial requirements.

- Complete and sign MLB LTS data input sheet, and the MLB ADAMS checklist.
Done? Yes ☐ No ☐
- Consult with MLB Reviewer if there are questions about IC limits, SUNSI,
templates and format. Done? Yes ☐ No ☐
MLB Reviewer name, if consulted: _____
Comment:

This Action is Certified By:

Date:

Attachment A
Decommissioning Scheduler Delay Request

University of Missouri
License Number 24-00513032
Docket Number 030-02278
Date of Request: February 17, 2011 (ML110540477)

Discussion: The following is paraphrased from excerpts from the licensee's attachment "Alternate Decommissioning Schedule Justification Pickard Hall 405 S. Ninth Street, Columbia, MO," dated February 17, 2010 (typo on cover page, date should be 2011),

The University's Pickard Hall, is located at 405 S. Ninth Street on the University of Missouri (MU) campus in Columbia, Missouri. The Hall has been determined to contain 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

The University performed additional radiological characterization work in Pickard Hall to collect information important to decommissioning and to support the revision of their DFP to include Pickard Hall. The licensee's 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. The University 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 University indicates in its request, that based on 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. The University indicates in its attachment that they are 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 condition.

The University indicates that a definitive estimate regarding 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 cannot be determined, and requests that submittal of a DP be delayed indefinitely subject to periodic review by the NRC to coincide with broad scope license renewal. The University contends that the alternate schedule is necessary to the effective conduct of decommissioning operations, and that it does not present an undue risk from radiation to the public health and safety, and is in the public interest.

Review criteria and Guidance: The MCIDB staff used the NRC guidance document "NUREG-1757, Vol. 3, Rev. 1, Consolidated Decommissioning Guidance, Financial Assurance, Recordkeeping, and Timeliness," for the review of the licensee's request. The general sections addressing this review are discussed in Section 2.2 Extension or Alternative Schedule for Decommissioning," and Section 2.6, "Review Criteria for Extension or Alternative Time Schedule Requests."

B/17

The review steps from the NUREG guidance, and staff comments are as follows:

Step 1: NRC staff will document and communicate to the licensee their position on the safety and environmental acceptability of the request, which forms the basis for the subsequent licensing action.

MCIDB staff completed the review of the licensee's request and generated a number of requests for additional information in letter dated xx/xx/xxxx (MLxxxxxxx).

Step 2 To demonstrate that delaying the start of decommissioning will not be detrimental to public health and safety, a licensee should submit the following:

- A discussion of its record of regulatory compliance, particularly its compliance with NRC regulations, and

1.

2.

- the health and safety plan that will be in effect during the standby period.

Step 3 Demonstration that an Extension of the Time Period for Initiation of Decommissioning is Otherwise in the Public Interest

To support a request for an extension of the time period in 10 CFR 30.36(d), a licensee should provide the following:

- The date that principal activities ceased at the site, separate building, or outdoor area, as provided for in 10 CFR 30.36(d)(3) and 30.36(d)(4).
- The date a request for an extension of the time period is required, as provided for in 10 CFR 30.36(f)
- The length of postponement requested.
- Whether a DP will ultimately be required for the site.
- The reason the licensee is requesting an extension of the time period for initiation of decommissioning schedule and an explanation of how the public's interest will be served by NRC approval of the extension. For example, licensees who request to go on standby rather than decommission could address whether decommissioning of the facility will require dismantlement, such that the facility will no longer be available for nuclear purposes. Operators of Federal facilities could explain how an extension of the time period for initiation of decommissioning would better take into account a broader Federal plan for decommissioning that establishes priority, funding, and schedules, thereby reducing the public funds needed for decommissioning the facility.
- A demonstration that the facilities will not significantly deteriorate during a standby period, if applicable. Facilities should be sufficiently maintained such that they may become operational without extensive repairs and decommissioning is not significantly more complex at a later date.

-
- A discussion of the current decommissioning cost estimate and the potential for increased decommissioning costs if an extension of the time period is approved.
 - Evidence of adequate financial assurance for the ultimate decommissioning of the site. Financial assurance documentation will be reviewed in accordance with Chapter 4 and Appendix A of this volume.
 - A discussion (a) of the extent and nature of contamination and the potential for migration by airborne or ground water pathways and (b) of the plan for monitoring and maintaining the site, separate building, or outdoor area during the extension period. The plan should be sufficiently detailed to demonstrate that public and worker health and safety and the environment will not be negatively affected during the extension period. The operating maintenance and radiation protection programs previously approved by NRC may be continued during the extension period. The plan should also demonstrate that the applicant will conduct sufficient monitoring, during the extension period, to assure that residual contamination does not become a public or a worker health and safety issue

UNIVERSITY of MISSOURI

ENVIRONMENTAL HEALTH AND SAFETY

TO: Mr. Mike Lafranzo
Senior Health Physicist
Region III
U.S. Nuclear Regulatory Commission
Materials Control, ISFSI, and Decommissioning Branch
Division of Nuclear Materials and Safety
2443 Warrenville Road Ste. 210
Lisle, Illinois 60532-4352

FROM: Mr. Jack Crawford
Radiation Safety Officer / Assistant Director
Environmental Health & Safety
University of Missouri - Columbia
Columbia, MO 65211-3050

DATE: October 3rd, 2011

SUBJECT: Request for Extension of Response Time for Reply to Notice of Violation letter dated September 16, 2011, Docket No. 030-02278, License No. 24-00513-32

Dear Mr. Lafranzo:

As you and I discussed on the phone on September 27, the University of Missouri would like to formally request an extension of the due date for our Reply to the Notice of Violation (NOV) which was submitted in the NRC letter to MU Docket No. 030-02278 dated September 16, 2011.

The reason for this extension is to provide us time to have more data from radiation surveys and associated modeling to support our response to the NOV. We have recently contracted with Chase Environmental to perform additional characterization of Pickard Hall. We have been informed that their final report will not be available by the due date for our response. Additionally we have contracted with another independent consultant to help us in the review of our response and activities related to Pickard Hall. Therefore, we are requesting the date of our submission to be extended to November 4th, 2011.

We also want to bring to your attention that although the NRC letter is dated September 16th, the university did not receive it until September 26. We do not know why there was a delay however it has resulted in a reduced time period to develop our response.

RECEIVED OCT 07 2011

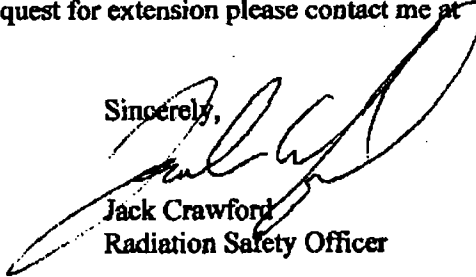


8 Research Park Dev Bldg, Columbia, MO 65211 Phone: 573-882-7018 Fax: 573-882-7940 ehs.missouri.edu
Missouri's Flagship University

B/18 12

If you have any questions or concerns about this request for extension please contact me at (573)-882-0931 or crawfordw@missouri.edu.

Sincerely,



Jack Crawford
Radiation Safety Officer

cc: J. Jones
S. Jurisson
M. Kotlas
RSO File
U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington,
DC 20555-001



TRIP REPORT

DATE OF TRIP: September 27, 2012

MEMORANDUM TO: The Curators of the University of Missouri File

LOCATION: The Curators of the University of Missouri
Environmental Health & Safety
8 Research Park Development Bldg.
Columbia, Missouri 65211

LICENSE NO.: 24-00513-32
DOCKET NO.: 030-02278

PARTICIPANTS: The Curators of the University of Missouri

Jacquelyn Jones, Vice Chancellor
Administrative Services

Maureen Kottas
Director of Environmental Health and Safety

Jack Crawford, Radiation Safety Officer

Mary Aldrich, Health Physicist

The Curators of the University of Missouri Consultant

Sue Engelhardt, President
Engelhardt & Associates, Inc.

U.S. Nuclear Regulatory Commission (NRC)

Michael LaFranzo, Senior Health Physicist
NRC Region III, Division of Nuclear Material Safety, Material
Control, ISFSI, and Decommissioning Branch (MCIDB)
michael.lafranzo@nrc.gov, (630) 829-9865

PURPOSE: TO DISCUSS THE LICENSEE'S REQUESTED ALTERNATE
SCHEDULE FOR SUBMITTAL OF A DECOMMISSIONING PLAN
(PICKARD HALL) AND NRC'S REVIEW OF LETTER DATED
FEBRUARY 17, 2011 (ML110540477) AND
CHARACTERIZATION SURVEY REPORT DATED JULY 16,
2010 (ML102800311, ML102800322, ML102800330,
ML102800336, ML102800398, ML 102800412, ML102800452,
ML102800455, ML102800458, ML102800463, ML102800467,
AND ML102800563) – LICENSE MAIL CONTROL NO. 574562

B/19

BACKGROUND:

In a letter dated November 17, 2009 (ML093270544), the licensee notified the NRC that residual radioactivity believed to be naturally occurring radioactive material (NORM) had been identified in the basement of Pickard Hall from activities that occurred early in the 1900's, and that this contamination exceeded the NRC's radiological screening values for unrestricted use.

On January 26 and 27, 2010, the U.S. Nuclear Regulatory Commission (NRC) conducted a reactive inspection at the University of Missouri, Columbia, Missouri Campus which was documented in IR030-02278/10-01(ML100600810). The purpose of the reactive inspection was to assess the University's actions to address radiological contamination identified (NORM) had been identified in the basement of Pickard Hall from activities that occurred early in the 1900's. The reactive inspection documented that the contamination in Pickard Hall did exceed the NRC's radiological screening values for unrestricted use.

On July 16, 2010, the licensee submitted a radiological characterization survey of Pickard Hall (ML102800311, ML102800322, ML102800330, ML102800336, ML102800398, ML10200412, ML102800452, ML102800455, ML102800458, ML102800463, ML102800467, and ML102800563).

On February 17, 2011, the licensee submitted a request for an Alternate Schedule to delay the submittal of a Decommissioning Plan (ML110540477).

On August 25-26, 2011, the NRC conducted an decommissioning inspection of the licensee and documented in Inspection Report 030-02278/11-002 (ML112720592) with an associated Notice of Violation (ML11264A063). The licensee responded to the contents of the report and Notice of Violation in documents dated November 2, 2011 (ML11353A101, ML11353A106, and ML11353A107).

DISCUSSION:

The NRC staff met with Senior Management and the RSO to discuss the NRC's review of the documents dated July 16, 2010 and February 17, 2011. Specifically, the NRC's discussion centered on potential informational deficiencies in the licensee's Alternate Schedule request.

The NRC toured Pickard Hall with Jack Crawford and Mary Aldrich to verify no significant changes had occurred that would affect the licensee's Alternate Schedule request.

CONCLUSION:

The NRC plans to send a letter to the licensee which will document NRC's Request for Additional Information (RAI). The RAI's will address deficiencies in the licensee's request for an

Alternate Schedule. The NRC committed to submit the letter within 15 days of September 27, 2012.

The NRC did not identify any significant changes to Pickard Hall which would affect the licensee's Alternate Schedule request.

Contact:

Michael M. LaFranzo, 630-829-9865

Lipa, Christine

From: Lipa, Christine
Sent: Friday, October 05, 2012 7:58 AM
To: Shaughnessy, Patrice
Subject: FW: Steam Tunnel document for adams (University of Missouri Survey Map of Steam Tunnel section near Pickard Hall)
Attachments: Radiation Survey of Steam Tunnel near MUs Pickard Hall 09.19.12.xlsx

Also add Mail control # 574562 to the profile. thanks

From: Lee, Peter
Sent: Thursday, September 27, 2012 3:22 PM
To: Lipa, Christine
Subject: FW: University of Missouri Survey Map of Steam Tunnel section near Pickard Hall

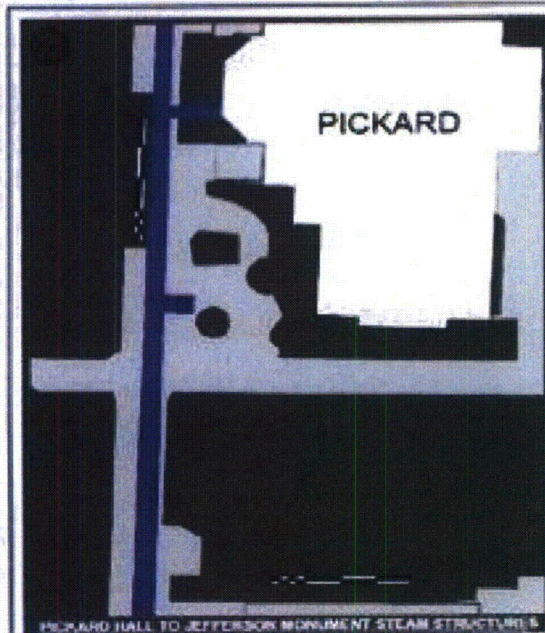
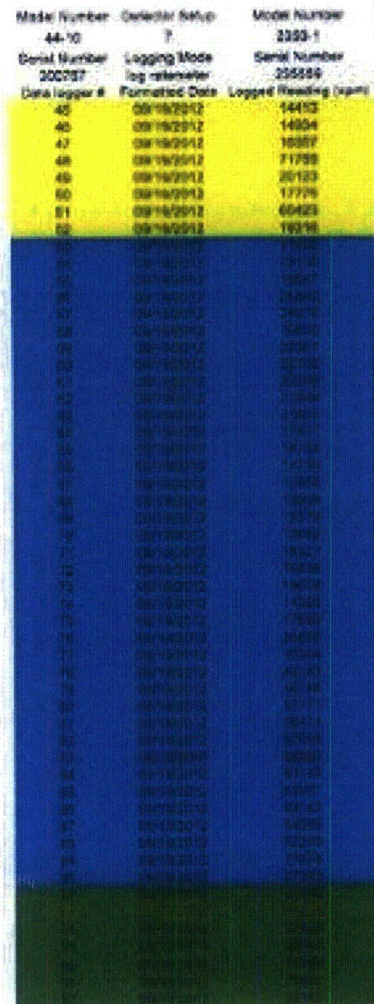
FYI

From: Crawford, Jack [<mailto:crawfordw@missouri.edu>]
Sent: Tuesday, September 25, 2012 7:39 AM
To: Lee, Peter; Aldrich, Mary
Subject: RE: University of Missouri Survey Map of Steam Tunnel section near Pickard Hall

Dr. Lee here is the map of the radiation survey of parts of the steam tunnel near MU's Pickard hall.

If you have questions please let us know.

Jack Crawford
MU RSO

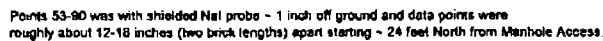


Location: MU Steam Tunnel Performed By: Mary Aldrich/Jack Crawford/Dr. Peter Lee Date: 09/19/2012

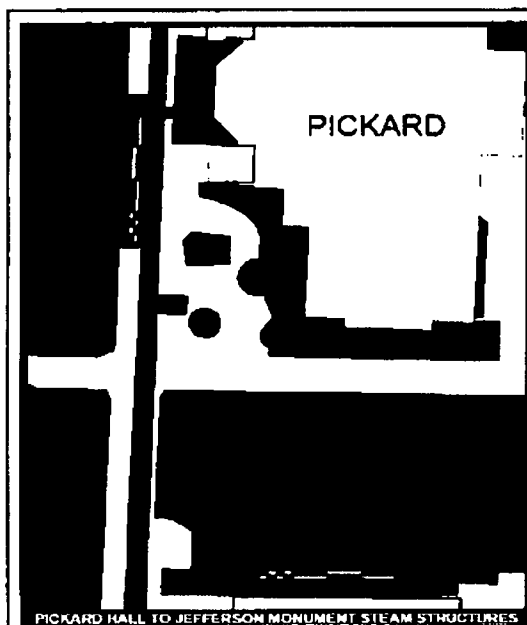
Location: MU Steam Tunnel

Performed By Mary Aldrich/Jack Crawford/Dr. Peter Lee

Date 09 19 2012



Model Number	Detector Setup	Model Number
44-10	7	2350-1
Serial Number	Logging Mode	Serial Number
300787	log rslsmeter	235559
Data logger #	Formatted Date	Logged Reading (cpm)
45	09/18/2012	14413
46	09/19/2012	14934
47	09/19/2012	16357
48	09/19/2012	71789
49	09/19/2012	20123
50	09/18/2012	17775
51	09/19/2012	60423
52	09/18/2012	19216



Lipa, Christine

From: LaFranzo, Michael
Sent: Thursday, January 03, 2013 1:49 PM
To: Lipa, Christine
Cc: Tapp, Jeremy; Lee, Peter; Rodriguez, Lionel; Tehrani, Navid
Subject: University of Missouri - Alternate work schedule changes

Christine,

The licensee contacted me today and indicated that they are planning a significant change in future actions involving Pickard Hall. Specifically, they are now planning to move the entire museum complex out of Pickard Hall and then determine what additional course of action needs to be done. I am in discussions with the licensee on scheduling a telephone call next week to discuss more specifics. Although still a long term process, it will change the licensee's request for an "indefinite" time to start decommissioning to more a long term, more definitive timeframe.

As a call out to interested parties, if anyone would like to be on that telephone contact, please let me know and I can keep you informed of times, dates and phone numbers. Thank you

Michael LaFranzo



B/21

TELEPHONE CONVERSATION RECORD

DATE OF CALL: January 14, 2013
LICENSEE: Curators of the University of Missouri – Columbia Campus
LICENSE NO.: 24-00513-32
DOCKET NO. 030-02278

PARTICIPANTS: **The Curators of the University of Missouri**

Jacquelyn Jones, Vice Chancellor
Administrative Services

Maureen Kottas
Director of Environmental Health and Safety

Gary Ward
Vice President of Campus Facilities

Jack Crawford
Radiation Safety Officer
Phone: 573-882-0931

The Curators of the University of Missouri Consultant

Sue Engelhardt, President
Engelhardt & Associates, Inc.

U.S. Nuclear Regulatory Commission (NRC)

Mike LaFranzo, Senior Health Physicist
NRC Region III, Division of Nuclear Materials Safety (DNMS)
Materials Control, ISFSI, and Decommissioning Branch (MCIDB)
michael.lafranzo@nrc.gov; (630) 829-9865

SUBJECT: TO DISCUSS LICENSEE'S PROPOSED CHANGES TO ALTERNATIVE
DECOMMISSIONING SCHEDULE REQUEST AS DOCUMENTED IN A LETTER
DATED FEBRUARY 17, 2011 (ML110540477) (MAIL CONTROL NO. 574562)

The licensee requested this telephonic conversation to discuss potential changes to the licensee's initial request for an indefinite delay in the implementation of a Decommission Plan submittal.

B/22

The licensee explained that conditions may have changed sufficiently to relocate material and personnel from the museum in Pickard Hall to another facility located approximately 5 miles distance from the University Campus, a building referred to as Ells Fischel. Ells Fischel is currently occupied but plans are in place to move material and personnel from that facility to a new facility being built on campus; the building name will be the Patient Care Tower. The licensee informed the NRC that the new Patient Care Tower is expected to be complete by March 2013. The licensee stated that such conditions could allow Pickard Hall to be decommissioned in a shorter timeframe than discussed in the Decommissioning Alternate Schedule Request document dated February 17, 2011.

The licensee informed the NRC that such a change in proposed decommissioning activities and timeframes is contingent upon numerous variables including, but not limited to: completion of the Patient Care Tower; renovations or modifications, if any, to Ells Fischel to accommodate the material currently within Pickard Hall; staffing considerations; and physical movement of material from Pickard Hall.

The licensee does plan to submit responses to NRC's Request for Additional Information (ML12312A095) by February 9, 2013. In addition to the responses, the licensee stated that additional information concerning decommissioning timeframes could be included.

The NRC informed the licensee that, due to the potential change in decommissioning activities and timeframes, a Federal Register Notice and Environmental Assessment may be needed to be issued prior to any licensing action completion concerning any Alternate Work Schedule and Decommissioning Plan.

End of Conversation

May 23, 2013

Contact: Mary Jo Banken
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BankenM@missouri.edu

Christian Basi
Associate Director
(573) 882-4430
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'Renew Mizzou' Project Continues MU's Stewardship Model to Improve Academic Performance, Safety of Historic Francis Quadrangle Buildings

COLUMBIA, Mo. -- Utilizing the University of Missouri's stewardship renovation model, MU is planning a \$22.85 million project to improve the academic performance of Swallow Hall and install safety features, including a sprinkler system and new fire alarm, in Jesse Hall, pending approval from the UM Board of Curators. In addition, the decommissioning of Pickard Hall will continue. The project, "Renew Mizzou," will eliminate the need for more than \$14.3 million in deferred-maintenance costs associated with these buildings. The initial cost for this project will come from various campus funding sources.

"We take our responsibility of providing quality academic buildings and maintaining our structures very seriously," said Gary Ward, associate vice chancellor-facilities. "The Mizzou Stewardship Model successfully funded the renovation of Tate and Switzler halls, adding five classrooms and 34 faculty offices by using funds from our maintenance budget for these buildings that otherwise would have been spent merely maintaining outdated structures. Addressing these three historic buildings on the Quadrangle using this model is essential to our students, staff, faculty and anyone who visits our outstanding museums housed in Pickard and Swallow, home to priceless artifacts. Jesse Hall, along with the Columns, is the iconic core of Missouri's flagship university."

Renew Mizzou will address three issues:

Improving the academic performance of buildings. In Swallow Hall, renovating the building could gain up to 5,000 gross square feet (gsf) that is currently unusable. The additional space will contain quality classroom/multipurpose space. Also, the existing space will be renovated to be more flexible and reconfigurable to be used for both office and dry lab space.

Timeline:

- May 2014 – faculty and staff will move from building.
- June 2014 – construction begins.
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Building ready for the fall 2015 semester.
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Decommissioning Pickard Hall. As has been reported previously, portions of Pickard Hall still contain some radiation that resulted from experiments conducted in the 1900s. While

-more-

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RENEW MIZZOU PROJECT—2

remediation of the radioactive materials has been ongoing and the portion of the building that is currently in use is safe, university officials will take this opportunity to clear the entire building, conduct further testing and perform any necessary additional work.

Timeline:

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- *COST: \$1.5 million (for move and preparation of space for the museum only; costs for testing dependent upon assessment of facility.)*

As its 19th Century buildings age, MU's list of deferred-maintenance projects grows by more than \$20 million each year. However, only \$13.3 million is allocated to the maintenance budget annually (\$5.7 million of which is required for daily service needs, leaving only \$7.6 million for proactive maintenance projects). As a result, in the past four years, Campus Facilities initiated the "Mizzou Stewardship Model," which focuses on renovating entire academic buildings to meet current codes, adding classroom and faculty office space, and removing the building from a list of 30 buildings requiring continual maintenance. The money saved in maintenance of renovated buildings can then be used to pay for additional deferred-maintenance projects.

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Once Swallow Hall renovations are complete, anthropology and art history and archaeology faculty and staff will all move back into Swallow Hall prior to the beginning of the fall 2015 semester. The Museum of Anthropology and the Museum of Art & Archaeology will be housed at Mizzou North, formerly Ellis Fischel Cancer Center, for the foreseeable future. Jesse Hall staff will return to their building when the work is complete.

MU administrators have been working on a plan to move faculty and staff to the most efficient areas of campus for their particular operations. Some staff in other campus buildings will be moved temporarily so that services needing to stay close to the center of campus can do so. For more details, see chart.

“RENEW MIZZOU” TEMPORARY RELOCATION INFORMATION

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Admissions, Student Financial Aid, Cashiers, Registrar (certain functions only), Accounting (outpost/certain functions only)	Jesse Hall	West Reading Rooms, Ellis Library
Graduate School, International Programs	Jesse Hall	McReynolds Hall
Registrar (certain functions), Vice Provost for Enrollment Management, Student Information Systems, Vice Provost for Undergraduate Studies	Jesse Hall	Heinkel Building
News Bureau, Constituent Relations, University Events	Jesse Hall	Hillel Center (leased space)
Office of Research, Office of Sponsored Programs Administration, Budget, Vice Chancellor of Administrative Services, Business Services, Accounting Services, and “behind-the-scenes” staff of Cashiers, Office of Admissions and Student Financial Aid	Jesse Hall	Mizzou North (former Ellis Fischel Cancer Center building)
Concert Series staff and some KBIA staff	Jesse Hall	Missouri Theatre
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Marketing	Jesse Hall	Rock Quarry Center

Logaras, Harral

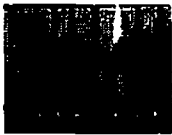
From: Logaras, Harral
Sent: Friday, May 24, 2013 9:49 AM
To: Harry Bozoian
Cc: Robert D. Stout (Robert.Stout@dnr.mo.gov); Henke, Keith; Beetem, Jane; Barker, Allan; Orlikowski, Robert; Lipa, Christine
Subject: FW: University of Missouri: Press Release.doc
Attachments: Ward -- renew mizzou project.doc

Mr. Bozoian,

I am forwarding a University of Missouri press release in case you have not yet seen it. Please recall that during our recent briefing, I mentioned that Pickard Hall at University of Missouri, Columbia is involved with a radiological decommissioning plan. This press release, while broader in scope, does mention that decommissioning and indicates the University intends to look seriously at proceeding. Please contact me with any questions you may have, and best wishes for this holiday weekend.

Sincerely,

Harral Logaras, MBA
U. S. NRC Region III
Regional Government Liaison
630-829-9659
NRC 24 hour Operations Center 301-816-5100



State Flags of Region-III

Link to the *Award Winning* NRC Information Digest ([Click Here for Volume 23](#))
Link to NRC Actions on Japan Emergency <http://www.nrc.gov/japan/japan-info.html>
Link to NRC Fact Sheets and Brochures <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/>

From: Crawford, Jack [<mailto:crawfordw@missouri.edu>]
Sent: Thursday, May 23, 2013 3:22 PM
To: LaFranzo, Michael
Subject: Press Release.doc

Mike,

This is the press release document that was just sent to the local affiliates and St. Louis (AP).

It covers the "Renew Mizzou" project that encompasses a discussion on plans for Pickard Hall as well.

It does not go into a lot of detail but does discuss a timeline that was mentioned by my leadership in earlier discussions.

Christina Basi our PIO indicated that you or your PA folks are welcome to contact him if they have any questions.

It may be assumed but I wanted to be clear we are still and will continue to perform monthly surveillances and exposure monitoring of Pickard as well as those items discussed in our response to the RAI's.

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I don't have much else in details as this was just brought to my attention last week. But I am sure I will be in very close discussions with my leadership on how we are going to proceed but this is what I have now.

Regards.

Jack Crawford
MU RSO

May 23, 2013

Contact:

Mary Jo Banken
Executive Director
(573) 882-6212
BankenM@missouri.edu

Christian Basi
Associate Director
(573) 882-4430
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• RENEW MIZZOU PROJECT—2

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Registrar (certain functions), Vice Provost for Enrollment Management, Student Information Systems, Vice Provost for Undergraduate Studies	Jesse Hall	Heinkel Building
News Bureau, Constituent Relations, University Events	Jesse Hall	Hillel Center (leased space)
Office of Research, Office of Sponsored Programs Administration, Budget, Vice Chancellor of Administrative Services, Business Services, Accounting Services, and “behind-the-scenes” staff of Cashiers, Office of Admissions and Student Financial Aid	Jesse Hall	Mizzou North (former Ellis Fischel Cancer Center building)
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Marketing	Jesse Hall	Rock Quarry Center

University of Missouri
Review of License RAI response
Month of June 2013

References:

Licensee letter and attachments dated July 16, 2010 – ML102800579
NRC letter dated November 6, 2012 – ML12312A095
Licensee letter dated Feb 6, 2013 – ML13126A170
Licensee letter dated May 10, 2013 – ML13135A616
License Public News release from May 23, 2013 – Not in ADAMS

NOTE: The licensee will need to have some timeliness commitments placed in their license regarding the alternate work schedule.

NOTE: Region III will require HQ input to resolve many of items identified below.

NOTE: There are several recommendations to perform a site inspection – suggest in late July or early August when new licensee Director arrives.

RAI-01a:

NRC Request: The licensee should provide specific dates for the proposed Alternate Schedule.

Licensee Response: Request extension until December 2013. Licensee stated that better timeframes can be developed.

NRC Response: The licensee plans only to start "testing" or developing additional information to properly characterize the building so remediation can take place. The licensee will need to submit additional information associated with the characterization (how long will it take and can they perform the analysis under their license: aka: is a DP required)

RAI-01b:

NRC Request: The licensee should provide a description of how the University will begin planning for and a proposed schedule for the movement of artifacts located within the museum that would allow for the start of decommissioning.

Licensee Response: Removing artifacts and other material from building by December 2013.

NRC Response: NRC should perform an on-site inspection to determine what will be move, how will it be moved and whether the movement of material will result in the transfer of contamination within and out of the building.

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RAI-01c:

NRC Request: The licensee should demonstrate that conditions of Pickard Hall will not significantly deteriorate and potentially cause a radiological hazard during the proposed alternate Schedule timeframe.

Licensee Response: Will continue monthly radiological surveillances and radiation control will continue to involve Campus Facilities in any maintenance on the building.

NRC Response: Appears adequate for the short time frames now requested as compared to the indefinite time frames in the earlier request.

RAI-01d:

NRC Request: *The licensee should discuss the current decommissioning cost estimate and the potential for increased decommissioning costs, if an Alternate Schedule is approved.*

Licensee Response: *look at ATTACHMENT 1-MU's DFP, May 2011 and DF located via licensing prior to NRC comment.*

NRC Response: *See above – Check with HQ to determine if values are adequate.*

RAI-02a:

NRC Request: The licensee should provide schematics for the ducts to demonstrate that removable contamination does not have a pathway to areas where members of the public or occupation workers are located.

Licensee Response: Continuing to obtain schematics of floor plans and duct work. Some attached. The last paragraph – last sentence "Current radiological surveys of accessible areas" is incomplete.

NRC Response: Prior to performing assessment in December 2013, the licensee should have all available past and current schematics of the building available and analyzed for potential contamination and structural integrity of the hard-points. NOTE: NRC should ask if additional information should have been included the last paragraph – last sentence (page 3) of the licensee's response.

RAI-02b

NRC Request: *The licensee should develop, implement and maintain procedures to ensure members of the public or occupation workers do not gain unauthorized access to the ducts within the walls without authorization from the licensee's radiation safety program.*

Licensee Response: Development of "Pickard Hall Radiological Operations and Restrictions," RSIP-DC-01. Also, page 18 of 20 from letter dated May 10, 2013 is not in color and is a color coded map.

NRC response: Request licensee provide color map and at minimum the licensee has a color map. Although the licensee's procedure is already a part of the radiation safety program, an on-site inspection should be performed to ensure this procedure is adequate for the next 5 months or more.

RAI-02c

NRC Request: The licensee should provide documentation to show that the contamination will not migrate from under the basement floor to areas where members of the public or occupation workers could be exposed to radioactive material over the timeframe of the Alternate Schedule.

License Response: Licensee did not respond to question.

NRC Response: Although the licensee did not respond to the question, the issue is addressed in the licensee RSIP-DC-01 procedure.

RAI-02d

NRC Request: The licensee should demonstrate whether contamination under the soil has the potential to impact the ground water, potable or not, in the area of Pickard Hall.

Licensee Response: Licensee is requesting the December 2013 extension.

NRC Response: Seems reasonable

RAI-02e

NRC Request: The licensee should develop, implement and maintain procedures to ensure members of the public or occupation workers do not gain access to the contamination under the basement floor without authorization from the licensee's radiation safety program.

Licensee Response: The issue is addressed in the licensee RSIP-DC-01 procedure.

NRC Response: Seems reasonable

RAI-02f

NRC Request: The licensee should provide a detailed description of the workers in Pickard Hall who will be considered occupational radiation workers and what training those individuals are to have received as occupational workers. This includes current and future workers within Pickard Hall.

Licensee Response: The issue is addressed in the licensee RSIP-DC-01 procedure.

NRC Response: Seems reasonable

RAI-02g

NRC Request: The licensee should provide a description of what is meant by "invasive activities" and how the licensee plans to control them in accordance with 10 CFR 30.36.

Licensee Response: "invasive activities" is to mean any activity which may disturb building surfaces such as drilling, scraping, etc. Plans to control such activity are addressed in the licensee RSIP-DC-01 procedure.

NRC Response: Seems reasonable

RAI-02h

NRC Request: The licensee should provide a description of how and how often the licensee will inspect the integrity of the encapsulant.

Licensee Response: Monthly routine surveillances.

NRC Response: Seems reasonable

RAI-02i

NRC Request: The licensee should provide a description of what actions the licensee will take if the encapsulant is determined to be compromised.

Licensee Response: Decontaminate, re-encapsulate or control area.

NRC Response: Seems reasonable

RAI-02j

NRC Request: The licensee should provide a description of the locations and periodicity of the routine surveillance program that will be used for Pickard Hall.

Licensee Response: Maps provided of routine surveillance program.

NRC Response: Checked with other documented sources and seems reasonable.

RAI-02k

NRC Request: *The licensee should provide the type of instruments and capabilities of each instrument that will be used to monitor the building.*

Licensee Response: *Licensee provided instruments used during surveys.*

NRC Response: *NRC did not identify instruments that were capable and calibrated to alpha radiation nor specific to Ra-226. This calls into question whether the licensee can detect 20 DPM/100 cm² alpha. The licensee shall be contacted again to determine if such an instrument exists and ensure the instrument is calibrated for alpha detection and efficiency.*

RAI-02l

NRC Request: *The licensee should provide a description of why the listing of Pickard Hall on the National Register for Historic Buildings affects conduct of decommissioning operations and how this effect will be changed if the Alternate Schedule is granted or denied.*

Licensee Response: *Geographical area where Pickard Hall is located is on the National Register of Historic Places as "Francis Quadrangle Historic District" but the building is not specifically.*

NRC Response: *Since work will need to be done outside of the building, under the slab and soil outside, NRC will need to consider the area for the purposes of National Historic Places.*

RAI-02m

NRC Request: *The licensee should describe how the conduct of decommissioning operations would affect these activities which include, but are not limited to, operation of the museum; undergraduate, graduate, and other instructional programs; current and future museum contracts; and museum artifacts both in the basement and the upper floors storage and viewing areas. Additionally, the licensee should provide an estimated timeline for the length of disruption during decommissioning activities for each area.*

Licensee Response: *Programs will move to another building.*

NRC Response: The original request for an indefinite delay stated one of the reasons was that the operation of the museum; undergraduate, graduate, and other instructional programs would be severely impacted. However, that issue is not considered applicable under the new proposal.

RAI-02n

NRC Request: The licensee should provide legible copy of Attachment 1.

Licensee Response: Licensee provided requested documents.

NRC Response: NRC review did not identify any abnormal radon levels. All were at or below 4 pCi/l as recommended by EPA. No action warranted.

RAI-03a

NRC Request: *The licensee should provide documentation that 400 ft² did not collect a sufficient amount of dust so that no correction was necessary for alpha shielding from dust loading.*

Licensee Response: *The licensee did not demonstrate whether alpha contamination could be measured or whether dust loading was a factor.*

NRC Response: *Due to the lack of information, the NRC does not accept the licensee's statements that alpha contamination was/was not or could be detected using such survey mechanisms.*

RAI-03b

NRC Request: *The licensee should provide documentation regarding efficiency corrections for alpha shielding from dust loading, if applicable.*

Licensee Response: *The licensee did not provide any documentation associated with efficiency of dust loading.*

NRC Response: *Due to the lack of information, the NRC does not accept the licensee's statements that alpha contamination was/was not or could be detected using such survey mechanisms taking into account dust loading.*

RAI-03c

NRC Request: The licensee should provide information that clarifies the statements in Section 9.2.2 in relationship to Appendix F and Appendix G.

Licensee Response: Licensee clarified that the twice background was referencing only outdoor GPS based gamma scans.

NRC Response: A review indicated that the new information does clarify the statements.

RAI-03d

NRC Request: The licensee should provide explanation of how the gamma scans noted in Appendix F and Appendix G relate to dose rates and potential spread of contamination for those individuals who have access to those areas.

Licensee Response: The licensee is controlled access to those areas.

NRC Response: Seems reasonable

RAI-03e

NRC Request: The licensee should provide documented training and/or survey procedures to ensure that scanning techniques could achieve the scanning rates for the Ludlum Model 43-68.

Licensee Response: Chase possessed procedures and described by the licensee.

NRC Response: A review of the description seems reasonable to declare the surveys were probably done adequately.

RAI-03f

NRC Request: *The licensee should provide procedures or other documentation used to convert cpm (the readout for a Ludlum 44-10) to pCi/g for Ra-226, Th232 and Unat.*

Licensee Response: *The licensee stated that because of source term geometry could not be accurately determined, no attempt was made to determine a correlation between activity concentrations and surface exposure rates.*

NRC Response: *Based on the licensee's response, the NRC cannot accept the licensee's correlation between cpm measurements to pCi/g.*

RAI-03g

NRC Request: The licensee should provide Chain of Custody Procedure.

Licensee Response: Licensee provided Chain of Custody procedure.

NRC Response: Seems reasonable.

RAI-03h

NRC Request: The licensee should develop, implement and maintain procedures on how the licensee will ensure the proper control and encapsulation of those and any other areas where radioactive material are located. The procedures shall include appropriate encapsulation and control verification over time and actions to be taken if encapsulation and/or control have been compromised. Contamination areas identified both inside and outside of the building shall be considered.

Licensee Response: Licensee submitted procedure to address issues above.

NRC Response: A review of the procedure addressed above areas and seems reasonable.

RAI-03i

NRC Request: *The licensee should develop, implement and maintain training procedures for any and all groups of individuals who have access to any area where residual radioactivity exists that have the ability to compromise the encapsulation and/or control of areas. Contamination areas identified both inside and outside of the building shall be considered.*

Licensee Response: *Licensee submitted procedure to address issues above.*

NRC Response: *A review of the procedure addressed above areas and seems reasonable.*

RAI-03j

NRC Request: *The licensee should develop, implement and maintain procedures to limit the intrusion of water into areas where residual radioactivity exists.*

Licensee Response: Licensee submitted procedure to address issues above.

NRC Response: A routine inspection should review contents and implementation of the procedure to limit water intrusion.

RAI-03k

NRC Request: The licensee should develop, implement and maintain procedures regarding contingency plans of water intrusion into areas where residual radioactivity exists. These procedures shall address radiological analysis of water, contamination control and disposal of potentially contaminated water.

Licensee Response: Licensee submitted procedure to address issues above.

NRC Response: A routine inspection should be conducted to ensure the licensee has the capability to radiologically analysis water.

RAI-03l

NRC Request: The licensee should develop, implement and maintain procedures to ensure unauthorized individuals do not gain access to the Feeder or Steam Tunnels.

Licensee Response: Licensee submitted procedure to address issues above.

NRC Response: A routine inspection should be conducted to ensure the licensee can maintain access control to the Feeder or Steam Tunnels.

RAI-03m

NRC Request: The licensee should provide schematics of known and potentially contaminated drain and sewer lines.

Licensee Response: Licensee provided schematics of known drain and sewer lines.

NRC Response: The licensee is requesting until December 2013 to determine the potential contamination of drain and sewer lines as assessment could damage art work and activities with Pickard Hall. Seems reasonable as the licensee will do no work in those lines without assessment and they have been there for decades and the possibility of possessing significant quantities of mobile contamination is small.

RAI-03n

NRC Request: *The licensee should develop, implement and maintain procedures to ensure unauthorized individuals do not gain access to known contaminated drain and sewer lines.*

Licensee Response: *Licensee submitted procedure to address issues above.*

NRC Response: *The NRC should conduct an inspection to verify procedure is in place and fully functional.*

RAI-03o

NRC Request: The licensee should develop, implement and maintain procedures to periodically verify contamination from the steam tunnel, drains and sewer lines has not spread beyond the known contamination confines.

Licensee Response: The licensee does not plan to perform contamination surveys until December 2013.

NRC Response: The original alternate schedule request was for an indefinite decommissioning plan delay. Since the licensee has now initiated a different time schedule of less than a year prior to contamination surveys and considering how much time has passed, the request seems reasonable.

RAI-04a

NRC Request: The licensee should develop, implement and maintain procedures to address fire suppression systems in those areas where residual contamination exists.

Licensee Response: Building has fire detection and fire extinguishers. Fire department is readily accessible if an incident occurs.

NRC Response: The original alternate schedule request was for an indefinite decommissioning plan delay. Since the licensee has now initiated a different time schedule of less than a year prior and the amount of time to install those systems could be several years away (planning, funding, radiological issues, etc...), the request seems reasonable.

RAI-04b

NRC Request: The licensee should provide analysis of potential onsite and off-site radiological contamination and dose to members of the public if a fire were to consume areas where residual contamination exists.

Licensee Response: Did not address issue other than assessment will start in December 2013.

NRC Response: The original alternate schedule request was for an indefinite decommissioning plan delay. Since the licensee has now initiated a different time schedule of less than a year, the request seems reasonable.

RAI-04c

NRC Request: *The licensee should develop, implement and maintain training procedures for any and all responders to an emergency within the building that could involve the release of radiological contamination. (e.g. fire and police departments)*

Licensee Response: *The licensee is in the process of development of decommissioning program. Did not address the question.*

NRC Response: *As this decommissioning assessment and remediation could take a number of years, and adequate internal fire prevention and mitigation systems are not in place, the RAI-04c is still valid and needs to be addressed for any licensing action.*

RAI-04d

NRC Request: *The licensee should provide analysis of potential onsite and offsite radiological contamination and dose to members of the public if a natural disaster were to occur (tornado, flood, earthquake, etc.) and cause damage to the Pickard Hall in areas where residual contamination exists.*

Licensee Response: *Licensee is pursuing the relocation of Pickard Hall so the assessment and eventual remediation could occur. The licensee did not adequately address the question.*

NRC Response: *Tornado's, flood's, earthquakes, etc... are long term issues that should be ask under the licensee's previous request of an indefinite delay. However, such issues may not be as relevant in the short term – suggestion to discuss with HQ on applicability.*

RAI-05a

NRC Request: The licensee should provide radiological evaluations of all areas above concerning fixed and removable contamination.

Licensee Response: Licensee is pursuing the relocation of Pickard Hall so the assessment and eventual remediation could occur. The licensee did not adequately address the question.

NRC Response: Adequate evaluations have been made to-date for routine work. Although the licensee did not directly address the question, I believe an adequate amount of information exists to ensure the safety of workers and the public with current procedures prior to further assessment and remediation efforts.

RAI-05b

NRC Request: The licensee should develop, implement and maintain procedures for movement of any and all furniture, mechanical equipment or any other item to address and/or identify any fixed or removable contamination that may have resulted, either directly or indirectly, from such movement.

Licensee Response: The licensee has developed procedures to limit the movement of material and equipment and address contamination in those areas.

NRC Response: Based upon the information available, the response appears adequate.

RAI-05c

NRC Request: The licensee should develop, implement and maintain procedures on how to control any fixed or removable contamination, as identified from actions concerning RAI-05b, to ensure members of the general public and occupational workers are not unnecessarily exposed to radiation and/or radioactive material.

Licensee Response: The licensee has developed procedures to limit exposure to workers and members of the public.

NRC Response: Based upon the information available, the response appears adequate.

Orlikowski, Robert

From: Lipa, Christine
Sent: Tuesday, July 16, 2013 4:51 PM
To: Orlikowski, Robert
Subject: FW: University of Missouri Survey Map of Steam Tunnel section near Pickard Hall
Attachments: Radiation Survey of Steam Tunnel near MUs Pickard Hall 09.19.12.xlsx

another old email i couldnt delete without sending to you so someone has it.

From: Lipa, Christine
Sent: Monday, October 01, 2012 8:02 PM
To: LaFranzo, Michael
Cc: Lee, Peter
Subject: FW: University of Missouri Survey Map of Steam Tunnel section near Pickard Hall

FYI - Peter plans to attach this to his 591 report

From: Lee, Peter
Sent: Thursday, September 27, 2012 3:57 PM
To: Lipa, Christine
Subject: FW: University of Missouri Survey Map of Steam Tunnel section near Pickard Hall

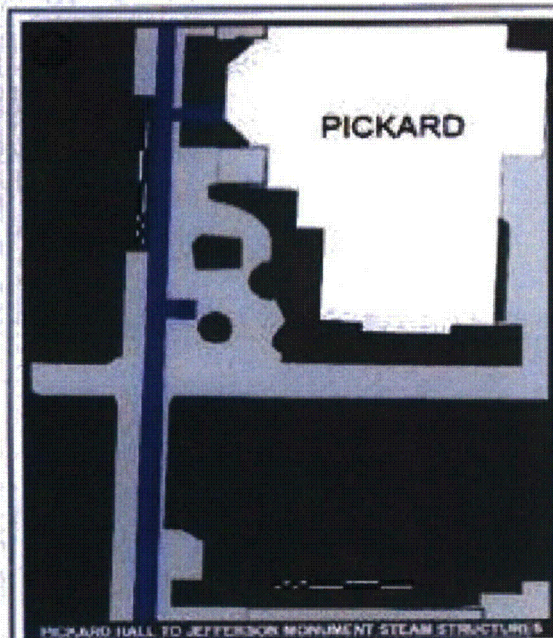
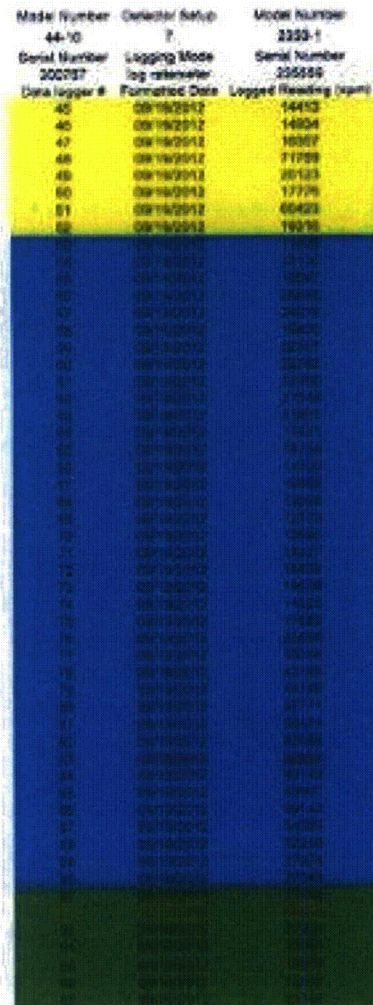
From: Crawford, Jack [<mailto:crawfordw@missouri.edu>]
Sent: Tuesday, September 25, 2012 7:39 AM
To: Lee, Peter; Aldrich, Mary
Subject: RE: University of Missouri Survey Map of Steam Tunnel section near Pickard Hall

Dr. Lee here is the map of the radiation survey of parts of the steam tunnel near MU's Pickard hall.

If you have questions please let us know.

Jack Crawford
MU RSO

Date: 08/10/2012



LaFranzo, Michael

From: Bolling, Lloyd
Sent: Thursday, July 25, 2013 12:18 PM
To: LaFranzo, Michael
Subject: RE: U. of Missouri

Michael:

Thank you for your prompt reply. Can you point me to any "Publically Available" articles or reports? The local HP group is asking and I don't want to send them anything that is not for public consumption.

Thanks again,
Lloyd

From: LaFranzo, Michael
Sent: Thursday, July 25, 2013 12:13 PM
To: Bolling, Lloyd
Subject: RE: U. of Missouri

Lloyd,

In 2009, the licensee informed the regional office that Pickard Hall, the building referenced in the document, contained Ra-226. The licensee submitted an Alternate Work Schedule in accordance with 10 CFR 30.36 requesting an indefinite delay in submitting a Decommissioning Plan. In 2011, the NRC held a public meeting on campus to discuss the issue and the Region has issued several letters requesting the licensee address certain aspects of the request to comply with NEPA, NRC regulations and general radiation safety practices. A licensing action has been in-house since that time.

Earlier this month, the licensee decided to retract their request for an indefinite delay and committed to submitting a letter to NRC within the next 30 days stating that they will submit a Decommissioning Plan, in whole or in part, to complete the decommissioning of the building within 12 months. The Region anticipates the licensee will submit a DP mid-next year but will most likely take longer than 24 months to complete the plan due to the size and complexity of the project.

Do you need additional details?

Michael LaFranzo
Senior Health Physicist
USNRC Region III, DNMS, MCID





From: Bolling, Lloyd
Sent: Thursday, July 25, 2013 10:37 AM
To: LaFranzo, Michael
Subject: U. of Missouri

Michael:

I saw the attached article in the "NRC in the News". Do you have any further information on this?

<http://www.columbiamissourian.com/a/163249/radium-game-the-life-and-legacy-of-herman-schlundt/>

Thanks,
Lloyd Bolling, Health Physicist
Licensing Branch
Division of Materials Safety & State Agreements
Office of Federal, State, Materials
& Environmental Programs
 Lloyd.Bolling@nrc.gov
 301-415-7637 (office)

University of Missouri - Columbia Pickard Hall Phase 3 Characterization Survey Report

**University of Missouri
Museum of Art and Archaeology
1 Pickard Hall
Columbia, MO 65201**

**Performed Under:
Chase Environmental Group's
Commonwealth of Kentucky
Radioactive Materials
License No. 201-605-90**

October 2011



**Prepared by:
Chase Environmental Group, Inc.
109 Flint Road
Oak Ridge, TN 37830
865-481-8801**

51


B/28

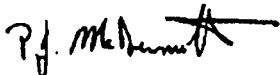
**University of Missouri
Pickard Hall
Phase III
Characterization Survey Report**

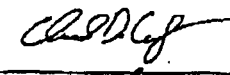
**University of Missouri
Museum of Art and Archaeology
1 Pickard Hall, Columbia, MO 65201**

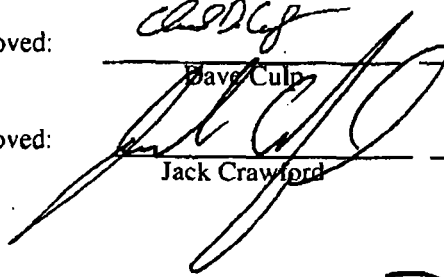
**Work Performed Under:
Chase Environmental Group's
Commonwealth of Kentucky
Radioactive Materials
License No. 201-605-90**

October 17, 2011

Prepared:  Project Manager Date: 10/17/2011
Ken Gavlik

Reviewed:  Certified Health Physicist Date: 11/2/11
Patrick McDermott

Approved:  Radiological Engineer Date: 11/3/11
Dave Culp

Approved:  MU Representative Date: 11/3/11
Jack Crawford



**Prepared by:
Chase Environmental Group, Inc.
109 Flint Road
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865-481-8801**

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ACRONYM LIST

AEC	US Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
DAC	Derived Air Concentration
DQO	Data Quality Objective
EF	Emanation Factor
GPS	Global Positioning System
HEPA	High Efficiency Particulate Air (Filter)
LAW	Large Area Wipe
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
MU	University of Missouri
NRC	U.S. Nuclear Regulatory Commission
NIST	National Institute of Standards and Technology
PPE	Personal Protective Equipment
RPP	Radiation Protection Program
RF	Resuspension Factor
RWP	Radiation Work Permit

1 INTRODUCTION

The University of Missouri (MU) identified residual radioactivity from historical operations in several areas of Pickard Hall located at 1 Pickard Hall, Columbia, MO 65211-1420. Built in 1892, Pickard is currently used as the Museum of Art and Archaeology and houses the Department of Art History and Archaeology. The museum is located on the first and second floors of the building and the basement is currently used for storage of museum artifacts and faculty office space. The building is listed on the National Register of Historic Places.

Historically, the basement of Pickard Hall was used for separation of radium from uranium ores in the early 1900's. Residual radioactivity exists on normally inaccessible structural surfaces and is being routinely monitored by MU. MU operates under broad scope license number 24-00513-32. The residual materials had historically been regulated by the State of Missouri, but are now licensed by the NRC coincidental with implementation of the NRC's expanded definition of byproduct material.

Initial characterization surveys consisted of two phases, and were conducted to the extent possible without interfering with operations (moving artifacts, causing excess vibration, etc.).

- Phase I was performed in December 2009 and included accessible indoor surfaces, outdoor gamma scans, and sampling of various materials to quantify the nuclides of concern.
- Phase II was performed in several mobilizations from February to June 2010, and included roof surveys, global positioning system (GPS) gamma scans of outdoor areas, soil sampling, and post-encapsulation surveys of basement mechanical spaces (Rooms 13 and 15).

Phase 1 and Phase 2 characterization results are documented in the "*Pickard Hall Characterization Survey Report*" dated July 16, 2010. Initial characterization results indicated that the facility did not meet current decommissioning criteria for unrestricted release. Further characterization was complicated by the current use of the building as an operational museum and classroom venue. MU secured building operations and provided additional access to some areas to accommodate this Phase 3 of characterization activities.

MU procured Chase Environmental Group, Inc. (Chase) to collect additional radiological data to estimate the quantity of residual radioactivity in several inaccessible areas. Additionally, simple remediation was performed in some areas while access was provided for characterization. Characterization and remediation involved invasive activities such as removal of small amounts of building concrete; therefore, all work was completed under the Chase Commonwealth of Kentucky radioactive materials license number 201-605-90 utilizing a reciprocal agreement with the NRC.

All characterization activities were performed in accordance with the "University of Missouri – Columbia Pickard Hall Phase III Characterization Work Plan" (Plan) dated September 2011, Chase's Radioactive Materials License requirements and US Nuclear Regulatory Commission (NRC) regulations. The Plan was developed using the applicable guidance provided in NUREG 1757, "Consolidated NMSS Decommissioning Guidance" and NUREG 1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM), and provided the approach, methods, and techniques for radiological characterization of impacted areas of the facility. On-site work was performed from September 30, 2011 to October 3, 2011.

2 SITE DESCRIPTION AND HISTORY

2.1 Building Description

Pickard Hall has a footprint of 8,500 square feet with approximately 25,000 gross square feet of floor area over three elevations. The brick building sits on a stone and mortar foundation. The basement floor is poured concrete with tile and carpet coverings. Floors on the first and second elevations are ceramic tile or carpeted. Interior walls are plaster and sheetrock. The interior of the facility underwent a significant renovation in 1974 that resulted in minor changes to the layout of the basement. The entire ventilation system has been upgraded since the usage of radioactive materials; however some original ventilation ducts remain in the building, but are not in use and are terminated in the attic. There are original drains that have been terminated at floor level and grouted.

A site map is provided in Appendix A, and floor plans in Appendix B.

2.2 Historical Operations

In the early 1900's, the basement of Pickard Hall (originally called the Chemical Building) was used for separation of radium-226 from uranium ores and research activities that included Th-232 daughters. The processes and areas of usage are generally known to MU staff.

2.3 Ownership

Pickard Hall is owned by MU.

2.4 License History

Operations were performed in the early 1900's and preceded the AEC and licensing of radioactive materials. The state of Missouri regulated the materials until recently when the NRC expanded its definition of byproduct materials resulting in the materials being licensed under the MU broad scope byproduct materials license in 2009.

2.5 Current and Future Use

Pickard Hall is currently used by the University's Department of Art History and Archaeology, and the use is not expected to change. Impacted areas are controlled by MU's Environmental Health and Safety Department.

3 NUCLIDES OF CONCERN

Based on the previous characterization performed at Pickard Hall, Ra-226 and Th-232 are potential nuclides of concern. Analytical results from samples of contaminated materials collected during Phase I characterization indicate that greater than 80% of the residual radioactivity is Ra-226.

4 INVESTIGATION LEVELS

Investigation levels for surface activity were established to determine appropriate data quality objectives for characterization surveys. Because the facility used alpha emitting nuclides with very restrictive default screening values, it is expected that a site-specific dose model will be used to decommission the site and surface contamination limits will be greater than NRC Policy and Guidance Directive FC 83-23¹. However, FC 83-23 limits for Ra-226 are used as investigation levels to ensure adequate detection sensitivity for future use of characterization data. Surface contamination quantification is based on alpha measurements. However, because contamination exists under coverings that would shield alphas, beta-gamma measurements were qualitatively performed to detect contamination under floor and wall coverings that would not be detected by alpha measurements. Beta-gamma investigation levels were conservatively set at ten times the alpha investigation levels. The investigation levels are:

- Alpha: 100 dpm/100cm² total and 20 dpm/100cm² removable
- Beta-Gamma: 1,000 dpm/100cm² total and 200 dpm/100cm² removable

To demonstrate the appropriateness of the gross alpha investigation levels, nuclides of concern and progeny were modeled using NRC-approved DandD, Version 2.1 software. DandD output reports were included in Appendix C of the "*Pickard Hall Characterization Survey Report*" dated July 16, 2010. Each nuclide was modeled at an activity concentration of 1 dpm/100cm². Implicit progeny doses were included in parent doses and the initial activity was not distributed. All default parameter values were used except the recommended Resuspension Factor (RF). A RF of 1E-6/m (as recommended in NUREG 1720 "Re-evaluation of the Indoor Resuspension Factor for the Screening Analysis of the Building Occupancy Scenario for NRC's License Termination Rule") is used. This method was chosen because it is simple and conservative. Higher screening values could be obtained using RESRAD-BUILD with ICRP 72 dose conversion factors and site-specific parameter values.

The nuclides of concern have decay chains that emit a variety of different types of radiation. It is important to understand the equilibrium state of the chain in order to convert from activity of the parent to gross alpha activity (the number of alphas per decay). Because the nuclides of concern were chemically separated nearly a century ago, all nuclides are assumed to be in secular equilibrium. The RESRAD-BUILD default

¹ These are the same limits as Regulatory Guide 1.86

deterministic radon emanation fraction (EF) of 0.2 is used to estimate the presence of progeny below radon. Calculations of gross alpha screening values are presented below.

Table 4-1: Basis for Alpha Investigation Levels

Nuclide	Dose ² per dpm/100cm ² (mrem)	Screening Value ³ (dpm/100cm ²)	Alphas per Decay Before Rn	Alphas per Decay Rn+C	1- EF	Corrected Alphas per Decay Rn+C ⁴	Total Alphas per Decay ⁵	Gross Alpha Screening Value ⁶ (dpm/100cm ²)
Th-232+C	0.303	83	3	3	0.8	2.4	5.4	448
Th-230+C	0.0661	378	2	4	0.8	3.2	5.2	1,966
Ra-226+C	0.0172	1,453	1	4	0.8	3.2	4.2	6,103
U-238+C	0.103	243	4	4	0.8	3.2	7.2	1,750

The lowest gross alpha screening value is 448 dpm/100cm². DandD assumes a removable fraction of 10% such that a removable contamination limit of 45 dpm/100cm² alpha is implied. Therefore, the investigation levels are appropriate for determining adequate detection sensitivities for characterization surveys.

5 DATA QUALITY OBJECTIVES

The following is a list of the major Data Quality Objectives (DQOs) used for the survey design:

- Alpha scanning was conducted at a rate to achieve an MDC_{scan} of less than the investigation level of 100 dpm/100cm².
- Beta scanning was conducted at a rate to achieve an MDC_{scan} of less than the investigation level of 1,000 dpm/1000cm².
- Alpha static measurements were taken to achieve an MDC_{static} of less than the investigation level of 100 dpm/100cm².
- Beta static measurements were taken to achieve an MDC_{static} of less than the investigation level of 1,000 dpm/100cm².
- Alpha removable contamination measurements were counted to an MDC_{smear} of less than the investigation level of 20 dpm/100cm².
- Beta removable contamination measurements were counted to an MDC_{smear} of less than the investigation level of 200 dpm/100cm².
- Individual measurements were made to a 95% confidence interval.

6 SURVEY INSTRUMENTATION

Radiation instrumentation was carefully selected and utilized in a manner such that the detection sensitivity of each instrument was below the investigation levels.

² Values obtained from DandD reports

³ 25 mrem / (dose per dpm/100cm²)

⁴ (alphas per decay Rn + C) * (1-EF)

⁵ (alphas per decay before Rn) + (corrected alphas per decay of Rn + C)

⁶ Screening value * total alphas per decay

6.1 Instrument Calibration

Chase's radiation detection instruments were calibrated at least annually with National Institute of Standards and Technology (NIST) traceable sources and to radiation emission types and energies that provided detection capabilities similar to the nuclides of concern. The background, source check and field measurement count times for radiation detection instrumentation were verified by the Project Manager to ensure the validity of measurements. Instrument calibration certificates are provided in Appendix C.

6.2 Functional Checks

Laboratory instruments and portable field instruments were response tested daily when in use. Background and source measurements were performed as part of the daily instrument check and compared with the acceptance range for instrument and site conditions. No instruments failed functional checks.

6.3 Counting Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and measurement of total and removable contamination were chosen to provide a minimum detectable concentration (MDC) that met the DQOs. MARSSIM equations relative to building surfaces were modified to convert to units of dpm/100cm². Count times and scanning rates were determined using the following equations:

6.3.1 Static Counting MDC

Static counting MDC at a 95% confidence level was calculated using the following equation, which is an expansion of NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29 \sqrt{B_R \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100}}$$

Where:

- MDC_{static} = minimum detectable concentration (dpm/100cm²)
- B_R = background count rate (counts per minute)
- t_b = background count time (minutes)
- t_s = sample count time (minutes)
- E_{tot} = total detector efficiency for radionuclide emission of interest (cpm/dpm)
- A = detector probe area (cm²)

6.3.2 Beta Ratemeter Scanning MDC

Scanning MDC at a 95% confidence level was calculated using the following equation, which is a combination of MARSSIM equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d' \sqrt{b_i} \left(\frac{60}{i} \right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100cm^2}}$$

Where:

- MDC_{scan} = minimum detectable concentration (dpm/100cm²)
 d' = desired performance variable (1.38)
 b_i = background counts during the residence interval (counts)
 i = residence interval (seconds)
 p = surveyor efficiency (0.5)
 E_{tot} = total detector efficiency for radionuclide emission of interest (cpm/dpm)
 A = detector probe area (cm²)

6.3.3 Alpha Ratemeter Scanning

Per MARSSIM section 6.7.2.2 it is not practical to determine a fixed MDC for alpha scanning. It is more useful to determine the probability of detecting an area of contamination at a predetermined activity level for a given scan rate. MARSSIM provides formulas and probability concepts for alpha scanning when the background is less than 3 cpm (not applicable for this project) and for detectors with background values of approximately 5-10 cpm. MARSSIM Appendix J provides derivations of the formulas used to determine these detection probabilities.

Background Rates of ~ 5-10 cpm

For instruments with background levels from 5-10 cpm, the surveyor usually will need to get at least 2 counts while passing over the source before stopping for further investigation. Therefore, the MDC is determined based on the probability of detecting two or more counts. MARSSIM Equation 6-14 is used to determine the probability of observing two or more counts:

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE + B)t}{60} \right) \left(e^{-\frac{(GE+B)t}{60}} \right)$$

where:

- $P(n \geq 2)$ = probability of getting two or more counts during time interval t
 G = contamination activity (dpm)
 E = detector total efficiency (cpm/dpm)
 B = background count rate (cpm)
 t = time period over the source

6.3.4 Smear Counting MDC

Smear counting Minimum Detectable Concentration at a 95% confidence level was calculated using the following equation, which is an expansion of NUREG 1507, Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{SMEAR} = \frac{3 + 3.29 \sqrt{B_R \cdot t_s \cdot \left(1 + \frac{t_s}{t_b}\right)}}{t_s \cdot E}$$

Where:

MDC_{SMEAR} = Minimum detectable concentration level in dpm/smear.
 B_R = background count rate in counts per minute
 t_b = background count times in minutes
 t_s = sample count times in minutes
 E = instrument efficiency for the radionuclide emission of interest

6.3.5 Instrumentation Specifications

The instrumentation used for the characterization surveys is summarized in the following tables.

Table 6-1: Instrumentation Specifications

Detector Model	Detector Type	Detector Area (cm ²)	Meter Model	Window Thickness (mg/cm ²)	Typical Efficiency (%)
Ludlum 43-68	Gas Flow Proportional	126	Ludlum 2221	0.8	10 (Th-230) 20 (Tc-99)
Ludlum 43-37 Floor Monitor	Gas Flow Proportional	582	Ludlum 2221	0.8	10 (Th-230) 20 (Tc-99)
Ludlum 43-10-1	Phoswich	32	Ludlum 2929	0.4	35 (Th-230) 20 (Tc-99)
Ludlum 44-10	2" x 2" Sodium Iodide	N/A	Ludlum 2241	N/A	760 cpm per μ R/hr (Ra-226) 830 cpm per μ R/hr (Th-232)
Bicron MicroRem	Tissue Equivalent Organic Scintillation	N/A	N/A	N/A	N/A

Table 6-2: Typical Instrument Operating Parameters and Sensitivities

Measurement Type	Detector Model	Scan Rate (in/s)	Count Time (s)	Bkg. Time (s)	Bkg. (cpm)	MDC (dpm/100cm ²)
Gross Alpha Surface Scans	Ludlum 43-68	0.2	N/A	60	12	100
Gross Alpha Surface Scans	Ludlum 43-37	3.9	N/A	60	20	100
Gross Beta Surface Scans	Ludlum 43-68	1.9	N/A	60	500	1,000
Gross Beta Surface Scans	Ludlum 43-37	20.7	N/A	60	1,500	1,000
Gross Alpha Total Surface Activity	Ludlum 43-68	N/A	120	600	12	82
Gross Alpha Total Surface Activity	Ludlum 43-37	N/A	60	60	20	41
Gross Beta Total Surface Activity	Ludlum 43-68	N/A	60	60	500	425
Gross Beta Total Surface Activity	Ludlum 43-37	N/A	60	60	1,500	157
Gross Alpha Removable Activity	Ludlum 2929	N/A	60	600	1	18
Gross Beta Removable Activity	Ludlum 2929	N/A	60	600	70	159

6.4 Efficiency Determination

MARSSIM protocols for building structures use ISO-7503-1 methodology that takes into account the texture of the surface and the 2π detector efficiency. Under MARSSIM, the default surface efficiency for alpha emissions and beta emissions with maximum energies less than 400 KeV is conservatively set at 0.25, resulting in a total efficiency of approximately one half of the 4π efficiency. For smear counting, the 4π efficiency was used. Due to the cleanliness of the smears, no correction was made for the shielding effects of alphas from dust loading.

7 CHARACTERIZATION SURVEY DESIGN

7.1 Characterization Goals

This characterization effort can be summarized in three specific goals:

- **Goal 1: Characterize Previously Inaccessible Areas:** Collect surface activity and dose rate measurements in areas that were not accessible during Phase 1 and Phase 2. These areas include the Elevator Shaft, Elevator Mechanical Room, and under the stage in Room 106.

- **Goal 2: Determine the Source of Elevated Gamma Exposure Rates:** Attempt to determine if elevated gamma exposure rates in some rooms are due to residual radioactivity within the room, or from adjacent areas. These areas include Rooms 17, 17A, 104, 111, 112, 205, and 206.
- **Goal 3: Estimate Activity in Inaccessible Areas:** Estimate the activity in several inaccessible areas with elevated gamma exposure rates based on gamma measurements and modeling using MicroshieldTM. These areas include the corridor outside Room 9, Room 17/17A, under the stage in Room 106, Room 205, Room 206, and a wall in Room 213.

Surveys were designed to collect the information necessary to accomplish the goals of characterization as described below.

7.2 Characterization Methods

7.2.1 Characterization of Previously Inaccessible Areas

The following measurements were taken to the extent possible in the Elevator Shaft, Elevator Mechanical Room, and under the stage in Room 106:

- Scans of 100% of accessible surfaces for alpha and beta emissions using gas flow proportional detectors
- Scans of 100% of accessible surfaces for gamma emissions using a 2"x2" sodium iodide detector at a distance of 10 cm
- Alpha and beta removable activity measurements of 100% of accessible surfaces utilizing large area wipes
- At judgmental locations:
 - Static measurements for alpha and beta surface activity
 - Static measurements for gamma emissions at a distance of 10 cm
 - Dose rate measurements at a distance of 1m
 - Disc smears for alpha and beta removable activity

7.2.2 Determination of the Source of Elevated Gamma Exposure Rates

The following measurements were taken to the extent possible in Rooms 17, 17A, 104 (above and below), 111 (above 9 feet), 112 (above 9 feet), 205, and 206:

- At systematic sample locations (with maximum spacing of 1 meter) adequate to ensure sufficient sample density for modeling:
 - Static measurements for gamma emissions on contact with surfaces, and at various distances to establish exposure rate trends
 - Dose rate measurements at a distance of 1m from surfaces

7.2.3 Estimation of Activity in Inaccessible Areas

The following measurements were taken to the extent possible in Rooms 9 (corridor), 17/17A, 106 (stage), 213 (wall), 205 (floor), and 206 (floor).

- Scans of 100% of accessible surfaces for gamma emissions using a 2"x2" sodium iodide detector at a distance of 10 cm
- At systematic sample locations (with maximum spacing of 1 meter) adequate to ensure sufficient sample density for modeling:
 - Static measurements for gamma emissions at the following distances
 - On contact
 - 1 foot
 - 1 meter
 - Dose rate measurements at a distance of 1 m

7.3 Background Determination

For surface activity measurements, an ambient background was determined in a non-impacted area at waist level using a timed one-minute count. This background was subtracted from gross measurements, and was used to calculate the actual survey MDCs. Material-specific background determinations were not performed.

For static measurements for gamma emissions, a mean reference background was calculated from the background measurements acquired in Appendix E of the "*University of Missouri – Columbia Pickard Hall Initial Characterization Survey Report*" dated December 2009. The background was subtracted from gross measurements and results shown are net cpm. See Appendix D – Background Gamma Measurements.

7.4 Surface Scans

The purpose of scanning was to identify locations of elevated activity. Where elevated activity was identified, the surveyor stopped and re-scanned the suspect area at a slower rate to determine if the elevated activity was sustained. In order to aid in locating the area for additional measurements, the boundary of the elevated area was recorded wherever sustained increase in the audible response was identified. 100% of all accessible surfaces, as required by survey package instructions, were scanned for alpha, beta and gamma emissions as appropriate.

7.4.1 Alpha/Beta Scans

Alpha and beta scans were performed by moving the detector probe over surfaces at a distance of less than one centimeter and at a rate less than the maximum allowable scan rate necessary to achieve DQOs.

7.4.2 Gamma Scans

Gamma scans were performed by moving a 2"x 2" sodium iodide detector over a surface at a distance of 10 cm and at a rate of 0.5 m/s. Scans included all accessible areas as required by survey package instructions.

7.5 Static Measurements

Direct surveys (static measurements) for alpha/beta total surface activity were taken on accessible building surfaces where elevated activity was identified, and at randomly selected locations in areas without elevated activity. Measurements locations are presented in Appendix E.

7.5.1 Alpha/Beta Static Measurements

Alpha and beta static measurements were performed independently by holding the probe at a distance of less than one centimeter and performing a one-minute timed count. Field measurements were converted to activity concentrations using the following equation:

$$\text{Activity (dpm/100cm}^2\text{)} = \frac{\text{cpm}_{\text{sample}} - \text{cpm}_{\text{background}}}{E_{\text{total}} * \frac{A}{100\text{cm}^2}}$$

Alpha and Beta static measurement results are provided in Appendix F.

7.5.2 Gamma Static Measurements

Gamma static measurements were performed by holding the probe at the distance specified in the survey instructions per the characterization survey design and performing a one-minute timed count. Results are provided in Appendix G.

7.6 Removable Contamination Measurements

7.6.1 Large Area Wipes (LAWs)

LAWs were performed of 100% of accessible surfaces, as required by survey package instructions, by wiping an oil-impregnated dust cloth over the surfaces and then performing alpha and beta static measurements on the cloth. LAWs are more sensitive and have wider coverage than disc smears, but cannot be accurately quantified in dpm/100cm². LAWs were used as qualitative measures of removable surface contamination. No elevated activity was detected on any LAW.

7.6.2 Disc Smears

Disc smears were collected at each static measurement location and at additional locations where geometry prohibited static measurements. Results are provided in Appendix F.

7.7 Dose Rates

Dose rate measurements were performed using a tissue-equivalent Bicron MicroRem meter as required by survey package instructions. The instrument was selected due to its flat energy response. Because the Bicron is a ratemeter, an average of ten instantaneous rates was determined at each location by covering the meter and recording the measurement observed when it is uncovered (this is a relatively unbiased method to obtain an average). Dose rates were performed at each gamma static measurement location at a distance of one meter from the source (midpoint of a receptor). Dose rate measurement results are provided in Appendix G.

7.8 Data Validation

Field data was reviewed and validated to ensure:

- Completeness of forms and that the type of survey had correctly been assigned
- The MDCs for measurements met the established data quality objectives; independent calculations were performed for a representative sample of data sheets
- Instrument calibrations and daily functional checks were performed accurately and at the required frequency

8 CHARACTERIZATION RESULTS

Characterization results are provided below for each of the characterization goals.

8.1.1 Characterization of Previously Inaccessible Areas

Room 106 – Area Under Stage

Phase I characterization identified elevated gamma exposure rates on the stage in lecture hall and auditorium Room 106 in the southwest corner of the first floor, and in the ceiling of the room below.

The stage is a raised wood-framed platform approximately 12" above the floor level. The area requiring additional characterization was under the stage and spanned the entire front section of the room. MU personnel removed the carpet on the stage and made the initial cuts in to the particle board and plywood stage flooring materials to provide access to areas under the stage. Chase personnel performed preliminary surveys of the stage area for total and removable activity using scans, LAWs and disc smears to determine initial radiological conditions. Surveys indicated no elevated total or removable activity on the surface of the stage.

An 8' x 8' section of particle board and plywood stage flooring was removed to access the area under the stage. The stage was supported by evenly spaced 2"x10" wood joists. Tongue and groove wood sub-floor was located approximately 10 inches below the stage and is assumed to be original to the building construction. The subfloor has a 12"x12" opening for conduit. Chase used this opening to access and investigate the area below the subfloor. Two staggered 8"x10" wooden trusses stacked one on top of the other in line

with the outside wall of the basement were located under the subfloor. Under the trusses, the drywall ceiling for the basement extended across the entire area, supported by sheet metal braces. The area between the sub-floor and basement ceiling appeared to be empty.

Chase personnel performed gamma scans of the area by moving a 2"x2" NaI detector over the surfaces of the subfloor at a distance of approximately 10 cm from the source of elevated gamma exposure rates, and a rate of 0.5 m/s. The scans indicated elevated gamma on the floor of the stage in very close proximity to the back (outside) wall. Obstructions (joists, the sub-floor, and conduit) prohibited easy access to the areas of elevated gamma exposure rates. Upon further investigation, it was determined that the source of the elevated readings were the wooden support trusses. The top truss showed significantly higher gamma exposure rate (on-contact of 21K net cpm). Chase personnel were able to acquire a one-minute timed gamma static and disc smear on each support truss. Disc smears indicated elevated removable activity on the trusses. The trusses were remediated as described in Section 9. However, due to the very limited access, the radiological status of the trusses cannot be accurately determined without removal of additional structural materials. The residual activity on the truss was estimated as part of Goal 3 described below.

Elevator Shaft and Elevator Mechanical Room

The Elevator Shaft and Elevator Mechanical Room were not accessible during Phase 1 characterization. MU and its subcontractor performed lockout-tagout of all equipment in the elevator shaft and elevator mechanical room, including electrical equipment and rotating machinery. Chase personnel performed surveys of the elevator shaft and mechanical room for total and removable activity using scans, LAWs, and disc smears to determine initial radiological conditions. Residual radioactivity was identified in the elevator mechanical room and was remediated. Remediation is described in Section 9.

Goal 1 characterization survey results are summarized in the table below. Total and removable surface activity results are presented in Appendix F. Gamma exposure rate results are presented in Appendix G.

Table 8-1: Previously Inaccessible Area Characterization Results

Room	Gamma Count Rate ⁷ (cpm)	Dose Rate (μR/hr)	Maximum Surface Activity (dpm/100cm ²)			
			Total		Removable	
			β ⁸	α	β	α
Elevator Shaft	11K	2.1	486	<MDC	<MDC	7
Elevator Mechanical Room (Pre-Remediation)	5K	1.5	39K	1,043	83	6
106 (Pre-Remediation)	21K	1.2	Not Accessible	Not Accessible	648	362

⁷ Gamma count rates were determined using a 2" x 2" NaI detector.

⁸ The beta channel on the gas flow proportional counter does not discriminate alpha radiation. Therefore, the beta channel is actually alpha+beta.

8.1.2 Determination of the Source of Elevated Gamma Exposure Rates

Phase 1 characterization surveys indicated elevated gamma exposure rates in Rooms 104, 205, 206, 111, and 112. Additionally, elevated gamma exposure rates were subsequently identified by the NRC in an area of Room 17 that was not accessible during Phase 1 characterization. The locations of the sources of the elevated exposure rates (the rooms containing residual radioactivity) could not be clearly determined from previous characterization results. MU asked Chase to performing additional surveys to attempt to determine whether residual activity existed in these rooms, or if the source of elevated exposure rates was in adjacent rooms.

Rooms 17/17A

These adjacent rooms are in the northeast corner of the basement, and currently are used as a woodshop (Room 17) and faculty office area (Room 17A). During Phase 1 characterization, Chase was prohibited from moving items in occupied areas, so these areas of elevated gamma exposure were not well documented. In order to more accurately characterize these areas, and determine the source of the elevated gamma exposure, Chase personnel performed gamma scans of the area by moving a 2"x2" NaI detector over wall and floor surfaces at a distance of 10 cm and a rate of 0.5 m/s. Scans indicated elevated exposure rates (28K net cpm on contact in Room 17A and 25K net cpm on contact in Room 17) on the floor near the wall. In both rooms many obstructions prohibited easy access to the areas of elevated gamma exposure. In Room 17, the area is behind a cyclone separating vacuum system. In Room 17A, the area is beside and underneath an immovable storage cabinet that could not be safely moved due to its bulky nature. The storage cabinet would require emptying the contents and disassembly to move thereby limiting access for completion of all planned surveys. Because this area of residual radioactivity appears to be a point source, a systematic grid pattern was not used to collect characterization data.

Because this area was not documented during Phase 1 characterization, a disc smear and a one-minute timed alpha/beta/gamma and gamma static was performed on-contact with the sample location at each location. Results indicate no elevated alpha or beta/gamma removable activity. Results are provided in Appendix F.

Dose rate measurements were performed on contact with the sample location using a tissue-equivalent Bicron MicroRem, with the maximum dose rate of 10µrem/hr. A one-minute timed gamma static was acquired at a distance of one foot from sample locations in both rooms and at one meter from the sample locations in Room 17. This data was used to model the inaccessible residual activity in the wall at the base of the floor in the corner of room 17A, possibly a terminated drain line.

Because of ongoing operations in these rooms, the residual activity could not be accessed. In order to access the residual radioactivity, at a minimum, the storage cabinet would need to be emptied, disassembled and removed, the cyclone separation vacuum system disassembled and removed, a large area of floor tile removed, the drywall removed, and potentially small amounts of concrete removed.

The source of elevated activity appears to be residual radioactivity in the wall near the floor tile in room 17A. Room 17's elevated activity appears to be a result of the close proximity to room 17A's area of residual activity. See the graphical representation in Appendix I – Graphical Representations of Source Origination Investigation Results. Room 17 NaI net cpm parallels room 17A at a lower count rate, consistent with a reduction in gamma exposure rate due to shielding and distance.

Room 104

Room 104 is currently used as a display room for casts and statues for the museum. The area below Room 104 in the basement is comprised of artifact storage areas and mechanical space. Phase I characterization identified elevated gamma exposure rates in Room 104 that was assumed to be caused by residual radioactivity in the basement. MU asked Chase to collect additional information to verify that the source of elevated gamma exposure rates is due to activity in the basement, and is not due to residual radioactivity under the carpet in Room 104.

Gamma exposure rate measurements were collected on-contact and at a distance of one meter from floor surfaces on a systematic 1m grid pattern. Also, gamma exposure rate measurements were performed at corresponding locations in the basement at distances of two meters from the basement floor and on-contact with the basement ceiling (approximately three meters from the basement floor sample locations). Gamma exposure rate measurement results for a distance of one meter from the basement floor were obtained from Phase I characterization results. Additionally, dose rate measurements were performed using a tissue-equivalent Bicron MicroRem at distances of two meters above the basement floor and one meter above the Room 104 floor. Results are presented in Appendix G. This data was used to graph the exposure rate vs. distance from the basement floor to determine the source of elevated exposure rates in Room 104. Specifically, to determine if significant residual radioactivity exists under the carpet in Room 104.

Based on graphs of exposure rate results, the elevated activity appears to originate from the basement. The exposure rates decrease with increasing distance from the basement floor, and there is no increase in exposure rate at the floor level in Room 104 vs. the ceiling level in the basement. Graphs and explanations are presented in Appendix I.

Rooms 205, 206, 111, and 112

Elevated gamma exposure rates were identified in Rooms 205/206 on the second floor and in the rooms directly below on the first floor, Rooms 111/112. Rooms 205 and 206 currently house museum displays. Rooms 111 and 112 are office spaces. MU asked Chase to attempt to determine the source of elevated gamma exposure rates as part of the second goal, and then estimate the activity as part of the third characterization goal.

Chase personnel performed gamma scans of the area by moving a 2"x2" NaI detector over wall and floor surfaces at a distance of 10 cm and a rate of 0.5 m/s in order to identify the location of highest exposure rate. The scans indicated elevated exposure rates existed over most of the floor, including indications of elevated activity in the corners of the rooms attributed to geometry of the measurement location and the building materials. The locations of highest on-contact results (61K net cpm in Room 205 and 16K net cpm in Room 206) were used as start locations for a systematic grid sample pattern with maximum sample spacing of one meter. This resulted in seventeen sample locations in Room 205 and fifteen sample locations in Room 206. At each sample location a one-minute timed gamma static measurement was performed on-contact and at distances of one foot and one meter from the surface. Dose rate measurements were performed at each location using a tissue-equivalent Bicron MicroRem at a distance of one meter from the surface. The maximum dose rates were 19µrem/hr in Room 205 and 25µrem/hr in Room 206.

Rooms 111 and 112 contain an irreplaceable, extremely fragile drop ceiling. Therefore, access was limited to small viewing areas obtained by carefully moving tiles or accessing from the ceiling access hatch in the corridor adjacent to room 111.

From Chase's limited vantage points, the original ceiling is approximately 24" above the drop ceiling. A newer (not original) 12"x12" ventilation duct passes through the area between the drop ceiling and the original ceiling above and appears to be the only object between the ceilings. The exact layout and contents of the area between the drop ceiling and the original ceiling cannot be accurately determined due to obstructed access. Chase personnel duplicated the sample layout from Rooms 205 and 206 above and performed one-minute static counts with a 2" x 2" NaI detector. Due to the access limitations, measurements could not be taken on the original ceiling surface, and could only be acquired at approximately one meter from the ceiling (~ ten feet from the floor level). Dose rate measurements were also performed using a tissue-equivalent Bicron MicroRem at a distance of approximately one meter from the sample location.

Gamma measurement results are presented in Appendix G. The measurements acquired were used to graph the measurements above the floor in Rooms 205/206 and below the ceiling in Rooms 111/112 to determine the source of the elevated gamma exposure rates. Graphs are presented in Appendix I. As indicated in Appendix I, conclusive results pinpointing the exact location of the contamination is not supported by the raw data. However, the data does support the conclusion that contamination lies somewhere between the drop ceiling in 111/112 and below the carpet on the floor of 205/206. Logic would lead one to conclude that the contamination lies below the carpet of 205/206.

Additional samples were performed in room 111 during the initial characterization of Pickard Hall in December 2009. Comparison of the results for room 111 at one meter from the floor from the *Pickard Hall, Characterization Survey Report* dated June 16, 2010 indicate that the average, minimum and maximum gamma exposure rate results are less than those acquired in excess of three meters from the room 111 floor. The exposure rates increase with increasing distance from room 111 floor indicating the source of the elevated gamma exposure rates is not from the floor of room 111.

8.1.3 Estimation of Activity in Inaccessible Areas

Measurements were acquired at all areas of concern at varying lateral locations and distances from the source, and used to model a correlation of net cpm as indicated on a 2'x2" NaI probe to source activity in the inaccessible area.

Because the exact location of the source and the amount of shielding is not known (it is not known if there is underlayment, padding, or other materials under carpeted areas without removing portions of the carpet), the amount of shielding is estimated and sensitivity analysis of shielding thickness is performed to provide a range of shield thickness/density possibilities.

See Appendix H – Residual Activity Calculations and MicroShield™ Reports for an explanation of the modeling and calculations process. A summary of the results is provided in the table below. Detailed descriptions for each area are provided afterwards.

Table 8-2: Summary of Activity Estimates

Area	Assumed Source Geometry	Assumed Shielding Material	Shield Thickness Sensitivity Range (ft)	Dose Point (cm) ⁹	Mean NaI Response (net cpm)	Estimated Activity Range (μCi)
Room 9 Corridor Floor	Isotropic Plane	Carpet	0.01-0.04	30	18,305	15-17
				100	8,727	19-21
Room 17/17A Wall	Point	Vinyl Tile	0.02-0.06	30	7,609	0.8-0.9
				100	3,000	3-3
Room 106 Stage	Isotropic Plane	Wood	0.02-0.06	30	9,212	5-5
				100	6,881	15-16
Rooms 205 Floor	Isotropic Plane	Carpet	0.01-0.04	30	25,915	36-39
				100	24,657	72-79
Rooms 206 Floor	Isotropic Plane	Carpet	0.01-0.04	30	11,569	12-13
				100	10,513	25-27
Room 213 Wall	Point	Plaster/wood	0.04-0.13	30	28,062	3-3
				100	14,278	16-16

⁹ Distance from shield surface

Corridor Outside Room 9

This corridor connects the office library (Room 1) and the artifact storage room (Room 12) and is bordered by the two offices on the west and the elevator shaft and elevator mechanical room on the east. Elevated gamma exposure rates were previously identified during Phase I Characterization. MU requested additional surveys of the area in order to estimate the activity in the inaccessible areas under the carpet, and/or possibly in the concrete.

Chase personnel performed gamma scans of the area by moving a 2"x2" NaI detector over wall and floor the surfaces at a distance of 10 cm and a rate of 0.5 m/s in order to identify the area with the highest gamma exposure rate. The scans indicated elevated gamma exposure rates over a large portion of the floor. The areas of highest activity (132K and 195K net cpm on contact) were used as a start location for a systematic sample pattern. The systematic pattern included a maximum sample spacing of one meter and contained eleven evenly distributed sample locations. At each sample location a one-minute timed count was performed on contact with the sample location and at distances of one foot and one meter from the surface. Dose rate measurements were performed using a tissue-equivalent Bicron MicroRem at a distance of one meter from the sample location, with the maximum dose rate of 13µrem/hr. Because of the operational status of the museum the residual activity under the carpet could not be accessed.

Room 17 and 17A

Chase used the data obtained during Goal 2 characterization to model the inaccessible residual activity in the wall in room 17A to estimate activity concentrations. The area of elevated gamma exposure rate was bound, and was conservatively assumed to be a point source of residual radioactivity shielded by tile in order to perform the modeling and subsequent activity concentration calculations.

Room 106 Stage Area

The scans of the stage had indicated elevated activity over the entire area of the stage; therefore, the area of highest activity (21k net cpm) was used as a start location for a systematic sample pattern. The systematic pattern was laid out with one meter sample spacing and contained ten sample locations. At each sample location a one-minute timed gamma static was performed at a distance of one foot and one meter from the sample location. Access limitations allowed only one on-contact measurement for the support truss. Dose rate measurements were performed using a tissue-equivalent Bicron MicroRem at a distance of one meter from the sample location, with the maximum dose rate of 10µrem/hr. Because of the safety hazards associated with opening a large penetration between floors, and removing portions of a structural support truss, MU decided to not perform further dismantlement for characterization purposes.

Room 213

Room 213 is currently a storage room for museum paintings. Elevated gamma exposure rates were discovered during Phase I characterization and the room is currently posted and controlled by MU. Access to the area of elevated gamma exposure would require removal of large sections of the wall, and the potential to damage or ruin priceless museum paintings. Chase personnel performed gamma scans of the area by moving a 2"x2" NaI detector over the surfaces at a distance of 10 cm and a rate of 0.5 m/s. The scans indicated elevated gamma exposure rates approximately 3.5 feet off the ground on the outside wall of the room (net cpm on-contact was 113K). The room contains many obstructions prohibiting easy access, most notably the racks of paintings.

Since this area of residual radioactivity appears to be a point source, a very basic systematic sampling protocol was used to estimate the activity concentration, with a sample spacing of 1 foot from the source. At each sample location a one-minute timed gamma static was performed on-contact with the sample location, and at a distance of one foot and one meter from the sample location. Dose rate measurements were performed at a distance of one meter from the sample location using a tissue-equivalent Bicron MicroRem, with the maximum dose rate of 30µrem/hr.

The data collected was used to model the inaccessible residual activity in the wall in Room 213 to estimate activity concentrations. The area of elevated activity was assumed to be a point source of residual radioactivity shielded by drywall/wood in order to perform the modeling and subsequent activity concentration calculations.

The source of elevated activity appears to be residual radioactivity on an original window sill under the new wall from a previous renovation. This is based on the location of the activity at the location of an original window at the window sill height.

Rooms 205/206

Chase used the data obtained during Goal 2 characterization to model the inaccessible residual activity under the carpet in Rooms 205 and 206 and estimate the activity. The area of elevated gamma exposure was bound, and was conservatively assumed to be a homogeneously distributed planar source of residual radioactivity shielded by carpet for the purposes of modeling and subsequent activity concentration calculations.

9 REMEDIATION

During characterization surveys, low levels of elevated residual radioactivity were identified in the elevator mechanical room and on a structural truss under the stage in Room 106. Due to the limited scope of remediation required and the difficulty in accessing these areas, MU decided to remediate these areas while access was provided for the characterization effort.

Access and remediation were governed by a Radiation Work Permit (RWP) and conducted to control the spread of contamination and keep personnel exposures ALARA. A work zone was established and controlled to prevent unauthorized access and the spread of radioactive material. Plastic sheeting was used as necessary to cover surfaces in the vicinity of operations. HEPA-filtered vacuums and HEPA-filtered negative air ventilation units were used to minimize the generation of airborne radioactivity. Newly exposed surfaces were characterized for residual radioactivity as remediation occurred. These surveys supplemented the characterization surveys. Remedial action surveys were performed to monitor the effectiveness of remediation efforts and ensure that surrounding areas were not cross-contaminated from remediation actions.

Elevator Mechanical Room

The surficial layer of contaminated concrete in the elevator mechanical room was removed using a shrouded hand-held scarifier attached to a HEPA-filtered vacuum.

Room 106 Stage Area

Residual removable radioactivity on accessible portions of the structural support beam under the stage in Room 106 was remediated by wet wiping. Due to access limitations, the truss was wet wiped to the extent Chase personnel could reach. Also, truss surfaces were not accessible to the gas flow detectors, so total activity measurements were not possible. MU decided to limit remediation to accessible surfaces and not to conduct further dismantlement of the stage or remove the ceiling in the basement due to time constraints and safety considerations. The stage flooring was re-installed after performing post-remediation surveys of accessible surfaces.

9.1 Personal Protective Equipment (PPE)

Personnel conducting remedial activities wore, at a minimum, safety glasses, hearing protection, Tyvek coveralls, rubber overshoes, latex or rubber gloves, and work gloves.

9.2 Air Sampling

Airborne particulate sampling was performed continuously during invasive work to assess the potential for internal exposures. A limiting airborne gross alpha concentration limit of $9.5\text{E-}10$ $\mu\text{Ci/ml}$ gross alpha was used to estimate doses from airborne radioactivity. This was based on a conservative nuclide distribution of 75% Ra-226 ($3\text{E-}10\mu\text{Ci/ml}$ DAC) and 25% Th-232 ($5\text{E-}13\mu\text{Ci/ml}$ DAC) with each in secular equilibrium. The highest air sample result was $4.63\text{E-}13$ $\mu\text{Ci/ml}$, 0.05 % of the DAC.

9.3 Remediation Survey Results

Remediation is summarized in the table below.

Table 9-1: Elevated Activity and Remediation Results

Room	Size (ft ²)	Location	Maximum Pre - Remediation					Maximum Post - Remediation			
			Gamma Count Rate ¹⁰ (cpm)	Surface Activity (dpm/100cm ²)				Surface Activity (dpm/100cm ²)			
				Total		Removable		Total		Removable	
				β ¹¹	α	β	α	β	α	β	α
11 Elevator Mech. Room	0.5	Floor	5,262	38,650	36	11	4	645	49	-34	5
	1.0	Floor	3,426	1,856	4	80	6	506	62	28	3
	0.5	Floor	5,220	11,360	-4	38	-2	346	84	116	1
	1.0	Floor	2,510	2,400	-1	40	-2	594	68	-27	-2
	0.25	Floor	4,125	10,624	75	44	1	439	93	6	5
	0.25	Floor	4,576	5,364	202	57	3	660	55	4	5
	0.25	Floor	3,854	11,448	1,043	15	1	759	93	-13	6
	0.5	Floor	5,262	3,797	524	4	-1	423	40	-2	-2
106 Under Stage	0.25	Wooden Beam	21,168	N/A	N/A	648	362	N/A	N/A	146	14
	0.25	Wooden Beam	N/A	N/A	N/A	108	51	N/A	N/A	102	8

10 REFERENCES

- NRC Regulations
- Chase's Commonwealth of Kentucky Radioactive Materials License Number 201-605-90
- Chase Environmental Group's Radiation Safety Manual.
- NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," August 2000
- NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," June 1998
- NUREG 1757, Volume 1, Revision 2, "Consolidated NMSS Decommissioning Guidance, Decommissioning Process for Materials Licensees," September, 2006
- ISO-7503-1, "Evaluation of Surface Contamination – Part 1: Beta Emitters and Alpha Emitters." 1988
- Pickard Hall, Characterization Survey Report, June 16, 2010

¹⁰ Gamma count rates were determined using a 2" x 2" NaI detector.

¹¹ The beta channel on the gas flow proportional counter does not discriminate alpha radiation. Therefore, the beta channel is actually alpha+beta.

Attachment B. Letter from Engelhardt & Associates, Inc., November 2nd 2011



2 November, 2011

Mr. Michael Lafranzo
Senior Health Physicist
United States Nuclear Regulatory Commission
Region III
Materials Control, ISFSI, and Decommissioning Branch
Division of Nuclear Materials and Safety
2443 Warrenville Road, Ste., 210
Lisle, IL 60532-4352

RE: NRC INSPECTION REPORT 030-02278/11-02 (DNMS) AND NOTICE
OF VIOLATION—CURATORS OF THE UNIVERSITY OF MISSOURI

CONSULTANT RESPONSE BASED ON REVIEW OF
INFORMATION NOTICE 96-28: SUGGESTED GUIDANCE
RELATING TO DEVELOPMENT AND IMPLEMENTATION OF
CORRECTIVE ACTION, NUMBER 9

Dear Mr. Lafranzo:

I, Susan J. Engelhardt, President, CEO, Engelhardt & Associates, Inc., a radiation safety consulting firm located in Milwaukee, WI and College Station, TX, have worked as the radiation safety consultant for the University of Missouri-Columbia since 1994. In this role, I review documents relating to the radiation safety program and correspondence with regulatory agencies. I also assist in development of procedures and program strategies to assure long term compliance with the Nuclear Regulatory Commission's rules and regulations. The relationship between Engelhardt & Associates, Inc. and the University of Missouri is ongoing; documents and program needs pertaining to the University and radiation safety regulations set forth by the NRC, are carefully reviewed by myself, my staff or both. Our findings are reviewed with the staff and management of the University.

As part of the radium project on campus, I am reviewing the project activities carefully and was recently on site to review the Pickard Hall activities directly. Based on this site visit and documentation presented to me regarding the radiation safety activities in the afore mentioned building, I concur with the responses being sent in response to the NOV from NRC. The coordination between the staff and Chase Environmental is excellent. In



addition, the staff is putting forth a concerted effort to have "fresh eyes" reviewing the project to avoid overlooking something pertinent to the best safety practices regarding this project.

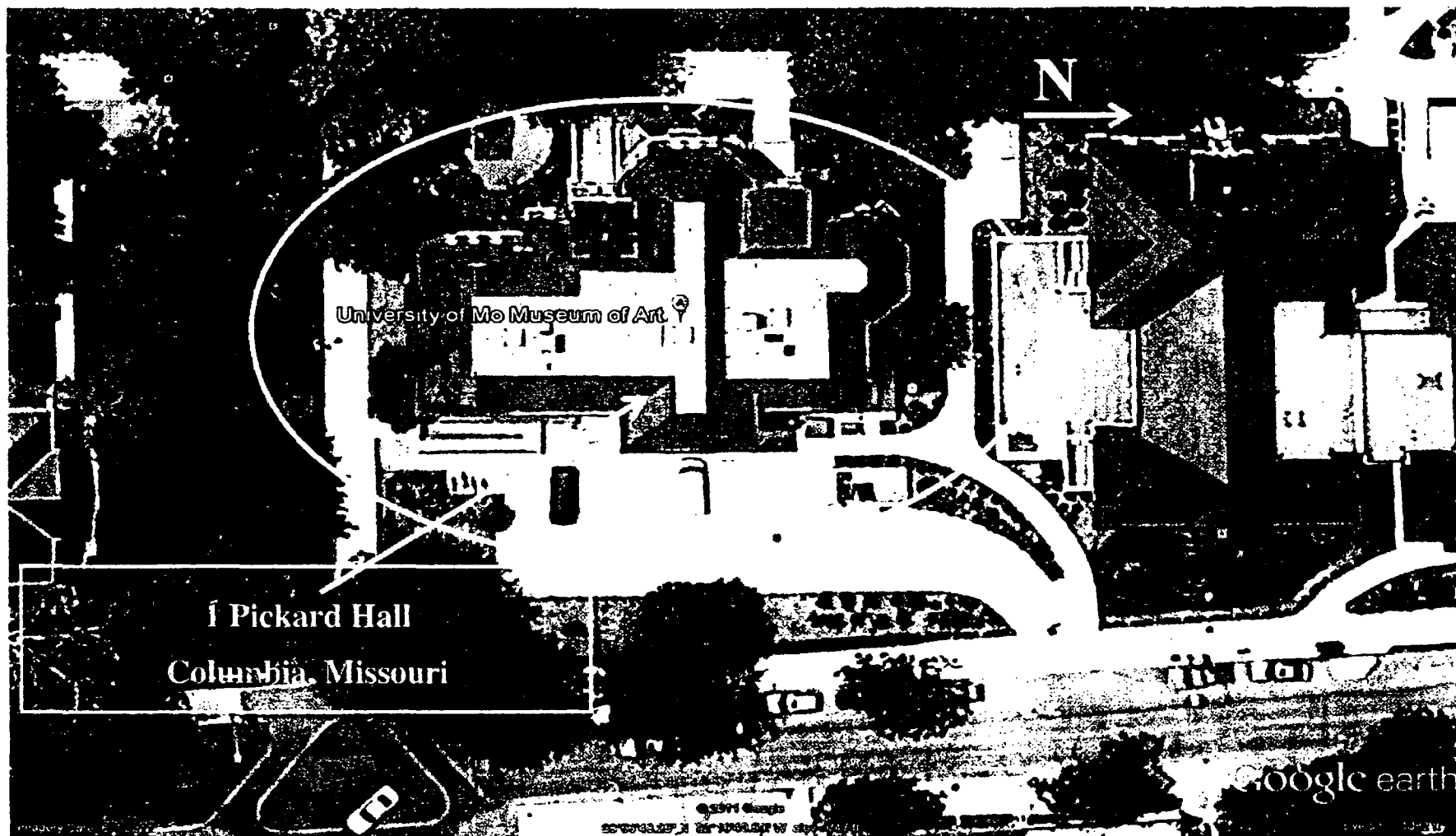
I will continue to monitor this project both on site, and by document review.

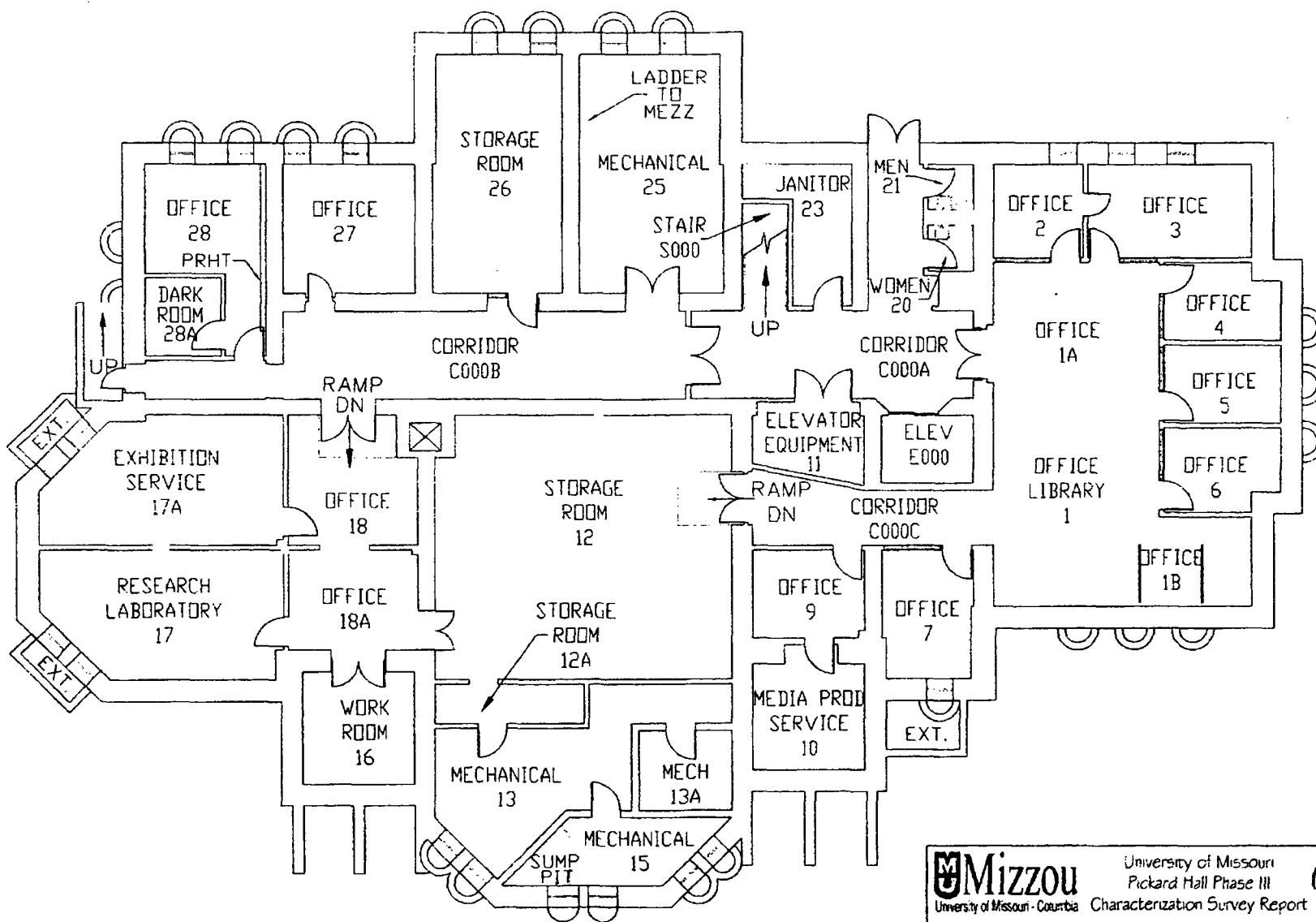
I feel that it is safe to say that the University of Missouri has, for many years, always used a consultant to assist with the radiation safety program. There are documents in the NRC's possession that can attest to this commitment (please see SPIP, dated 1995 in your records).

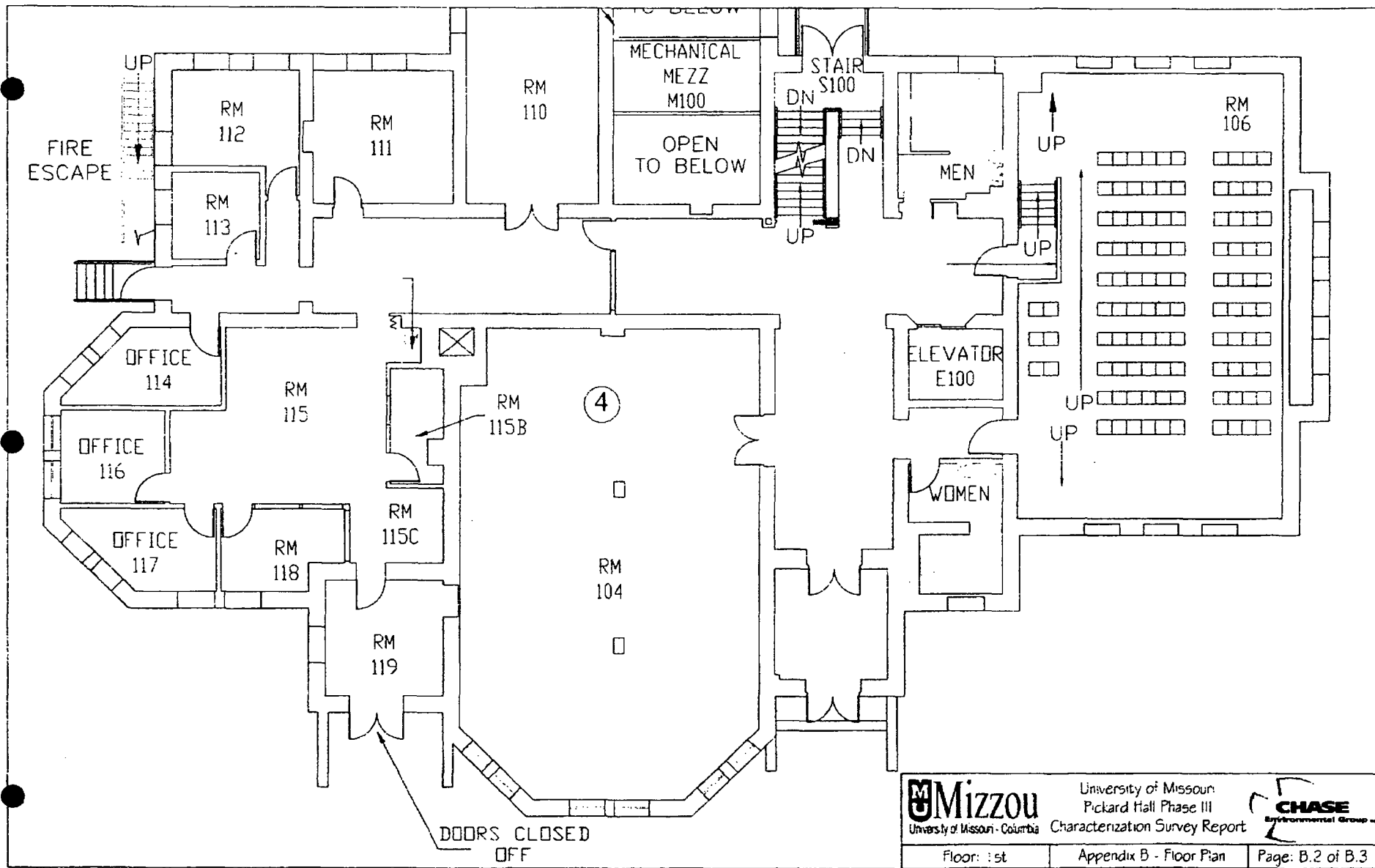
Should you have questions, please feel free to contact me directly at 608-213-0113.

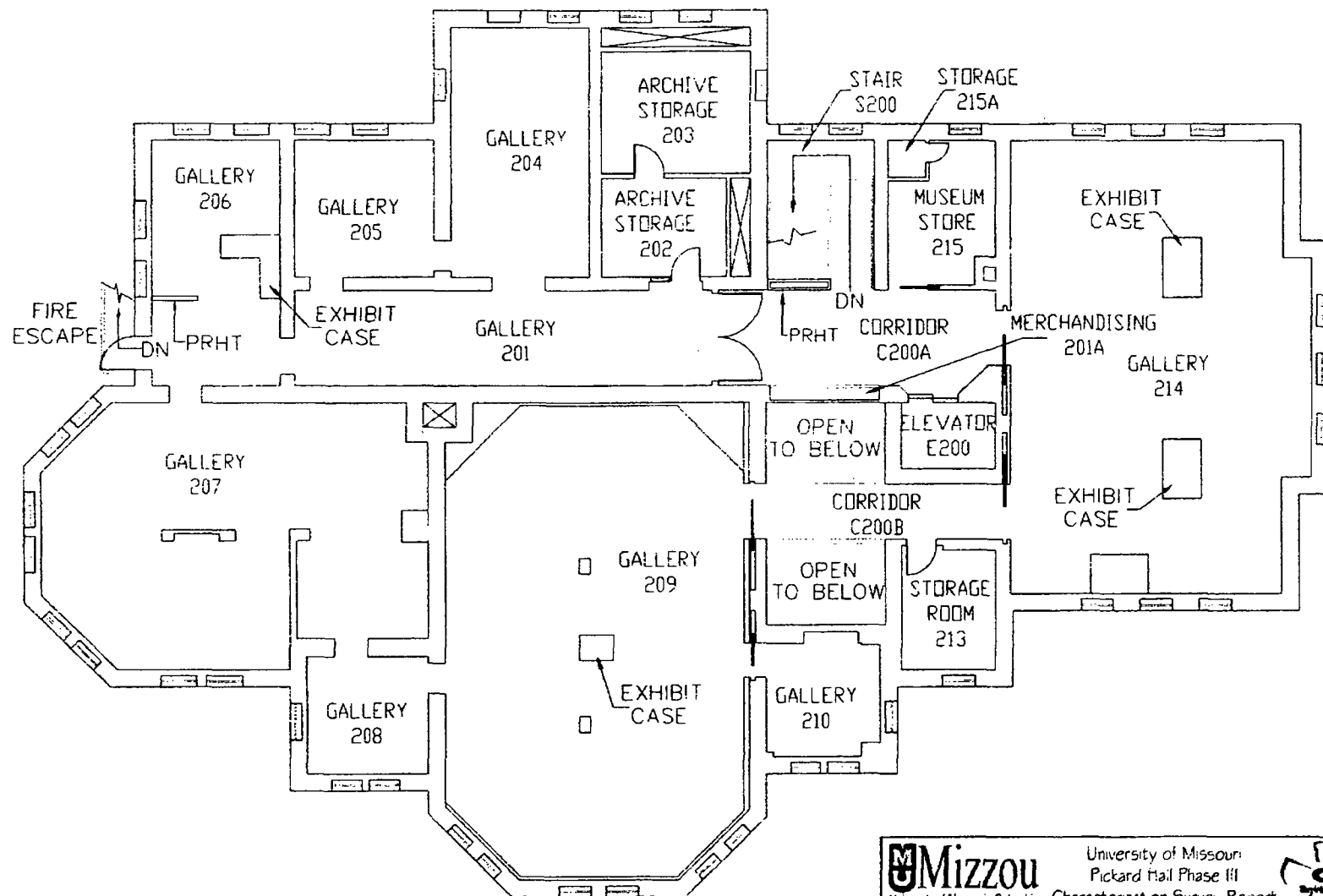
Sincerely,

Susan J. Engelhardt
President, CEO









University of Missouri
Pickard Hall Phase III
Characterization Survey Report



Floor: 2nd

Appendix B - Floor Plan

Page: B.3 of B.3

Owner: CHASE ENV

Griffin Inst

030511

☐ Repair (See Remarks)

Due and Repair (See Remarks)

NIST TRACEABLE EQUIPMENT USED DURING CALIBRATION

CAL DUE: 04/21/11

CAL DUE:

AF Mechanical Zero: 8

AL Mechanical Zero: 0

Scanned with CamScanner

AF.

AF.

% Error: 0.0%

% Error 0.03%

HIGH VOLTAGE POLYMER PHYSICAL RESEARCH UNIT

AF.

☐ Set ☐ Unset

REMARKS:

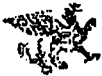
☐ No

No

03/09/12

PR102402

Entered by: CEG Initials



GRIFFIN INSTRUMENTS



CALIBRATION CERTIFICATE FOR

2929

SERIAL#

102010

Owner: CHASE ENV

DATE: 03/09/11

LOCATION:

Griffin Inst

TECH: E.M. Glenn

DATE LAST CAL EXPIRES:

03/01/11

Reason For Calibration:

☒ Due For Calibration☐ Repair (See Remarks)

CABLE LENGTH: 39"

☐ Other (See Remarks)☐ Due and Repair (See Remarks)

NIST TRACEABLE EQUIPMENT USED DURING CALIBRATION

MODEL: M-500

SERIAL #: 42386

CAL DUE: 04/21/11

MODEL:

SERIAL #:

CAL DUE:

Condition: ☒ Sat ☐ Unsat

AF Mechanical Zero: 0

AL Mechanical Zero: 0

Scaler Function Check: ☒ As Found ☐ As Left

Beta Channel Window (4-50 mV):

4-50

A.F.

Alpha Channel Window (175 mV, 120 for 3030):

180

A.F.

Alpha Counts w/Pulser @ 10,000 CPM:

9,999

A.F.

% Error: 0.0%

Beta Counts w/Pulser @ 10,000 CPM:

9,999

A.F.

% Error: 0.0%

HIGH VOLTAGE POWER SUPPLY CAL (2929 only)

1 KV Reading (R-5 on HV Board):

1

A.F.

Max HV (1500 V +):

☒ Sat ☐ Unsat

REMARKS:

Does Instrument Meet Final Acceptance Criteria?:

☒ Yes☐ No

Calibration Sticker Attached?:

☒ Yes☐ No

Date Instrument is Due For Next Calibration:

03/09/12

INSTRUMENT MARRIED WITH

43-10-1

PR102462

Performed/Reviewed by:

Date: 3/9/2011

Entered by: Initials



GRIFFIN INSTRUMENTS



PROBE #: PR102462

Date: 03/09/11

PLATEAU AND SET POINT DATA

HV/Venier:	Tc-99 Source Response SS (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Net A to B Xtatic <10%	B to A Xtatic <1%
	A ch.	B ch.	Net ER	A ch.	B ch.	Net ER	A ch.	B ch.		
N/A										

Alpha / Beta Bkg (cpm)		0	41				
HV/Venier		Pu-239	Tc-99 M	Tc-99 SS	Ti-232	C-14	Se-90
700 / 2.88	CPM:	7139		4608	5753	6818	3589
4 pi AL Efficiencies:		38.59%		28.40%	34.46%	13.59%	33.97%
2 pi AL Efficiencies:		78.03%		42.29%	70.42%	39.32%	53.74%

REMARKS:

Does Instrument Meet Final Acceptance Criteria?: ☒ Yes ☐ No

Calibration Sticker Attached?: ☒ Yes ☐ No

Date Instrument is Due For Next Calibration: 03/09/12

INSTRUMENT MARKED WITH 2929 #102010

Performed/Reviewed by:

CB.
B. A. [Signature]

Date: 3/9/2011

Entered by: *CB.* Initials

2 pi efficiencies denoted in Italic.

Calibrations performed to ANSI N423A-1997 standards.



Designer and Manufacturer
of
Scientific and Industrial
Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CHASE ENVIRONMENTAL ORDER NO. 20174128/362277

Ludlum Measurements, Inc. Model 2241 Serial No. 176627

Ludlum Measurements, Inc. Model 44-10 Serial No. PR202100

Cal. Date 5-May-11 Cal Due Date 5-May-12 Cal. Interval 1 Year Meterface 44-10

Check mark ☒ applies to applicable instr. and/or detector IAW mtg. spec. T. 74 °F RH 24 % Alt 705.8 mm Hg

☐ New Instrument ☐ Instrument Received ☐ Within Toler. $\pm 10\%$ ☐ 10-20% ☐ Out of Tol. ☒ Requiring Repair ☐ Other-See comments

☒ Mechanical ck. ☐ Meter Zeroed ☒ Background Subtract ☐ Input Sens. Linearity

☒ F/S Resp. ck. ☒ Reset ck. ☐ Window Operation

☒ Audio ck. ☒ Alarm Setting ck. ☒ Batt. ck. (Min. Volt) 2.2 VDC

☒ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☒ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 1100 V Input Sens. 10 mV Det. Oper. 1100 V at 10 mV Threshold mV

COMMENTS:

Det 1. Det 2.
Deadtime: 6 uSec 6 uSec Firmware: P04 08
Cal Constant: 100 -2 525 08
Alarm: 50 KC/m 5 mR/hr
Alert: 20 KC/m 2 mR/hr Overload checked but not set.

Gamma Calibration: GM detector calibrated against a source issued by NIST in which the level of activity is known.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND" READING	INSTRUMENT METER READING*
AUTO	2.00 mR/hr	NA	1.96 mR/hr
AUTO	1.50 mR/hr		1.51
	1.00 mR/hr		1.01
	500 μ R/hr		508 μ R/hr
	200 μ R/hr		210
	150 μ R/hr		151
	100 μ R/hr		103

Uncertainty within $\pm 10\%$ C.F. within $\pm 20\%$

Range(s) Calibrated Electronically

REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
800K cpm	NA	800K cpm	800K cpm	NA	200/15.67
200K cpm		200	200K cpm		1997
80K cpm		80	80K cpm		1001
20K cpm		20	20K cpm		2001
8K cpm		8	8K cpm		780
2K cpm		2	2K cpm		200
800 cpm		800	800 cpm		80
200 cpm		200	200 cpm		20

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1976. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 73410 ☐ 1151 ☐ 781 ☐ 059 ☐ 280 ☐ 60446 ☐ 70897

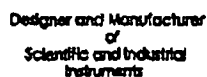
Cs-137 Gamma S/N ☐ 1142 ☐ G112 ☒ MS65 ☐ 5106 ☐ T1008 ☐ T877 ☐ ESS2 ☐ ESS1 ☐ 720 ☐ 734 ☐ 1416 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☐ Other

☒ m 500 S/N 63893 ☐ Oscilloscope S/N ☒ Multimeter S/N 93870637

Calibrated By: Jeremy Thompson Date 5-May-11

Reviewed By: Rhonda Hain Date 5-May-11



LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-8494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Detector 4410 Serial No. PR202100
Customer CHASE ENVIRONMENTAL Order #. 20174128/362227
Counter 2241 Serial No. 196627 Counter Input Sensitivity 10 mV
Count Time 6 seconds Distance Source to Detector Surface
Other _____

[illegible]

Signature Jeremy Thompson Date 5-Aug-11



GRIFFIN INSTRUMENTS



CALIBRATION CERTIFICATE FOR

2241

SERIAL#

198624

Owner: CHASE ENV

DATE: 03/09/11

LOCATION:

Griffin Inst

TECH: E.M. Glenn

DATE LAST CAL EXPIRES:

03/28/11

Reason For Calibration:

☒ Due For Calibration☐ Repair (See Remarks)☐ Other (See Remarks)☐ Due and Repair (See Remarks)

NIST TRACEABLE EQUIPMENT USED DURING CALIBRATION

MODEL: M-500

SERIAL #: 42388

CAL DUE: 04/21/11

MODEL:

SERIAL #:

CAL DUE:

☒ Fast/Slow Switch working properly☒ Audio Response☐ Geotropism

CABLE LENGTH 5'

CONDITION: Sat

NEW BATTERIES: ☐ Yes ☒ No

BATTERY CHECK: Sat

HV TEST ☐ N/A ☒ Sat ☐ Unsat

AF INPUT SENSITIVITY (mV) #1:

10

AL INPUT SENSITIVITY (mV) #1:

A.F.

AF INPUT SENSITIVITY (mV) #2:

N/A

AL INPUT SENSITIVITY (mV) #2:

N/A

AF INPUT SENSITIVITY (mV) #3:

N/A

AL INPUT SENSITIVITY (mV) #3:

N/A

AF INPUT SENSITIVITY (mV) #4:

N/A

AL INPUT SENSITIVITY (mV) #4:

N/A

RATE CPM AS FOUND % ERROR AS LEFT % ERROR

250	250	0.0%	A.F.	
2500	2503	0.1%	A.F.	
25K	25.036 K	0.1%	A.F.	
250K	250.318 K	0.1%	A.F.	

Is the 'As Found' Data Within 2% of the Set Point?:

☒ Yes ☐ No

DETECTOR 1:

AF 1-6

AL 1-6

DETECTOR 2:

AF 1-6

AL 1-6

DETECTOR 3:

AF 1-6

AL 1-6

DETECTOR 4:

AF 1-6

AL 1-6

0000 S-6	A.F.	N/A	N/A	N/A	N/A	N/A	N/A
0100 -2	A.F.	N/A	N/A	N/A	N/A	N/A	N/A
100	A.F.	N/A	N/A	N/A	N/A	N/A	N/A
1000	A.F.	N/A	N/A	N/A	N/A	N/A	N/A
10000	A.F.	N/A	N/A	N/A	N/A	N/A	N/A
100000	A.F.	N/A	N/A	N/A	N/A	N/A	N/A

REMARKS:

Does Instrument Meet Final Acceptance Criteria?:

☒ Yes☐ No

Calibration Sticker Attached?:

☒ Yes☐ No

Date Instrument Is Due For Next Calibration:

03/09/12

INSTRUMENT MARKED WITH

44-10

PR201041

Performed/Reviewed by:

Date: 3/9/2011

Entered by: Initials



GRIFFIN INSTRUMENTS



CALIBRATION CERTIFICATE FOR 44-10 PROBE # PR201041

Owner: CHASE ENV

DATE: 03/09/11

LOCATION: Griffin Inst

TECH: E.M. Glenn

DATE LAST CAL EXPIRES:

03/28/11

- ☒ Due For Calibration
☐ Repair (See Remarks)

- ☐ Other (See Remarks)
☐ Due and Repair

Cable Length: 5'

I.S.: 10mV

NIST TRACEABLE EQUIPMENT AND STANDARDS USED DURING CALIBRATION

MODEL: 2241 SERIAL #: 196624 CAL. DUE: 03/09/12

SOURCE #: 98-1818 ISOTOPE: Cs137 ACTIVITY: 1.23 uCi ASSAY DATE: 08/12/99

GEOMETRY: Jig upside down with source underneath, activity side up.

Physical Condition: ☒ Sat ☐ Unsat

Efficiency From Last Calibration: 5.1%

Previous HV Set Point: 1150 V

Counts (CPM)

Background (CPM)

Net CPM:

116550

7250

109300

AF Efficiency: 5.23%

Is the AF efficiency within 20% of the efficiency from the last calibration?

☒ Yes ☐ No

Reproducibility: 116550 117680 115270 Average: 116493.33

Are the individual counts within 10% of the average?

☒ Yes ☐ No

High Voltage:

Source Response (CPM):

Background (CPM):

Net CPM:

N/A

HV

RESPONSE

BACKGROUND

NET CPM

V

Efficiency:

REMARKS:

Does Instrument Meet Final Acceptance Criteria? ☒ Yes ☐ NoCalibration Sticker Attached? ☒ Yes ☐ No

Date Instrument is Due For Next Calibration: 03/09/12

INSTRUMENT MARKED WITH

2241

196624

Performed/Reviewed by:

Date: 3/9/2011

Entered by: Initials



GRIFFIN INSTRUMENTS



CALIBRATION CERTIFICATE FOR

2241-3

SERIAL#

253346

Owner: CHASE ENV

DATE: 07/08/11

LOCATION:

Griffin Inst

TECH: Joanne Glenn

DATE LAST CAL EXPIRES:

03/30/12

Reason For Calibration:

☐ Due For Calibration

☒ Repair (See Remarks)

☐ Other (See Remarks)

☐ Due and Repair (See Remarks)

NIST TRACEABLE EQUIPMENT USED DURING CALIBRATION

MODEL: M-500

SERIAL #: 114512

CAL DUE: 07/28/11

MODEL:

SERIAL #:

CAL DUE:

☒ Fast/Slow Switch working properly

☒ Audio Response

☒ Geotropism

CABLE LENGTH 5'

CONDITION: Sat

NEW BATTERIES: ☒ Yes ☐ No

BATTERY CHECK: Sat

AF HV (V) #1: 1750

AL HV (V) #1: A.F.

AF LS. (mV) #1: 4

AL LS. (mV) #1: 4

AF HV (V) #2: 1850

AL HV (V) #2: 1725

AF LS. (mV) #2: 4

AL LS. (mV) #2: 4

AF HV (V) #3: 1300

AL HV (V) #3: A.F.

AF LS. (mV) #3: 4

AL LS. (mV) #3: 4

AF HV (V) #4: 1300

AL HV (V) #4: A.F.

AF LS. (mV) #4: 4

AL LS. (mV) #4: 4

RATE CPM AS FOUND % ERROR AS LEFT % ERROR

250	250	0.0%	A.F.	
2500	2498	0.0%	A.F.	
25K	24,997 K	0.0%	A.F.	
250K	249,980 K	0.0%	A.F.	

Is the As Found Data Within 2% of the Set Point?:

☒ Yes ☐ No

DETECTOR 1:

AF 1-8

AL 1-8

DETECTOR 2:

AF 1-8

AL 1-8

DETECTOR 3:

AF 1-8

AL 1-8

DETECTOR 4:

AF 1-8

AL 1-8

0000 S-8	A.F.	0000 S-8	A.F.	0000 S-8	A.F.	0000 S-8	A.F.
0100 -2	A.F.	0100 -2	A.F.	0100 -2	A.F.	0100 -2	A.F.
0	A.F.	0	A.F.	0	A.F.	0	A.F.
m	A.F.	m	A.F.	m	A.F.	m	A.F.
1	A.F.	1	A.F.	1	A.F.	1	A.F.
000s	A.F.	000s	A.F.	000s	A.F.	000s	A.F.

REMARKS: LCD had all display digits lit up - Ludlum replaced Pin contact under handle. Det 1,3, 43-88, #PR285701; Det 2,4, 43-37, #PR259802.

Does Instrument Meet Final Acceptance Criteria?:

☒ Yes ☐ No

Calibration Sticker Attached?:

☒ Yes ☐ No

Date Instrument is Due For Next Calibration:

07/08/12

INSTRUMENT MARKED WITH

Performed/Reviewed by:

Joanne Glenn

Date: 7/8/2011

Entered by: Jn/Date



GRIFFIN INSTRUMENTS



CALIBRATION CERTIFICATE FOR 43-68 PROBE # PR285701

Owner: CHASE ENV

DATE: 07/08/11
TECH: Joanne Glenn

LOCATION: Griffin Inst
DATE LAST CAL EXPIRES: 03/30/12

REASON FOR CALIBRATION:

☐ Due For Calibration ☐ Repair (See Remarks) ☒ Other (See Remarks) ☐ Due and Repair

CABLE LENGTH: 5'

INPUT SENSITIVITY: 4 mV

NIST TRACEABLE EQUIPMENT AND STANDARDS USED DURING CALIBRATION

MODEL: 2241-3 SERIAL #: 253346 CAL DUE: 07/08/12

NIST TRACEABLE SOURCES USED

Source Number	Isotope	4 pi Activity	Assay Date	2 pi Activity
00TC470-0854	Tc99 SS	17,300 dpm	08/15/09	10,800 cpm
94TH470-1583	Th230	16,700 dpm	06/16/09	8,170 cpm
2698-00	Pu239	18,500 dpm	12/02/09	9,370 cpm
2897-00	Sr90	12,200 dpm	03/01/00	8,330 cpm
PX 726	C14	48,780 dpm	01/21/08	18,680 cpm

Efficiencies from last cal:

Condition: ☒ Sat ☐ Unsat

Pu: 24.66% Th: 22.67% Sr: 44.96%

Tc ss: 30.00% C14: 16.75% To Ni:

As Found (AF) Efficiencies:

HV/Venier:	Tc-99 Source Response Nickel (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Tc-99 Source Response Stainless Steel (CPM):		
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.	A ch.	B ch.	Net Eff.
1300 a / 1750 b				4444		23.89%	6	258	6248		28.85%

Net A to B X _{AbB} < 10%	B to A X _{BaB} < 1%

	Pu239	Tc99 Ni	Tc99 ss	Th-230	Sr90	C-14
AF CPM:	4444		5249	3522	4388	7841
AP 4 pi eff:	23.89%		28.85%	21.05%	44.45%	16.55%
AP 2 pi eff:	47.38%		46.31%	43.04%	62.59%	40.64%

Is as found efficiency within 20% of the efficiency from the last cal?

☒ Yes ☐ No (See Remarks)

Note: If the as found data is within 10% of the last calibration and the B-A X_{AbB} is < 1% and the A-B X_{BaB} is < 10%, then the technician may NPL the plateau section and go directly to repairs.

GRIFFIN INSTRUMENTS

PROBE #: PR285701

Date: 07/06/11

PLATEAU AND SET POINT DATA

HV/Venier:	Tc-99 Source Response SS (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Net A to B Xstd: <10%	B to A Xstd: <1%
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.		
N/A										

Alpha / Beta Bkg (cpm)	6	258				
HV/Venier	Pu-239	Tc-99 NI	Tc-99 SS	Th-230	C-14	Bi-210
1300 a / 1750 b	CPM: 4444		5249	3522	7841	4388
4 pi AL Efficiencies:	23.99%		28.85%	21.05%	16.58%	44.45%
2 pi AL Efficiencies:	47.26%		48.21%	43.04%	40.64%	63.58%

REMARKS: Motor repair. Det. 1, b. Det. 3, a.

Does Instrument Meet Final Acceptance Criteria? ☒ Yes ☐ No

Calibration Sticker Attached? ☒ Yes ☐ No

Date Instrument is Due For Next Calibration: 07/08/12

INSTRUMENT MARKED WITH 2241-3 # 283348

Performed/Reviewed by:

James Glone

Date: 7/8/2011

Entered by: *JP* Initials

2 pi efficiencies denoted in italics.

Calibration performed to ASTM M322A-1997 standards.



GRIFFIN INSTRUMENTS



CALIBRATION CERTIFICATE FOR 43-37 PROBE # PR269902

Owner: CHASE ENV

DATE: 07/09/11
TECH: E.M. Glenn

LOCATION: Griffin Inst
DATE LAST CAL EXPIRES: 03/30/12

REASON FOR CALIBRATION:

☐ Due For Calibration ☒ Repair (See Remarks) ☐ Other (See Remarks) ☐ Due and Repair

CABLE LENGTH: 10'

INPUT SENSITIVITY: 4 mV

NIST TRACEABLE EQUIPMENT AND STANDARDS USED DURING CALIBRATION

MODEL: 2241-3 SERIAL #: 263349 CAL DUE: 07/09/12

NIST TRACEABLE SOURCES USED

Source Number	Isotope	4 pi Activity	Assay Date	2 pi Activity
00TC470-0654	Tc99 S6	17,300 dpm	08/16/09	10,800 cpm
2697-00	Sr90	12,200 dpm	03/01/00	8,530 cpm
PX 728	C14	48,780 dpm	01/21/08	18,660 cpm
2696-00	Pu239	18,500 dpm	12/02/09	9,370 cpm
84TH70-1583	Th230	18,700 dpm	08/16/09	8,170 cpm

Efficiencies from last cal:

Condition: ☒ Sat ☐ Unsat

Pu: 24.35% Th: 23.21% Sr: 44.29%

Tc ss: 28.47% C14: 18.18% Tc Nt:

As Found (AF) Efficiencies:

HV / Vendor:	Tc-99 Source Response Nickel (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Tc-99 Source Response Stainless Steel (CPM):		
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.	A ch.	B ch.	Net Eff.
1300 a / 1850 b				4685		25.17%	8	1781		6862	25.37%

Net A to B X _{calc} < 10%	B to A X _{calc} < 1%

	Pu239	Tc99 Ni	Tc99 ss	Th-230	Sr90	C-14
AF CPM:	4685		6862	3890	5828	9598
AF 4 pi eff:	25.17%		25.37%	23.26%	41.43%	18.03%
AF 2 pi eff:	49.70%		47.05%	47.52%	59.29%	41.89%

Is as found efficiency within 20% of the efficiency from the last cal?

☒ Yes ☐ No (See Remarks)

Note: If the as found data is within 10% of the last calibration and the B-A X_{calc} is < 1% and the A-B X_{calc} is < 10%, then the technician may N/A the plateau section and go directly to remarks.

GRIFFIN INSTRUMENTS

PROBE #: PR259902

Date: 07/08/11

PLATEAU AND SET POINT DATA

HV / Verifier:	Tc-99 Source Response SS (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Net A to B Xcalc <10%	B to A Xcalc <1%
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.		
1850		4150	21.1%					802		
1700		5380	26.8%					883		
1725		6004	27.9%					1182		
1750		8079	27.8%					1278		

Alpha / Beta Bkg (cpm)		8	1182			
HV / Verifier	Pu-239	Tc-99 Bk	Tc-99 SS	Th-232	C-14	Bt-80
1900 a / 1725 b	CPM:	4565	6004	3890	8734	5048
4 pt AL Efficiencies:	28.17%	27.87%	23.25%	15.45%	41.83%	
2 pt AL Efficiencies:	49.60%	44.85%	47.52%	40.47%	59.56%	

REMARKS: Replaced torn mylar, repaired broken wire. A.F. taken after repair. Meter repair.

Does Instrument Meet Final Acceptance Criteria?: ☒ Yes ☐ No

Calibration Sticker Attached?: ☒ Yes ☐ No

Date Instrument is Due For Next Calibration: 07/08/12

INSTRUMENT MARKED WITH 2241-3 # 258346

Performed/Reviewed by: G. M. St. Jean Date: 7/9/2011

Entered by: CP Initials

2 pt efficiencies determined in static.

Calibrations performed to ANSI N4324A-1987 standards.



GRIFFIN INSTRUMENTS



CALIBRATION CERTIFICATE FOR

MICRO REM

SERIAL#

B226L

Owner: CHASE ENV

DATE: 09/14/11

LOCATION:

Griffin Inst

TECH: EM Glenn

DATE LAST CAL EXPIRES:

09/14/11

REASON FOR CALIBRATION:

Due for Calibration

NIST TRACEABLE EQUIPMENT AND SOURCES USED DURING CALIBRATION

PULSER MODEL: MP-2

PULSER SERIAL: 1000

PULSER CAL DUE:

07/31/12

SOURCE NUMBER: 10250

ISOTOPE: Cs137

ASSAY DATE:

08/30/07

☒ Geotronics

TEMP 80.0 F

BARO PRESS: 29.28"

HUMIDITY: 52%

A.F. Data

A.F. % ERROR

A.L. Data

A.L. % ERROR

uR/hr

x0.1 Scale*	4.5	12.5%	4	0.0%
x0.1 Scale*	18.5	15.6%	16	0.0%
x1 Scale*	40	0.0%	A.F.	
x1 Scale*	160	0.0%	A.F.	

*Pulsed Scale

mR/hr

x10 Scale	0.4	0.0%	A.F.	
x10 Scale	1.025	2.5%	A.F.	
x10 Scale	1.65	3.1%	A.F.	
x100 Scale	4.25	6.3%	4	0.0%
x100 Scale	11	10.0%	10.5	5.6%
x100 Scale	16.75	4.7%	15.75	1.6%
x1000 Scale	42.5	6.3%	40	0.0%
x1000 Scale	112.5	12.5%	108	0.0%
x1000 Scale	167.5	4.7%	157.5	1.6%

Is the As Found Data Within 20% of the Set Point?

☒ Yes ☐ No, See Remarks

REMARKS:

Does Instrument Meet Final Acceptance Criteria?

☒ Yes ☐ No

Calibration Sticker Attached?

☒ Yes ☐ No

Date Instrument is Due For Next Calibration:

09/14/12

Performed/Reviewed by:

EM Glenn

Date: 9/14/2011

Entered by: [Signature] Initials

Calibration performed to ANSI N422A-1997 standards.

Indoor Background Measurements - Switzer Hall Basement

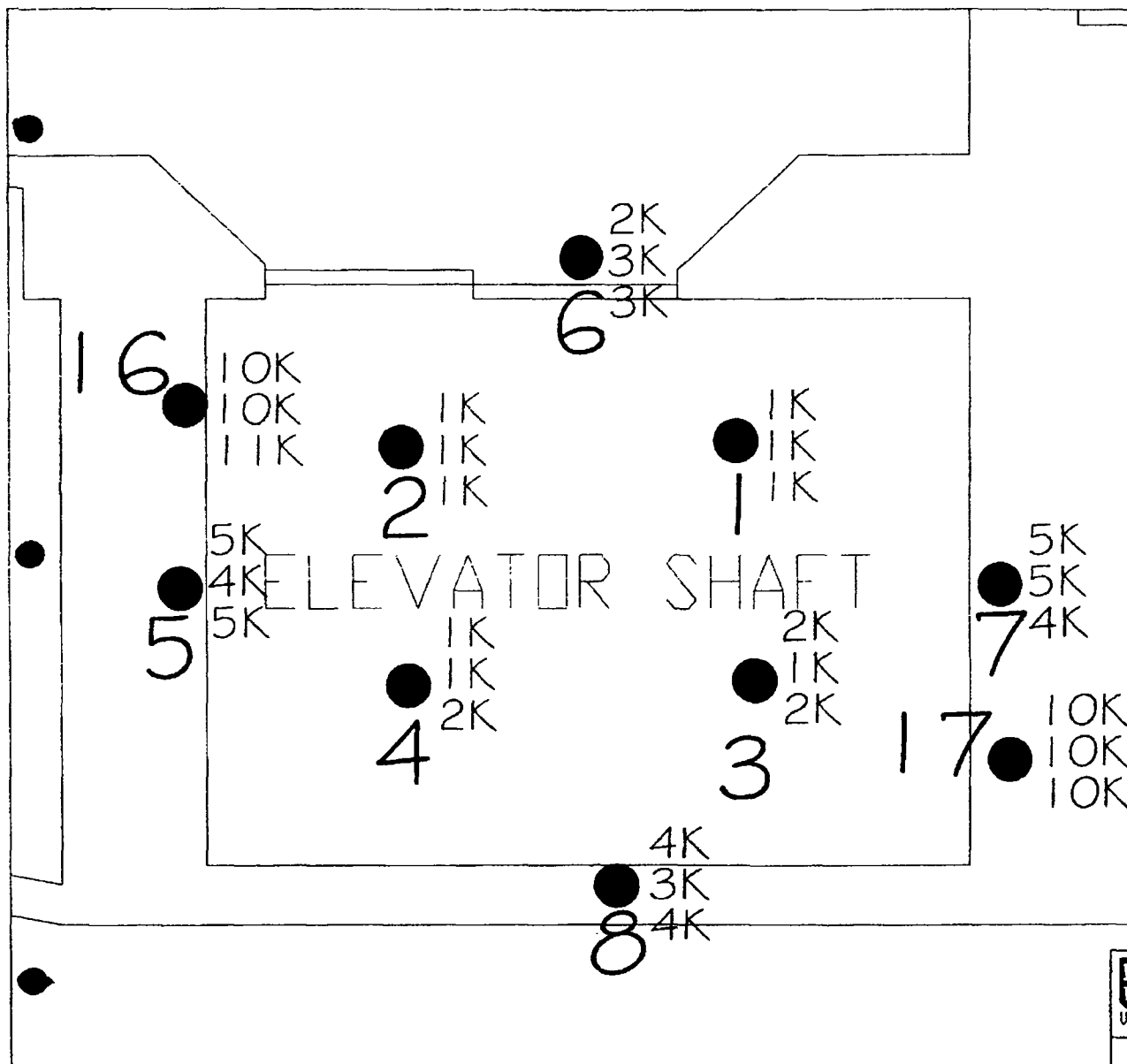
Location	Distance	NaI Static (cpm)	Bicron Instantaneous Measurements ($\mu\text{Rem/hr}$)										STDEV	Max	Mean
			1	2	3	4	5	6	7	8	9	10			
1	1m	7,178	7	8	7	6	6	7	8	7	6	8	0.8	8	7
2	1m	6,358	5	5	5	6	6	5	6	5	7	7	0.8	7	5.7
3	1m	6,440	6	6	7	6	7	6	5	6	5	6	0.7	7	6
4	1m	7,504	6	6	6	7	8	8	9	8	8	7	1.1	9	7.3
5	1m	6,981	6	6	5	5	5	6	6	6	7	6	0.6	7	5.8
6	1m	6,078	6	7	8	7	6	7	7	6	7	7	0.6	8	6.8
7	1m	6,752	7	6	7	7	7	6	7	6	6	8	0.7	8	6.7
8	1m	6,386	5	5	6	7	6	7	8	8	8	8	1.2	8	6.8
9	1m	6,716	6	7	7	7	8	8	8	10	10	9	1.3	10	8
10	1m	6,950	7	6	8	8	7	7	6	7	6	6	0.8	8	6.8
		STDEV	432										Mean		6.7
		Max	7,504												
		Mean	6,734												
		CV	6%												

Indoor Background Measurements - Switzer Hall Third Floor

Location	Distance	NaI Static (cpm)	Bicron Instantaneous Measurements ($\mu\text{Rem/hr}$)										STDEV	Max	Mean
			1	2	3	4	5	6	7	8	9	10			
1	1m	5,178	5	5	6	6	6	7	7	7	6	6	0.8	7	6.2
2	1m	6,660	6	6	8	8	8	7	7	7	10	8	1.2	10	7.5
3	1m	6,516	7	7	10	9	8	7	6	7	8	6	1.3	10	7.5
4	1m	4,770	7	8	9	8	8	7	7	6	6	5	1.2	9	7.1
5	1m	6,834	8	8	7	7	6	7	8	8	7	8	0.7	8	7.4
6	1m	7,783	8	7	9	8	7	9	8	8	8	8	0.7	9	8
7	1m	7,342	10	9	8	8	8	8	7	7	7	7	1.0	10	7.9
8	1m	7,882	8	9	8	9	9	10	10	10	9	8	0.8	10	9
9	1m	6,903	10	10	10	12	11	11	10	11	11	10	0.7	12	10.6
10	1m	7,022	8	10	8	8	8	9	10	9	10	10	0.9	10	9
		STDEV	1,012										Mean		8.0
		Max	7,882												
		Mean	6,689												
		CV	15%												

Outdoor Background
Measurements Quadrangle Near
Switzer Hall

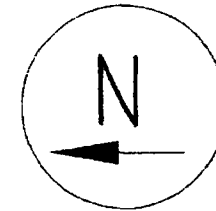
Switzer Hall		
Location	Distance	NaI Static (cpm)
1	10cm	7,095
2	10cm	7,110
3	10cm	7,098
4	10cm	6,856
5	10cm	6,449
6	10cm	6,013
7	10cm	6,234
8	10cm	6,292
9	10cm	6,842
10	10cm	6,809
STDEV		402
Max		7,110
Mean		6,680
CV		6%



All Gamma Static Results are Net CPM (> Background)
 Mean Reference Background Results - 6,701 cpm
 See Appendix F for total and removable results

#● - Sample Location
 Samples 5, 6, 7 and 8 taken on wall 1m from shaft floor
 Samples 1 & 2 taken at locations of highest activity as indicated during NaI scans on wall ~3m from shaft floor

Gamma Results as Follows:
 Top # - On Contact Result
 Middle # - 1 Foot Result
 Bottom # - 1 Meter Result



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 Pickard Hall Phase III
 Characterization Survey Report



Floor: Basement

Elevator Shaft

Appendix E.1 of E.14

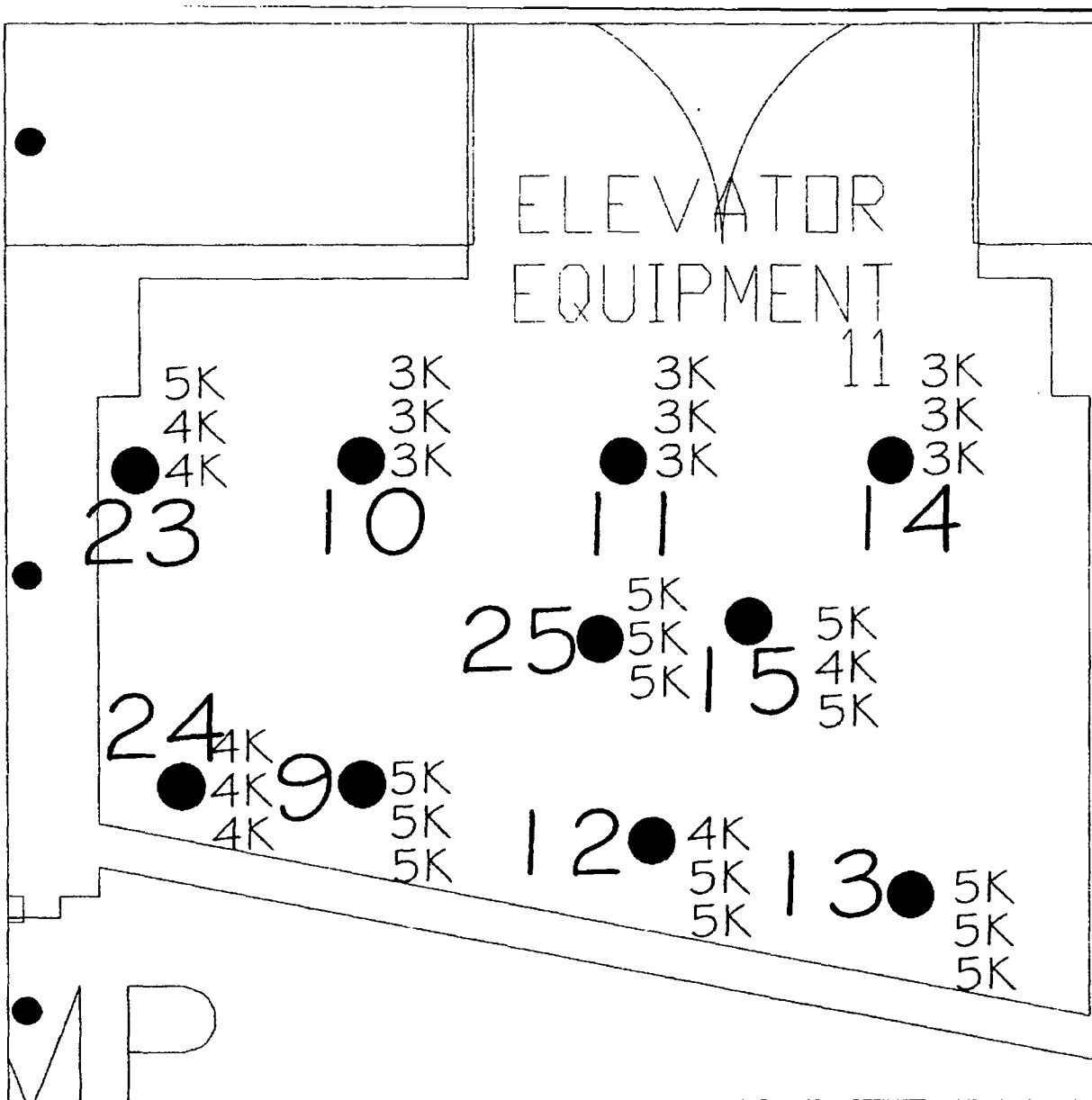
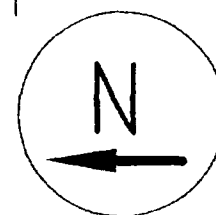
ELEVATOR
EQUIPMENT

All Gamma Static Results are Net CFM (> Background)
Mean Reference Background Results - 6.701 cpm
See Appendix F for total and removable results

#● - Sample Location
Sample locations 9, 10, 13, 14, 15, 23, 24, and 25
contained elevated residual alpha/beta/gamma total activity
as indicated during scan survey. Locations were
subsequently remediated

Gamma Results as Follows:
Top # - On Contact Result
Middle # - 1 Foot Result
Bottom # - 1 Meter Result

ELEVATOR
SHAFT



Mizzou
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University of Missouri
Pickard Hall Phase III
Characterization Survey Report

CHASE
Environmental Group

Floor: Basement

Elevator Mechanical Room

Appendix E.2 of E.14

ELEVATOR EQUIPMENT 11

All Gamma Static Results are Net CPM (> Background)

Mean Reference Background Results - 6,701 cpm

Gamma Results as Follows:

Top # - On Contact Result

Middle # - 1 Foot Result

Bottom # - 1 Meter Result

1 3K
10K
6K

4 39K
26K
13K

1 132K
46K
13K

7 8K
9K
5K

9 5K
6K
3K

5 196K
40K
16K

10 4K
6K
6K

3 5K
9K
8K

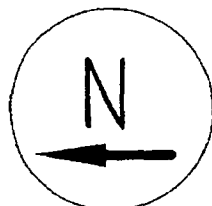
2 24K
27K
14K

CORRIDOR

6 7K
10K
5K

8 6K
13K
6K

OFFICE 9



Mizzou
University of Missouri - Columbia

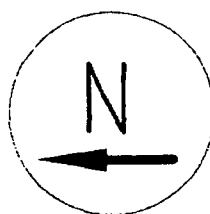
University of Missouri
Pickard Hall Phase III
Characterization Survey Report

CHASE
Environmental Group

Floor: Basement

Room 9 Corridor

Appendix E.3 of E.14



All Gamma Static Results are Net CFM (> Background)
Mean Reference Background Results = 6,701 cpm
See Appendix F for total and removable results

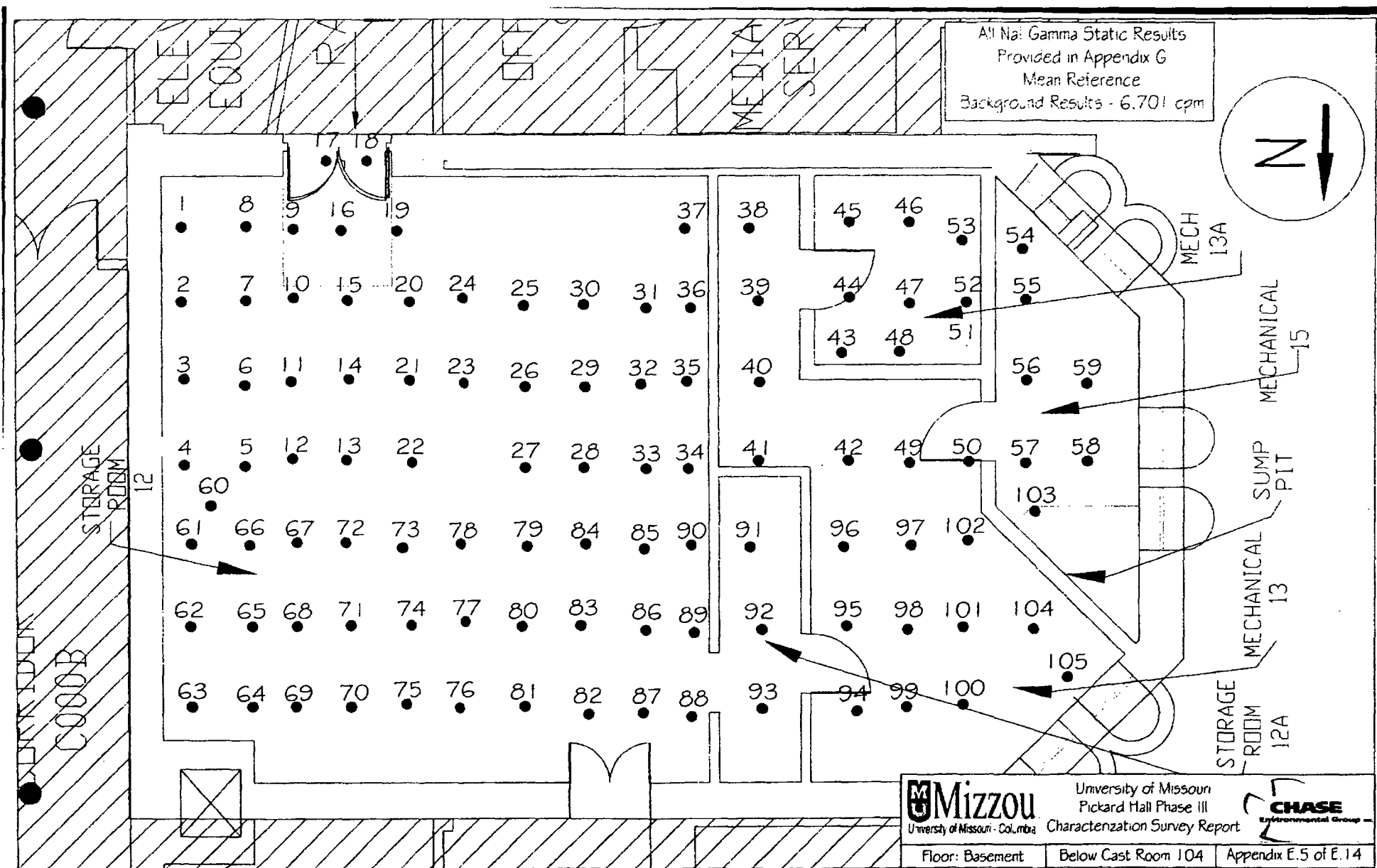
Gamma Results as follows:
Top # - On Contact Result
Middle # - 1 Foot Result
Bottom # - 1 Meter Result

17A

1 28K
9K
● INACCESSIBLE

2 25K
6K
3K

17

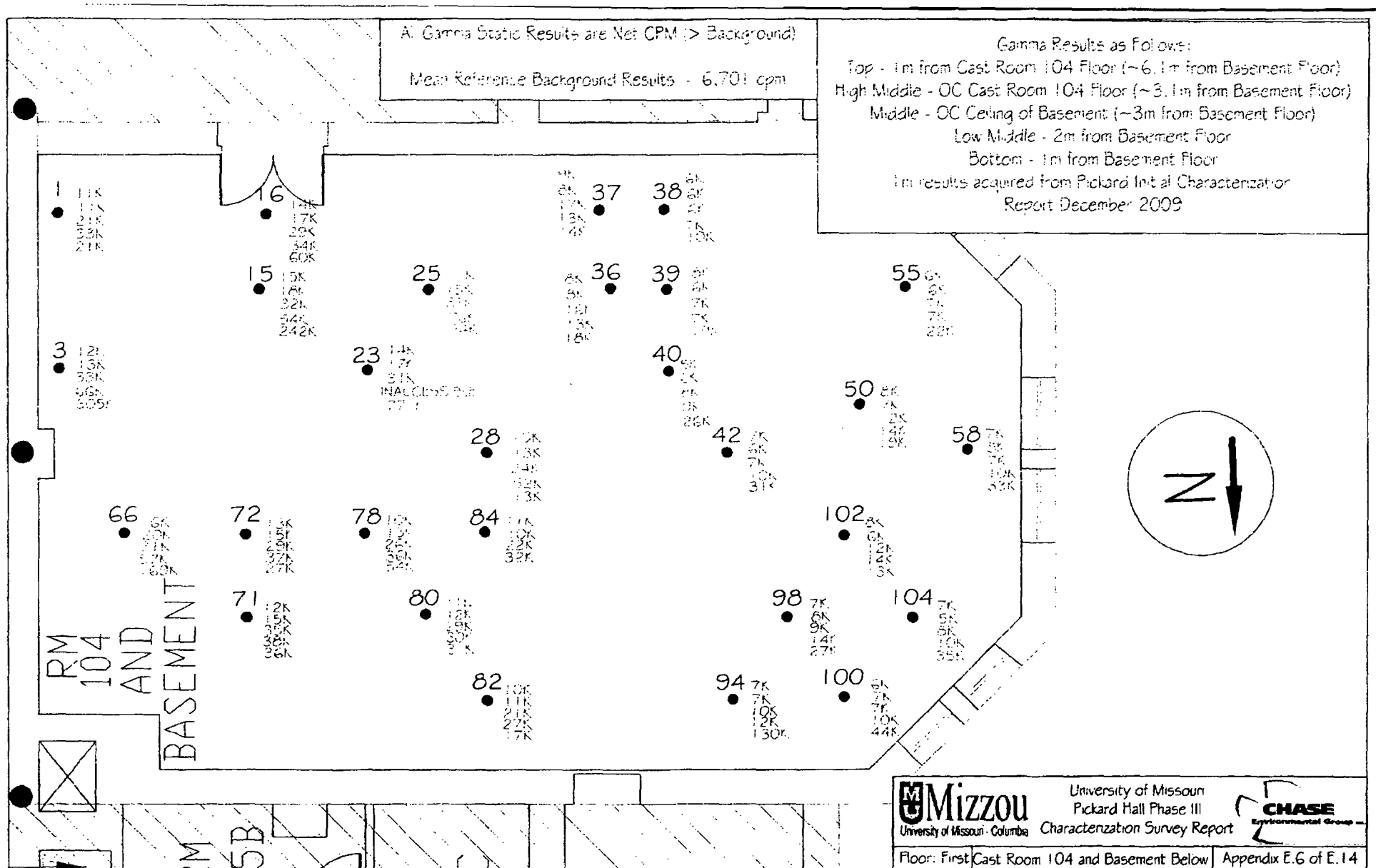


All Gamma Static Results are Net CPM (> Background)

Mean Reference Background Results - 6.701 cpm

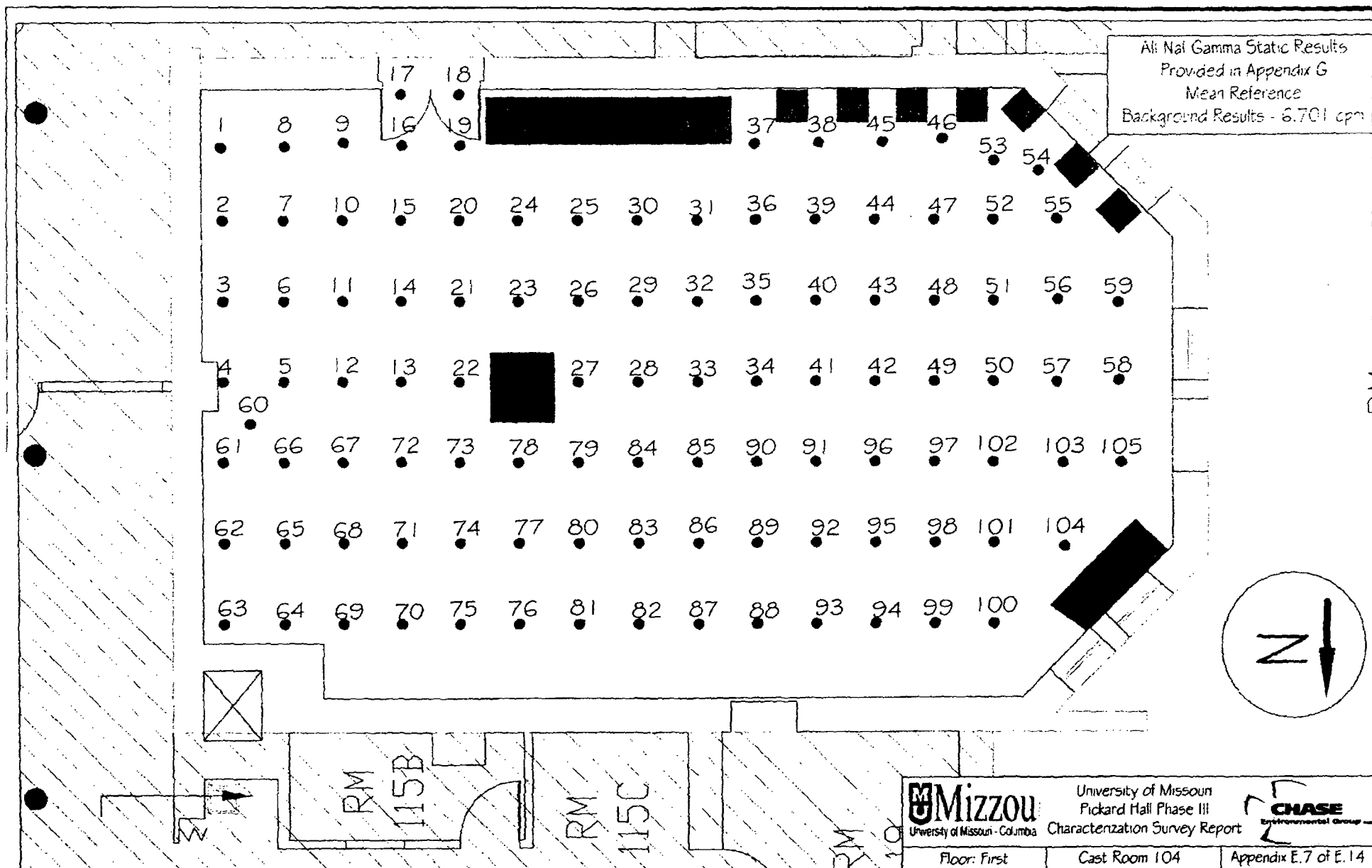
Gamma Results as Follows:

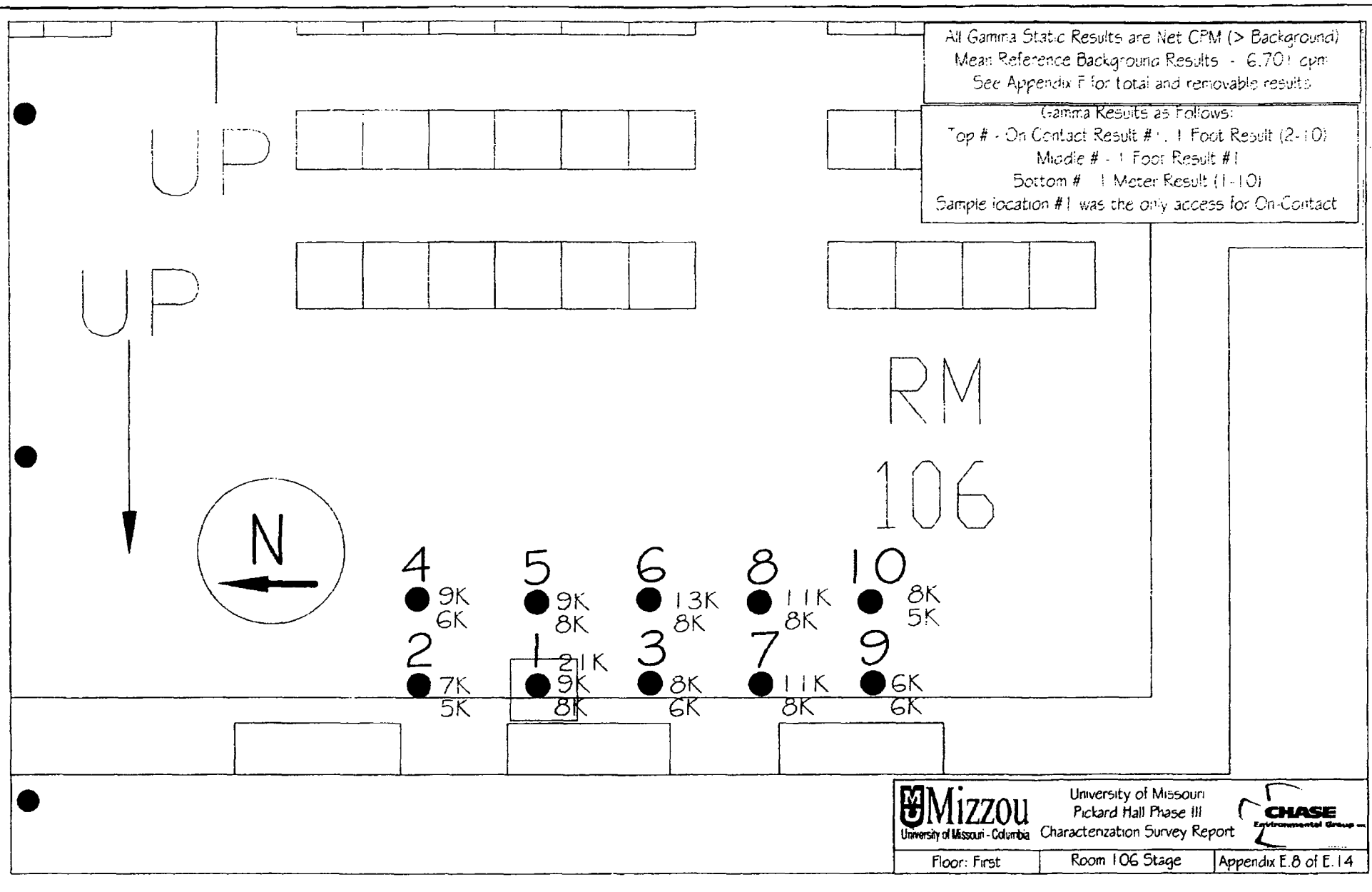
Top - 1m from Cast Room 104 Floor (~6.1m from Basement Floor)
 High Middle - OC Cast Room 104 Floor (~3.1m from Basement Floor)
 Middle - OC Ceiling of Basement (~3m from Basement Floor)
 Low Middle - 2m from Basement Floor
 Bottom - 1m from Basement Floor
 1m results acquired from Pickard Initial Characterization Report December 2009



University of Missouri
 Pickard Hall Phase III
 Characterization Survey Report







Mean Reference Background Results - 6.701 cpm

11

RM

1 1 1



University of Missouri
Pickard Hall Phase III
Characterization Survey Report

CHASE
Environmental Group —

Floor: First

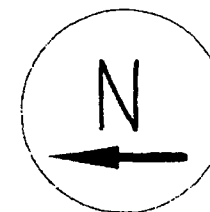
Room 111

Appendix E.9 of E.14

All Gamma Static Results are Net CPM (> Background)

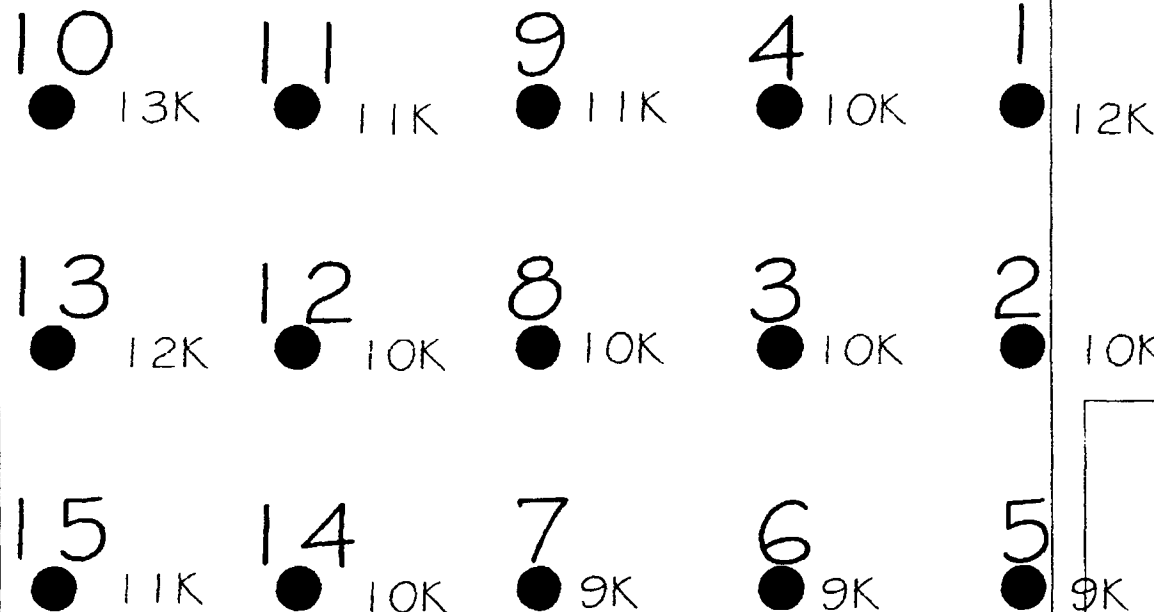
Mean Reference Background Results - 6.701 cpm

Gamma Results as Follows:
Sample # - 1 Meter Result



RM

112



Mizzou
University of Missouri - Columbia

University of Missouri
Pickard Hall Phase III
Characterization Survey Report

CHASE
Environmental Group

Floor: First

Room 112

Appendix E.10 of E.14

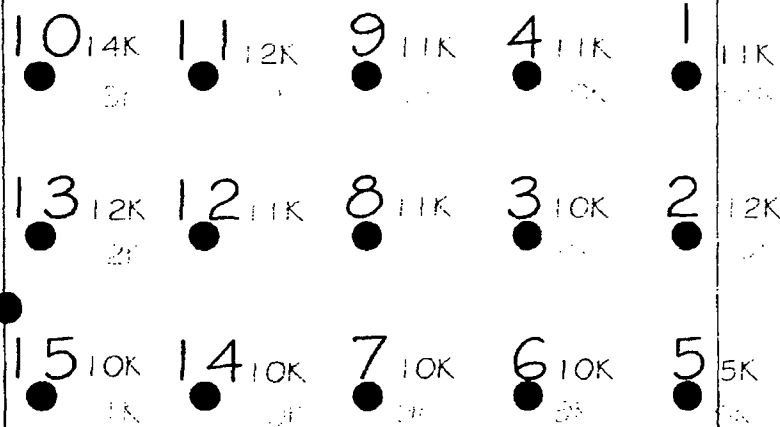
All Gamma Static Results are Net CPM (> Background)

Mean Reference Background Results - 6,701 cpm

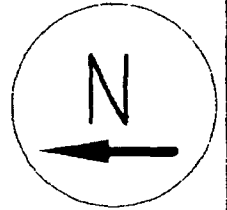
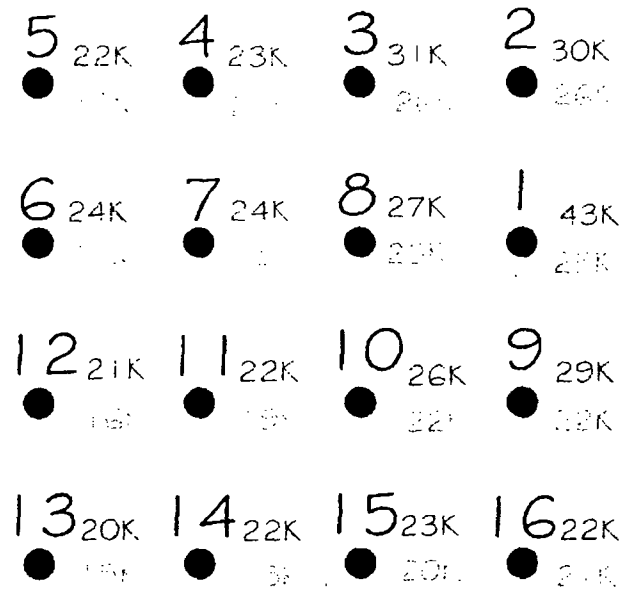
Gamma Results as Follows:

Top # - 1m from floor of 205 and 206

Bottom # - 1m from original top of wall



GALLERY
206



GALLERY
205



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Pickard Hall Phase III
Characterization Survey Report



Floor: Pickard Hall | 1st and 2nd Floor Comparison | Appendix E.11 of E.14

All Gamma Static Results are Net CPM (> Background)

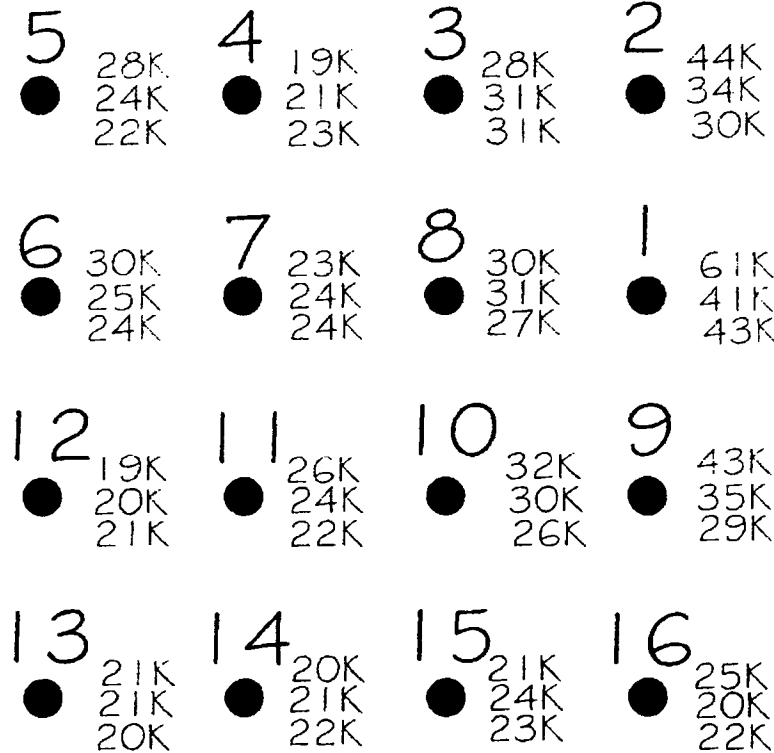
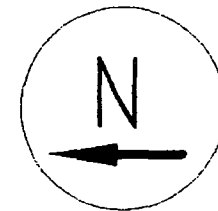
Mean Reference Background Results - 6,701 cpm

Gamma Results as Follows:

Top # - On Contact Result

Middle # - 1 Foot Result

Bottom # - 1 Meter Result



GALLERY
205



University of Missouri
Pickard Hall Phase III
Characterization Survey Report



Floor: Pickard Hall

Room 205

Appendix E.12 of E.14

All Gamma Static Results are Net CPM (> Background)

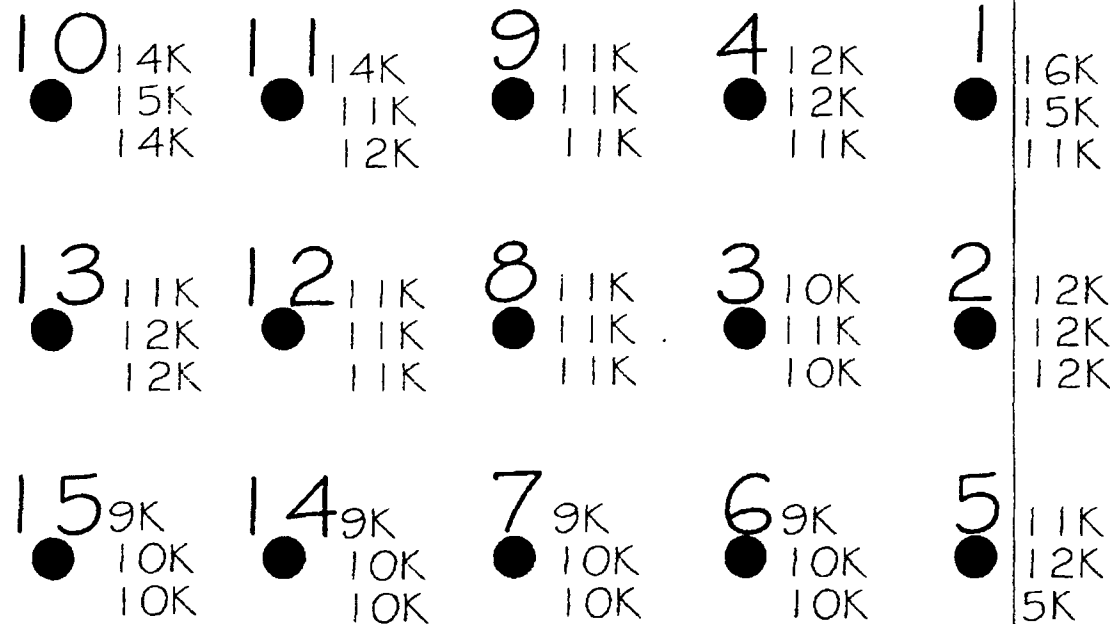
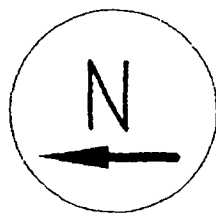
Mean Reference Background Results - 6.701 cpm

Gamma Results as Follows:

Top # - On Contact Result

Middle # - 1 Foot Result

Bottom # - 1 Meter Result



GALLERY
206

Mizzou
University of Missouri - Columbia

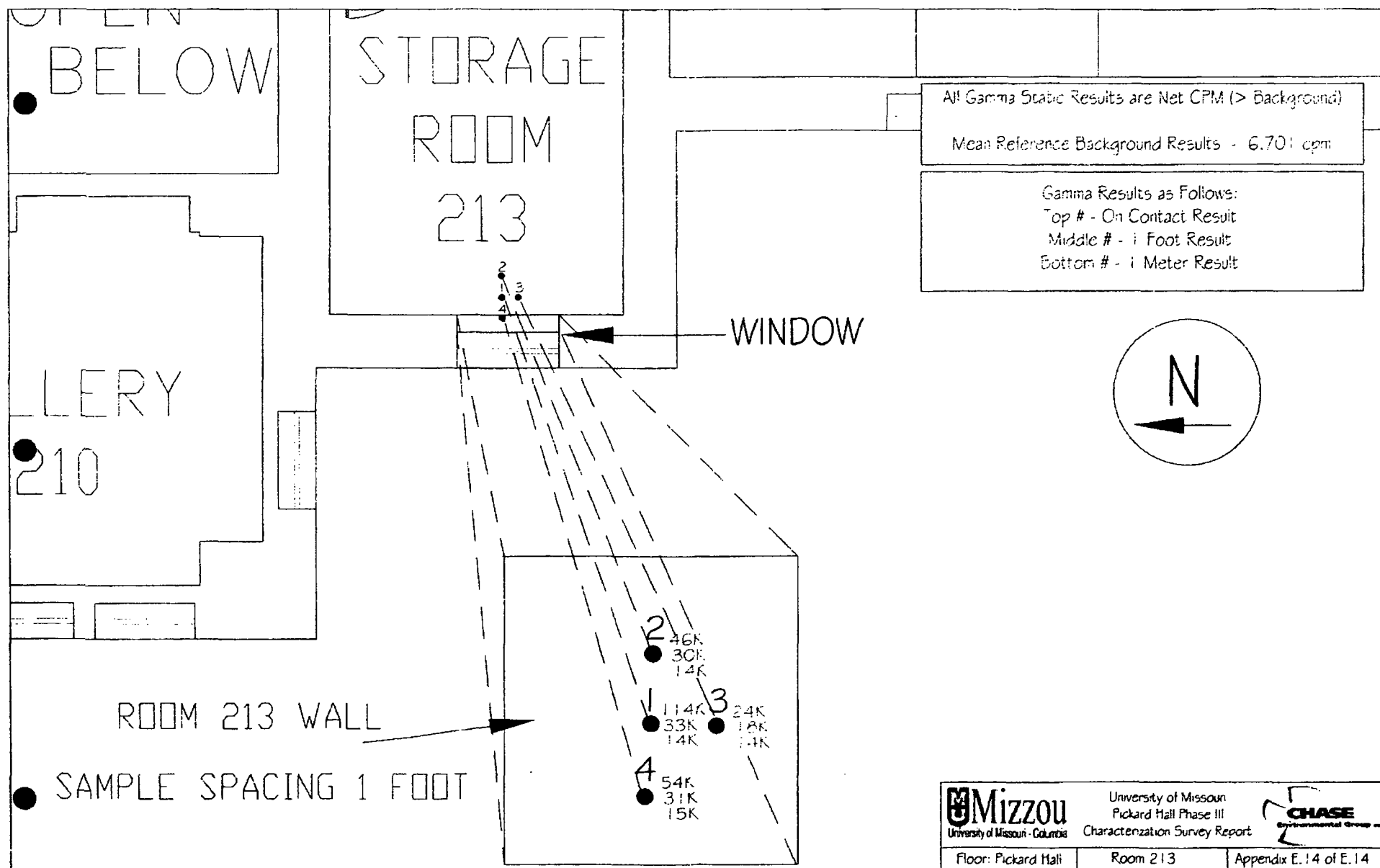
University of Missouri
Pickard Hall Phase III
Characterization Survey Report

CHASE
Environmental Group

Floor: Pickard Hall

Room 206

Appendix E.13 of E.14



Project: MU Pickard Hall, C1109016		Basement/Elevator Shaft and Mechanical Room		Type of Survey: Characterization				Surveyor 1: Brendan Mize				Surveyor 2: Ian O'Neil				Date: 10/3/2011	
Instrument / Serial #	Source Check	Cal. Due	Type	Total/Removable	Age (yrs)	Efficiency	Surface Efficiency	Total Efficiency	Sample	Bag	Area (cm ²)	MDC (dpm/100cm ²)	IL (dpm/100cm ²)	MDC % of IL	Comments: 2-pi efficiency for total surface activity measurements, 4-pi efficiency used for removable surface activity measurements See Map E.1, E.2, or E.7 for locations Elevated Activity at sample locations 9,10,13,14,15. Areas remediated, see F.3 for post remediation results		
Detector / Serial #																	
2241-3 / 253346																	
43-170/R259602	SAT	3/9/2012	Beta	Total	6-8	44.65%	0.24	11.70%	1	1	582	183	1000	18%			
2241-3 / 253346																	
43-170/R259602	SAT	3/9/2012	Alpha	Total	6	47.52%	0.25	11.88%	1	1	582	21	100	21%			
2929 / 102010																	
43-10-1 / PR102462	SAT	3/9/2012	Beta	Removable	51	26.40%	N/A	26.40%	2	10	100	75	200	37%	Reviewed: Ken Gavlik		
2929 / 102010																	
43-10-1 / PR102462	SAT	3/9/2012	Alpha	Removable	11	34.45%	N/A	34.45%	2	10	100	4	20	27%	Date: 10/3/2011		
Total Surface Activity												Removable Surface Activity					
Beta												Alpha					
Location - Room	Gross Counts	Net cpm	Activity (dpm/100cm ²)	Notes	Fraction of IL	Gross Counts	Net cpm	Activity (dpm/100cm ²)	Notes	Fraction of IL	Sum of Fractions	Gross Counts	Net cpm	Activity (dpm/100cm ²)	Notes	Fraction of IL	Sum of Fractions
1 - Elevator Shaft	734	73	114	<MDC	0.00	2	3	6	<MDC	0.00		122	10	18	<MDC	0.19	0.35
2 - Elevator Shaft	523	85	131	<MDC	0.00	4	2	3	<MDC	0.00		113	6.5	25	<MDC	0.12	0.60
3 - Elevator Shaft	543	65	100	<MDC	0.00	1	5	7	<MDC	0.00		111	4.5	17	<MDC	0.09	0.00
4 - Elevator Shaft	574	34	52	<MDC	0.00	1	5	7	<MDC	0.00		126	12	45	<MDC	0.23	0.00
5 - Elevator Shaft	643	35	54	<MDC	0.05	2	4	6	<MDC	0.00		132	15	57	<MDC	0.28	0.00
6 - Elevator Shaft	565	43	66	<MDC	0.00	3	4	6	<MDC	0.00		107	2.5	9	<MDC	0.05	0.00
7 - Elevator Shaft	646	38	58	<MDC	0.00	2	4	6	<MDC	0.00		112	5	19	<MDC	0.09	0.00
8 - Elevator Shaft	624	116	486		0.49	4	2	3	<MDC	0.00		109	5.5	13	<MDC	0.07	0.00
9 - Elev Mech Room	25,717	24,109	10,774		28.65	31	25	36		0.36		108	5	11	<MDC	0.06	0.20
10 - Elev Mech Room	1,814	1,206	1,254		1.86	9	3	4	<MDC	0.04		144	21	80		0.40	0.28
11 - Elev Mech Room	698	50	136	<MDC	0.14	4	2	3	<MDC	0.00		137	17.5	66	<MDC	0.33	0.06
12 - Elev Mech Room	642	14	52	<MDC	0.05	1	5	7	<MDC	0.00		146	22	83		0.42	0.00
13 - Elev Mech Room	7,988	7,580	7,569		11.36	3	3	4	<MDC	0.00		152	10	38	<MDC	0.19	0.00
14 - Elev Mech Room	2,167	1,559	1,570		2.40	5	1	1	<MDC	0.00		123	10.5	40	<MDC	0.20	0.00
15 - Elev Mech Room	7,510	6,902	6,914		10.62	48	32	73		0.75		123	11.5	44	<MDC	0.22	0.00

Project: MU Pickard Hall, C1109016				Basement and 1st Floor/room 17, 106 and Elevator Shaft and Mech Room				Type of Survey: Characterization				Surveyor 1: Brendan Milne				Surveyor 2: Ian F'Neil				Date: 10/1/2011			
Instrument / Serial # Detector / Serial #		Source Check	Cal Due	Type	Total Removable	Bgld (cpm)	Efficiency	Surface Efficiency	Total Efficiency	Sample	Bkg.	Area (m ²)	MDL (dpm/100cm ²)	TL (dpm/100cm ²)	MR (dpm/100cm ²)	% of TL	Comments: 2-pi efficiency for total surface activity measurements, 4-pi efficiency used for removable surface activity measurements See Map E.1, E.2, or E.7 for locations. Locations 18,19 and 20 are on subfloor and 21 and 22 are on the structural support timber Elevated Activity at sample locations 21,22,23,24,25 Areas remediated, see F.3 for post remediation results Reviewed: Ken Gavlik Date: 10/3/2011						
2241-3 / 253346																							
43-3719259902		SAT	7/6/2012	Beta	Total	625	44.65%	0.25	11.16%	1	1	582	184	1000	18%								
2241-3 / 253346																							
43-3719259902		SAT	7/6/2012	Alpha	Total	4	47.52%	0.25	11.88%	1	1	582	18	100	18%								
2929 / 102010																							
43-10-1 / PR102462		SAT	3/9/2012	Beta	Removable	55	26.40%	N/A	26.40%	2	10	100	7	200	39%								
2929 / 102010																							
43-10-1 / PR102462		SAT	3/9/2012	Alpha	Removable	0.8	34.45%	N/A	34.45%	2	10	100	5	20	22%								
Total Surface Activity												Removable Surface Activity											
Location - Room		Beta				Alpha				Sum of Fractions	Beta				Alpha				Sum of Fractions				
		Gross Counts	Net cpm	Activity (dpm/100cm ²)	Notes	Fraction of TL	Gross Counts	Net cpm	Activity (dpm/100cm ²)		Notes	Fraction of TL	Gross Counts	Net cpm	Activity (dpm/100cm ²)	Notes	Fraction of TL	Gross Counts		Net cpm	Activity (dpm/100cm ²)	Notes	Fraction of TL
16 - Elevator Shaft		1,259	634	976		0.98	2	-2	-1	<MDL	0.00	146	18	68	<MDL	0.34	1	-0.3	-1	<MDL	0.00		
17 - Elevator Shaft		1,024	399	614		0.61	4	0	0	<MDL	0.00	121	5.5	21	<MDL	0.10	2	0.2	1	<MDL	0.03		
18 - Room 106 Stage		Inaccessible due to Geometrical Constraints						Inaccessible due to Geometrical Constraints					115	2.5	9	<MDL	0.05	1	-0.3	-1	<MDL	0.00	
19 - Room 106 Stage		Inaccessible due to Geometrical Constraints						Inaccessible due to Geometrical Constraints					112	1	6	<MDL	0.02	4	1.2	3	<MDL	0.17	
20 - Room 106 Stage		Inaccessible due to Geometrical Constraints						Inaccessible due to Geometrical Constraints					113	1.5	6	<MDL	0.03	4	1.2	3	<MDL	0.17	
21 - Room 106 Stage		Inaccessible due to Geometrical Constraints						Inaccessible due to Geometrical Constraints					452	171	143	<MDL	3.24	251	124.7	102	<MDL	13.10	
22 - Room 106 Stage		Inaccessible due to Geometrical Constraints						Inaccessible due to Geometrical Constraints					167	28.5	108	<MDL	0.54	37	17.7	81	<MDL	2.57	
23 - Elev. Mech Room		4,110	3485	5,360		4.36	144	140	207		2.02	140	15	67	<MDL	0.28	4	1.2	3	<MDL	0.17		
24 - Elev. Mech Room		8,062	7437	11,428		11.43	725	721	1,043		10.43	118	4	15	<MDL	0.08	2	0.2	1	<MDL	0.03		
25 - Elev. Mech Room		7,092	7367	9,778		9.78	380	366	524		5.24	112	1	4	<MDL	0.02	1	-0.3	-1	<MDL	0.00		
26 - Room 17A		1,354	634	976		0.98	12	8	12	<MDL	0.12	116	3	11	<MDL	0.06	3	0.7	2	<MDL	0.10		
27 - Room 17		1,190	574	874		0.88	11	7	10	<MDL	0.10	107	11.7	46	<MDL	0.01	1	-0.3	-1	<MDL	0.00		

Project: MU Pickard Hall, C1109016				Basement and 1st Floor/Room 106, Elevator Shaft and Mechanical Room				Type of Survey: Post Remediation				Surveyor 1: Brendan Mize				Surveyor 2: Ian O'Neil				Date: 10/1/2011			
Instrument / Serial #		Source Check	Cal. Due	Type	Total Removable	Rdg (cpm)	Efficiency	Surface Efficiency	Total Efficiency	Count Rate (cts)		Area (cm ²)	MDC		IL		MDC % of IL	Comments: 2-pi efficiency for total surface activity measurements, 4-pi efficiency used for removable surface activity measurements. See Map E.1, E.2, or E.7 for locations. Remediated all accessible areas; however, a large portions under the sub floor under the stage are in accessible, allowing for minimal access to the structural support beam. Reviewed: Ken Gavlik Date: 10/3/2011					
Detector / Serial #										Sample	Rate		dpm/100cm ²	dpm/100cm ²									
2341.3 / 253346																							
43-37/PR25902		SAT	7/6/2012	Beta	Total	625	44.65%	0.23	11.16%	1	1	582	184	1000	18%								
2341.3 / 253346																							
43-37/PR25902		SAT	7/6/2012	Alpha	Total	4	47.52%	0.25	11.88%	1	1	582	18	100	18%								
2929 / 102010																							
43-10.1 / PR102462		SAT	3/9/2012	Beta	Removable	55	26.40%	N/A	26.40%	2	10	100	77	200	39%								
2929 / 102010																							
43-10.1 / PR102462		SAT	3/9/2012	Alpha	Removable	0.8	34.43%	N/A	34.45%	2	10	100	5	20	27%								
Total Surface Activity																							
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Pickard Hall Elevator Shaft Dose Rate Measurements - See Map Appendix E.1

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (µRem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
1	OC	7,902	1,201																
1	1ft	7,812	1,111																
1	1 m	8,102	1,401	5	5	6	5	5	5	4	5	5	5	0.5	6	5	-2	>2500	>2500
2	OC	7,319	618																
2	1ft	7,469	768																
2	1 m	7,417	716	5	5	6	6	7	6	6	6	6	5	0.6	7	5.8	-1.2	>2500	>2500
3	OC	8,211	1,510																
3	1ft	8,177	1,476																
3	1 m	8,201	1,500	9	8	8	7	7	7	8	9	8	9	0.8	9	8	1	>2500	>2500
4	OC	7,844	1,143																
4	1ft	7,963	1,262																
4	1 m	8,237	1,536	8	8	10	11	10	10	9	8	7	8	1.3	11	8.9	1.9	>2500	>2500
5	OC	11,662	4,961																
5	1ft	10,888	4,187																
5	1 m	11,255	4,554	8	7	7	8	7	7	7	8	8	9	0.7	9	7.6	0.6	>2500	>2500
6	OC	9,176	2,475																
6	1ft	9,861	3,160																
6	1 m	9,586	2,885	8	8	8	9	10	9	9	10	9	11	1.0	11	9.1	2.1	>2500	>2500
7	OC	11,443	4,742																
7	1ft	11,729	5,028																
7	1 m	10,992	4,291	8	8	9	8	9	8	11	10	9	9	1.0	11	8.9	1.9	>2500	>2500
8	OC	10,808	4,107																
8	1ft	10,164	3,463																
8	1 m	10,349	3,648	7	7	7	9	9	9	9	8	8	9	0.9	9	8.2	1.2	>2500	>2500
16	OC	16,882	10,181																
16	1ft	17,028	10,327																
16	1 m	17,400	10,699	8	8	9	8	9	8	11	10	9	9	1.0	11	8.9	1.9	>2500	>2500
17	OC	16,923	10,222																
17	1ft	16,854	10,153																
17	1 m	17,053	10,352	7	7	7	9	9	9	9	8	8	9	0.9	9	8.2	1.2	>2500	>2500

Pickard Hall Elevator Mechanical Room Dose Rate Measurements See Map Appendix E.2

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (µRem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 µrem/yr	100 µrem/yr
9	OC	11,963	5,262																
9	1ft	11,753	5,052																
9	1 m	11,859	5,158	8	8	8	8	8	7	7	6	6	8	0.8	8	7.4	0.4	>2500	>2500
10	OC	10,127	3,426																
10	1ft	10,001	3,300																
10	1 m	9,806	3,105	8	9	7	7	7	8	8	9	9	8	0.8	9	8	1	>2500	>2500
11	OC	9,925	3,224																
11	1ft	9,614	2,913																
11	1 m	9,881	3,180	9	8	8	7	7	7	8	9	8	9	0.8	9	8	1	>2500	>2500
12	OC	10,866	4,165																
12	1ft	11,597	4,896																
12	1 m	11,764	5,063	8	8	9	9	6	6	7	8	9	8	1.1	9	7.8	0.8	>2500	>2500
13	OC	11,921	5,220																
13	1ft	11,537	4,836																
13	1 m	11,823	5,122	7	7	7	9	7	8	7	9	9	8	0.9	9	7.8	0.8	>2500	>2500
14	OC	9,211	2,510																
14	1ft	9,403	2,702																
14	1 m	9,361	2,660	8	9	8	8	10	8	9	8	9	8	0.7	10	8.5	1.5	>2500	>2500
15	OC	10,826	4,125																
15	1ft	10,273	3,572																
15	1 m	11,843	5,142	8	9	9	7	9	7	11	8	9	7	1.3	11	8.4	1.4	>2500	>2500
23	OC	11,277	4,576																
23	1ft	10,861	4,160																
23	1 m	11,197	4,496	7	9	7	7	9	9	8	8	7	9	0.9	9	8	1	>2500	>2500
24	OC	10,555	3,854																
24	1ft	11,132	4,431																
24	1 m	11,087	4,386	8	8	9	9	5	6	6	8	9	9	1.5	9	7.7	0.7	>2500	>2500
25	OC	11,963	5,262																
25	1ft	11,416	4,715																
25	1 m	11,248	4,547	9	9	8	8	8	7	9	7	7	7	0.9	9	7.9	0.9	>2500	>2500

Pickard Hall Office 9 Corridor Dose Rate Measurements See Map Appendix E.3

Location	Distance	Nal Static (cpm)	Corrected Nal Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)													Annual Occupancy (hrs)		
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
1	OC	138,965	132,264																
1	1ft	52,543	45,842																
1	1 m	19,771	13,070	10	10	10	10	9	10	10	10	10	10	0.3	10	9.9	2.9	>2500	>2500
2	OC	30,523	23,822																
2	1ft	33,585	26,884																
2	1 m	20,790	14,089	9	10	11	11	12	11	11	11	11	11	0.8	12	10.8	3.8	>2500	>2500
3	OC	11,440	4,739																
3	1ft	15,778	9,077																
3	1 m	14,834	8,133	8	8	8	7	7	8	8	8	8	9	0.6	9	7.9	0.9	>2500	>2500
4	OC	45,225	38,524																
4	1ft	32,417	25,716																
4	1 m	20,007	13,306	9	9	9	9	8	8	9	9	8	8	0.5	9	8.6	1.6	>2500	>2500
5	OC	202,454	195,753																
5	1ft	46,714	40,013																
5	1 m	22,953	16,252	11	12	12	12	13	12	12	11	11	11	0.7	13	11.7	4.7	>2500	>2500
6	OC	14,137	7,436																
6	1ft	16,720	10,019																
6	1 m	11,203	4,502	8	8	8	7	7	6	6	6	5	6	1.1	8	6.7	-0.3	>2500	>2500
7	OC	14,505	7,804																
7	1ft	15,526	8,825																
7	1 m	12,014	5,313	8	8	7	7	6	6	6	5	5	5	1.2	8	6.3	-0.7	>2500	>2500
8	OC	12,344	5,643																
8	1ft	19,914	13,213																
8	1 m	12,919	6,218	7	7	8	8	7	8	7	7	6	6	0.7	8	7.1	0.1	>2500	>2500
9	OC	11,243	4,542																
9	1ft	12,206	5,505																
9	1 m	10,175	3,474	7	6	7	7	8	8	7	7	7	7	0.6	8	7.1	0.1	>2500	>2500
10	OC	11,006	4,305																
10	1ft	12,874	6,173																
10	1 m	12,283	5,582	10	10	9	9	9	9	8	9	8	8	0.7	10	8.9	1.9	>2500	>2500
11	OC	9,278	2,577																
11	1ft	16,791	10,090																
11	1 m	12,756	6,055	8	8	9	8	9	9	9	10	10	10	0.8	10	9	2	>2500	>2500

[illegible]

Pickard Hall Basement Below Cast Room 104 (1) Dose Rate Measurements See Map Appendix E-5

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
1	Ceiling	28,011	21,310																
1	2m	39,971	33,270	14	14	14	14	15	13	14	15	15	14	0.6	15	14.2	7.2	>2500	>2500
2	Ceiling	31,754	25,053																
2	2m	43,894	37,193	18	19	20	40	35	30	30	30	30	30	7.1	40	28.2	21.2	1,179	>2500
3	Ceiling	39,533	32,832																
3	2m	72,635	65,934	30	35	35	40	35	40	40	40	40	45	4.2	45	38	31	806	>2500
4	Ceiling	42,472	35,771																
4	2m	71,978	65,277	70	80	80	80	85	90	90	90	90	85	6.6	90	84	77	325	1,299
5	Ceiling	45,014	38,313																
5	2m	76,202	69,501	70	70	75	70	75	75	80	80	85	85	5.8	85	76.5	69.5	360	1,439
6	Ceiling	39,871	33,170																
6	2m	74,339	67,638	70	60	60	55	50	50	45	45	40	40	9.7	70	51.5	44.5	562	2,247
7	Ceiling	37,964	31,263																
7	2m	47,501	40,800	30	30	25	20	20	20	20	20	20	20	4.2	30	22.5	15.5	1,613	>2500
8	Ceiling	33,431	26,730																
8	2m	39,111	32,410	10	15	15	15	15	10	15	15	15	15	2.1	15	14	7	>2500	>2500
9	Ceiling	37,021	30,320																
9	2m	35,400	28,699	45	40	45	40	40	40	40	40	40	40	2.1	45	41	34	735	>2500
10	Ceiling	39,084	32,383																
10	2m	66,209	59,508	50	50	50	50	50	50	50	50	50	55	1.6	55	50.5	43.5	575	2,299
11	Ceiling	42,081	35,380																
11	2m	75,122	68,421	60	60	60	60	60	55	55	55	55	55	2.6	60	57.5	50.5	495	1,980
12	Ceiling	43,324	36,623																
12	2m	71,245	64,544	80	80	80	80	75	70	70	70	70	70	5.0	80	74.5	67.5	370	1,481
13	Ceiling	38,466	31,765																
13	2m	72,819	66,118	55	55	60	55	60	60	60	60	60	60	2.4	60	58.5	51.5	485	1,942
14	Ceiling	38,661	31,960																
14	2m	64,616	57,915	55	55	55	50	50	50	50	50	50	55	2.6	55	52	45	556	2,222
15	Ceiling	38,258	31,557																
15	2m	60,321	53,620	50	55	55	60	60	60	60	60	60	60	3.5	60	58	51	490	1,961

Pickard Hall Basement Below Cast Room 104 (2) Dose Rate Measurements See Map Appendix E.5

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)													Annual Occupancy (hrs)	25 mrem/yr	100 mrem/yr
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean		
16	Ceiling	36,040	29,339																
16	2m	41,024	34,323	55	55	50	45	45	40	40	40	40	40	6.2	55	45	38	658	>2500
17	Ceiling	19,926	13,225																
17	2m	37,716	31,015	30	25	30	30	30	35	35	30	30	30	2.8	35	30.5	23.5	1,064	>2500
18	Ceiling	19,961	13,260																
18	2m	36,924	30,223	35	40	40	40	40	35	40	40	40	40	2.1	40	39	32	781	>2500
19	Ceiling	37,581	30,880																
19	2m	40,765	34,064	45	50	50	55	55	55	55	55	60	60	4.6	60	54	47	532	2,128
20	Ceiling	37,002	30,301																
20	2m	59,861	53,160	65	70	65	65	70	70	70	70	65	65	2.6	70	67.5	60.5	413	1,653
21	Ceiling	40,081	33,380																
21	2m	65,811	59,110	60	55	55	55	55	55	60	60	60	55	2.6	60	57	50	500	2,000
22	Ceiling	37,571	30,870																
22	2m	75,921	69,220	50	50	50	50	50	55	55	55	55	60	3	60	53	46	543	2,174
23	Ceiling	37,958	31,257																
23	2m			INACCESSIBLE															
24	Ceiling	42,862	36,161																
24	2m			INACCESSIBLE															
25	Ceiling	39,447	32,746																
25	2m	82,937	76,236	90	90	95	90	95	95	90	90	90	90	2	95	92	85	296	1,183
26	Ceiling	35,128	28,427																
26	2m	56,412	49,711	85	80	75	60	60	60	55	50	50	50	13	85	63	56	450	1,802
27	Ceiling	28,437	21,736																
27	2m	60,663	53,962	50	45	45	45	45	40	40	40	40	40	3	50	43	36	694	>2500
28	Ceiling	31,197	24,496																
28	2m	58,212	51,511	30	30	25	25	25	25	25	20	20	20	4	30	25	18	1,429	>2500
29	Ceiling	32,494	25,793																
29	2m	56,409	49,708	25	25	25	30	30	30	25	25	25	20	3	30	26	19	1,316	>2500
30	Ceiling	36,783	30,082																
30	2m	60,548	53,847	40	40	40	45	45	45	45	45	45	50	3	50	44	37	676	>2500

Pickard Hall Basement/Below Cast Room 104 (3) Dose Rate Measurements See Map Appendix E.5

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
31	Ceiling	31,115	24,414																
31	2m	29,147	22,446	20	20	20	20	20	20	20	20	25	20	1.6	25	20.5	13.5	1,852	>2500
32	Ceiling	31,841	25,140																
32	2m	29,082	22,381	25	25	25	20	20	20	20	20	15	15	3.7	25	20.5	13.5	1,852	>2500
33	Ceiling	31,354	24,653																
33	2m	26,944	20,243	10	11	11	11	12	12	12	13	13	14	1.2	14	11.9	4.9	>2500	>2500
34	Ceiling	21,962	15,261																
34	2m	19,812	13,111	14	14	13	13	13	13	13	14	13	13	0.5	14	13.3	6.3	>2500	>2500
35	Ceiling	19,904	13,203																
35	2m	19,952	13,251	14	13	13	12	12	11	11	12	13	14	1.1	14	12.5	5.5	>2500	>2500
36	Ceiling	22,411	15,710																
36	2m	19,741	13,040	15	15	14	13	13	13	12	12	12	12	1.2	15	13.1	6.1	>2500	>2500
37	Ceiling	23,532	16,831																
37	2m	19,950	13,249	18	17	17	18	18	20	20	19	19	19	1.1	20	18.5	11.5	2,174	>2500
38	Ceiling	13,018	6,317																
38	2m	13,926	7,225	9	9	9	9	8	8	8	9	8	8	0.5	9	8.5	1.5	>2500	>2500
39	Ceiling	13,947	7,246																
39	2m	14,122	7,421	7	8	7	7	7	8	7	8	7	7	0.5	8	7.3	0.3	>2500	>2500
40	Ceiling	15,083	8,382																
40	2m	16,043	9,342	8	9	8	8	8	8	8	8	8	9	0.4	9	8.2	1.2	>2500	>2500
41	Ceiling	15,345	8,644																
41	2m	16,176	9,475	10	10	11	10	11	11	11	12	12	12	0.8	12	11	4	>2500	>2500
42	Ceiling	14,117	7,416																
42	2m	16,982	10,281	12	12	12	13	13	13	13	13	14	14	0.7	14	12.9	5.9	>2500	>2500
43	Ceiling	13,217	6,516																
43	2m	18,665	11,964	13	12	12	11	12	12	12	12	12	11	0.6	13	11.9	4.9	>2500	>2500
44	Ceiling	13,918	7,217																
44	2m	18,642	11,941	14	15	14	14	14	13	14	14	15	14	0.6	15	14.1	7.1	>2500	>2500
45	Ceiling	13,222	6,521																
45	2m	18,001	11,300	14	13	13	12	12	11	11	10	9	10	1.6	14	11.5	4.5	>2500	>2500

Pickard Hall Basement Below Cast Room 104 (4) Dose Rate Measurements See Map Appendix E.5

Piccolo Hall Basement Below East Road 104 (57 Data Point Measurements See Map Appendix A2)																			
Location	Distance	Nal Static (cpm)	Corrected Nal Static (cpm)	Bicron Instantaneous Measurements (µRem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 µrem/yr	100 µrem/yr
46	Ceiling	13,861	7,160																
46	2m	17,411	10,710	9	9	8	9	9	9	9	8	9	9	0.4	9	8.8	1.8	>2500	>2500
47	Ceiling	12,122	5,421																
47	2m	18,290	11,589	11	13	12	12	13	13	13	13	13	14	0.8	14	12.7	5.7	>2500	>2500
48	Ceiling	12,186	5,485																
48	2m	18,761	12,060	13	13	13	13	13	13	12	13	14	13	0.5	14	13	6	>2500	>2500
49	Ceiling	12,998	6,297																
49	2m	19,264	12,563	12	13	13	13	13	12	12	12	12	13	0.5	13	12.5	5.5	>2500	>2500
50	Ceiling	19,111	12,410																
50	2m	20,864	14,163	12	12	12	13	13	13	12	12	12	13	0.5	13	12.4	5.4	>2500	>2500
51	Ceiling	13,336	6,635																
51	2m	18,377	11,676	16	17	18	18	18	17	16	16	15	15	1.2	18	16.6	9.6	>2500	>2500
52	Ceiling	14,117	7,416																
52	2m	17,968	11,267	17	18	18	17	16	16	17	17	17	18	0.7	18	17.1	10.1	2,475	>2500
53	Ceiling	14,183	7,482																
53	2m	18,741	12,040	19	18	17	16	16	15	16	15	15	15	1.4	19	16.2	9.2	>2500	>2500
54	Ceiling	13,120	6,419																
54	2m	13,947	7,246	9	9	9	9	9	8	8	8	7	8	0.7	9	8.4	1.4	>2500	>2500
55	Ceiling	13,897	7,196																
55	2m	14,146	7,445	13	13	13	13	13	13	13	14	15	15	0.8	15	13.5	6.5	>2500	>2500
56	Ceiling	14,123	7,422																
56	2m	14,864	8,163	14	14	14	14	15	14	13	13	14	14	0.6	15	13.9	6.9	>2500	>2500
57	Ceiling	14,582	7,881																
57	2m	17,541	10,840	15	16	16	16	15	15	15	15	17	17	0.8	17	15.7	8.7	>2500	>2500
58	Ceiling	14,028	7,327																
58	2m	17,000	10,299	18	18	18	17	17	17	17	17	18	18	0.5	18	17.5	10.5	2,381	>2500
59	Ceiling	14,908	8,207																
59	2m	16,320	9,619	20	20	15	15	15	10	10	10	10	10	4.1	20	13.5	6.5	>2500	>2500
60	Ceiling	36,142	29,441																
60	2m			INACCESSIBLE															

Pickard Hall Basement Below Cast Room 104 (5) Dose Rate Measurements See Map Appendix E.5

Location	Distance	Nal Static (cpm)	Corrected Nal Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
61	Ceiling	33,971	27,270																
61	2m	66,015	59,314	55	60	60	55	60	60	65	60	60	60	2.8	65	59.5	52.5	476	1,905
62	Ceiling	39,004	32,303																
62	2m	69,271	62,570	60	60	55	60	60	60	60	60	65	65	2.8	65	60.5	53.5	467	1,869
63	Ceiling			INACCESSIBLE															
63	2m			INACCESSIBLE															
64	Ceiling			INACCESSIBLE															
64	2m			INACCESSIBLE															
65	Ceiling	39,265	32,564																
65	2m	65,126	58,425	50	50	50	50	50	50	55	50	50	50	1.6	55	50.5	43.5	575	2,299
66	Ceiling	38,121	31,420																
66	2m	64,172	57,471	50	50	50	55	55	55	55	50	55	55	2.6	55	53	46	543	2,174
67	Ceiling	37,070	30,369																
67	2m	56,835	50,134	40	40	40	40	40	40	40	45	45	45	2.4	45	41.5	34.5	725	>2500
68	Ceiling	40,424	33,723																
68	2m	59,242	52,541	45	40	35	40	40	35	35	35	40	40	3.4	45	38.5	31.5	794	>2500
69	Ceiling	44,939	38,238																
69	2m	60,136	53,435	INACCESSIBLE															
70	Ceiling	44,791	38,090																
70	2m	57,219	50,518	30	25	30	30	30	25	30	30	25	30	2.4	30	28.5	21.5	1,163	>2500
71	Ceiling	42,176	35,475																
71	2m	45,184	38,483	30	30	30	30	30	30	30	25	25	30	2.1	30	29	22	1,136	>2500
72	Ceiling	36,163	29,462																
72	2m	43,920	37,219	30	30	30	35	35	35	40	40	40	35	4.1	40	35	28	893	>2500
73	Ceiling	35,028	28,327																
73	2m	42,940	36,239	30	30	30	30	30	30	30	30	30	30	0.0	30	30	23	1,087	>2500
74	Ceiling	39,123	32,422																
74	2m	45,817	39,116	20	20	20	20	25	25	20	20	20	20	2.1	25	21	14	1,786	>2500
75	Ceiling	44,616	37,915																
75	2m	35,403	28,702	30	30	30	25	25	25	20	20	25	25	3.7	30	25.5	18.5	1,351	>2500

Pickard Hall Basement Below Cast Room 104 (6) Dose Rate Measurements See Map Appendix E.5

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rm/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
76	Ceiling	38,401	31,700																
76	2m	49,824	43,123	35	35	35	30	30	30	30	30	25	25	3.7	35	30.5	23.5	1,064	>2500
77	Ceiling	37,134	30,433																
77	2m	42,124	35,423	20	20	20	20	20	20	20	20	20	15	1.6	20	19.5	12.5	2,000	>2500
78	Ceiling	32,971	26,270																
78	2m	43,124	36,423	45	40	35	35	35	30	35	35	35	30	4.4	45	35.5	28.5	877	>2500
79	Ceiling	28,799	22,098																
79	2m	6,130	-571	25	25	30	30	30	25	25	25	20	20	3.7	30	25.5	18.5	1,351	>2500
80	Ceiling	35,487	28,786																
80	2m	36,794	30,093	16	17	16	17	18	17	18	18	18	19	1.0	19	17.4	10.4	2,404	>2500
81	Ceiling	28,582	21,881																
81	2m	31,860	25,159	18	18	18	18	19	18	19	19	18	19	0.5	19	18.4	11.4	2,193	>2500
82	Ceiling	27,776	21,075																
82	2m	34,112	27,411	19	19	18	19	19	19	18	17	20	20	0.9	20	18.8	11.8	2,119	>2500
83	Ceiling	29,326	22,625																
83	2m	39,820	33,119	45	45	40	45	40	35	35	30	30	30	6.3	45	37.5	30.5	820	>2500
84	Ceiling	28,602	21,901																
84	2m	38,236	31,535	20	20	20	20	20	20	20	20	20	20	0.0	20	20	13	1,923	>2500
85	Ceiling	2,859	-3,842																
85	2m	32,842	26,141	25	25	25	20	20	20	20	20	20	20	2.4	25	21.5	14.5	1,724	>2500
86	Ceiling	27,314	20,613																
86	2m	33,811	27,110	25	25	30	30	30	30	30	30	30	30	2.1	30	29	22	1,136	>2500
87	Ceiling	26,831	20,130																
87	2m	32,986	26,285	16	15	17	17	17	16	17	18	17	16	0.8	18	16.6	9.6	>2500	>2500
88	Ceiling	23,407	16,706																
88	2m	29,461	22,760	25	25	20	20	20	25	25	25	25	20	2.6	25	23	16	1,563	>2500
89	Ceiling	25,838	19,137																
89	2m	30,582	23,881	25	30	25	25	25	25	25	30	25	25	2.1	30	26	19	1,316	>2500
90	Ceiling	25,646	18,945																
90	2m	31,946	25,245	30	30	30	30	30	30	30	30	30	25	1.6	30	29.5	22.5	1,111	>2500

Pickard Hall Basement Below Cast Room 104 (7) Dose Rate Measurements See Map Appendix E.5

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (µRem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
91	Ceiling	24,061	17,360	15	15	15	15	15	15	15	15	15	10	1.6	15	14.5	7.5	>2500	>2500
91	2m			INACCESSIBLE															
92	Ceiling	22,334	15,633	15	15	20	20	20	20	15	15	15	15	2.6	20	17	10	2,500	>2500
92	2m			INACCESSIBLE															
93	Ceiling	20,108	13,407	20	20	20	20	20	19	19	19	19	19	0.5	20	19.5	12.5	2,000	>2500
93	2m			INACCESSIBLE															
94	Ceiling	16,838	10,137																
94	2m	18,601	11,900	10	10	10	10	10	15	15	15	15	10	2.6	15	12	5	>2500	>2500
95	Ceiling	15,924	9,223																
95	2m	18,168	11,467	13	14	14	15	15	15	16	15	16	15	0.9	16	14.8	7.8	>2500	>2500
96	Ceiling	14,104	7,403																
96	2m	16,450	9,749	14	15	14	14	15	16	15	15	14	14	0.7	16	14.6	7.6	>2500	>2500
97	Ceiling	15,111	8,410																
97	2m	18,962	12,261	14	15	14	14	15	16	15	15	14	14	0.7	16	14.6	7.6	>2500	>2500
98	Ceiling	15,999	9,298																
98	2m	20,807	14,106	14	15	15	14	15	16	16	15	15	16	0.7	16	15.1	8.1	>2500	>2500
99	Ceiling	16,231	9,530																
99	2m	19,411	12,710	17	17	16	15	16	15	14	14	15	14	1.2	17	15.3	8.3	>2500	>2500
100	Ceiling	14,555	7,854																
100	2m	16,984	10,283	16	17	16	16	16	16	16	19	18	18	1.1	19	16.8	9.8	>2500	>2500
101	Ceiling	13,947	7,246																
101	2m	17,281	10,580	17	16	16	17	16	15	15	16	16	16	0.7	17	16	9	>2500	>2500
102	Ceiling	18,736	12,035																
102	2m	20,751	14,050	15	15	16	15	15	15	15	16	16	15	0.5	16	15.3	8.3	>2500	>2500
103	Ceiling	19,267	12,566																
103	2m	19,864	13,163	15	15	16	15	15	15	15	16	16	15	0.5	16	15.3	8.3	>2500	>2500
104	Ceiling	15,189	8,488																
104	2m	17,184	10,483	40	40	35	35	35	35	30	30	30	30	3.9	40	34	27	926	>2500
105	Ceiling	15,617	8,916																
105	2m	17,343	10,642	10	10	10	10	10	11	10	10	9	10	0.5	11	10	3	>2500	>2500

Pickard Hall Cast Room 104 (1) Dose Rate Measurements See Map Appendix E.7

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (µRem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
1	OC-Floor	18,159	11,458																
1	1 m	17,428	10,727	12	12	11	11	12	13	12	12	12	11	0.6	13	11.8	4.8	>2500	>2500
2	OC-Floor	18,036	11,335																
2	1 m	16,926	10,225	11	12	11	11	10	10	10	11	10	11	0.7	12	10.7	3.7	>2500	>2500
3	OC-Floor	19,992	13,291																
3	1 m	18,313	11,612	12	11	14	13	14	13	13	14	14	14	1.0	14	13.2	6.2	>2500	>2500
4	OC-Floor	26,118	19,417																
4	1 m	21,892	15,191	14	12	12	13	13	13	13	12	12	13	0.7	14	12.7	5.7	>2500	>2500
5	OC-Floor	26,784	20,083																
5	1 m	21,946	15,245	15	15	14	3	13	12	12	12	14	15	3.6	15	12.5	5.5	>2500	>2500
6	OC-Floor	29,583	22,882																
6	1 m	23,811	17,110	15	14	14	14	15	15	15	15	17	18	1.3	18	15.2	8.2	>2500	>2500
7	OC-Floor	20,699	13,998																
7	1 m	19,817	13,116	15	16	18	16	16	15	15	14	15	16	1.1	18	15.6	8.6	>2500	>2500
8	OC-Floor	20,244	13,543																
8	1 m	19,111	12,410	13	14	14	13	13	14	15	13	13	13	0.7	15	13.5	6.5	>2500	>2500
9	OC-Floor	23,362	16,661																
9	1 m	20,462	13,761	12	12	12	12	13	13	13	12	13	13	0.5	13	12.5	5.5	>2500	>2500
10	OC-Floor	25,395	18,694																
10	1 m	20,861	14,160	17	18	18	17	17	16	15	15	16	17	1.1	18	16.6	9.6	>2500	>2500
11	OC-Floor	22,692	15,991																
11	1 m	1,994	-4,707	18	19	17	18	19	19	17	16	16	16	1.3	19	17.5	10.5	2,381	>2500
12	OC-Floor	28,319	21,618																
12	1 m	23,927	17,226	16	16	16	17	18	16	16	16	17	17	0.7	18	16.5	9.5	>2500	>2500
13	OC-Floor	28,319	21,618																
13	1 m	22,916	16,215	15	15	14	14	15	15	14	14	15	13	0.7	15	14.4	7.4	>2500	>2500
14	OC-Floor	28,545	21,844																
14	1 m	22,545	15,844	17	17	16	16	15	15	15	17	17	16	0.9	17	16.1	9.1	>2500	>2500
15	OC-Floor	24,424	17,723																
15	1 m	21,682	14,981	15	14	13	13	14	14	15	16	16	15	1.1	16	14.5	7.5	>2500	>2500

Pickard Hall Cast Room 104 (2) Dose Rate Measurements See Map Appendix E.7

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rm/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
16	OC-Floor	23,687	16,986																
16	1 m	21,112	14,411	15	14	14	14	15	14	13	13	12	12	1.1	15	13.6	6.6	>2500	>2500
17	OC-Floor	22,515	15,814																
17	1 m	20,497	13,796	15	15	13	13	13	13	14	13	12	13	1.0	15	13.4	6.4	>2500	>2500
18	OC-Floor	23,397	16,696																
18	1 m	20,681	13,980	14	14	13	14	13	13	12	13	12	14	0.8	14	13.2	6.2	>2500	>2500
19	OC-Floor	24,558	17,857																
19	1 m	20,323	13,622	15	15	14	13	13	14	13	13	12	12	1.1	15	13.4	6.4	>2500	>2500
20	OC-Floor	22,992	16,291																
20	1 m	19,421	12,720	15	14	14	15	15	14	15	16	16	16	0.8	16	15	8	>2500	>2500
21	OC-Floor	25,987	19,286																
21	1 m	20,811	14,110	16	16	16	16	15	16	16	16	15	14	0.7	16	15.6	8.6	>2500	>2500
22	OC-Floor	21,183	14,482																
22	1 m	20,002	13,301	13	13	11	12	12	12	13	14	14	14	1.0	14	12.8	5.8	>2500	>2500
23	OC-Floor	24,003	17,302																
23	1 m	20,767	14,066	13	12	12	12	12	12	12	12	11	11	0.6	13	11.9	4.9	>2500	>2500
24	OC-Floor	23,279	16,578																
24	1 m	20,112	13,411	14	14	13	14	14	14	14	14	13	14	0.4	14	13.8	6.8	>2500	>2500
25	OC-Floor	21,298	14,597																
25	1 m	18,117	11,416	13	13	12	12	11	10	10	10	10	11	1.2	13	11.2	4.2	>2500	>2500
26	OC-Floor	20,949	14,248																
26	1 m	18,468	11,767	11	11	11	11	11	10	10	9	9	9	0.9	11	10.2	3.2	>2500	>2500
27	OC-Floor	20,800	14,099																
27	1 m	17,111	10,410	10	10	10	9	10	11	12	11	11	12	1.0	12	10.6	3.6	>2500	>2500
28	OC-Floor	19,564	12,863																
28	1 m	16,766	10,065	11	10	10	11	12	13	13	12	12	12	1.1	13	11.6	4.6	>2500	>2500
29	OC-Floor	16,817	10,116																
29	1 m	14,441	7,740	12	12	12	11	11	13	11	12	12	11	0.7	13	11.7	4.7	>2500	>2500
30	OC-Floor	16,820	10,119																
30	1 m	14,572	7,871	9	10	9	11	10	10	9	9	9	9	0.7	11	9.5	2.5	>2500	>2500

Pickard Hall Cast Room 104 (3) Dose Rate Measurements See Map Appendix E.7

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
31	OC-Floor	14,104	7,403																
31	1 m	17,554	10,853	10	11	10	10	12	12	12	11	11	13	1.0	13	11.2	4.2	>2500	>2500
32	OC-Floor	15,076	8,375																
32	1 m	17,936	11,235	12	10	10	10	10	9	10	10	10	10	0.7	12	10.1	3.1	>2500	>2500
33	OC-Floor	15,680	8,979																
33	1 m	18,056	11,355	10	10	10	11	13	13	12	13	12	12	1.3	13	11.6	4.6	>2500	>2500
34	OC-Floor	17,981	11,280																
34	1 m	17,074	10,373	9	9	9	9	10	10	9	10	9	9	0.5	10	9.3	2.3	>2500	>2500
35	OC-Floor	15,680	8,979																
35	1 m	16,495	9,794	9	9	8	9	10	9	10	10	9	10	0.7	10	9.3	2.3	>2500	>2500
36	OC-Floor	15,076	8,375																
36	1 m	15,052	8,351	9	9	9	10	10	10	9	9	9	9	0.5	10	9.3	2.3	>2500	>2500
37	OC-Floor	14,241	7,540																
37	1 m	15,376	8,675	11	11	10	10	10	10	9	11	11	11	0.7	11	10.4	3.4	>2500	>2500
38	OC-Floor	12,611	5,910																
38	1 m	13,133	6,432	11	10	9	9	9	10	10	10	11	10	0.7	11	9.9	2.9	>2500	>2500
39	OC-Floor	12,822	6,121																
39	1 m	14,434	7,733	10	11	11	11	10	9	10	10	9	10	0.7	11	10.1	3.1	>2500	>2500
40	OC-Floor	12,569	5,868																
40	1 m	14,430	7,729	8	8	9	9	8	8	8	8	9	9	0.5	9	8.4	1.4	>2500	>2500
41	OC-Floor	13,192	6,491																
41	1 m	14,853	8,152	8	9	9	9	9	9	8	8	8	8	0.5	9	8.5	1.5	>2500	>2500
42	OC-Floor	13,061	6,360																
42	1 m	13,203	6,302	8	8	9	10	9	8	9	8	8	9	0.7	10	8.6	1.6	>2500	>2500
43	OC-Floor	11,010	4,309																
43	1 m	12,394	5,693	8	8	8	7	8	7	7	7	8	7	0.5	8	7.5	0.5	>2500	>2500
44	OC-Floor	12,175	5,474																
44	1 m	12,507	5,806	9	8	7	8	8	8	8	7	9	10	0.9	10	8.2	1.2	>2500	>2500
45	OC-Floor	12,440	5,739																
45	1 m	13,232	6,531	8	8	8	7	7	7	6	8	8	8	0.7	8	7.5	0.5	>2500	>2500

Pickard Hall Cast Room 104 (4) Dose Rate Measurements See Map Appendix E.7

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (µRem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
46	OC-Floor	12,233	5,532																
46	1 m	12,476	5,775	8	7	8	7	8	7	8	8	7	8	0.5	8	7.6	0.6	>2500	>2500
47	OC-Floor	10,751	4,050																
47	1 m	12,893	6,192	8	7	7	7	7	7	8	8	9	8	0.7	9	7.6	0.6	>2500	>2500
48	OC-Floor	11,611	4,910																
48	1 m	12,388	5,687	9	8	8	10	9	8	8	9	8	8	0.7	10	8.5	1.5	>2500	>2500
49	OC-Floor	12,604	5,903																
49	1 m	12,537	5,836	8	10	10	9	9	9	10	9	10	11	0.8	11	9.5	2.5	>2500	>2500
50	OC-Floor	13,982	7,281																
50	1 m	14,731	8,030	8	8	9	10	10	9	10	11	10	10	1.0	11	9.5	2.5	>2500	>2500
51	OC-Floor	13,986	7,285																
51	1 m	13,052	6,351	10	10	10	9	8	8	8	10	9	9	0.9	10	9.1	2.1	>2500	>2500
52	OC-Floor	13,111	6,410																
52	1 m	12,836	6,135	7	7	7	7	6	6	7	6	6	7	0.5	7	6.6	-0.4	>2500	>2500
53	OC-Floor	13,368	6,667																
53	1 m	12,647	5,946	9	9	9	8	8	9	9	8	8	8	0.5	9	8.5	1.5	>2500	>2500
54	OC-Floor	13,468	6,767																
54	1 m	12,081	5,380	9	8	8	8	8	9	8	8	8	8	0.4	9	8.2	1.2	>2500	>2500
55	OC-Floor	12,979	6,278																
55	1 m	12,865	6,164	7	7	7	8	9	10	11	10	11	10	1.6	11	9	2	>2500	>2500
56	OC-Floor	12,864	6,163																
56	1 m	13,066	6,365	10	9	9	9	9	9	9	8	7	8	0.8	10	8.7	1.7	>2500	>2500
57	OC-Floor	13,981	7,280																
57	1 m	15,250	8,549	9	9	9	8	9	8	8	9	9	9	0.5	9	8.7	1.7	>2500	>2500
58	OC-Floor	14,984	8,283																
58	1 m	13,999	7,298	8	8	8	9	9	10	11	10	12	11	1.4	12	9.6	2.6	>2500	>2500
59	OC-Floor	13,986	7,285																
59	1 m	13,077	6,376	8	7	7	6	6	7	8	7	7	8	0.7	8	7.1	0.1	>2500	>2500
60	OC-Floor	26,910	20,209																
60	1 m	22,234	15,533	11	12	11	13	13	14	13	13	12	13	1.0	14	12.5	5.5	>2500	>2500

Pickard Hall Cast Room 104 (5) Dose Rate Measurements See Map Appendix E.7

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
61	OC-Floor	24,032	17,331																
61	1 m	21,090	14,389	12	11	10	10	10	11	12	13	12	11	1.0	13	11.2	4.2	>2500	>2500
62	OC-Floor	26,700	19,999																
62	1 m	22,484	15,783	13	12	14	13	13	13	12	12	12	13	0.7	14	12.7	5.7	>2500	>2500
63	OC-Floor	28,420	21,719																
63	1 m	21,483	14,782	12	13	13	12	12	13	12	12	12	12	0.5	13	12.3	5.3	>2500	>2500
64	OC-Floor	28,455	21,754																
64	1 m	20,016	13,315	15	13	12	13	13	12	12	11	12	13	1.1	15	12.6	5.6	>2500	>2500
65	OC-Floor	25,862	19,161																
65	1 m	23,055	16,354	16	15	14	14	13	12	12	11	12	12	1.6	16	13.1	6.1	>2500	>2500
66	OC-Floor	26,391	19,690																
66	1 m	22,395	15,694	14	14	14	14	13	14	15	16	16	15	1.0	16	14.5	7.5	>2500	>2500
67	OC-Floor	23,117	16,416																
67	1 m	23,844	17,143	15	16	14	14	15	14	13	12	11	12	1.6	16	13.6	6.6	>2500	>2500
68	OC-Floor	23,374	16,673																
68	1 m	22,968	16,267	11	12	10	11	12	11	11	10	11	10	0.7	12	10.9	3.9	>2500	>2500
69	OC-Floor	23,042	16,341																
69	1 m	19,178	12,477	13	12	11	13	12	13	13	14	15	14	1.2	15	13	6	>2500	>2500
70	OC-Floor	22,017	15,316																
70	1 m	18,194	11,493	13	12	11	13	13	13	13	12	12	12	0.7	13	12.4	5.4	>2500	>2500
71	OC-Floor	21,486	14,785																
71	1 m	18,426	11,725	12	12	11	10	10	10	9	10	10	11	1.0	12	10.5	3.5	>2500	>2500
72	OC-Floor	21,986	15,285																
72	1 m	19,276	12,575	11	11	11	11	11	10	12	13	12	12	0.8	13	11.4	4.4	>2500	>2500
73	OC-Floor	20,367	13,666																
73	1 m	20,487	13,786	14	13	15	15	15	14	15	12	12	13	1.2	15	13.8	6.8	>2500	>2500
74	OC-Floor	20,196	13,495																
74	1 m	19,476	12,775	11	11	11	11	12	12	13	14	13	13	1.1	14	12.1	5.1	>2500	>2500
75	OC-Floor	19,488	12,787																
75	1 m	16,707	10,006	11	11	11	11	10	9	10	10	9	10	0.8	11	10.2	3.2	>2500	>2500

Pickard Hall Cast Room 104 (6) Dose Rate Measurements See Map Appendix E.7

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
76	OC-Floor	17,642	10,941																
76	1 m	16,238	9,537	12	11	11	11	10	11	10	10	9	8	1.2	12	10.3	3.3	>2500	>2500
77	OC-Floor	19,784	13,083																
77	1 m	16,814	10,113	7	8	7	8	8	8	8	8	8	8	0.4	8	7.8	0.8	>2500	>2500
78	OC-Floor	19,206	12,505																
78	1 m	16,972	10,271	8	9	9	10	10	9	9	9	9	8	0.7	10	9	2	>2500	>2500
79	OC-Floor	17,742	11,041																
79	1 m	17,821	11,120	10	9	10	9	11	11	11	10	11	10	0.8	11	10.2	3.2	>2500	>2500
80	OC-Floor	18,481	11,780																
80	1 m	17,653	10,952	8	9	9	10	9	9	9	9	9	10	0.6	10	9.1	2.1	>2500	>2500
81	OC-Floor	16,495	9,794																
81	1 m	17,028	10,327	11	11	11	10	11	10	9	9	8	9	1.1	11	9.9	2.9	>2500	>2500
82	OC-Floor	18,010	11,309																
82	1 m	16,289	9,588	11	10	11	10	10	10	10	10	9	8	0.9	11	9.9	2.9	>2500	>2500
83	OC-Floor	17,459	10,758																
83	1 m	20,196	13,495	9	9	9	9	11	12	12	11	11	11	1.3	12	10.4	3.4	>2500	>2500
84	OC-Floor	17,168	10,467																
84	1 m	17,783	11,082	13	13	13	12	13	12	11	11	12	11	0.9	13	12.1	5.1	>2500	>2500
85	OC-Floor	18,471	11,770																
85	1 m	16,681	9,980	9	9	10	9	8	10	10	11	10	11	0.9	11	9.7	2.7	>2500	>2500
86	OC-Floor	18,482	11,781																
86	1 m	16,416	9,715	10	9	9	8	8	9	8	9	8	8	0.7	10	8.6	1.6	>2500	>2500
87	OC-Floor	16,581	9,880																
87	1 m	15,208	8,507	10	9	9	8	8	9	10	9	9	9	0.7	10	9	2	>2500	>2500
88	OC-Floor	14,654	7,953																
88	1 m	17,994	11,293	10	10	9	9	9	8	8	8	9	8	0.8	10	8.8	1.8	>2500	>2500
89	OC-Floor	17,368	10,667																
89	1 m	16,347	9,646	8	7	7	6	7	7	7	7	6	7	0.6	8	6.9	-0.1	>2500	>2500
90	OC-Floor	18,201	11,500																
90	1 m	16,128	9,427	7	7	7	7	3	7	7	7	6	6	1.3	7	6.4	-0.6	>2500	>2500

Pickard Hall Cast Room 104 (7) Dose Rate Measurements See Map Appendix E.7

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements ($\mu\text{R}/\text{hr}$)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
91	OC-Floor	15,585	8,884																
91	1 m	16,128	9,427	11	10	11	10	11	10	11	11	10	9	0.7	11	10.4	3.4	>2500	>2500
92	OC-Floor	16,711	10,010																
92	1 m	15,184	8,483	11	10	10	9	9	9	9	9	8	8	0.9	11	9.2	2.2	>2500	>2500
93	OC-Floor	13,936	7,235																
93	1 m	13,968	7,267	10	9	9	10	9	10	10	10	11	10	0.6	11	9.8	2.8	>2500	>2500
94	OC-Floor	13,845	7,144																
94	1 m	13,342	6,641	8	8	8	7	7	7	7	7	8	8	0.5	8	7.5	0.5	>2500	>2500
95	OC-Floor	15,617	8,916																
95	1 m	15,406	8,705	6	6	6	7	8	8	7	7	8	8	0.9	8	7.1	0.1	>2500	>2500
96	OC-Floor	14,602	7,901																
96	1 m	14,333	7,632	8	8	9	9	9	9	9	10	10	10	0.7	10	9.1	2.1	>2500	>2500
97	OC-Floor	14,385	7,684																
97	1 m	14,681	7,980	10	10	11	10	9	9	9	9	9	9	0.7	11	9.5	2.5	>2500	>2500
98	OC-Floor	15,101	8,400																
98	1 m	13,694	6,993	10	11	10	11	10	10	11	10	9	8	0.9	11	10	3	>2500	>2500
99	OC-Floor	13,185	6,484																
99	1 m	12,821	6,120	10	11	10	10	10	10	9	9	8	8	1.0	11	9.5	2.5	>2500	>2500
100	OC-Floor	13,690	6,989																
100	1 m	12,618	5,917	6	6	6	6	7	8	7	7	7	7	0.7	8	6.7	-0.3	>2500	>2500
101	OC-Floor	14,074	7,373																
101	1 m	14,986	8,285	7	8	8	7	7	7	8	8	8	7	0.5	8	7.5	0.5	>2500	>2500
102	OC-Floor	12,789	6,088																
102	1 m	14,402	7,701	8	9	9	9	8	8	8	10	10	9	0.8	10	8.8	1.8	>2500	>2500
103	OC-Floor	12,126	5,425																
103	1 m	13,861	7,160	8	8	8	9	9	9	9	10	9	8	0.7	10	8.7	1.7	>2500	>2500
104	OC-Floor	12,084	5,383																
104	1 m	13,418	6,717	8	8	8	9	10	9	8	8	8	7	0.8	10	8.3	1.3	>2500	>2500
105	OC-Floor	13,526	6,825																
105	1 m	13,286	6,585	8	9	9	9	9	8	9	8	8	10	0.7	10	8.7	1.7	>2500	>2500

Pickard Hall Room 106 Stage Dose Rate Measurements See Map Appendix E.8

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Boron Instantaneous Measurements (µR/hr)										Annual Occupancy (hrs)					
				1	2	3	4	5	6	7	8	9	10		STDEV	Max	Mean	Corrected Mean	25 mrems/yr
1	OC	28.168	21.168																
1	1 ft	16.114	9.114																
1	1 m	14.681	7.681	7	8	7	7	8	9	9	8	9	9	0.9	9	7.9	0.9	>2500	
2	1 ft	14.332	7.332																
2	1 m	12.214	5.214	8	8	7	7	7	7	7	8	8	7	0.5	8	7.4	0.4	>2500	
3	1 ft	14.927	7.927																
3	1 m	12.993	5.993	10	9	8	8	7	7	7	8	8	7	1.0	10	7.9	0.9	>2500	
4	1 ft	16.104	9.104																
4	1 m	12.861	5.861	7	7	7	6	6	6	8	7	7	7	0.6	8	6.8	-0.2	>2500	
5	1 ft	16.264	9.264																
5	1 m	14.686	7.686	7	7	6	7	7	6	6	7	7	7	0.5	7	6.7	-0.3	>2500	
6	1 ft	19.974	12.974																
6	1 m	15.178	8.178	8	8	8	8	7	7	8	8	8	7	0.5	8	7.6	0.6	>2500	
7	1 ft	18.176	11.176																
7	1 m	15.116	8.116	7	7	7	8	8	9	10	9	9	10	1.0	10	8.2	1.2	>2500	
8	1 ft	18.231	11.231																
8	1 m	15.774	8.774	7	7	7	8	8	8	8	8	9	9	0.8	9	7.8	0.8	>2500	
9	1 ft	13.134	6.134																
9	1 m	13.046	6.046	7	7	6	7	6	7	7	8	9	9	1.1	9	7.4	0.4	>2500	
10	1 m	12.263	5.263	8	8	8	8	8	8	7	8	7	7	0.5	8	7.7	0.7	>2500	

Pickard Hall Room 111 (1) Dose Rate Measurements See Map Appendix E.9

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (µRem/hr)													Annual Occupancy (hrs)		
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
1	OC																		
1	1ft																		
1	1m	32,195	25,494	11	11	10	9	9	11	11	12	12	12	1.1	12	10.8	3.8	>2500	>2500
2	OC																		
2	1ft																		
2	1m	33,182	26,481	12	11	11	10	10	12	11	11	11	12	0.7	12	11.1	4.1	>2500	>2500
3	OC																		
3	1ft																		
3	1m	32,244	25,543	10	11	13	12	12	12	11	11	12	13	0.9	13	11.7	4.7	>2500	>2500
4	OC																		
4	1ft																		
4	1m	26,447	19,746	11	10	11	10	9	10	9	9	9	9	0.8	11	9.7	2.7	>2500	>2500
5	OC																		
5	1ft																		
5	1m	22,832	16,131	8	8	9	9	9	9	11	10	11	10	1.1	11	9.4	2.4	>2500	>2500
6	OC																		
6	1ft																		
6	1m	24,162	17,461	10	9	9	9	9	8	9	10	10	9	0.6	10	9.2	2.2	>2500	>2500
7	OC																		
7	1ft																		
7	1m	25,130	18,429	11	12	12	13	12	13	11	11	12	12	0.7	13	11.9	4.9	>2500	>2500
8	OC																		
8	1ft																		
8	1m	30,119	23,418	10	10	9	9	10	9	9	10	10	10	0.5	10	9.6	2.6	>2500	>2500
9	OC																		
9	1ft																		
9	1m	29,178	22,477	12	12	12	11	10	11	11	11	12	11	0.7	12	11.3	4.3	>2500	>2500
10	OC																		
10	1ft																		
10	1m	28,632	21,931	12	11	10	11	10	11	12	11	12	10	0.8	12	11	4	>2500	>2500
11	OC																		
11	1ft																		
11	1m	25,697	18,996	10	11	13	14	14	14	13	13	12	11	1.4	14	12.5	5.5	>2500	>2500
12	OC																		
12	1ft																		
12	1m	22,611	15,910	10	10	9	10	11	10	10	10	9	9	0.6	11	9.8	2.8	>2500	>2500
13	OC																		
13	1ft																		
13	1m	21,914	15,213	9	9	8	8	8	8	7	7	7	7	0.8	9	7.8	0.8	>2500	>2500

Pickard Hall Room 111 (2) Dose Rate Measurements See Map Appendix E.9

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
14	OC			INACCESSIBLE															
14	1ft			INACCESSIBLE															
14	1 m	24,323	17,622	11	11	11	10	11	12	12	12	12	13	0.8	13	11.5	4.5	>2500	>2500
15	OC			INACCESSIBLE															
15	1ft			INACCESSIBLE															
15	1 m	26,528	19,827	12	11	11	12	11	10	11	11	11	10	0.7	12	11	4	>2500	>2500
16	OC			INACCESSIBLE															
16	1ft			INACCESSIBLE															
16	1 m	27,411	20,710	14	13	13	13	15	13	13	12	12	11	1.1	15	12.9	5.9	>2500	>2500
17	OC			INACCESSIBLE															
17	1ft			INACCESSIBLE															
17	1 m	27,338	20,637	15	14	14	14	13	14	13	14	15	13	0.7	15	13.9	6.9	>2500	>2500

Pickard Hall Room 112 (1) Dose Rate Measurements See Map Appendix E.10

Picard Hall Room 112 (1) Dose Rate Measurements See Map Appendix E.10																					
Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)			
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr		
1	OC			INACCESSIBLE																	
1	1ft			INACCESSIBLE																	
1	1 m	19,200	12,499	6	6	7	7	7	7	8	8	7	7	0.7	8	7	0	>2500	>2500		
2	OC			INACCESSIBLE																	
2	1ft			INACCESSIBLE																	
2	1 m	17,193	10,492	8	8	7	6	5	5	5	8	8	7	1.3	8	6.7	-0.3	>2500	>2500		
3	OC			INACCESSIBLE																	
3	1ft			INACCESSIBLE																	
3	1 m	16,371	9,670	8	8	9	8	8	9	12	11	9	9	1.4	12	9.1	2.1	>2500	>2500		
4	OC			INACCESSIBLE																	
4	1ft			INACCESSIBLE																	
4	1 m	16,753	10,052	8	8	8	7	7	8	8	7	6	6	0.8	8	7.3	0.3	>2500	>2500		
5	OC			INACCESSIBLE																	
5	1ft			INACCESSIBLE																	
5	1 m	16,038	9,337	6	6	6	6	5	7	7	6	6	6	0.6	7	6.1	-0.9	>2500	>2500		
6	OC			INACCESSIBLE																	
6	1ft			INACCESSIBLE																	
6	1 m	16,007	9,306	7	8	8	8	8	8	7	7	9	8	0.6	9	7.8	0.8	>2500	>2500		
7	OC			INACCESSIBLE																	
7	1ft			INACCESSIBLE																	
7	1 m	15,903	9,202	6	7	6	5	5	5	7	7	7	7	0.9	7	6.2	-0.8	>2500	>2500		
8	OC			INACCESSIBLE																	
8	1ft			INACCESSIBLE																	
8	1 m	16,634	9,933	6	6	5	5	5	6	7	7	7	7	0.9	7	6.1	-0.9	>2500	>2500		
9	OC			INACCESSIBLE																	
9	1ft			INACCESSIBLE																	
9	1 m	17,526	10,825	7	8	8	8	9	9	9	9	9	8	0.7	9	8.4	1.4	>2500	>2500		
10	OC			INACCESSIBLE																	
10	1ft			INACCESSIBLE																	
10	1 m	19,752	13,051	7	7	7	7	7	7	7	7	6	7	0.3	7	6.9	-0.1	>2500	>2500		
11	OC			INACCESSIBLE																	
11	1ft			INACCESSIBLE																	
11	1 m	17,644	10,943	5	7	7	8	8	8	7	6	6	7	1.0	8	6.9	-0.1	>2500	>2500		
12	OC			INACCESSIBLE																	
12	1ft			INACCESSIBLE																	
12	1 m	16,969	10,268	7	6	6	5	6	6	6	6	6	6	0.5	7	6	-1	>2500	>2500		

Pickard Hall Room 112 (2) Dose Rate Measurements See Map Appendix E.10

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rm/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
13	OC			INACCESSIBLE															
13	1ft			INACCESSIBLE															
13	1 m	18,644	11,943	7	6	7	6	6	6	7	7	6	6	0.5	7	6.4	-0.6	>2500	>2500
14	OC			INACCESSIBLE															
14	1ft			INACCESSIBLE															
14	1 m	16,722	10,021	7	7	8	8	8	7	7	7	7	7	0.5	8	7.3	0.3	>2500	>2500
15	OC			INACCESSIBLE															
15	1ft			INACCESSIBLE															
15	1 m	17922	11,221	8	9	8	7	7	8	7	9	7	9	0.9	9	7.9	0.9	>2500	>2500

Pickard Hall Room 205 (1) Dose Rate Measurements See Map Appendix E.12

Pickard Hall Room 205 (1) Dose Rate Measurements See Map Appendix C-1																			
Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rm/hr)													Annual Occupancy (hrs)		
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
1	OC	67,310	60,609																
1	1ft	48,098	41,397																
1	1 m	49,314	42,613	7	8	9	8	9	8	8	10	9	11	1.2	11	8.7	1.7	>2500	>2500
2	OC	50,253	43,552																
2	1ft	40,994	34,293																
2	1 m	37,000	30,299	11	11	13	14	12	11	12	14	15		1.5	15	12.6	5.6	>2500	>2500
3	OC	34,734	28,033																
3	1ft	37,637	30,936																
3	1 m	37,263	30,562	9	8	9	8	7	8	8	8	10	11	1.2	11	8.6	1.6	>2500	>2500
4	OC	26,047	19,346																
4	1ft	27,956	21,255																
4	1 m	29,436	22,735	9	9	9	9	9	8	8	8	8	7	0.7	9	8.4	1.4	>2500	>2500
5	OC	34,473	27,772																
5	1ft	30,477	23,776																
5	1 m	28,528	21,827	9	10	9	10	9	7	9	8	9	10	0.9	10	9.0	2.0	>2500	>2500
6	OC	36,742	30,041																
6	1ft	31,966	25,265																
6	1 m	30,267	23,566	9	9	8	8	7	10	10	10	10	9	1.1	10	9.0	2.0	>2500	>2500
7	OC	29,569	22,868																
7	1ft	31,186	24,485																
7	1 m	30,584	23,883	10	9	9	11	11	9	8	8	9	8	1.1	11	9.2	2.2	>2500	>2500
8	OC	36,569	29,868																
8	1ft	38,117	31,416																
8	1 m	33,816	27,115	13	12	12	12	12	10	10	9	8	9	1.7	13	10.7	3.7	>2500	>2500
9	OC	49,465	42,764																
9	1ft	42,094	35,393																
9	1 m	36,030	29,329	9	8	8	7	8	8	10	11	10	9	1.2	11	8.8	1.8	>2500	>2500
10	OC	38,888	32,187																
10	1ft	36,804	30,103																
10	1 m	32,271	25,570	12	11	11	10	10	9	10	9	11	12	1.1	12	10.5	3.5	>2500	>2500
11	OC	32,704	26,003																
11	1ft	30,397	23,696																
11	1 m	28,791	22,090	10	10	11	10	10	11	11	11	12	12	0.8	12	10.8	3.8	>2500	>2500
12	OC	26,017	19,316																
12	1ft	26,201	19,500																
12	1 m	27,534	20,833	11	10	10	10	10	10	10	10	10	9	0.5	11	10.0	3.0	>2500	>2500
13	OC	27,201	20,500																
13	1ft	27,348	20,647																
13	1 m	26,769	20,068	11	11	11	11	11	11	11	10	10	9	0.7	11	10.6	3.6	>2500	>2500

Pickard Hall Room 205 (2) Dose Rate Measurements See Map Appendix E.12

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)										STDEV	Max	Mean	Corrected Mean	Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10					25 mrem/yr	100 mrem/yr
14	OC	26,262	19,561																
14	1ft	28,001	21,300																
14	1 m	28956	22,255	9	11	11	10	9	9	9	9	9	8	1.0	11	9.4	2.4	>2500	>2500
15	OC	27506	20,805																
15	1ft	30505	23,804																
15	1 m	30076	23,375	12	10	11	11	11	10	11	10	10	10	0.7	12	10.6	3.6	>2500	>2500
16	OC	32,089	25,388																
16	1ft	26,426	19,725																
16	1 m	28,928	22,227	19	19	17	16	16	17	16	16	16	14	1.5	19	16.6	9.6	>2500	>2500
17	OC	23,963	17,262																
17	1ft	27,361	20,660																
17	1 m	24,627	17,926	16	16	15	16	16	15	14	14	14	14	0.9	16	15	8	>2500	>2500

Pickard Hall Room 206 (1) Dose Rate Measurements See Map Appendix E.13

Location	Distance	NaI Static (cpm)		Bicron Instantaneous Measurements (μ Rm/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
1	OC	23,160	16,459																
1	1ft	21,616	14,915																
1	1 m	17,606	10,905	25	20	20	20	20	20	20	20	20	25	2.1	25	21	14	1,786	>2500
2	OC	18,644	11,943																
2	1ft	18,738	12,037																
2	1 m	18,246	11,545	25	20	20	20	20	20	25	25	25	20	2.6	25	22	15	1,667	>2500
3	OC	16,555	9,854																
3	1ft	17,486	10,785																
3	1 m	17,112	10,411	20	20	20	25	20	20	20	20	20	20	1.6	25	20.5	13.5	1,852	>2500
4	OC	19,106	12,405																
4	1ft	18,781	12,080																
4	1 m	17,385	10,684	16	17	17	18	19	20	19	17	19	20	1.4	20	18.2	11.2	2,232	>2500
5	OC	17,656	10,955																
5	1ft	18,408	11,707																
5	1 m	11,286	4,585	18	18	20	18	18	18	18	17	16	16	1.2	20	17.7	10.7	2,336	>2500
6	OC	15,901	9,200																
6	1ft	16,530	9,829																
6	1 m	16,561	9,860	16	15	15	15	15	15	16	16	14	15	0.6	16	15.2	8.2	>2500	>2500
7	OC	16,027	9,326																
7	1ft	16,264	9,563																
7	1 m	16,275	9,574	16	16	14	14	14	14	15	17	18	16	1.4	18	15.4	8.4	>2500	>2500
8	OC	17,704	11,003																
8	1ft	18,070	11,369																
8	1 m	17,471	10,770	16	19	19	18	19	18	19	18	18	17	1.0	19	18.1	11.1	2,252	>2500
9	OC	18,005	11,304																
9	1ft	18,177	11,476																
9	1 m	17,462	10,761	18	17	19	20	25	20	25	20	20	20	2.6	25	20.4	13.4	1,866	>2500
10	OC	20,568	13,867																
10	1ft	21,977	15,276																
10	1 m	20,674	13,973	14	15	16	16	17	16	17	18	19	20	1.8	20	16.8	9.8	>2500	>2500
11	OC	20,275	13,574																
11	1ft	18,136	11,435																
11	1 m	18,670	11,969	17	16	16	16	18	20	19	19	18	18	1.4	20	17.7	10.7	2,336	>2500
12	OC	17,296	10,595																
12	1ft	17,731	11,030																
12	1 m	17,528	10,827	19	18	18	18	18	17	17	18	17	18	0.6	19	17.8	10.8	2,315	>2500

Pickard Hall Room 206 (2) Dose Rate Measurements See Map Appendix E.13

Location	Distance	NaI Static (cpm)		Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
13	OC	17,844	11,143																
13	1ft	19,143	12,442																
13	1 m	18,901	12,200	14	13	12	13	15	15	13	17	15	16	1.6	17	14.3	7.3	>2500	>2500
14	OC	15,894	9,193																
14	1ft	16,307	9,606																
14	1 m	16592	9,891	18	18	18	18	18	17	17	15	16	16	1.1	18	17.1	10.1	2,475	>2500
15	OC	16195	9,494																
15	1ft	16682	9,981																
15	1 m	16438	9,737	15	16	17	19	19	18	18	17	16	15	1.5	19	17	10	2,500	>2500

Pickard Hall Storage Room 213 Wall Dose Rate Measurements See Map Appendix E.14

Location	Distance	NaI Static (cpm)	Corrected NaI Static (cpm)	Bicron Instantaneous Measurements (μ Rem/hr)														Annual Occupancy (hrs)	
				1	2	3	4	5	6	7	8	9	10	STDEV	Max	Mean	Corrected Mean	25 mrem/yr	100 mrem/yr
1	OC	120,577	113,876																
1	1ft	39,973	33,272																
1	1 m	21,195	14,494	30	30	25	25	25	20	20	20	20	20	4.1	30	23.5	16.5	1,515	>2500
2	OC	52,544	45,843																
2	1ft	36,798	30,097																
2	1 m	21,115	14,414	9	9	10	10	9	11	13	14	13	1	3.6	14	9.9	2.9	>2500	>2500
3	OC	30,366	23,665																
3	1ft	24,285	17,584																
3	1 m	20,356	13,655	11	10	10	10	10	10	9	11	10	10	0.6	11	10.1	3.1	>2500	>2500
4	OC	60,722	54,021																
4	1ft	37,994	31,293																
4	1 m	21,249	14,548	15	14	14	14	13	13	13	13	13	14	0.7	15	13.6	6.6	>2500	>2500

Residual Activity Calculations

The activity of the areas of concern at Pickard Hall was estimated using Microshield™ models to establish a correlation between the average net count rate of a 2" x 2" sodium iodide detector (at distances of 1 foot and one meter from the surface) and the activity in inaccessible areas while accounting for the appropriate geometry and shielding modifications.

Because residual activity was identified under floor coverings and behind walls, modeling was performed using reasonable estimates of the shielding characteristics of materials covering the activity. Due to uncertainty regarding the materials and thicknesses, sensitivity analysis was performed on the shield thickness to provide a range of possible activity levels for various material characteristics.

The correlation of count rate to activity concentration requires three steps: 1) for a total source activity of 1 μCi of Ra-226 in secular equilibrium, and source geometry based on characterization surveys, determine the exposure rate with buildup in $\mu\text{R/hr}$, 2) determine the relationship between the exposure rate associated with 1 μCi of total activity and the NaI count rate (cpm/ μCi on a 2"x2" NaI probe), 3) correlating the average net count rate on a 2"x2" NaI probe for the area of concern to a total activity of the source. The methodology is described below.

1) $\mu\text{R/hr per } \mu\text{Ci}$

To determine the exposure rate (mR/hr) produced for each of the gamma energies that Ra-226 and its progeny produce, it is necessary to run a model in Microshield™ with the approximate source size, composition, and shielding as the area of concern. The result is a list of exposure rates (mR/hr) that correlate to each of the gamma energies produced by Ra-226 and its progeny. The following factors were included in the Microshield™ modeling:

- Source Term: uniformly distributed 1 μCi Ra-226 in secular equilibrium with progeny (entered as 2 μCi) and then decayed one half-life within Microshield™ to ingrow progeny and obtain a final Ra-226 activity of 1 μCi). Radon emanation was not considered.
- Source Term Geometry: rectangular or point, based upon likely geometry of inaccessible contamination as determined by NaI detector measurements.
- Source Term Dimensions: determined for each area based on likely dimensions of inaccessible contamination as determined by NaI detector response.

- Dose Point: both 1ft and 1m analysis were run based upon the average height of the NaI scintillation detector above the surface when collecting static measurement data.
- Shielding: to analyze the sensitivity of exposure rate from varying the thickness of floor coverings and flooring components, models were run with shielding at 0.7 g/cc to approximate shielding due to flooring.

The modeling code performed the calculations and determined total exposure rates with buildup Ra-226+C. The reports are presented at the end of this appendix. Microshield™ also provided the exposure rates for a number of gamma energies associated with the source term inputs. The exposure rate in mR/hr at each energy is then converted to μ R/hr value.

2) cpm/ μ Ci on a 2"x2" NaI probe

Utilizing the exposure rate results from Microshield and NUREG-1507 Table 6.3, it is possible to convert the exposure rate in μ R/hr for each gamma energy to the resulting cpm reading on a 2"x2" NaI detector for each gamma energy. The sum of each of these results will give the 2"x2" NaI detector response in cpm for 1 μ Ci of Ra-226 in secular equilibrium. This gives a relationship between μ Ci of Ra-226 and cpm on a NaI.

3) Estimating Activity

$$\text{Estimated Activity}(\mu\text{Ci}) = \frac{\text{average net count rate (cpm)}}{\text{count rate to activity ratio (cpm per } \mu\text{Ci)}}$$

Summaries of Modeling reports and calculations are provided in the following tables:

Table H-1: Activity Estimate Room 205

Dose Point (cm)	Mean NaI Response (cpm)	Shield Thickness (ft)	NaI Response (cpm/ μ Ci)	Estimated Activity (μ Ci)
30	25,915	0.01	725	35.75
		0.02	694	37.37
		0.03	675	38.39
		0.04	663	39.08
100	24,657	0.01	341	72.37
		0.02	329	74.99
		0.03	320	77.09
		0.04	313	78.70

Table H-2: Activity Estimate Room 206

Dose Point (cm)	Mean NaI Response (cpm)	Shield Thickness (ft)	NaI Response (cpm/ μ Cl)	Estimated Activity (μ Cl)
30	11,569	0.01	985	11.75
		0.02	941	12.29
		0.03	914	12.66
		0.04	897	12.90
100	10,513	0.01	417	25.24
		0.02	403	26.12
		0.03	391	26.86
		0.04	383	27.44

Table H-3: Activity Estimate Room 9 Corridor

Dose Point (cm)	Mean NaI Response (cpm)	Shield Thickness (ft)	NaI Response (cpm/ μ Cl)	Estimated Activity (μ Cl)
30	18,305	0.01	1,220	15.01
		0.02	1,167	15.69
		0.03	1,131	16.18
		0.04	1,108	16.52
100	8,727	0.01	457	19.09
		0.02	442	19.73
		0.03	430	20.28
		0.04	421	20.73

Table H-4: Activity Estimate Room 106 Stage

Dose Point (cm)	Mean NaI Response (cpm)	Shield Thickness (ft)	NaI Response (cpm/ μ Cl)	Estimated Activity (μ Cl)
30	9,212	0.02	1,856	4.96
		0.04	1,777	5.18
		0.05	1,740	5.30
		0.06	1,722	5.35
100	6,881	0.02	476	14.45
		0.04	455	15.12
		0.05	445	15.46
		0.06	441	15.61

Table H-5: Activity Estimate Room 213 Wall

Dose Point (cm)	Mean NaI Response (cpm)	Shield Thickness (ft)	NaI Response (cpm/ μ Cl)	Estimated Activity (μ Cl)
30	28,062	0.04	8,536	3.29
		0.07	8,159	3.44
		0.10	8,085	3.47
		0.13	8,128	3.45
100	14,278	0.04	877	16.29
		0.07	844	16.93
		0.10	839	17.03
		0.13	844	16.92

Table H-6: Activity Estimate Room 17A Wall

Dose Point (cm)	Mean NaI Response (cpm)	Shield Thickness (ft)	NaI Response (cpm/ μ Cl)	Estimated Activity (μ Cl)
30	7,609	0.02	9,978	0.76
		0.04	9,424	0.81
		0.05	9,082	0.84
		0.06	8,885	0.86
100	3,000	0.02	963	3.11
		0.04	915	3.28
		0.05	886	3.38
		0.06	924	3.25

MicroShield 8.01 CEG (8.00-0000)

Date	By	Checked

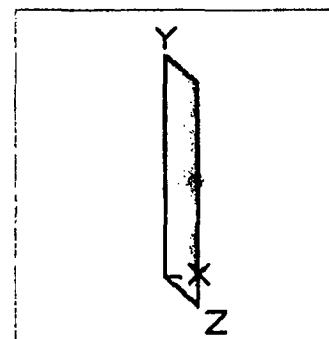
Filename	Run Date	Run Time	Duration
pickard6.msdl	October 24, 2011	10:59:03 PM	00:00:00

Project Info	
Case Title	Pickard Carpet
Description	1 ft Basement Corridor adjacent Room9
Geometry	4 - Rectangular Area - Vertical

Source Dimensions	
Width	182.88 cm (6 ft)
Height	457.2 cm (15 ft)

Dose Points			
A	X	Y	Z
#1	31.115 cm (1 ft 0.2 in)	228.6 cm (7 ft 6.0 in)	91.44 cm (3 ft)

Shields			
Shield N	Dimension	Material	Density
Shield 1	.021 ft	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices				
Number of Groups: 25				
Lower Energy Cutoff: 0.015				
Photons < 0.015: Included				
Library: Grove				
Nuclide	Ci	Bq	μCi/cm²	Bq/cm²
Bi-210	1.0137e-006	3.7507e+004	1.2124e-005	4.4858e-001
Bi-214	9.9981e-007	3.6993e+004	1.1958e-005	4.4243e-001
Pb-210	1.0137e-006	3.7507e+004	1.2124e-005	4.4858e-001
Pb-214	9.9981e-007	3.6993e+004	1.1958e-005	4.4243e-001
Po-210	1.0139e-006	3.7516e+004	1.2127e-005	4.4869e-001
Po-214	9.9960e-007	3.6985e+004	1.1955e-005	4.4234e-001
Po-218	1.0000e-006	3.7000e+004	1.1960e-005	4.4252e-001
Ra-226	1.0000e-006	3.7000e+004	1.1960e-005	4.4252e-001
Rn-222	1.0000e-006	3.7000e+004	1.1960e-005	4.4252e-001

Buildup: The material reference is Air Gap	
Integration Parameters	
Z Direction	20
Y Direction	20

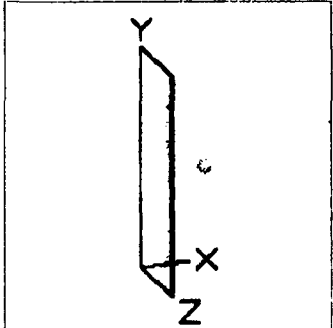
Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	8.411e-04	9.628e-04	7.214e-05	8.258e-05
0.05	1.928e+03	7.184e-04	1.077e-03	1.914e-06	2.868e-06

0.08	8.529e+03	5.221e-03	7.508e-03	8.263e-06	1.188e-05
0.1	5.022e+01	3.882e-05	5.328e-05	5.940e-08	8.151e-08
0.2	3.985e+03	6.363e-03	7.717e-03	1.123e-05	1.362e-05
0.3	7.634e+03	1.864e-02	2.157e-02	3.536e-05	4.091e-05
0.4	1.416e+04	4.670e-02	5.257e-02	9.099e-05	1.024e-04
0.5	6.608e+02	2.752e-03	3.043e-03	5.402e-06	5.973e-06
0.6	1.784e+04	8.985e-02	9.810e-02	1.754e-04	1.915e-04
0.8	3.496e+03	2.376e-02	2.550e-02	4.520e-05	4.849e-05
1.0	1.158e+04	9.927e-02	1.054e-01	1.830e-04	1.943e-04
1.5	7.043e+03	9.186e-02	9.606e-02	1.545e-04	1.616e-04
2.0	9.900e+03	1.737e-01	1.800e-01	2.686e-04	2.783e-04
Totals	1.014e+05	5.597e-01	5.995e-01	1.052e-03	1.135e-03
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.01 ft)
0.015	1.461e+04	1.209e-03	1.333e-03	1.037e-04	1.143e-04
0.05	1.928e+03	7.954e-04	9.857e-04	2.119e-06	2.626e-06
0.08	8.529e+03	5.714e-03	6.911e-03	9.043e-06	1.094e-05
0.1	5.022e+01	4.229e-05	4.991e-05	6.470e-08	7.636e-08
0.2	3.985e+03	6.829e-03	7.557e-03	1.205e-05	1.334e-05
0.3	7.634e+03	1.982e-02	2.140e-02	3.760e-05	4.060e-05
0.4	1.416e+04	4.936e-02	5.253e-02	9.617e-05	1.023e-04
0.5	6.608e+02	2.896e-03	3.052e-03	5.684e-06	5.991e-06
0.6	1.784e+04	9.417e-02	9.862e-02	1.838e-04	1.925e-04
0.8	3.496e+03	2.477e-02	2.570e-02	4.711e-05	4.888e-05
1.0	1.158e+04	1.030e-01	1.063e-01	1.899e-04	1.960e-04
1.5	7.043e+03	9.470e-02	9.694e-02	1.593e-04	1.631e-04
2.0	9.900e+03	1.783e-01	1.817e-01	2.758e-04	2.809e-04
Totals	1.014e+05	5.817e-01	6.031e-01	1.122e-03	1.172e-03
	Sensitivity	Variable	Shield #1	(2 of 4)	(0.02 ft)
0.015	1.461e+04	8.639e-04	9.866e-04	7.410e-05	8.463e-05
0.05	1.928e+03	7.240e-04	1.070e-03	1.929e-06	2.851e-06
0.08	8.529e+03	5.257e-03	7.462e-03	8.320e-06	1.181e-05
0.1	5.022e+01	3.908e-05	5.301e-05	5.978e-08	8.110e-08
0.2	3.985e+03	6.397e-03	7.704e-03	1.129e-05	1.360e-05
0.3	7.634e+03	1.873e-02	2.156e-02	3.552e-05	4.089e-05
0.4	1.416e+04	4.689e-02	5.257e-02	9.137e-05	1.024e-04
0.5	6.608e+02	2.763e-03	3.044e-03	5.423e-06	5.974e-06
0.6	1.784e+04	9.017e-02	9.814e-02	1.760e-04	1.916e-04
0.8	3.496e+03	2.384e-02	2.551e-02	4.534e-05	4.852e-05
1.0	1.158e+04	9.955e-02	1.055e-01	1.835e-04	1.945e-04
1.5	7.043e+03	9.207e-02	9.612e-02	1.549e-04	1.617e-04
2.0	9.900e+03	1.741e-01	1.801e-01	2.692e-04	2.785e-04
Totals	1.014e+05	5.614e-01	5.998e-01	1.057e-03	1.137e-03
	Sensitivity	Variable	Shield #1	(3 of 4)	(0.03 ft)
0.015	1.461e+04	6.335e-04	7.397e-04	5.434e-05	6.345e-05
0.05	1.928e+03	6.607e-04	1.145e-03	1.760e-06	3.049e-06
0.08	8.529e+03	4.847e-03	8.003e-03	7.670e-06	1.266e-05
0.1	5.022e+01	3.618e-05	5.609e-05	5.535e-08	8.581e-08

0.2	3.985e+03	6.001e-03	7.852e-03	1.059e-05	1.386e-05
0.3	7.634e+03	1.771e-02	2.171e-02	3.359e-05	4.118e-05
0.4	1.416e+04	4.459e-02	5.260e-02	8.688e-05	1.025e-04
0.5	6.608e+02	2.638e-03	3.035e-03	5.179e-06	5.957e-06
0.6	1.784e+04	8.639e-02	9.766e-02	1.686e-04	1.906e-04
0.8	3.496e+03	2.295e-02	2.533e-02	4.366e-05	4.817e-05
1.0	1.158e+04	9.621e-02	1.047e-01	1.774e-04	1.929e-04
1.5	7.043e+03	8.954e-02	9.531e-02	1.507e-04	1.604e-04
2.0	9.900e+03	1.699e-01	1.785e-01	2.628e-04	2.761e-04
Totals	1.014e+05	5.421e-01	5.966e-01	1.003e-03	1.111e-03
	Sensitivity	Variable	Shield #1	(4 of 4)	(0.04 ft)
0.015	1.461e+04	4.738e-04	5.626e-04	4.064e-05	4.825e-05
0.05	1.928e+03	6.044e-04	1.206e-03	1.610e-06	3.213e-06
0.08	8.529e+03	4.478e-03	8.507e-03	7.086e-06	1.346e-05
0.1	5.022e+01	3.355e-05	5.898e-05	5.133e-08	9.024e-08
0.2	3.985e+03	5.636e-03	7.990e-03	9.948e-06	1.410e-05
0.3	7.634e+03	1.676e-02	2.184e-02	3.179e-05	4.143e-05
0.4	1.416e+04	4.243e-02	5.262e-02	8.267e-05	1.025e-04
0.5	6.608e+02	2.521e-03	3.026e-03	4.948e-06	5.939e-06
0.6	1.784e+04	8.281e-02	9.718e-02	1.616e-04	1.897e-04
0.8	3.496e+03	2.211e-02	2.514e-02	4.206e-05	4.782e-05
1.0	1.158e+04	9.302e-02	1.038e-01	1.715e-04	1.914e-04
1.5	7.043e+03	8.710e-02	9.451e-02	1.465e-04	1.590e-04
2.0	9.900e+03	1.659e-01	1.770e-01	2.566e-04	2.737e-04
Totals	1.014e+05	5.239e-01	5.935e-01	9.571e-04	1.091e-03

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.01 ft)	5.817e-01	6.031e-01	1.122e-03	1.172e-03
1	(2 of 4)	(0.02 ft)	5.614e-01	5.998e-01	1.057e-03	1.137e-03
1	(3 of 4)	(0.03 ft)	5.421e-01	5.966e-01	1.003e-03	1.111e-03
1	(4 of 4)	(0.04 ft)	5.239e-01	5.935e-01	9.571e-04	1.091e-03

MicroShield 8.01 CEG (8.00-0000)			
Date	By	Checked	
Filename	Run Date	Run Time	Duration
pickard7.msdl	October 24, 2011	11:00:55 PM	00:00:00
Project Info			
Case Title	Pickard Carpet		
Description	1m Basement Corridor adjacent Room9		
Geometry	4 - Rectangular Area - Vertical		
Source Dimensions			
Width	182.88 cm (6 ft)		
Height	457.2 cm (15 ft)		
Dose Points			
A	X	Y	Z
#1	100.635 cm (3 ft 3.6 in)	228.6 cm (7 ft 6.0 in)	91.44 cm (3 ft)
Shields			
Shield N	Dimension	Material	Density
Shield 1	.635 cm	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices				
Number of Groups: 25				
Lower Energy Cutoff: 0.015				
Photons < 0.015: Included				
Library: Grove				
Nuclide	Ci	Bq	μCi/cm²	Bq/cm²
Bi-210	1.0137e-006	3.7507e+004	1.2124e-005	4.4858e-001
Bi-214	9.9981e-007	3.6993e+004	1.1958e-005	4.4243e-001
Pb-210	1.0137e-006	3.7507e+004	1.2124e-005	4.4858e-001
Pb-214	9.9981e-007	3.6993e+004	1.1958e-005	4.4243e-001
Po-210	1.0139e-006	3.7516e+004	1.2127e-005	4.4869e-001
Po-214	9.9960e-007	3.6985e+004	1.1955e-005	4.4234e-001
Po-218	1.0000e-006	3.7000e+004	1.1960e-005	4.4252e-001
Ra-226	1.0000e-006	3.7000e+004	1.1960e-005	4.4252e-001
Rn-222	1.0000e-006	3.7000e+004	1.1960e-005	4.4252e-001

Buildup: The material reference is Air Gap	
Integration Parameters	
Z Direction	20
Y Direction	20

Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	3.633e-04	4.148e-04	3.116e-05	3.558e-05
0.05	1.928e+03	2.871e-04	3.777e-04	7.649e-07	1.006e-06

0.08	8.529e+03	2.073e-03	2.640e-03	3.281e-06	4.178e-06
0.1	5.022e+01	1.537e-05	1.898e-05	2.352e-08	2.903e-08
0.2	3.985e+03	2.495e-03	2.839e-03	4.403e-06	5.011e-06
0.3	7.634e+03	7.264e-03	8.011e-03	1.378e-05	1.520e-05
0.4	1.416e+04	1.812e-02	1.962e-02	3.531e-05	3.823e-05
0.5	6.608e+02	1.065e-03	1.139e-03	2.090e-06	2.235e-06
0.6	1.784e+04	3.467e-02	3.677e-02	6.768e-05	7.178e-05
0.8	3.496e+03	9.134e-03	9.576e-03	1.737e-05	1.821e-05
1.0	1.158e+04	3.805e-02	3.962e-02	7.014e-05	7.302e-05
1.5	7.043e+03	3.505e-02	3.611e-02	5.896e-05	6.075e-05
2.0	9.900e+03	6.608e-02	6.765e-02	1.022e-04	1.046e-04
Totals	1.014e+05	2.147e-01	2.248e-01	4.071e-04	4.299e-04
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.3048 cm)
0.015	1.461e+04	4.621e-04	5.130e-04	3.963e-05	4.400e-05
0.05	1.928e+03	3.048e-04	3.594e-04	8.120e-07	9.575e-07
0.08	8.529e+03	2.186e-03	2.523e-03	3.459e-06	3.993e-06
0.1	5.022e+01	1.616e-05	1.831e-05	2.472e-08	2.802e-08
0.2	3.985e+03	2.599e-03	2.806e-03	4.587e-06	4.953e-06
0.3	7.634e+03	7.527e-03	7.977e-03	1.428e-05	1.513e-05
0.4	1.416e+04	1.871e-02	1.961e-02	3.646e-05	3.822e-05
0.5	6.608e+02	1.096e-03	1.141e-03	2.152e-06	2.239e-06
0.6	1.784e+04	3.562e-02	3.688e-02	6.952e-05	7.199e-05
0.8	3.496e+03	9.353e-03	9.619e-03	1.779e-05	1.830e-05
1.0	1.158e+04	3.887e-02	3.981e-02	7.165e-05	7.338e-05
1.5	7.043e+03	3.566e-02	3.629e-02	5.999e-05	6.106e-05
2.0	9.900e+03	6.707e-02	6.801e-02	1.037e-04	1.052e-04
Totals	1.014e+05	2.195e-01	2.256e-01	4.241e-04	4.394e-04
	Sensitivity	Variable	Shield #1	(2 of 4)	(0.6096 cm)
0.015	1.461e+04	3.700e-04	4.219e-04	3.174e-05	3.619e-05
0.05	1.928e+03	2.885e-04	3.763e-04	7.684e-07	1.002e-06
0.08	8.529e+03	2.082e-03	2.631e-03	3.294e-06	4.164e-06
0.1	5.022e+01	1.543e-05	1.893e-05	2.361e-08	2.895e-08
0.2	3.985e+03	2.503e-03	2.837e-03	4.417e-06	5.006e-06
0.3	7.634e+03	7.284e-03	8.009e-03	1.382e-05	1.519e-05
0.4	1.416e+04	1.817e-02	1.962e-02	3.540e-05	3.823e-05
0.5	6.608e+02	1.067e-03	1.139e-03	2.095e-06	2.236e-06
0.6	1.784e+04	3.474e-02	3.678e-02	6.782e-05	7.180e-05
0.8	3.496e+03	9.151e-03	9.579e-03	1.741e-05	1.822e-05
1.0	1.158e+04	3.811e-02	3.963e-02	7.025e-05	7.305e-05
1.5	7.043e+03	3.509e-02	3.612e-02	5.904e-05	6.077e-05
2.0	9.900e+03	6.616e-02	6.768e-02	1.023e-04	1.047e-04
Totals	1.014e+05	2.150e-01	2.248e-01	4.084e-04	4.305e-04
	Sensitivity	Variable	Shield #1	(3 of 4)	(0.9144 cm)
0.015	1.461e+04	2.972e-04	3.449e-04	2.549e-05	2.958e-05
0.05	1.928e+03	2.730e-04	3.939e-04	7.273e-07	1.049e-06
0.08	8.529e+03	1.983e-03	2.744e-03	3.139e-06	4.342e-06
0.1	5.022e+01	1.474e-05	1.956e-05	2.255e-08	2.993e-08

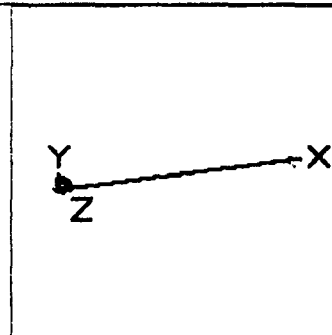
0.2	3.985e+03	2.410e-03	2.867e-03	4.254e-06	5.061e-06
0.3	7.634e+03	7.049e-03	8.040e-03	1.337e-05	1.525e-05
0.4	1.416e+04	1.764e-02	1.963e-02	3.437e-05	3.825e-05
0.5	6.608e+02	1.039e-03	1.137e-03	2.039e-06	2.232e-06
0.6	1.784e+04	3.389e-02	3.668e-02	6.615e-05	7.160e-05
0.8	3.496e+03	8.953e-03	9.539e-03	1.703e-05	1.814e-05
1.0	1.158e+04	3.737e-02	3.945e-02	6.889e-05	7.272e-05
1.5	7.043e+03	3.454e-02	3.595e-02	5.811e-05	6.048e-05
2.0	9.900e+03	6.525e-02	6.735e-02	1.009e-04	1.042e-04
Totals	1.014e+05	2.107e-01	2.241e-01	3.945e-04	4.229e-04
	Sensitivity	Variable	Shield #1	(4 of 4)	(1.2192 cm)
0.015	1.461e+04	2.393e-04	2.823e-04	2.053e-05	2.421e-05
0.05	1.928e+03	2.585e-04	4.125e-04	6.886e-07	1.099e-06
0.08	8.529e+03	1.890e-03	2.862e-03	2.991e-06	4.528e-06
0.1	5.022e+01	1.408e-05	2.022e-05	2.154e-08	3.094e-08
0.2	3.985e+03	2.321e-03	2.898e-03	4.097e-06	5.116e-06
0.3	7.634e+03	6.823e-03	8.072e-03	1.294e-05	1.531e-05
0.4	1.416e+04	1.713e-02	1.964e-02	3.338e-05	3.826e-05
0.5	6.608e+02	1.011e-03	1.135e-03	1.985e-06	2.229e-06
0.6	1.784e+04	3.306e-02	3.658e-02	6.453e-05	7.140e-05
0.8	3.496e+03	8.760e-03	9.500e-03	1.666e-05	1.807e-05
1.0	1.158e+04	3.665e-02	3.927e-02	6.755e-05	7.239e-05
1.5	7.043e+03	3.399e-02	3.578e-02	5.719e-05	6.019e-05
2.0	9.900e+03	6.437e-02	6.702e-02	9.954e-05	1.036e-04
Totals	1.014e+05	2.065e-01	2.235e-01	3.821e-04	4.165e-04

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.3048 cm)	2.195e-01	2.256e-01	4.241e-04	4.394e-04
1	(2 of 4)	(0.6096 cm)	2.150e-01	2.248e-01	4.084e-04	4.305e-04
1	(3 of 4)	(0.9144 cm)	2.107e-01	2.241e-01	3.945e-04	4.229e-04
1	(4 of 4)	(1.2192 cm)	2.065e-01	2.235e-01	3.821e-04	4.165e-04

MicroShield 8.01 CEG (8.00-0000)			
Date	By	Checked	
Filename	Run Date	Run Time	Duration
pickard14.msd	October 24, 2011	11:13:23 PM	00:00:00
Project Info			
Case Title		Pickard Wood	
Description		RM17A Wall 1ft	
Geometry		1 - Point	

Dose Points			
A	X	Y	Z
#1	31.751 cm (1 ft 0.5 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Shield 1	1.27 cm	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices		
Number of Groups: 25		
Lower Energy Cutoff: 0.015		
Photons < 0.015: Included		
Library: Grove		
Nuclide	Ci	Bq
Bi-210	1.0137e-006	3.7507e+004
Bi-214	9.9981e-007	3.6993e+004
Pb-210	1.0137e-006	3.7507e+004
Pb-214	9.9981e-007	3.6993e+004
Po-210	1.0139e-006	3.7516e+004
Po-214	9.9960e-007	3.6985e+004
Po-218	1.0000e-006	3.7000e+004
Ra-226	1.0000e-006	3.7000e+004
Rn-222	1.0000e-006	3.7000e+004

Buildup: The material reference is Air Gap
Integration Parameters

Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	4.015e-03	4.860e-03	3.444e-04	4.169e-04
0.05	1.928e+03	6.240e-03	8.947e-03	1.662e-05	2.383e-05
0.08	8.529e+03	4.568e-02	6.194e-02	7.228e-05	9.802e-05
0.1	5.022e+01	3.397e-04	4.422e-04	5.197e-07	6.766e-07
0.2	3.985e+03	5.549e-02	6.519e-02	9.793e-05	1.151e-04

0.3	7.634e+03	1.621e-01	1.831e-01	3.075e-04	3.474e-04
0.4	1.416e+04	4.054e-01	4.476e-01	7.898e-04	8.720e-04
0.5	6.608e+02	2.386e-02	2.594e-02	4.683e-05	5.092e-05
0.6	1.784e+04	7.779e-01	8.371e-01	1.518e-03	1.634e-03
0.8	3.496e+03	2.053e-01	2.178e-01	3.906e-04	4.142e-04
1.0	1.158e+04	8.566e-01	9.007e-01	1.579e-03	1.660e-03
1.5	7.043e+03	7.908e-01	8.208e-01	1.331e-03	1.381e-03
2.0	9.900e+03	1.493e+00	1.538e+00	2.309e-03	2.378e-03
Totals	1.014e+05	4.827e+00	5.112e+00	8.804e-03	9.392e-03
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.635 cm)
0.015	1.461e+04	8.091e-03	9.276e-03	6.940e-04	7.956e-04
0.05	1.928e+03	6.865e-03	8.277e-03	1.829e-05	2.205e-05
0.08	8.529e+03	4.944e-02	5.791e-02	7.824e-05	9.164e-05
0.1	5.022e+01	3.659e-04	4.196e-04	5.597e-07	6.419e-07
0.2	3.985e+03	5.894e-02	6.408e-02	1.040e-04	1.131e-04
0.3	7.634e+03	1.708e-01	1.820e-01	3.240e-04	3.452e-04
0.4	1.416e+04	4.249e-01	4.473e-01	8.278e-04	8.715e-04
0.5	6.608e+02	2.490e-02	2.601e-02	4.888e-05	5.105e-05
0.6	1.784e+04	8.094e-01	8.408e-01	1.580e-03	1.641e-03
0.8	3.496e+03	2.126e-01	2.192e-01	4.044e-04	4.169e-04
1.0	1.158e+04	8.839e-01	9.072e-01	1.629e-03	1.672e-03
1.5	7.043e+03	8.113e-01	8.271e-01	1.365e-03	1.392e-03
2.0	9.900e+03	1.526e+00	1.550e+00	2.361e-03	2.397e-03
Totals	1.014e+05	4.988e+00	5.139e+00	9.435e-03	9.809e-03
	Sensitivity	Variable	Shield #1	(2 of 4)	(1.06e+00 cm)
0.015	1.461e+04	5.072e-03	6.039e-03	4.350e-04	5.180e-04
0.05	1.928e+03	6.442e-03	8.718e-03	1.716e-05	2.322e-05
0.08	8.529e+03	4.690e-02	6.057e-02	7.422e-05	9.584e-05
0.1	5.022e+01	3.482e-04	4.345e-04	5.327e-07	6.648e-07
0.2	3.985e+03	5.662e-02	6.482e-02	9.992e-05	1.144e-04
0.3	7.634e+03	1.650e-01	1.828e-01	3.129e-04	3.467e-04
0.4	1.416e+04	4.118e-01	4.475e-01	8.023e-04	8.718e-04
0.5	6.608e+02	2.420e-02	2.596e-02	4.750e-05	5.097e-05
0.6	1.784e+04	7.882e-01	8.383e-01	1.539e-03	1.636e-03
0.8	3.496e+03	2.077e-01	2.182e-01	3.951e-04	4.151e-04
1.0	1.158e+04	8.656e-01	9.029e-01	1.596e-03	1.664e-03
1.5	7.043e+03	7.976e-01	8.229e-01	1.342e-03	1.384e-03
2.0	9.900e+03	1.504e+00	1.542e+00	2.326e-03	2.384e-03
Totals	1.014e+05	4.880e+00	5.121e+00	8.987e-03	9.506e-03
	Sensitivity	Variable	Shield #1	(3 of 4)	(1.48e+00 cm)
0.015	1.461e+04	3.179e-03	3.905e-03	2.727e-04	3.350e-04
0.05	1.928e+03	6.045e-03	9.182e-03	1.610e-05	2.446e-05
0.08	8.529e+03	4.448e-02	6.334e-02	7.040e-05	1.002e-04
0.1	5.022e+01	3.314e-04	4.501e-04	5.069e-07	6.886e-07
0.2	3.985e+03	5.438e-02	6.556e-02	9.598e-05	1.157e-04
0.3	7.634e+03	1.593e-01	1.835e-01	3.021e-04	3.481e-04
0.4	1.416e+04	3.991e-01	4.476e-01	7.775e-04	8.722e-04

0.5	6.608e+02	2.352e-02	2.592e-02	4.616e-05	5.088e-05
0.6	1.784e+04	7.676e-01	8.359e-01	1.498e-03	1.631e-03
0.8	3.496e+03	2.030e-01	2.173e-01	3.861e-04	4.133e-04
1.0	1.158e+04	8.477e-01	8.985e-01	1.563e-03	1.656e-03
1.5	7.043e+03	7.841e-01	8.187e-01	1.319e-03	1.377e-03
2.0	9.900e+03	1.483e+00	1.534e+00	2.293e-03	2.372e-03
Totals	1.014e+05	4.775e+00	5.104e+00	8.640e-03	9.298e-03
	Sensitivity	Variable	Shield #1	(4 of 4)	(1.905 cm)
0.015	1.461e-04	1.993e-03	2.512e-03	1.709e-04	2.154e-04
0.05	1.928e+03	5.673e-03	9.672e-03	1.511e-05	2.576e-05
0.08	8.529e+03	4.219e-02	6.625e-02	6.677e-05	1.048e-04
0.1	5.022e+01	3.153e-04	4.662e-04	4.824e-07	7.132e-07
0.2	3.985e+03	5.223e-02	6.632e-02	9.219e-05	1.170e-04
0.3	7.634e+03	1.538e-01	1.843e-01	2.917e-04	3.496e-04
0.4	1.416e+04	3.867e-01	4.478e-01	7.536e-04	8.726e-04
0.5	6.608e-02	2.285e-02	2.588e-02	4.486e-05	5.079e-05
0.6	1.784e-04	7.476e-01	8.334e-01	1.459e-03	1.627e-03
0.8	3.496e-03	1.983e-01	2.163e-01	3.772e-04	4.115e-04
1.0	1.158e-04	8.302e-01	8.943e-01	1.530e-03	1.648e-03
1.5	7.043e+03	7.709e-01	8.146e-01	1.297e-03	1.370e-03
2.0	9.900e+03	1.461e+00	1.526e+00	2.259e-03	2.360e-03
Totals	1.014e+05	4.674e+00	5.088e+00	8.359e-03	9.153e-03

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.635 cm)	4.988e+00	5.139e+00	9.435e-03	9.809e-03
1	(2 of 4)	(1.06e+00 cm)	4.880e+00	5.121e+00	8.987e-03	9.506e-03
1	(3 of 4)	(1.48e+00 cm)	4.775e+00	5.104e+00	8.640e-03	9.298e-03
1	(4 of 4)	(1.905 cm)	4.674e+00	5.088e+00	8.359e-03	9.153e-03

MicroShield 8.01 CEG (8.00-0000)

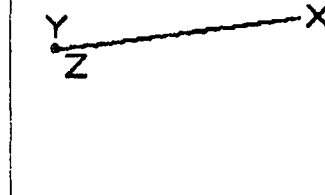
Date	By	Checked

Filename	Run Date	Run Time	Duration
pickard15.msd	October 24, 2011	11:15:28 PM	00:00:00

Project Info	
Case Title	Pickard Wood
Description	RM17A Wall 1m
Geometry	1 - Point

Dose Points			
A	X	Y	Z
#1	101.27 cm (3 ft 3.9 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Shield 1	1.27 cm	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices		
Number of Groups: 25		
Lower Energy Cutoff: 0.015		
Photons < 0.015: Included		
Library: Grove		
Nuclide	Ci	Bq
Bi-210	1.0137e-006	3.7507e+004
Bi-214	9.9981e-007	3.6993e+004
Pb-210	1.0137e-006	3.7507e+004
Pb-214	9.9981e-007	3.6993e+004
Po-210	1.0139e-006	3.7516e+004
Po-214	9.9960e-007	3.6985e+004
Po-218	1.0000e-006	3.7000e+004
Ra-226	1.0000e-006	3.7000e+004
Rn-222	1.0000e-006	3.7000e+004

Buildup: The material reference is Air Gap
Integration Parameters

Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	3.468e-04	4.233e-04	2.975e-05	3.631e-05
0.05	1.928e+03	6.033e-04	8.915e-04	1.607e-06	2.375e-06
0.08	8.529e+03	4.429e-03	6.160e-03	7.009e-06	9.748e-06
0.1	5.022e+01	3.296e-05	4.387e-05	5.043e-08	6.711e-08
0.2	3.985e+03	5.398e-03	6.427e-03	9.527e-06	1.134e-05

0.3	7.634e+03	1.579e-02	1.802e-02	2.995e-05	3.419e-05
0.4	1.416e+04	3.953e-02	4.400e-02	7.701e-05	8.573e-05
0.5	6.608e+02	2.328e-03	2.549e-03	4.569e-06	5.003e-06
0.6	1.784e+04	7.594e-02	8.222e-02	1.482e-04	1.605e-04
0.8	3.496e+03	2.006e-02	2.138e-02	3.816e-05	4.067e-05
1.0	1.158e+04	8.375e-02	8.843e-02	1.544e-04	1.630e-04
1.5	7.043e+03	7.740e-02	8.058e-02	1.302e-04	1.356e-04
2.0	9.900e+03	1.463e-01	1.510e-01	2.262e-04	2.335e-04
Totals	1.014e+05	4.719e-01	5.021e-01	8.566e-04	9.179e-04
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.635 cm)
0.015	1.461e+04	6.989e-04	8.102e-04	5.995e-05	6.949e-05
0.05	1.928e+03	6.636e-04	8.247e-04	1.768e-06	2.197e-06
0.08	8.529e+03	4.794e-03	5.759e-03	7.587e-06	9.114e-06
0.1	5.022e+01	3.551e-05	4.162e-05	5.432e-08	6.367e-08
0.2	3.985e+03	5.734e-03	6.318e-03	1.012e-05	1.115e-05
0.3	7.634e+03	1.664e-02	1.791e-02	3.157e-05	3.397e-05
0.4	1.416e+04	4.143e-02	4.397e-02	8.072e-05	8.568e-05
0.5	6.608e+02	2.430e-03	2.556e-03	4.770e-06	5.016e-06
0.6	1.784e+04	7.902e-02	8.258e-02	1.542e-04	1.612e-04
0.8	3.496e+03	2.078e-02	2.152e-02	3.952e-05	4.094e-05
1.0	1.158e+04	8.642e-02	8.907e-02	1.593e-04	1.642e-04
1.5	7.043e+03	7.940e-02	8.119e-02	1.336e-04	1.366e-04
2.0	9.900e+03	1.495e-01	1.521e-01	2.312e-04	2.353e-04
Totals	1.014e+05	4.875e-01	5.047e-01	9.143e-04	9.549e-04
	Sensitivity	Variable	Shield #1	(2 of 4)	(1.06e+00 cm)
0.015	1.461e+04	4.381e-04	5.265e-04	3.757e-05	4.516e-05
0.05	1.928e+03	6.228e-04	8.687e-04	1.659e-06	2.314e-06
0.08	8.529e+03	4.547e-03	6.023e-03	7.196e-06	9.532e-06
0.1	5.022e+01	3.379e-05	4.311e-05	5.170e-08	6.595e-08
0.2	3.985e+03	5.508e-03	6.391e-03	9.721e-06	1.128e-05
0.3	7.634e+03	1.607e-02	1.799e-02	3.048e-05	3.412e-05
0.4	1.416e+04	4.015e-02	4.399e-02	7.823e-05	8.571e-05
0.5	6.608e+02	2.361e-03	2.551e-03	4.635e-06	5.008e-06
0.6	1.784e+04	7.696e-02	8.234e-02	1.502e-04	1.607e-04
0.8	3.496e+03	2.030e-02	2.143e-02	3.861e-05	4.076e-05
1.0	1.158e+04	8.463e-02	8.864e-02	1.560e-04	1.634e-04
1.5	7.043e+03	7.806e-02	8.078e-02	1.313e-04	1.359e-04
2.0	9.900e+03	1.473e-01	1.514e-01	2.278e-04	2.341e-04
Totals	1.014e+05	4.770e-01	5.029e-01	8.735e-04	9.280e-04
	Sensitivity	Variable	Shield #1	(3 of 4)	(1.48e+00 cm)
0.015	1.461e+04	2.746e-04	3.399e-04	2.355e-05	2.915e-05
0.05	1.928e+03	5.844e-04	9.150e-04	1.557e-06	2.437e-06
0.08	8.529e+03	4.313e-03	6.299e-03	6.826e-06	9.969e-06
0.1	5.022e+01	3.216e-05	4.465e-05	4.920e-08	6.830e-08
0.2	3.985e+03	5.290e-03	6.464e-03	9.337e-06	1.141e-05
0.3	7.634e+03	1.552e-02	1.806e-02	2.943e-05	3.426e-05
0.4	1.416e+04	3.891e-02	4.401e-02	7.582e-05	8.575e-05

0.5	6.608e+02	2.295e-03	2.547e-03	4.504e-06	4.999e-06
0.6	1.784e+04	7.495e-02	8.210e-02	1.463e-04	1.603e-04
0.8	3.496e+03	1.983e-02	2.134e-02	3.772e-05	4.058e-05
1.0	1.158e+04	8.288e-02	8.822e-02	1.528e-04	1.626e-04
1.5	7.043e+03	7.674e-02	8.037e-02	1.291e-04	1.352e-04
2.0	9.900e+03	1.452e-01	1.506e-01	2.245e-04	2.328e-04
Totals	1.014e+05	4.668e-01	5.013e-01	8.415e-04	9.096e-04
	Sensitivity	Variable	Shield #1	(4 of 4)	(1.905 cm)
0.015	1.461e+04	1.721e-04	2.184e-04	1.476e-05	1.873e-05
0.05	1.928e+03	5.484e-04	9.637e-04	1.461e-06	2.567e-06
0.08	8.529e+03	4.091e-03	6.588e-03	6.474e-06	1.043e-05
0.1	5.022e+01	3.060e-05	4.624e-05	4.682e-08	7.074e-08
0.2	3.985e+03	5.082e-03	6.538e-03	8.969e-06	1.154e-05
0.3	7.634e+03	1.498e-02	1.814e-02	2.842e-05	3.440e-05
0.4	1.416e+04	3.771e-02	4.403e-02	7.348e-05	8.579e-05
0.5	6.608e+02	2.230e-03	2.542e-03	4.377e-06	4.991e-06
0.6	1.784e+04	7.299e-02	8.186e-02	1.425e-04	1.598e-04
0.8	3.496e+03	1.938e-02	2.124e-02	3.686e-05	4.040e-05
1.0	1.158e+04	8.117e-02	8.780e-02	1.496e-04	1.618e-04
1.5	7.043e+03	7.545e-02	7.997e-02	1.269e-04	1.345e-04
2.0	9.900e+03	1.431e-01	1.498e-01	2.213e-04	2.316e-04
Totals	1.014e+05	4.569e-01	4.997e-01	8.151e-04	8.967e-04

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.635 cm)	4.875e-01	5.047e-01	9.143e-04	9.549e-04
1	(2 of 4)	(1.06e+00 cm)	4.770e-01	5.029e-01	8.735e-04	9.280e-04
1	(3 of 4)	(1.48e+00 cm)	4.668e-01	5.013e-01	8.415e-04	9.096e-04
1	(4 of 4)	(1.905 cm)	4.569e-01	4.997e-01	8.151e-04	8.967e-04

MicroShield 8.01 CEG (8.00-0000)					
Date	By	Checked			
Filename	Run Date	Run Time	Duration		
pickard8.msd	October 24, 2011	11:03:09 PM	00:00:00		
Project Info					
Case Title	Pickard Wood				
Description	1ft Rm 106 Stage				
Geometry	4 - Rectangular Area - Vertical				
Source Dimensions					
Width	20.32 cm (8.0 in)				
Height	457.2 cm (15 ft)				
Dose Points					
A	X	Y	Z		
#1	31.75 cm (1 ft 0.5 in)	228.6 cm (7 ft 6.0 in)	10.16 cm (4.0 in)		
Shields					
Shield N	Dimension	Material	Density		
Shield 1	1.27 cm	Custom	0.7		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Standard Indices Number of Groups: 25 Lower Energy Cutoff: 0.015 Photons < 0.015: Included Library: Grove					
Nuclide	Ci	Bq	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2	
Bi-210	1.0137e-006	3.7507e+004	1.0911e-004	4.0372e+000	
Bi-214	9.9981e-007	3.6993e+004	1.0762e-004	3.9819e+000	
Pb-210	1.0137e-006	3.7507e+004	1.0911e-004	4.0372e+000	
Pb-214	9.9981e-007	3.6993e+004	1.0762e-004	3.9819e+000	
Po-210	1.0139e-006	3.7516e+004	1.0914e-004	4.0382e+000	
Po-214	9.9960e-007	3.6985e+004	1.0760e-004	3.9810e+000	
Po-218	1.0000e-006	3.7000e+004	1.0764e-004	3.9827e+000	
Ra-226	1.0000e-006	3.7000e+004	1.0764e-004	3.9826e+000	
Rn-222	1.0000e-006	3.7000e+004	1.0764e-004	3.9827e+000	
Buildup: The material reference is Air Gap Integration Parameters					
Z Direction				20	
Y Direction				20	
Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate $\text{MeV}/\text{cm}^2/\text{sec}$ No Buildup	Fluence Rate $\text{MeV}/\text{cm}^2/\text{sec}$ With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	4.245e-04	5.240e-04	3.641e-05	4.495e-05
0.05	1.928e+03	1.050e-03	1.943e-03	2.797e-06	5.176e-06



0.08	8.529e+03	7.857e-03	1.356e-02	1.243e-05	2.146e-05
0.1	5.022e+01	5.884e-05	9.473e-05	9.002e-08	1.449e-07
0.2	3.985e+03	9.810e-03	1.313e-02	1.731e-05	2.318e-05
0.3	7.634e+03	2.900e-02	3.618e-02	5.502e-05	6.863e-05
0.4	1.416e+04	7.315e-02	8.755e-02	1.425e-04	1.706e-04
0.5	6.608e+02	4.333e-03	5.046e-03	8.506e-06	9.905e-06
0.6	1.784e+04	1.420e-01	1.623e-01	2.772e-04	3.168e-04
0.8	3.496e+03	3.778e-02	4.206e-02	7.186e-05	7.999e-05
1.0	1.158e+04	1.585e-01	1.738e-01	2.922e-04	3.203e-04
1.5	7.043e+03	1.478e-01	1.582e-01	2.486e-04	2.662e-04
2.0	9.900e+03	2.808e-01	2.964e-01	4.342e-04	4.583e-04
Totals	1.014e+05	8.926e-01	9.907e-01	1.599e-03	1.786e-03
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.635 cm)
0.015	1.461e+04	1.045e-03	1.223e-03	8.961e-05	1.049e-04
0.05	1.928e+03	1.234e-03	1.745e-03	3.287e-06	4.648e-06
0.08	8.529e+03	9.006e-03	1.211e-02	1.425e-05	1.917e-05
0.1	5.022e+01	6.692e-05	8.645e-05	1.024e-07	1.323e-07
0.2	3.985e+03	1.091e-02	1.274e-02	1.925e-05	2.248e-05
0.3	7.634e+03	3.183e-02	3.579e-02	6.038e-05	6.789e-05
0.4	1.416e+04	7.955e-02	8.748e-02	1.550e-04	1.704e-04
0.5	6.608e+02	4.679e-03	5.071e-03	9.185e-06	9.955e-06
0.6	1.784e+04	1.525e-01	1.637e-01	2.977e-04	3.194e-04
0.8	3.496e+03	4.024e-02	4.258e-02	7.654e-05	8.099e-05
1.0	1.158e+04	1.678e-01	1.761e-01	3.093e-04	3.246e-04
1.5	7.043e+03	1.548e-01	1.605e-01	2.605e-04	2.700e-04
2.0	9.900e+03	2.923e-01	3.007e-01	4.520e-04	4.650e-04
Totals	1.014e+05	9.460e-01	9.998e-01	1.747e-03	1.860e-03
	Sensitivity	Variable	Shield #1	(2 of 4)	(1.06e+00 cm)
0.015	1.461e+04	5.682e-04	6.905e-04	4.874e-05	5.923e-05
0.05	1.928e+03	1.107e-03	1.884e-03	2.948e-06	5.019e-06
0.08	8.529e+03	8.216e-03	1.310e-02	1.300e-05	2.073e-05
0.1	5.022e+01	6.138e-05	9.203e-05	9.390e-08	1.408e-07
0.2	3.985e+03	1.016e-02	1.301e-02	1.793e-05	2.295e-05
0.3	7.634e+03	2.991e-02	3.606e-02	5.673e-05	6.841e-05
0.4	1.416e+04	7.520e-02	8.754e-02	1.465e-04	1.706e-04
0.5	6.608e+02	4.444e-03	5.055e-03	8.724e-06	9.922e-06
0.6	1.784e+04	1.454e-01	1.628e-01	2.838e-04	3.177e-04
0.8	3.496e+03	3.858e-02	4.223e-02	7.338e-05	8.032e-05
1.0	1.158e+04	1.615e-01	1.745e-01	2.978e-04	3.217e-04
1.5	7.043e+03	1.501e-01	1.590e-01	2.525e-04	2.675e-04
2.0	9.900e+03	2.846e-01	2.978e-01	4.400e-04	4.605e-04
Totals	1.014e+05	9.098e-01	9.937e-01	1.642e-03	1.805e-03
	Sensitivity	Variable	Shield #1	(3 of 4)	(1.48e+00 cm)
0.015	1.461e+04	3.191e-04	3.994e-04	2.737e-05	3.426e-05
0.05	1.928e+03	9.967e-04	1.996e-03	2.655e-06	5.317e-06
0.08	8.529e+03	7.519e-03	1.400e-02	1.190e-05	2.215e-05
0.1	5.022e+01	5.645e-05	9.720e-05	8.636e-08	1.487e-07

0.2	3.985e+03	9.478e-03	1.325e-02	1.673e-05	2.339e-05
0.3	7.634e+03	2.814e-02	3.629e-02	5.338e-05	6.883e-05
0.4	1.416e+04	7.118e-02	8.754e-02	1.387e-04	1.706e-04
0.5	6.608e+02	4.226e-03	5.037e-03	8.295e-06	9.886e-06
0.6	1.784e+04	1.387e-01	1.618e-01	2.708e-04	3.159e-04
0.8	3.496e+03	3.701e-02	4.188e-02	7.039e-05	7.966e-05
1.0	1.158e+04	1.556e-01	1.730e-01	2.868e-04	3.189e-04
1.5	7.043e+03	1.455e-01	1.575e-01	2.449e-04	2.650e-04
2.0	9.900e+03	2.771e-01	2.949e-01	4.285e-04	4.561e-04
Totals	1.014e+05	8.759e-01	9.877e-01	1.560e-03	1.770e-03
	Sensitivity	Variable	Shield #1	(4 of 4)	(1.905 cm)
0.015	1.461e+04	1.826e-04	2.343e-04	1.566e-05	2.009e-05
0.05	1.928e+03	9.008e-04	2.077e-03	2.400e-06	5.534e-06
0.08	8.529e+03	6.898e-03	1.478e-02	1.092e-05	2.340e-05
0.1	5.022e+01	5.204e-05	1.019e-04	7.962e-08	1.559e-07
0.2	3.985e+03	8.859e-03	1.346e-02	1.564e-05	2.376e-05
0.3	7.634e+03	2.651e-02	3.647e-02	5.029e-05	6.918e-05
0.4	1.416e+04	6.745e-02	8.747e-02	1.314e-04	1.704e-04
0.5	6.608e+02	4.022e-03	5.016e-03	7.894e-06	9.846e-06
0.6	1.784e+04	1.325e-01	1.609e-01	2.586e-04	3.140e-04
0.8	3.496e+03	3.553e-02	4.153e-02	6.758e-05	7.899e-05
1.0	1.158e+04	1.500e-01	1.714e-01	2.764e-04	3.160e-04
1.5	7.043e+03	1.412e-01	1.560e-01	2.375e-04	2.625e-04
2.0	9.900e+03	2.699e-01	2.921e-01	4.174e-04	4.517e-04
Totals	1.014e+05	8.440e-01	9.815e-01	1.492e-03	1.746e-03

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.635 cm)	9.460e-01	9.998e-01	1.747e-03	1.860e-03
1	(2 of 4)	(1.06e+00 cm)	9.098e-01	9.937e-01	1.642e-03	1.805e-03
1	(3 of 4)	(1.48e+00 cm)	8.759e-01	9.877e-01	1.560e-03	1.770e-03
1	(4 of 4)	(1.905 cm)	8.440e-01	9.815e-01	1.492e-03	1.746e-03

MicroShield 8.01 CEG (8.00-0000)

Date	By	Checked

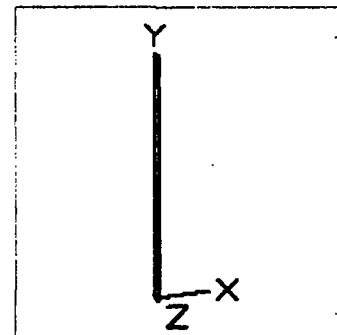
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pickard9.msdl	October 24, 2011	11:05:39 PM	00:00:00

Project Info	
Case Title	Pickard Wood
Description	1m Rm 106 Stage
Geometry	4 - Rectangular Area - Vertical

Source Dimensions	
Width	20.32 cm (8.0 in)
Height	457.2 cm (15 ft)

Dose Points			
A	X	Y	Z
#1	101.27 cm (3 ft 3.9 in)	228.6 cm (7 ft 6.0 in)	10.16 cm (4.0 in)

Shields			
Shield N	Dimension	Material	Density
Shield 1	1.27 cm	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices				
Number of Groups: 25				
Lower Energy Cutoff: 0.015				
Photons < 0.015: Included				
Library: Grove				
Nuclide	Ci	Bq	μCi/cm²	Bq/cm²
Bi-210	1.0137e-006	3.7507e+004	1.0911e-004	4.0372e+000
Bi-214	9.9981e-007	3.6993e+004	1.0762e-004	3.9819e+000
Pb-210	1.0137e-006	3.7507e+004	1.0911e-004	4.0372e+000
Pb-214	9.9981e-007	3.6993e+004	1.0762e-004	3.9819e+000
Po-210	1.0139e-006	3.7516e+004	1.0914e-004	4.0382e+000
Po-214	9.9960e-007	3.6985e+004	1.0760e-004	3.9810e+000
Po-218	1.0000e-006	3.7000e+004	1.0764e-004	3.9827e+000
Ra-226	1.0000e-006	3.7000e+004	1.0764e-004	3.9826e+000
Rn-222	1.0000e-006	3.7000e+004	1.0764e-004	3.9827e+000

Buildup: The material reference is Air Gap	
Integration Parameters	
Z Direction	20
Y Direction	20

Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	1.174e-04	1.457e-04	1.007e-05	1.249e-05
0.05	1.928e+03	2.864e-04	4.843e-04	7.630e-07	1.290e-06

0.08	8.529e+03	2.128e-03	3.317e-03	3.367e-06	5.249e-06
0.1	5.022e+01	1.589e-05	2.334e-05	2.432e-08	3.571e-08
0.2	3.985e+03	2.629e-03	3.322e-03	4.641e-06	5.864e-06
0.3	7.634e+03	7.737e-03	9.237e-03	1.468e-05	1.752e-05
0.4	1.416e+04	1.945e-02	2.245e-02	3.789e-05	4.374e-05
0.5	6.608e+02	1.149e-03	1.297e-03	2.255e-06	2.547e-06
0.6	1.784e+04	3.757e-02	4.179e-02	7.333e-05	8.157e-05
0.8	3.496e+03	9.962e-03	1.085e-02	1.895e-05	2.064e-05
1.0	1.158e+04	4.169e-02	4.485e-02	7.685e-05	8.267e-05
1.5	7.043e+03	3.870e-02	4.085e-02	6.512e-05	6.873e-05
2.0	9.900e+03	7.333e-02	7.653e-02	1.134e-04	1.183e-04
Totals	1.014e+05	2.348e-01	2.551e-01	4.213e-04	4.607e-04
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.635 cm)
0.015	1.461e+04	2.750e-04	3.241e-04	2.358e-05	2.780e-05
0.05	1.928e+03	3.250e-04	4.355e-04	8.658e-07	1.160e-06
0.08	8.529e+03	2.364e-03	3.026e-03	3.741e-06	4.788e-06
0.1	5.022e+01	1.754e-05	2.172e-05	2.684e-08	3.324e-08
0.2	3.985e+03	2.850e-03	3.246e-03	5.030e-06	5.730e-06
0.3	7.634e+03	8.298e-03	9.159e-03	1.574e-05	1.737e-05
0.4	1.416e+04	2.071e-02	2.243e-02	4.034e-05	4.371e-05
0.5	6.608e+02	1.217e-03	1.302e-03	2.388e-06	2.555e-06
0.6	1.784e+04	3.962e-02	4.204e-02	7.733e-05	8.205e-05
0.8	3.496e+03	1.044e-02	1.095e-02	1.985e-05	2.082e-05
1.0	1.158e+04	4.348e-02	4.528e-02	8.015e-05	8.347e-05
1.5	7.043e+03	4.005e-02	4.127e-02	6.738e-05	6.944e-05
2.0	9.900e+03	7.552e-02	7.733e-02	1.168e-04	1.196e-04
Totals	1.014e+05	2.452e-01	2.568e-01	4.532e-04	4.785e-04
	Sensitivity	Variable	Shield #1	(2 of 4)	(1.06e+00 cm)
0.015	1.461e+04	1.552e-04	1.898e-04	1.332e-05	1.628e-05
0.05	1.928e+03	2.987e-04	4.675e-04	7.957e-07	1.245e-06
0.08	8.529e+03	2.203e-03	3.217e-03	3.487e-06	5.090e-06
0.1	5.022e+01	1.642e-05	2.279e-05	2.513e-08	3.486e-08
0.2	3.985e+03	2.701e-03	3.297e-03	4.766e-06	5.819e-06
0.3	7.634e+03	7.919e-03	9.211e-03	1.502e-05	1.747e-05
0.4	1.416e+04	1.986e-02	2.244e-02	3.869e-05	4.373e-05
0.5	6.608e+02	1.171e-03	1.299e-03	2.298e-06	2.550e-06
0.6	1.784e+04	3.824e-02	4.187e-02	7.464e-05	8.173e-05
0.8	3.496e+03	1.012e-02	1.088e-02	1.924e-05	2.070e-05
1.0	1.158e+04	4.228e-02	4.499e-02	7.794e-05	8.293e-05
1.5	7.043e+03	3.915e-02	4.099e-02	6.586e-05	6.897e-05
2.0	9.900e+03	7.405e-02	7.679e-02	1.145e-04	1.188e-04
Totals	1.014e+05	2.382e-01	2.557e-01	4.306e-04	4.653e-04
	Sensitivity	Variable	Shield #1	(3 of 4)	(1.48e+00 cm)
0.015	1.461e+04	8.904e-05	1.120e-04	7.637e-06	9.609e-06
0.05	1.928e+03	2.747e-04	5.002e-04	7.317e-07	1.333e-06
0.08	8.529e+03	2.055e-03	3.421e-03	3.251e-06	5.413e-06
0.1	5.022e+01	1.538e-05	2.391e-05	2.353e-08	3.657e-08

0.2	3.985e+03	2.560e-03	3.348e-03	4.518e-06	5.909e-06
0.3	7.634e+03	7.559e-03	9.263e-03	1.434e-05	1.757e-05
0.4	1.416e+04	1.904e-02	2.246e-02	3.711e-05	4.376e-05
0.5	6.608e+02	1.127e-03	1.296e-03	2.212e-06	2.544e-06
0.6	1.784e+04	3.691e-02	4.171e-02	7.205e-05	8.141e-05
0.8	3.496e+03	9.808e-03	1.082e-02	1.866e-05	2.057e-05
1.0	1.158e+04	4.112e-02	4.470e-02	7.579e-05	8.240e-05
1.5	7.043e+03	3.826e-02	4.071e-02	6.438e-05	6.850e-05
2.0	9.900e+03	7.262e-02	7.626e-02	1.123e-04	1.179e-04
Totals	1.014e+05	2.314e-01	2.546e-01	4.130e-04	4.570e-04
	Sensitivity	Variable	Shield #1	(4 of 4)	(1.905 cm)
0.015	1.461e+04	5.170e-05	6.661e-05	4.434e-06	5.714e-06
0.05	1.928e+03	2.527e-04	5.293e-04	6.733e-07	1.410e-06
0.08	8.529e+03	1.917e-03	3.624e-03	3.033e-06	5.736e-06
0.1	5.022e+01	1.441e-05	2.504e-05	2.204e-08	3.832e-08
0.2	3.985e+03	2.427e-03	3.400e-03	4.284e-06	6.002e-06
0.3	7.634e+03	7.216e-03	9.315e-03	1.369e-05	1.767e-05
0.4	1.416e+04	1.827e-02	2.247e-02	3.559e-05	4.378e-05
0.5	6.608e+02	1.085e-03	1.293e-03	2.130e-06	2.538e-06
0.6	1.784e+04	3.563e-02	4.154e-02	6.955e-05	8.109e-05
0.8	3.496e+03	9.509e-03	1.075e-02	1.809e-05	2.045e-05
1.0	1.158e+04	3.998e-02	4.442e-02	7.370e-05	8.187e-05
1.5	7.043e+03	3.740e-02	4.043e-02	6.293e-05	6.803e-05
2.0	9.900e+03	7.121e-02	7.573e-02	1.101e-04	1.171e-04
Totals	1.014e+05	2.250e-01	2.536e-01	3.983e-04	4.514e-04

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.635 cm)	2.452e-01	2.568e-01	4.532e-04	4.785e-04
1	(2 of 4)	(1.06e+00 cm)	2.382e-01	2.557e-01	4.306e-04	4.653e-04
1	(3 of 4)	(1.48e+00 cm)	2.314e-01	2.546e-01	4.130e-04	4.570e-04
1	(4 of 4)	(1.905 cm)	2.250e-01	2.536e-01	3.983e-04	4.514e-04

MicroShield 8.01
CEG (8.00-0000)

Date	By	Checked

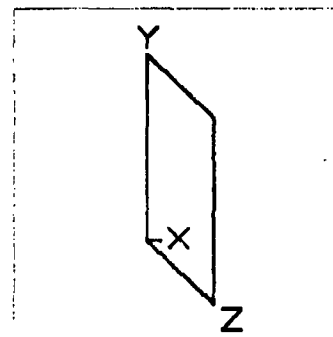
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pickard2.msd	October 24, 2011	10:46:23 PM	00:00:00

Project Info	
Case Title	Pickard Carpet
Description	1ft Room 205
Geometry	4 - Rectangular Area - Vertical

Source Dimensions	
Width	426.72 cm (14 ft 0.0 in)
Height	426.72 cm (14 ft 0.0 in)

Dose Points			
A	X	Y	Z
#1	31.114 cm (1 ft 0.2 in)	213.36 cm (7 ft 0.0 in)	213.36 cm (7 ft 0.0 in)

Shields			
Shield N	Dimension	Material	Density
Shield 1	.021 ft	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices				
Number of Groups: 25				
Lower Energy Cutoff: 0.015				
Photons < 0.015: Included				
Library: Grove				
Nuclide	Ci	Bq	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2
Bi-210	1.0137e-006	3.7507e+004	5.5671e-006	2.0598e-001
Bi-214	9.9981e-007	3.6993e+004	5.4907e-006	2.0316e-001
Pb-210	1.0137e-006	3.7507e+004	5.5670e-006	2.0598e-001
Pb-214	9.9981e-007	3.6993e+004	5.4907e-006	2.0316e-001
Po-210	1.0139e-006	3.7516e+004	5.5684e-006	2.0603e-001
Po-214	9.9960e-007	3.6985e+004	5.4896e-006	2.0311e-001
Po-218	1.0000e-006	3.7000e+004	5.4918e-006	2.0320e-001
Ra-226	1.0000e-006	3.7000e+004	5.4918e-006	2.0320e-001
Rn-222	1.0000e-006	3.7000e+004	5.4918e-006	2.0320e-001

Buildup: The material reference is Air Gap	
Integration Parameters	
Z Direction	20
Y Direction	20

Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	4.257e-04	4.910e-04	3.651e-05	4.212e-05
0.05	1.928e+03	4.112e-04	6.832e-04	1.095e-06	1.820e-06

0.08	8.529e+03	3.008e-03	4.765e-03	4.760e-06	7.541e-06
0.1	5.022e+01	2.242e-05	3.349e-05	3.430e-08	5.123e-08
0.2	3.985e+03	3.704e-03	4.730e-03	6.538e-06	8.348e-06
0.3	7.634e+03	1.090e-02	1.312e-02	2.068e-05	2.488e-05
0.4	1.416e+04	2.741e-02	3.185e-02	5.340e-05	6.205e-05
0.5	6.608e+02	1.620e-03	1.839e-03	3.179e-06	3.610e-06
0.6	1.784e+04	5.298e-02	5.922e-02	1.034e-04	1.156e-04
0.8	3.496e+03	1.406e-02	1.537e-02	2.673e-05	2.923e-05
1.0	1.158e+04	5.885e-02	6.352e-02	1.085e-04	1.171e-04
1.5	7.043e+03	5.467e-02	5.786e-02	9.198e-05	9.735e-05
2.0	9.900e+03	1.036e-01	1.084e-01	1.603e-04	1.676e-04
Totals	1.014e+05	3.317e-01	3.619e-01	6.171e-04	6.773e-04
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.01 ft)
0.015	1.461e+04	6.487e-04	7.221e-04	5.564e-05	6.194e-05
0.05	1.928e+03	4.670e-04	6.137e-04	1.244e-06	1.635e-06
0.08	8.529e+03	3.367e-03	4.290e-03	5.329e-06	6.789e-06
0.1	5.022e+01	2.496e-05	3.082e-05	3.818e-08	4.715e-08
0.2	3.985e+03	4.048e-03	4.604e-03	7.145e-06	8.127e-06
0.3	7.634e+03	1.178e-02	1.299e-02	2.235e-05	2.464e-05
0.4	1.416e+04	2.939e-02	3.181e-02	5.727e-05	6.199e-05
0.5	6.608e+02	1.727e-03	1.846e-03	3.390e-06	3.624e-06
0.6	1.784e+04	5.623e-02	5.962e-02	1.097e-04	1.164e-04
0.8	3.496e+03	1.481e-02	1.552e-02	2.817e-05	2.953e-05
1.0	1.158e+04	6.170e-02	6.423e-02	1.137e-04	1.184e-04
1.5	7.043e+03	5.682e-02	5.854e-02	9.560e-05	9.849e-05
2.0	9.900e+03	1.071e-01	1.097e-01	1.657e-04	1.696e-04
Totals	1.014e+05	3.482e-01	3.645e-01	6.653e-04	7.012e-04
	Sensitivity	Variable	Shield #1	(2 of 4)	(0.02 ft)
0.015	1.461e+04	4.388e-04	5.051e-04	3.764e-05	4.332e-05
0.05	1.928e+03	4.151e-04	6.786e-04	1.106e-06	1.808e-06
0.08	8.529e+03	3.034e-03	4.729e-03	4.800e-06	7.484e-06
0.1	5.022e+01	2.260e-05	3.328e-05	3.458e-08	5.092e-08
0.2	3.985e+03	3.729e-03	4.720e-03	6.582e-06	8.330e-06
0.3	7.634e+03	1.097e-02	1.311e-02	2.080e-05	2.486e-05
0.4	1.416e+04	2.756e-02	3.184e-02	5.369e-05	6.205e-05
0.5	6.608e+02	1.628e-03	1.840e-03	3.195e-06	3.611e-06
0.6	1.784e+04	5.322e-02	5.925e-02	1.039e-04	1.157e-04
0.8	3.496e+03	1.411e-02	1.538e-02	2.684e-05	2.925e-05
1.0	1.158e+04	5.906e-02	6.358e-02	1.089e-04	1.172e-04
1.5	7.043e+03	5.483e-02	5.791e-02	9.225e-05	9.743e-05
2.0	9.900e+03	1.039e-01	1.085e-01	1.607e-04	1.678e-04
Totals	1.014e+05	3.329e-01	3.621e-01	6.204e-04	6.788e-04
	Sensitivity	Variable	Shield #1	(3 of 4)	(0.03 ft)
0.015	1.461e+04	3.106e-04	3.649e-04	2.664e-05	3.130e-05
0.05	1.928e+03	3.708e-04	7.254e-04	9.877e-07	1.933e-06
0.08	8.529e+03	2.743e-03	5.121e-03	4.340e-06	8.104e-06
0.1	5.022e+01	2.054e-05	3.555e-05	3.142e-08	5.440e-08

0.2	3.985e+03	3.443e-03	4.831e-03	6.077e-06	8.527e-06
0.3	7.634e+03	1.023e-02	1.322e-02	1.940e-05	2.508e-05
0.4	1.416e+04	2.587e-02	3.187e-02	5.040e-05	6.210e-05
0.5	6.608e+02	1.536e-03	1.833e-03	3.015e-06	3.598e-06
0.6	1.784e+04	5.043e-02	5.888e-02	9.844e-05	1.149e-04
0.8	3.496e+03	1.346e-02	1.524e-02	2.559e-05	2.898e-05
1.0	1.158e+04	5.658e-02	6.293e-02	1.043e-04	1.160e-04
1.5	7.043e+03	5.293e-02	5.729e-02	8.906e-05	9.639e-05
2.0	9.900e+03	1.008e-01	1.073e-01	1.559e-04	1.659e-04
Totals	1.014e+05	3.187e-01	3.596e-01	5.841e-04	6.629e-04
	Sensitivity	Variable	Shield #1	(4 of 4)	(0.04 ft)
0.015	1.461e+04	2.271e-04	2.709e-04	1.948e-05	2.323e-05
0.05	1.928e+03	3.326e-04	7.570e-04	8.861e-07	2.016e-06
0.08	8.529e+03	2.489e-03	5.450e-03	3.938e-06	8.625e-06
0.1	5.022e+01	1.872e-05	3.750e-05	2.864e-08	5.737e-08
0.2	3.985e+03	3.186e-03	4.925e-03	5.623e-06	8.693e-06
0.3	7.634e+03	9.550e-03	1.330e-02	1.812e-05	2.524e-05
0.4	1.416e+04	2.432e-02	3.186e-02	4.738e-05	6.209e-05
0.5	6.608e+02	1.451e-03	1.826e-03	2.848e-06	3.583e-06
0.6	1.784e+04	4.783e-02	5.851e-02	9.337e-05	1.142e-04
0.8	3.496e+03	1.284e-02	1.510e-02	2.442e-05	2.871e-05
1.0	1.158e+04	5.423e-02	6.230e-02	9.997e-05	1.148e-04
1.5	7.043e+03	5.112e-02	5.668e-02	8.601e-05	9.536e-05
2.0	9.900e+03	9.780e-02	1.061e-01	1.512e-04	1.641e-04
Totals	1.014e+05	3.054e-01	3.571e-01	5.533e-04	6.507e-04

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.01 ft)	3.482e-01	3.645e-01	6.653e-04	7.012e-04
1	(2 of 4)	(0.02 ft)	3.329e-01	3.621e-01	6.204e-04	6.788e-04
1	(3 of 4)	(0.03 ft)	3.187e-01	3.596e-01	5.841e-04	6.629e-04
1	(4 of 4)	(0.04 ft)	3.054e-01	3.571e-01	5.533e-04	6.507e-04

MicroShield 8.01 CEG (8.00-0000)

Date	By	Checked

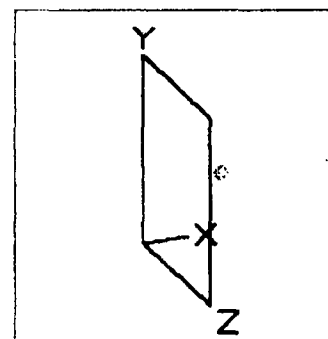
Filename	Run Date	Run Time	Duration
pickard3.msdl	October 24, 2011	10:51:20 PM	00:00:00

Project Info	
Case Title	Pickard Carpet
Description	1m Room 205
Geometry	4 - Rectangular Area - Vertical

Source Dimensions	
Width	426.72 cm (14 ft 0.0 in)
Height	426.72 cm (14 ft 0.0 in)

Dose Points			
A	X	Y	Z
#1	100.0 cm (3 ft 3.4 in)	213.36 cm (7 ft 0.0 in)	213.36 cm (7 ft 0.0 in)

Shields			
Shield N	Dimension	Material	Density
Shield 1	.006 m	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices				
Number of Groups: 25				
Lower Energy Cutoff: 0.015				
Photons < 0.015: Included				
Library: Grove				
Nuclide	Ci	Bq	μCi/cm²	Bq/cm²
Bi-210	1.0137e-006	3.7507e+004	5.5671e-006	2.0598e-001
Bi-214	9.9981e-007	3.6993e+004	5.4907e-006	2.0316e-001
Pb-210	1.0137e-006	3.7507e+004	5.5670e-006	2.0598e-001
Pb-214	9.9981e-007	3.6993e+004	5.4907e-006	2.0316e-001
Po-210	1.0139e-006	3.7516e+004	5.5684e-006	2.0603e-001
Po-214	9.9960e-007	3.6985e+004	5.4896e-006	2.0311e-001
Po-218	1.0000e-006	3.7000e+004	5.4918e-006	2.0320e-001
Ra-226	1.0000e-006	3.7000e+004	5.4918e-006	2.0320e-001
Rn-222	1.0000e-006	3.7000e+004	5.4918e-006	2.0320e-001

Buildup: The material reference is Air Gap	
Integration Parameters	
Z Direction	20
Y Direction	20

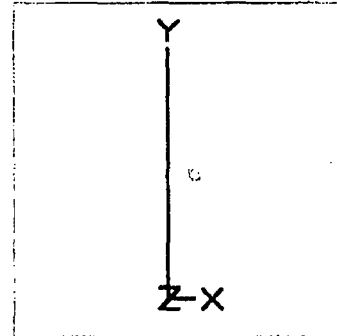
Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	2.469e-04	2.842e-04	2.118e-05	2.438e-05
0.05	1.928e+03	2.116e-04	2.902e-04	5.638e-07	7.730e-07

0.08	8.529e+03	1.533e-03	2.025e-03	2.425e-06	3.204e-06
0.1	5.022e+01	1.138e-05	1.450e-05	1.740e-08	2.218e-08
0.2	3.985e+03	1.852e-03	2.149e-03	3.269e-06	3.794e-06
0.3	7.634e+03	5.404e-03	6.048e-03	1.025e-05	1.147e-05
0.4	1.416e+04	1.350e-02	1.479e-02	2.630e-05	2.882e-05
0.5	6.608e+02	7.940e-04	8.579e-04	1.559e-06	1.684e-06
0.6	1.784e+04	2.588e-02	2.769e-02	5.051e-05	5.405e-05
0.8	3.496e+03	6.825e-03	7.206e-03	1.298e-05	1.371e-05
1.0	1.158e+04	2.846e-02	2.981e-02	5.245e-05	5.494e-05
1.5	7.043e+03	2.625e-02	2.716e-02	4.416e-05	4.570e-05
2.0	9.900e+03	4.954e-02	5.090e-02	7.660e-05	7.871e-05
Totals	1.014e+05	1.605e-01	1.692e-01	3.023e-04	3.213e-04
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.003048 m)
0.015	1.461e+04	3.245e-04	3.634e-04	2.783e-05	3.117e-05
0.05	1.928e+03	2.267e-04	2.740e-04	6.039e-07	7.299e-07
0.08	8.529e+03	1.628e-03	1.921e-03	2.577e-06	3.040e-06
0.1	5.022e+01	1.205e-05	1.391e-05	1.843e-08	2.129e-08
0.2	3.985e+03	1.942e-03	2.121e-03	3.427e-06	3.743e-06
0.3	7.634e+03	5.630e-03	6.019e-03	1.068e-05	1.142e-05
0.4	1.416e+04	1.401e-02	1.479e-02	2.729e-05	2.881e-05
0.5	6.608e+02	8.211e-04	8.597e-04	1.612e-06	1.687e-06
0.6	1.784e+04	2.669e-02	2.779e-02	5.210e-05	5.423e-05
0.8	3.496e+03	7.014e-03	7.243e-03	1.334e-05	1.378e-05
1.0	1.158e+04	2.916e-02	2.998e-02	5.376e-05	5.526e-05
1.5	7.043e+03	2.678e-02	2.733e-02	4.505e-05	4.598e-05
2.0	9.900e+03	5.039e-02	5.121e-02	7.793e-05	7.919e-05
Totals	1.014e+05	1.646e-01	1.699e-01	3.162e-04	3.290e-04
	Sensitivity	Variable	Shield #1	(2 of 4)	(0.006096 m)
0.015	1.461e+04	2.521e-04	2.897e-04	2.162e-05	2.485e-05
0.05	1.928e+03	2.127e-04	2.889e-04	5.667e-07	7.696e-07
0.08	8.529e+03	1.540e-03	2.016e-03	2.437e-06	3.191e-06
0.1	5.022e+01	1.143e-05	1.445e-05	1.748e-08	2.211e-08
0.2	3.985e+03	1.859e-03	2.147e-03	3.281e-06	3.790e-06
0.3	7.634e+03	5.421e-03	6.046e-03	1.028e-05	1.147e-05
0.4	1.416e+04	1.354e-02	1.479e-02	2.638e-05	2.882e-05
0.5	6.608e+02	7.960e-04	8.580e-04	1.563e-06	1.684e-06
0.6	1.784e+04	2.594e-02	2.770e-02	5.063e-05	5.406e-05
0.8	3.496e+03	6.839e-03	7.209e-03	1.301e-05	1.371e-05
1.0	1.158e+04	2.851e-02	2.982e-02	5.255e-05	5.497e-05
1.5	7.043e+03	2.629e-02	2.718e-02	4.423e-05	4.572e-05
2.0	9.900e+03	4.960e-02	5.092e-02	7.670e-05	7.874e-05
Totals	1.014e+05	1.608e-01	1.693e-01	3.033e-04	3.218e-04
	Sensitivity	Variable	Shield #1	(3 of 4)	(0.009144 m)
0.015	1.461e+04	1.968e-04	2.304e-04	1.688e-05	1.977e-05
0.05	1.928e+03	1.997e-04	3.046e-04	5.321e-07	8.115e-07
0.08	8.529e+03	1.456e-03	2.117e-03	2.305e-06	3.349e-06
0.1	5.022e+01	1.084e-05	1.502e-05	1.658e-08	2.297e-08

0.2	3.985e+03	1.780e-03	2.174e-03	3.142e-06	3.837e-06
0.3	7.634e+03	5.221e-03	6.074e-03	9.903e-06	1.152e-05
0.4	1.416e+04	1.309e-02	1.480e-02	2.550e-05	2.884e-05
0.5	6.608e+02	7.718e-04	8.564e-04	1.515e-06	1.681e-06
0.6	1.784e+04	2.521e-02	2.761e-02	4.920e-05	5.389e-05
0.8	3.496e+03	6.670e-03	7.174e-03	1.269e-05	1.365e-05
1.0	1.158e+04	2.787e-02	2.967e-02	5.138e-05	5.468e-05
1.5	7.043e+03	2.581e-02	2.703e-02	4.342e-05	4.547e-05
2.0	9.900e+03	4.882e-02	5.063e-02	7.550e-05	7.830e-05
Totals	1.014e+05	1.571e-01	1.687e-01	2.920e-04	3.158e-04
	Sensitivity	Variable	Shield #1	(4 of 4)	(0.012192 m)
0.015	1.461e+04	1.544e-04	1.838e-04	1.324e-05	1.576e-05
0.05	1.928e+03	1.876e-04	3.213e-04	4.996e-07	8.559e-07
0.08	8.529e+03	1.378e-03	2.222e-03	2.180e-06	3.517e-06
0.1	5.022e+01	1.028e-05	1.560e-05	1.573e-08	2.387e-08
0.2	3.985e+03	1.705e-03	2.201e-03	3.009e-06	3.885e-06
0.3	7.634e+03	5.028e-03	6.101e-03	9.538e-06	1.157e-05
0.4	1.416e+04	1.265e-02	1.481e-02	2.466e-05	2.885e-05
0.5	6.608e+02	7.484e-04	8.549e-04	1.469e-06	1.678e-06
0.6	1.784e+04	2.450e-02	2.752e-02	4.782e-05	5.372e-05
0.8	3.496e+03	6.504e-03	7.140e-03	1.237e-05	1.358e-05
1.0	1.158e+04	2.725e-02	2.951e-02	5.023e-05	5.440e-05
1.5	7.043e+03	2.534e-02	2.688e-02	4.263e-05	4.522e-05
2.0	9.900e+03	4.806e-02	5.035e-02	7.432e-05	7.786e-05
Totals	1.014e+05	1.535e-01	1.681e-01	2.820e-04	3.109e-04

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.003048 m)	1.646e-01	1.699e-01	3.162e-04	3.290e-04
1	(2 of 4)	(0.006096 m)	1.608e-01	1.693e-01	3.033e-04	3.218e-04
1	(3 of 4)	(0.009144 m)	1.571e-01	1.687e-01	2.920e-04	3.158e-04
1	(4 of 4)	(0.012192 m)	1.535e-01	1.681e-01	2.820e-04	3.109e-04

MicroShield 8.01 CEG (8.00-0000)					
Date		By		Checked	
Filename	Run Date		Run Time	Duration	
pickard4.msdc	October 14, 2011		9:48:07 AM	00:00:00	
Project Info					
Case Title	Pickard Carpet				
Description	1 ft Room 206				
Geometry	4 - Rectangular Area - Vertical				
Source Dimensions					
Width	396.24 cm (13 ft 0.0 in)				
Height	304.8 cm (10 ft 0.0 in)				
Dose Points					
A	X	Y	Z		
#1	31.115 cm (1 ft 0.2 in)	152.4 cm (5 ft 0.0 in)	228.6 cm (7 ft 6.0 in)		
Shields					
Shield N	Dimension	Material	Density		
Shield 1	.021 ft	Custom	0.7		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Standard Indices					
Number of Groups: 25					
Lower Energy Cutoff: 0.015					
Photons < 0.015: Included					
Library: Grove					
Nuclide	Ci	Bq	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2	
Bi-210	1.0137e-006	3.7507e+004	8.3934e-006	3.1056e-001	
Bi-214	9.9981e-007	3.6993e+004	8.2783e-006	3.0630e-001	
Pb-210	1.0137e-006	3.7507e+004	8.3934e-006	3.1055e-001	
Pb-214	9.9981e-007	3.6993e+004	8.2783e-006	3.0630e-001	
Po-210	1.0139e-006	3.7516e+004	8.3954e-006	3.1063e-001	
Po-214	9.9960e-007	3.6985e+004	8.2766e-006	3.0623e-001	
Po-218	1.0000e-006	3.7000e+004	8.2800e-006	3.0636e-001	
Ra-226	1.0000e-006	3.7000e+004	8.2799e-006	3.0636e-001	
Rn-222	1.0000e-006	3.7000e+004	8.2800e-006	3.0636e-001	
Buildup: The material reference is Air Gap					
Integration Parameters					
Z Direction				20	
Y Direction				20	
Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	6.262e-04	7.205e-04	5.371e-05	6.180e-05
0.05	1.928e+03	5.709e-04	8.968e-04	1.521e-06	2.389e-06

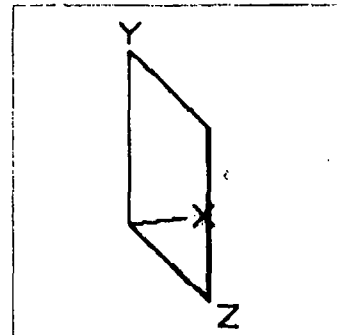


0.08	8.529e+03	4.161e-03	6.242e-03	6.585e-06	9.878e-06
0.1	5.022e+01	3.098e-05	4.410e-05	4.739e-08	6.747e-08
0.2	3.985e+03	5.096e-03	6.320e-03	8.994e-06	1.115e-05
0.3	7.634e+03	1.496e-02	1.761e-02	2.838e-05	3.340e-05
0.4	1.416e+04	3.754e-02	4.284e-02	7.314e-05	8.348e-05
0.5	6.608e+02	2.215e-03	2.477e-03	4.348e-06	4.863e-06
0.6	1.784e+04	7.237e-02	7.983e-02	1.413e-04	1.558e-04
0.8	3.496e+03	1.917e-02	2.073e-02	3.645e-05	3.944e-05
1.0	1.158e+04	8.015e-02	8.572e-02	1.477e-04	1.580e-04
1.5	7.043e+03	7.429e-02	7.809e-02	1.250e-04	1.314e-04
2.0	9.900e+03	1.406e-01	1.463e-01	2.175e-04	2.262e-04
Totals	1.014e+05	4.518e-01	4.878e-01	8.447e-04	9.179e-04
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.01 ft)
0.015	1.461e+04	9.305e-04	1.031e-03	7.981e-05	8.846e-05
0.05	1.928e+03	6.394e-04	8.126e-04	1.703e-06	2.165e-06
0.08	8.529e+03	4.601e-03	5.690e-03	7.282e-06	9.005e-06
0.1	5.022e+01	3.408e-05	4.100e-05	5.213e-08	6.273e-08
0.2	3.985e+03	5.513e-03	6.174e-03	9.731e-06	1.090e-05
0.3	7.634e+03	1.602e-02	1.746e-02	3.040e-05	3.312e-05
0.4	1.416e+04	3.993e-02	4.281e-02	7.780e-05	8.341e-05
0.5	6.608e+02	2.344e-03	2.486e-03	4.601e-06	4.880e-06
0.6	1.784e+04	7.627e-02	8.031e-02	1.489e-04	1.567e-04
0.8	3.496e+03	2.007e-02	2.092e-02	3.818e-05	3.979e-05
1.0	1.158e+04	8.356e-02	8.656e-02	1.540e-04	1.596e-04
1.5	7.043e+03	7.686e-02	7.890e-02	1.293e-04	1.327e-04
2.0	9.900e+03	1.448e-01	1.478e-01	2.239e-04	2.286e-04
Totals	1.014e+05	4.716e-01	4.910e-01	9.057e-04	9.494e-04
	Sensitivity	Variable	Shield #1	(2 of 4)	(0.02 ft)
0.015	1.461e+04	6.446e-04	7.400e-04	5.529e-05	6.347e-05
0.05	1.928e+03	5.758e-04	8.906e-04	1.534e-06	2.373e-06
0.08	8.529e+03	4.193e-03	6.199e-03	6.636e-06	9.810e-06
0.1	5.022e+01	3.120e-05	4.386e-05	4.774e-08	6.710e-08
0.2	3.985e+03	5.126e-03	6.309e-03	9.048e-06	1.113e-05
0.3	7.634e+03	1.504e-02	1.760e-02	2.853e-05	3.338e-05
0.4	1.416e+04	3.771e-02	4.284e-02	7.348e-05	8.347e-05
0.5	6.608e+02	2.224e-03	2.478e-03	4.366e-06	4.864e-06
0.6	1.784e+04	7.266e-02	7.987e-02	1.418e-04	1.559e-04
0.8	3.496e+03	1.923e-02	2.075e-02	3.658e-05	3.946e-05
1.0	1.158e+04	8.040e-02	8.579e-02	1.482e-04	1.581e-04
1.5	7.043e+03	7.449e-02	7.815e-02	1.253e-04	1.315e-04
2.0	9.900e+03	1.410e-01	1.464e-01	2.180e-04	2.264e-04
Totals	1.014e+05	4.533e-01	4.881e-01	8.488e-04	9.200e-04
	Sensitivity	Variable	Shield #1	(3 of 4)	(0.03 ft)
0.015	1.461e+04	4.621e-04	5.419e-04	3.964e-05	4.648e-05
0.05	1.928e+03	5.201e-04	9.566e-04	1.386e-06	2.548e-06
0.08	8.529e+03	3.831e-03	6.699e-03	6.062e-06	1.060e-05
0.1	5.022e+01	2.864e-05	4.671e-05	4.381e-08	7.146e-08

0.2	3.985e+03	4.774e-03	6.444e-03	8.426e-06	1.137e-05
0.3	7.634e+03	1.413e-02	1.773e-02	2.680e-05	3.364e-05
0.4	1.416e+04	3.565e-02	4.287e-02	6.947e-05	8.354e-05
0.5	6.608e+02	2.113e-03	2.470e-03	4.147e-06	4.849e-06
0.6	1.784e+04	6.927e-02	7.943e-02	1.352e-04	1.550e-04
0.8	3.496e+03	1.844e-02	2.058e-02	3.507e-05	3.914e-05
1.0	1.158e+04	7.740e-02	8.502e-02	1.427e-04	1.567e-04
1.5	7.043e+03	7.220e-02	7.742e-02	1.215e-04	1.303e-04
2.0	9.900e+03	1.372e-01	1.450e-01	2.122e-04	2.242e-04
Totals	1.014e+05	4.361e-01	4.852e-01	8.026e-04	8.985e-04
	Sensitivity	Variable	Shield #1	(4 of 4)	(0.04 ft)
0.015	1.461e+04	3.401e-04	4.052e-04	2.917e-05	3.476e-05
0.05	1.928e+03	4.713e-04	1.004e-03	1.255e-06	2.675e-06
0.08	8.529e+03	3.508e-03	7.134e-03	5.552e-06	1.129e-05
0.1	5.022e+01	2.634e-05	4.925e-05	4.029e-08	7.534e-08
0.2	3.985e+03	4.453e-03	6.568e-03	7.859e-06	1.159e-05
0.3	7.634e+03	1.329e-02	1.785e-02	2.521e-05	3.387e-05
0.4	1.416e+04	3.374e-02	4.289e-02	6.573e-05	8.357e-05
0.5	6.608e+02	2.008e-03	2.462e-03	3.942e-06	4.833e-06
0.6	1.784e+04	6.608e-02	7.900e-02	1.290e-04	1.542e-04
0.8	3.496e+03	1.769e-02	2.041e-02	3.364e-05	3.882e-05
1.0	1.158e+04	7.455e-02	8.427e-02	1.374e-04	1.553e-04
1.5	7.043e+03	7.001e-02	7.669e-02	1.178e-04	1.290e-04
2.0	9.900e+03	1.336e-01	1.436e-01	2.066e-04	2.221e-04
Totals	1.014e+05	4.198e-01	4.824e-01	7.632e-04	8.821e-04

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.01 ft)	4.716e-01	4.910e-01	9.057e-04	9.494e-04
1	(2 of 4)	(0.02 ft)	4.533e-01	4.881e-01	8.488e-04	9.200e-04
1	(3 of 4)	(0.03 ft)	4.361e-01	4.852e-01	8.026e-04	8.985e-04
1	(4 of 4)	(0.04 ft)	4.198e-01	4.824e-01	7.632e-04	8.821e-04

MicroShield 8.01 CEG (8.00-0000)					
Date		By		Checked	
Filename	Run Date	Run Time	Duration		
pickard5.msdl	October 24, 2011	10:56:19 PM	00:00:00		
Project Info					
Case Title		Pickard Carpet			
Description		1m Room 206			
Geometry		4 - Rectangular Area - Vertical			
Source Dimensions					
Width	396.24 cm (13 ft 0.0 in)				
Height	304.8 cm (10 ft 0.0 in)				
Dose Points					
A	X	Y	Z		
#1	100.635 cm (3 ft 3.6 in)	152.4 cm (5 ft 0.0 in)	228.6 cm (7 ft 6.0 in)		
Shields					
Shield N	Dimension	Material	Density		
Shield 1	.006 m	Custom	0.7		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Standard Indices Number of Groups: 25 Lower Energy Cutoff: 0.015 Photons < 0.015: Included Library: Grove					
Nuclide	Ci	Bq	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2	
Bi-210	1.0137e-006	3.7507e+004	8.3934e-006	3.1056e-001	
Bi-214	9.9981e-007	3.6993e+004	8.2783e-006	3.0630e-001	
Pb-210	1.0137e-006	3.7507e+004	8.3934e-006	3.1055e-001	
Pb-214	9.9981e-007	3.6993e+004	8.2783e-006	3.0630e-001	
Po-210	1.0139e-006	3.7516e+004	8.3954e-006	3.1063e-001	
Po-214	9.9960e-007	3.6985e+004	8.2766e-006	3.0623e-001	
Po-218	1.0000e-006	3.7000e+004	8.2800e-006	3.0636e-001	
Ra-226	1.0000e-006	3.7000e+004	8.2799e-006	3.0636e-001	
Rn-222	1.0000e-006	3.7000e+004	8.2800e-006	3.0636e-001	
Buildup: The material reference is Air Gap Integration Parameters					
Z Direction				20	
Y Direction				20	
Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate $\text{MeV}/\text{cm}^2/\text{sec}$ No Buildup	Fluence Rate $\text{MeV}/\text{cm}^2/\text{sec}$ With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	3.202e-04	3.668e-04	2.746e-05	3.146e-05
0.05	1.928e+03	2.607e-04	3.476e-04	6.945e-07	9.260e-07



0.08	8.529e+03	1.884e-03	2.428e-03	2.982e-06	3.843e-06
0.1	5.022e+01	1.398e-05	1.744e-05	2.138e-08	2.667e-08
0.2	3.985e+03	2.271e-03	2.601e-03	4.008e-06	4.590e-06
0.3	7.634e+03	6.616e-03	7.332e-03	1.255e-05	1.391e-05
0.4	1.416e+04	1.651e-02	1.795e-02	3.218e-05	3.497e-05
0.5	6.608e+02	9.705e-04	1.042e-03	1.905e-06	2.044e-06
0.6	1.784e+04	3.161e-02	3.363e-02	6.170e-05	6.564e-05
0.8	3.496e+03	8.331e-03	8.754e-03	1.585e-05	1.665e-05
1.0	1.158e+04	3.472e-02	3.622e-02	6.399e-05	6.676e-05
1.5	7.043e+03	3.199e-02	3.301e-02	5.382e-05	5.553e-05
2.0	9.900e+03	6.034e-02	6.185e-02	9.331e-05	9.564e-05
Totals	1.014e+05	1.958e-01	2.055e-01	3.705e-04	3.920e-04
	Sensitivity	Variable	Shield #1	(1 of 4)	(0.003048 m)
0.015	1.461e+04	4.123e-04	4.595e-04	3.536e-05	3.942e-05
0.05	1.928e+03	2.776e-04	3.300e-04	7.395e-07	8.791e-07
0.08	8.529e+03	1.992e-03	2.316e-03	3.152e-06	3.665e-06
0.1	5.022e+01	1.473e-05	1.679e-05	2.253e-08	2.569e-08
0.2	3.985e+03	2.370e-03	2.569e-03	4.184e-06	4.534e-06
0.3	7.634e+03	6.868e-03	7.299e-03	1.303e-05	1.385e-05
0.4	1.416e+04	1.708e-02	1.794e-02	3.327e-05	3.496e-05
0.5	6.608e+02	1.001e-03	1.043e-03	1.964e-06	2.048e-06
0.6	1.784e+04	3.252e-02	3.373e-02	6.347e-05	6.584e-05
0.8	3.496e+03	8.541e-03	8.796e-03	1.625e-05	1.673e-05
1.0	1.158e+04	3.550e-02	3.640e-02	6.544e-05	6.710e-05
1.5	7.043e+03	3.258e-02	3.319e-02	5.481e-05	5.584e-05
2.0	9.900e+03	6.129e-02	6.219e-02	9.477e-05	9.617e-05
Totals	1.014e+05	2.004e-01	2.063e-01	3.865e-04	4.011e-04
	Sensitivity	Variable	Shield #1	(2 of 4)	(0.006096 m)
0.015	1.461e+04	3.264e-04	3.734e-04	2.800e-05	3.202e-05
0.05	1.928e+03	2.620e-04	3.462e-04	6.979e-07	9.223e-07
0.08	8.529e+03	1.892e-03	2.420e-03	2.995e-06	3.829e-06
0.1	5.022e+01	1.403e-05	1.738e-05	2.147e-08	2.660e-08
0.2	3.985e+03	2.278e-03	2.598e-03	4.021e-06	4.586e-06
0.3	7.634e+03	6.635e-03	7.330e-03	1.259e-05	1.390e-05
0.4	1.416e+04	1.656e-02	1.795e-02	3.226e-05	3.497e-05
0.5	6.608e+02	9.728e-04	1.042e-03	1.910e-06	2.045e-06
0.6	1.784e+04	3.168e-02	3.364e-02	6.184e-05	6.565e-05
0.8	3.496e+03	8.347e-03	8.758e-03	1.588e-05	1.666e-05
1.0	1.158e+04	3.478e-02	3.623e-02	6.410e-05	6.678e-05
1.5	7.043e+03	3.203e-02	3.302e-02	5.390e-05	5.556e-05
2.0	9.900e+03	6.041e-02	6.187e-02	9.342e-05	9.568e-05
Totals	1.014e+05	1.962e-01	2.056e-01	3.716e-04	3.926e-04
	Sensitivity	Variable	Shield #1	(3 of 4)	(0.009144 m)
0.015	1.461e+04	2.592e-04	3.020e-04	2.223e-05	2.590e-05
0.05	1.928e+03	2.473e-04	3.633e-04	6.587e-07	9.677e-07
0.08	8.529e+03	1.799e-03	2.528e-03	2.846e-06	4.001e-06
0.1	5.022e+01	1.337e-05	1.800e-05	2.046e-08	2.754e-08

0.2	3.985e+03	2.190e-03	2.628e-03	3.865e-06	4.638e-06
0.3	7.634e+03	6.411e-03	7.360e-03	1.216e-05	1.396e-05
0.4	1.416e+04	1.605e-02	1.796e-02	3.128e-05	3.499e-05
0.5	6.608e+02	9.458e-04	1.040e-03	1.857e-06	2.041e-06
0.6	1.784e+04	3.087e-02	3.354e-02	6.025e-05	6.546e-05
0.8	3.496e+03	8.158e-03	8.720e-03	1.552e-05	1.659e-05
1.0	1.158e+04	3.407e-02	3.606e-02	6.280e-05	6.647e-05
1.5	7.043e+03	3.150e-02	3.286e-02	5.300e-05	5.528e-05
2.0	9.900e+03	5.955e-02	6.156e-02	9.208e-05	9.519e-05
Totals	1.014e+05	1.921e-01	2.049e-01	3.586e-04	3.855e-04
	Sensitivity	Variable	Shield #1	(4 of 4)	(0.012192 m)
0.015	1.461e+04	2.065e-04	2.446e-04	1.771e-05	2.098e-05
0.05	1.928e+03	2.335e-04	3.812e-04	6.219e-07	1.016e-06
0.08	8.529e+03	1.710e-03	2.642e-03	2.706e-06	4.181e-06
0.1	5.022e+01	1.275e-05	1.863e-05	1.950e-08	2.851e-08
0.2	3.985e-03	2.105e-03	2.658e-03	3.716e-06	4.691e-06
0.3	7.634e+03	6.195e-03	7.390e-03	1.175e-05	1.402e-05
0.4	1.416e+04	1.557e-02	1.796e-02	3.033e-05	3.500e-05
0.5	6.608e-02	9.196e-04	1.038e-03	1.805e-06	2.038e-06
0.6	1.784e+04	3.007e-02	3.344e-02	5.870e-05	6.527e-05
0.8	3.496e+03	7.974e-03	8.682e-03	1.517e-05	1.651e-05
1.0	1.158e+04	3.337e-02	3.589e-02	6.152e-05	6.615e-05
1.5	7.043e+03	3.098e-02	3.269e-02	5.212e-05	5.500e-05
2.0	9.900e+03	5.870e-02	6.124e-02	9.077e-05	9.470e-05
Totals	1.014e+05	1.880e-01	2.043e-01	3.469e-04	3.796e-04

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(0.003048 m)	2.004e-01	2.063e-01	3.865e-04	4.011e-04
1	(2 of 4)	(0.006096 m)	1.962e-01	2.056e-01	3.716e-04	3.926e-04
1	(3 of 4)	(0.009144 m)	1.921e-01	2.049e-01	3.586e-04	3.855e-04
1	(4 of 4)	(0.012192 m)	1.880e-01	2.043e-01	3.469e-04	3.796e-04

MicroShield 8.01 CEG (8.00-0000)

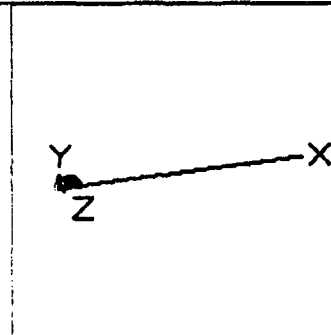
Date	By	Checked

Filename	Run Date	Run Time	Duration
pickard12.ms	October 24, 2011	11:07:29 PM	00:00:00

Project Info	
Case Title	Pickard Wood
Description	RM213 Wall 1ft
Geometry	1 - Point

Dose Points			
A	X	Y	Z
#1	33.02 cm (1 ft 1.0 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Shield 1	2.54 cm	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices		
Number of Groups: 25		
Lower Energy Cutoff: 0.015		
Photons < 0.015: Included		
Library: Grove		
Nuclide	Ci	Bq
Bi-210	1.0137e-006	3.7507e+004
Bi-214	9.9981e-007	3.6993e+004
Pb-210	1.0137e-006	3.7507e+004
Pb-214	9.9981e-007	3.6993e+004
Po-210	1.0139e-006	3.7516e+004
Po-214	9.9960e-007	3.6985e+004
Po-218	1.0000e-006	3.7000e+004
Ra-226	1.0000e-006	3.7000e+004
Rn-222	1.0000e-006	3.7000e+004

Buildup: The material reference is Air Gap
Integration Parameters

Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	9.121e-04	1.188e-03	7.823e-05	1.019e-04
0.05	1.928e+03	4.766e-03	9.669e-03	1.270e-05	2.576e-05
0.08	8.529e+03	3.603e-02	6.553e-02	5.702e-05	1.037e-04
0.1	5.022e+01	2.706e-04	4.544e-04	4.140e-07	6.952e-07
0.2	3.985e+03	4.546e-02	6.238e-02	8.023e-05	1.101e-04

0.3	7.634e+03	1.349e-01	1.715e-01	2.559e-04	3.253e-04
0.4	1.416e+04	3.411e-01	4.143e-01	6.647e-04	8.073e-04
0.5	6.608e+02	2.024e-02	2.386e-02	3.973e-05	4.684e-05
0.6	1.784e+04	6.643e-01	7.672e-01	1.297e-03	1.497e-03
0.8	3.496e+03	1.771e-01	1.987e-01	3.368e-04	3.780e-04
1.0	1.158e+04	7.438e-01	8.209e-01	1.371e-03	1.513e-03
1.5	7.043e+03	6.948e-01	7.474e-01	1.169e-03	1.258e-03
2.0	9.900e+03	1.322e+00	1.400e+00	2.044e-03	2.165e-03
Totals	1.014e+05	4.185e+00	4.683e+00	7.406e-03	8.332e-03
	Sensitivity	Variable	Shield #1	(1 of 4)	(1.27 cm)
0.015	1.461e+04	3.704e-03	4.484e-03	3.177e-04	3.846e-04
0.05	1.928e+03	5.768e-03	8.275e-03	1.537e-05	2.204e-05
0.08	8.529e+03	4.222e-02	5.728e-02	6.681e-05	9.065e-05
0.1	5.022e+01	3.140e-04	4.090e-04	4.804e-07	6.257e-07
0.2	3.985e+03	5.129e-02	6.028e-02	9.053e-05	1.064e-04
0.3	7.634e+03	1.498e-01	1.693e-01	2.842e-04	3.212e-04
0.4	1.416e+04	3.747e-01	4.138e-01	7.302e-04	8.063e-04
0.5	6.608e+02	2.206e-02	2.399e-02	4.329e-05	4.708e-05
0.6	1.784e+04	7.191e-01	7.740e-01	1.404e-03	1.511e-03
0.8	3.496e+03	1.898e-01	2.013e-01	3.611e-04	3.830e-04
1.0	1.158e+04	7.920e-01	8.328e-01	1.460e-03	1.535e-03
1.5	7.043e+03	7.312e-01	7.589e-01	1.230e-03	1.277e-03
2.0	9.900e+03	1.381e+00	1.422e+00	2.135e-03	2.199e-03
Totals	1.014e+05	4.463e+00	4.727e+00	8.138e-03	8.683e-03
	Sensitivity	Variable	Shield #1	(2 of 4)	(2.12e+00 cm)
0.015	1.461e+04	1.455e-03	1.856e-03	1.248e-04	1.592e-04
0.05	1.928e+03	5.079e-03	9.180e-03	1.353e-05	2.445e-05
0.08	8.529e+03	3.799e-02	6.266e-02	6.011e-05	9.915e-05
0.1	5.022e+01	2.844e-04	4.387e-04	4.351e-07	6.712e-07
0.2	3.985e+03	4.733e-02	6.167e-02	8.353e-05	1.088e-04
0.3	7.634e+03	1.397e-01	1.708e-01	2.650e-04	3.239e-04
0.4	1.416e+04	3.520e-01	4.142e-01	6.858e-04	8.070e-04
0.5	6.608e+02	2.083e-02	2.390e-02	4.088e-05	4.692e-05
0.6	1.784e+04	6.821e-01	7.694e-01	1.331e-03	1.502e-03
0.8	3.496e+03	1.812e-01	1.996e-01	3.447e-04	3.796e-04
1.0	1.158e+04	7.595e-01	8.248e-01	1.400e-03	1.520e-03
1.5	7.043e+03	7.067e-01	7.512e-01	1.189e-03	1.264e-03
2.0	9.900e+03	1.341e+00	1.407e+00	2.074e-03	2.176e-03
Totals	1.014e+05	4.275e+00	4.697e+00	7.613e-03	8.412e-03
	Sensitivity	Variable	Shield #1	(3 of 4)	(2.96e+00 cm)
0.015	1.461e+04	5.717e-04	7.594e-04	4.904e-05	6.514e-05
0.05	1.928e+03	4.473e-03	1.018e-02	1.192e-05	2.713e-05
0.08	8.529e+03	3.418e-02	6.853e-02	5.408e-05	1.085e-04
0.1	5.022e+01	2.576e-04	4.706e-04	3.940e-07	7.200e-07
0.2	3.985e+03	4.366e-02	6.310e-02	7.706e-05	1.114e-04
0.3	7.634e+03	1.303e-01	1.722e-01	2.471e-04	3.266e-04
0.4	1.416e+04	3.306e-01	4.145e-01	6.442e-04	8.077e-04

0.5	6.608e+02	1.967e-02	2.382e-02	3.861e-05	4.676e-05
0.6	1.784e+04	6.469e-01	7.650e-01	1.263e-03	1.493e-03
0.8	3.496e+03	1.730e-01	1.978e-01	3.290e-04	3.763e-04
1.0	1.158e+04	7.285e-01	8.170e-01	1.343e-03	1.506e-03
1.5	7.043e+03	6.831e-01	7.436e-01	1.149e-03	1.251e-03
2.0	9.900e+03	1.302e+00	1.393e+00	2.014e-03	2.154e-03
Totals	1.014e+05	4.098e+00	4.670e+00	7.220e-03	8.274e-03
	Sensitivity	Variable	Shield #1	(4 of 4)	(3.81 cm)
0.015	1.461e+04	2.246e-04	3.075e-04	1.927e-05	2.637e-05
0.05	1.928e+03	3.939e-03	1.071e-02	1.049e-05	2.853e-05
0.08	8.529e+03	3.075e-02	7.496e-02	4.866e-05	1.186e-04
0.1	5.022e+01	2.333e-04	5.049e-04	3.569e-07	7.724e-07
0.2	3.985e+03	4.028e-02	6.456e-02	7.110e-05	1.139e-04
0.3	7.634e+03	1.215e-01	1.736e-01	2.304e-04	3.294e-04
0.4	1.416e+04	3.105e-01	4.149e-01	6.050e-04	8.084e-04
0.5	6.608e+02	1.858e-02	2.374e-02	3.647e-05	4.660e-05
0.6	1.784e+04	6.136e-01	7.605e-01	1.198e-03	1.484e-03
0.8	3.496e+03	1.651e-01	1.961e-01	3.141e-04	3.730e-04
1.0	1.158e+04	6.986e-01	8.092e-01	1.288e-03	1.492e-03
1.5	7.043e+03	6.602e-01	7.361e-01	1.111e-03	1.239e-03
2.0	9.900e+03	1.265e+00	1.378e+00	1.956e-03	2.131e-03
Totals	1.014e+05	3.929e+00	4.643e+00	6.888e-03	8.191e-03

Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(1.27 cm)	4.463e+00	4.727e+00	8.138e-03	8.683e-03
1	(2 of 4)	(2.12e-00 cm)	4.275e+00	4.697e+00	7.613e-03	8.412e-03
1	(3 of 4)	(2.96e-00 cm)	4.098e+00	4.670e+00	7.220e-03	8.274e-03
1	(4 of 4)	(3.81 cm)	3.929e+00	4.643e+00	6.888e-03	8.191e-03

MicroShield 8.01 CEG (8.00-0000)

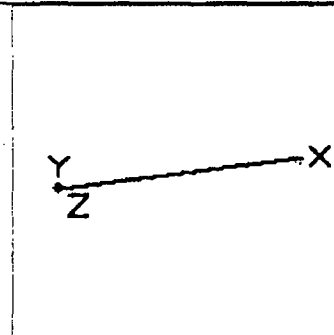
Date	By	Checked

Filename	Run Date	Run Time	Duration
pickard13.msd	October 24, 2011	11:11:47 PM	00:00:00

Project Info	
Case Title	Pickard Wood
Description	RM213 Wall 1m
Geometry	1 - Point

Dose Points			
A	X	Y	Z
#1	102.54 cm (3 ft 4.4 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Shield 1	2.54 cm	Custom	0.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices		
Number of Groups: 25		
Lower Energy Cutoff: 0.015		
Photons < 0.015: Included		
Library: Grove		
Nuclide	Ci	Bq
Bi-210	1.0137e-006	3.7507e+004
Bi-214	9.9981e-007	3.6993e+004
Pb-210	1.0137e-006	3.7507e+004
Pb-214	9.9981e-007	3.6993e+004
Po-210	1.0139e-006	3.7516e+004
Po-214	9.9960e-007	3.6985e+004
Po-218	1.0000e-006	3.7000e+004
Ra-226	1.0000e-006	3.7000e+004
Rn-222	1.0000e-006	3.7000e+004

Buildup: The material reference is Air Gap
Integration Parameters

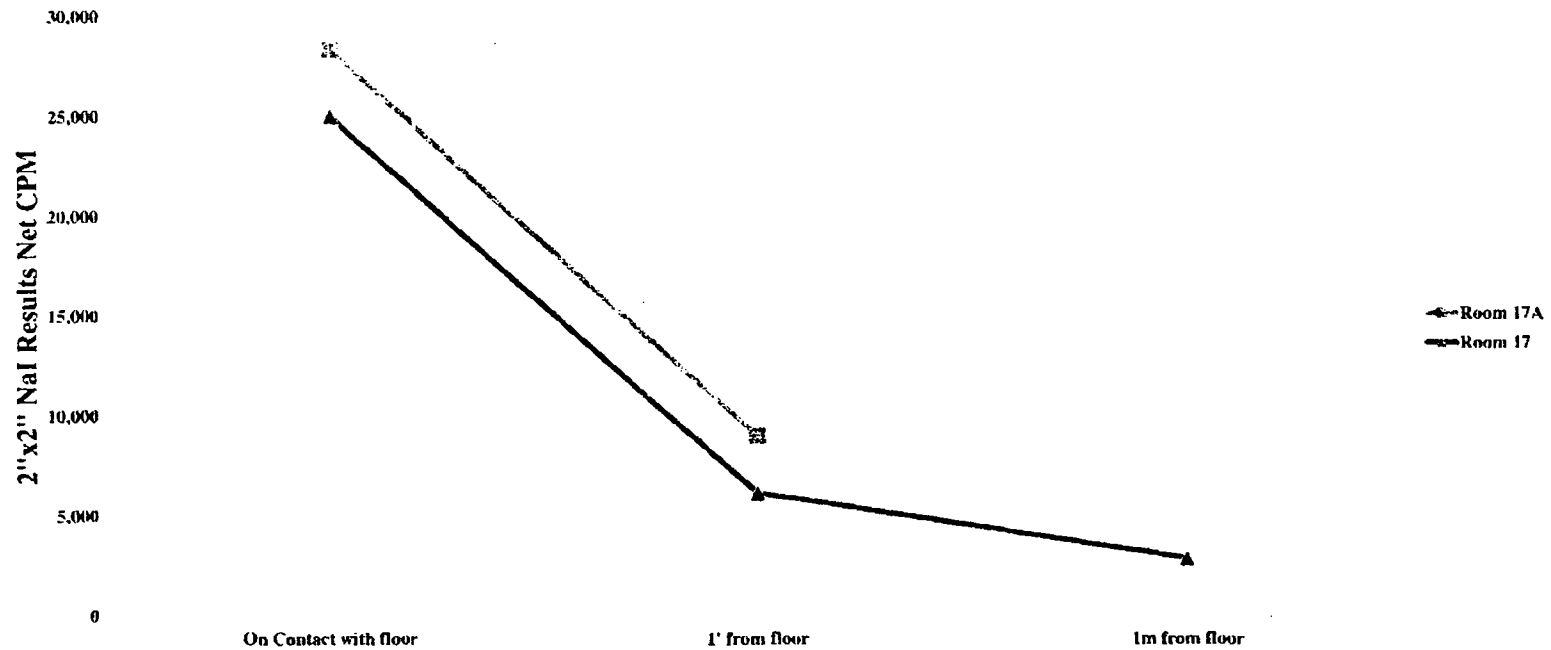
Results					
Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.461e+04	8.311e-05	1.088e-04	7.128e-06	9.336e-06
0.05	1.928e+03	4.861e-04	1.016e-03	1.295e-06	2.708e-06
0.08	8.529e+03	3.686e-03	6.875e-03	5.832e-06	1.088e-05
0.1	5.022e+01	2.771e-05	4.755e-05	4.239e-08	7.275e-08
0.2	3.985e+03	4.665e-03	6.488e-03	8.234e-06	1.145e-05

0.3	7.634e+03	1.386e-02	1.780e-02	2.630e-05	3.377e-05
0.4	1.416e+04	3.509e-02	4.297e-02	6.837e-05	8.373e-05
0.5	6.608e+02	2.084e-03	2.473e-03	4.090e-06	4.855e-06
0.6	1.784e+04	6.841e-02	7.950e-02	1.335e-04	1.552e-04
0.8	3.496e+03	1.825e-02	2.058e-02	3.471e-05	3.915e-05
1.0	1.158e+04	7.672e-02	8.502e-02	1.414e-04	1.567e-04
1.5	7.043e+03	7.173e-02	7.740e-02	1.207e-04	1.302e-04
2.0	9.900e+03	1.365e-01	1.450e-01	2.111e-04	2.242e-04
Totals	1.014e+05	4.316e-01	4.853e-01	7.628e-04	8.622e-04
	Sensitivity	Variable	Shield #1	(1 of 4)	(1.27 cm)
0.015	1.461e+04	3.375e-04	4.120e-04	2.895e-05	3.534e-05
0.05	1.928e+03	5.882e-04	8.698e-04	1.567e-06	2.317e-06
0.08	8.529e+03	4.319e-03	6.009e-03	6.834e-06	9.510e-06
0.1	5.022e+01	3.215e-05	4.280e-05	4.918e-08	6.547e-08
0.2	3.985e+03	5.264e-03	6.269e-03	9.291e-06	1.106e-05
0.3	7.634e+03	1.540e-02	1.758e-02	2.921e-05	3.335e-05
0.4	1.416e+04	3.855e-02	4.292e-02	7.511e-05	8.362e-05
0.5	6.608e+02	2.270e-03	2.486e-03	4.456e-06	4.880e-06
0.6	1.784e+04	7.407e-02	8.020e-02	1.446e-04	1.565e-04
0.8	3.496e+03	1.957e-02	2.086e-02	3.722e-05	3.967e-05
1.0	1.158e+04	8.168e-02	8.625e-02	1.506e-04	1.590e-04
1.5	7.043e+03	7.549e-02	7.859e-02	1.270e-04	1.322e-04
2.0	9.900e+03	1.426e-01	1.472e-01	2.206e-04	2.277e-04
Totals	1.014e+05	4.602e-01	4.897e-01	8.354e-04	8.953e-04
	Sensitivity	Variable	Shield #1	(2 of 4)	(2.12e+00 cm)
0.015	1.461e+04	1.326e-04	1.701e-04	1.137e-05	1.459e-05
0.05	1.928e+03	5.180e-04	9.650e-04	1.380e-06	2.571e-06
0.08	8.529e+03	3.886e-03	6.573e-03	6.149e-06	1.040e-05
0.1	5.022e+01	2.911e-05	4.591e-05	4.454e-08	7.024e-08
0.2	3.985e+03	4.857e-03	6.414e-03	8.572e-06	1.132e-05
0.3	7.634e+03	1.436e-02	1.773e-02	2.724e-05	3.363e-05
0.4	1.416e+04	3.621e-02	4.295e-02	7.055e-05	8.369e-05
0.5	6.608e+02	2.144e-03	2.478e-03	4.209e-06	4.864e-06
0.6	1.784e+04	7.025e-02	7.973e-02	1.371e-04	1.556e-04
0.8	3.496e+03	1.868e-02	2.067e-02	3.553e-05	3.932e-05
1.0	1.158e+04	7.834e-02	8.543e-02	1.444e-04	1.575e-04
1.5	7.043e+03	7.296e-02	7.780e-02	1.228e-04	1.309e-04
2.0	9.900e+03	1.385e-01	1.457e-01	2.142e-04	2.253e-04
Totals	1.014e+05	4.409e-01	4.867e-01	7.835e-04	8.698e-04
	Sensitivity	Variable	Shield #1	(3 of 4)	(2.96e+00 cm)
0.015	1.461e+04	5.209e-05	6.956e-05	4.468e-06	5.966e-06
0.05	1.928e+03	4.562e-04	1.071e-03	1.215e-06	2.852e-06
0.08	8.529e+03	3.496e-03	7.190e-03	5.532e-06	1.138e-05
0.1	5.022e+01	2.637e-05	4.925e-05	4.034e-08	7.534e-08
0.2	3.985e+03	4.481e-03	6.562e-03	7.909e-06	1.158e-05
0.3	7.634e+03	1.339e-02	1.788e-02	2.539e-05	3.391e-05
0.4	1.416e+04	3.401e-02	4.299e-02	6.626e-05	8.376e-05

0.5	6.608e+02	2.025e-03	2.469e-03	3.975e-06	4.847e-06
0.6	1.784e+04	6.663e-02	7.926e-02	1.300e-04	1.547e-04
0.8	3.496e+03	1.783e-02	2.049e-02	3.392e-05	3.898e-05
1.0	1.158e+04	7.513e-02	8.461e-02	1.385e-04	1.560e-04
1.5	7.043e+03	7.052e-02	7.701e-02	1.187e-04	1.296e-04
2.0	9.900e+03	1.346e-01	1.442e-01	2.081e-04	2.230e-04
Totals	1.014e+05	4.226e-01	4.839e-01	7.440e-04	8.566e-04
	Sensitivity	Variable	Shield #1	(4 of 4)	(3.81 cm)
0.015	1.461e+04	2.047e-05	2.809e-05	1.755e-06	2.410e-06
0.05	1.928e+03	4.017e-04	1.113e-03	1.070e-06	2.966e-06
0.08	8.529e+03	3.145e-03	7.864e-03	4.977e-06	1.245e-05
0.1	5.022e+01	2.388e-05	5.283e-05	3.654e-08	8.082e-08
0.2	3.985e+03	4.134e-03	6.714e-03	7.297e-06	1.185e-05
0.3	7.634e+03	1.248e-02	1.803e-02	2.368e-05	3.419e-05
0.4	1.416e+04	3.194e-02	4.303e-02	6.224e-05	8.383e-05
0.5	6.608e+02	1.912e-03	2.461e-03	3.754e-06	4.830e-06
0.6	1.784e+04	6.319e-02	7.880e-02	1.233e-04	1.538e-04
0.8	3.496e+03	1.702e-02	2.031e-02	3.237e-05	3.864e-05
1.0	1.158e+04	7.206e-02	8.381e-02	1.328e-04	1.545e-04
1.5	7.043e+03	6.817e-02	7.623e-02	1.147e-04	1.283e-04
2.0	9.900e+03	1.307e-01	1.427e-01	2.021e-04	2.207e-04
Totals	1.014e+05	4.052e-01	4.812e-01	7.101e-04	8.485e-04

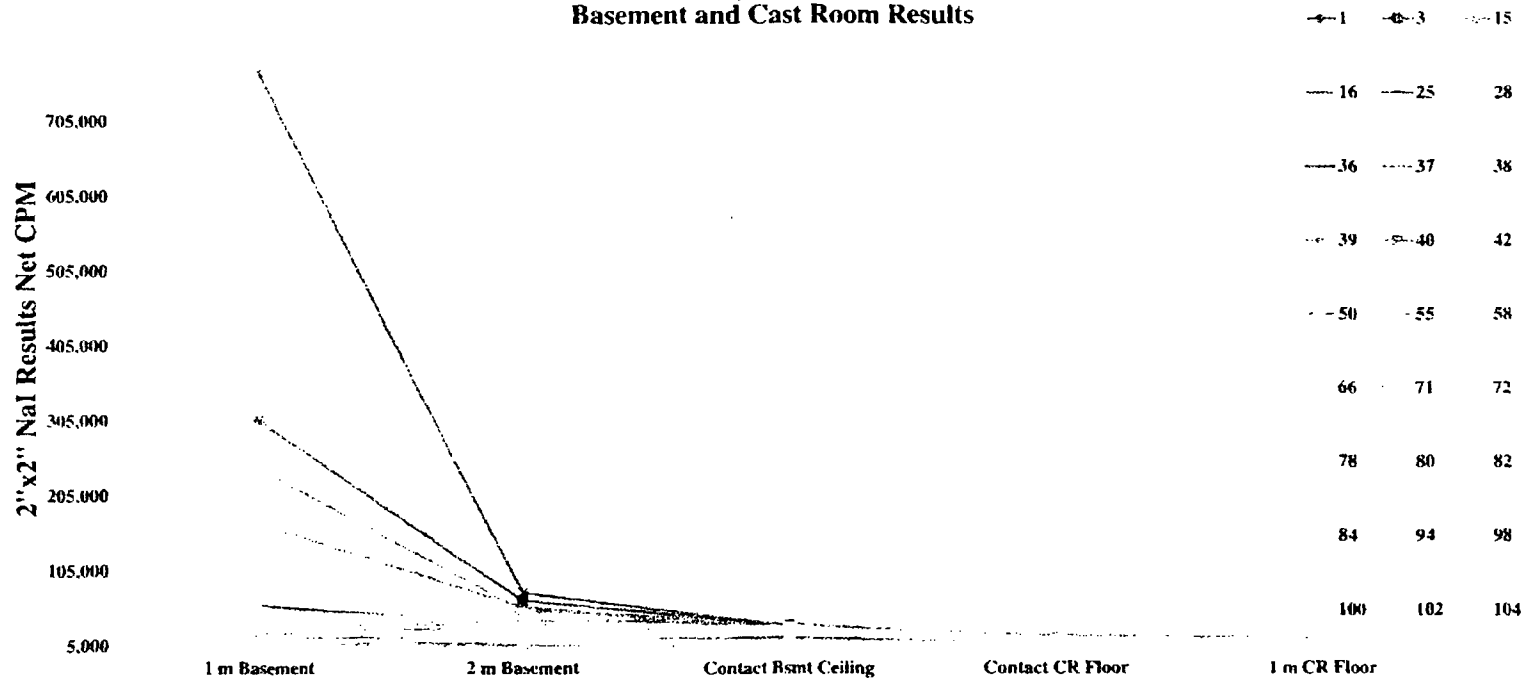
Sensitivity Analysis Summary - Shield #1						
Dose Point #	Sensitivity	Sensitivity Dimension	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1	(1 of 4)	(1.27 cm)	4.602e-01	4.897e-01	8.354e-04	8.953e-04
1	(2 of 4)	(2.12e+00 cm)	4.409e-01	4.867e-01	7.835e-04	8.698e-04
1	(3 of 4)	(2.96e+00 cm)	4.226e-01	4.839e-01	7.440e-04	8.566e-04
1	(4 of 4)	(3.81 cm)	4.052e-01	4.812e-01	7.101e-04	8.485e-04

Room 17A/17 Source Origination Investigation Results All Results



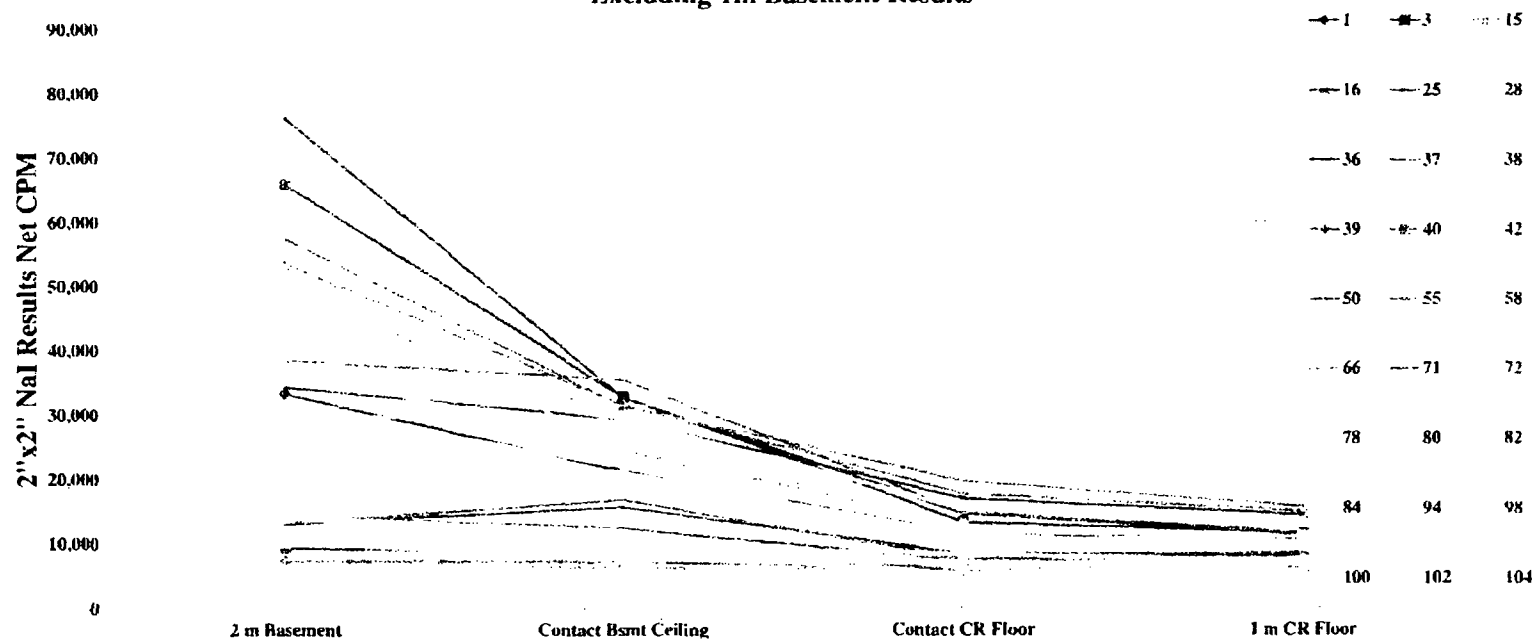
The chart above indicates the source of elevated gamma exposure rates in room 17 originate in room 17A at the base of the wall near the floor surface. The resultant elevated count rate noted in room 17 parallels room 17A at a lower count rate, consistent with a reduction due to shielding and distance. The sample location 1m from the floor in room 17A was inaccessible.

Room 104 Source Origination Investigation Results Basement and Cast Room Results



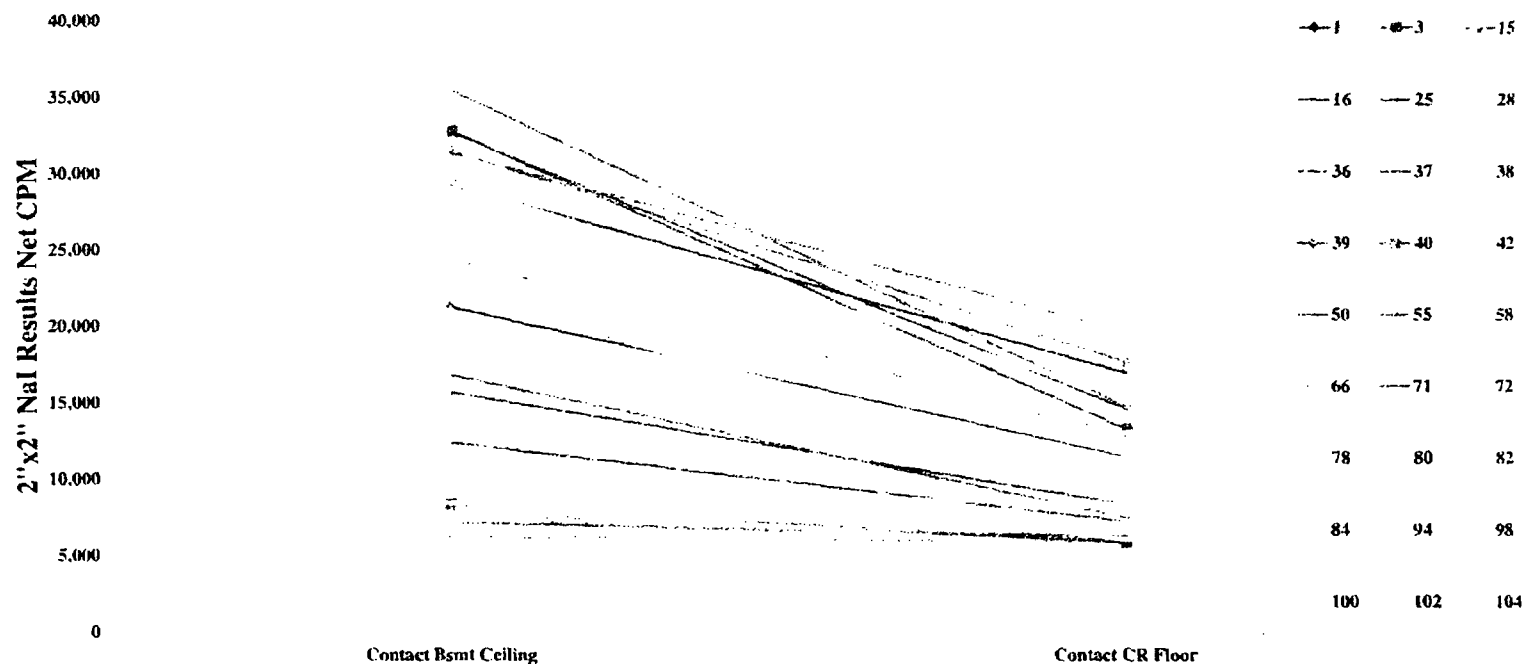
The chart above indicates the source of elevated gamma exposure rate in room 104 originates in the basement. The sample set contains a negative slope in count rate as the distance from the basement floor increases. Because the scale makes it difficult to decipher data from 2m above the basement floor to 1m above room 104 floor, additional graphical representations follow which remove the 1m location and concentrate on specific distances to show the specific trends.

Room 104 Source Origination Investigation Results Excluding 1m Basement Results



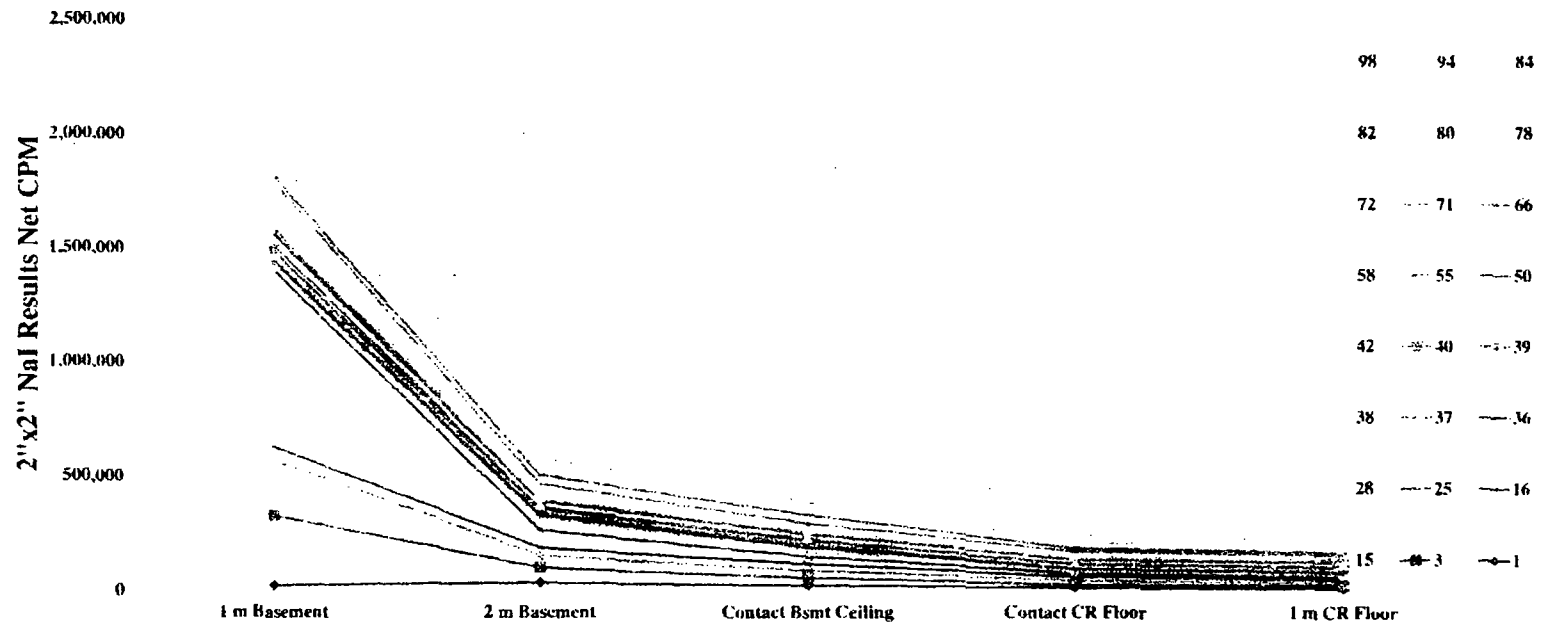
The chart above indicates the source of elevated gamma exposure rate originates in the basement at or below 2m above the basement floor. From the trend noted in the previous graphical representation it can be concluded the source of elevated activity originates in the basement floor due to the correlation and slope between the 1 m basement and 2m basement count rates presented. Shielding exists at the on-contact basement ceiling location and the on-contact east room floor locations. The following narrows the data even further to two sets of samples.

Room 104 Source Origination Investigation Results Below and Above Cast Room Floor



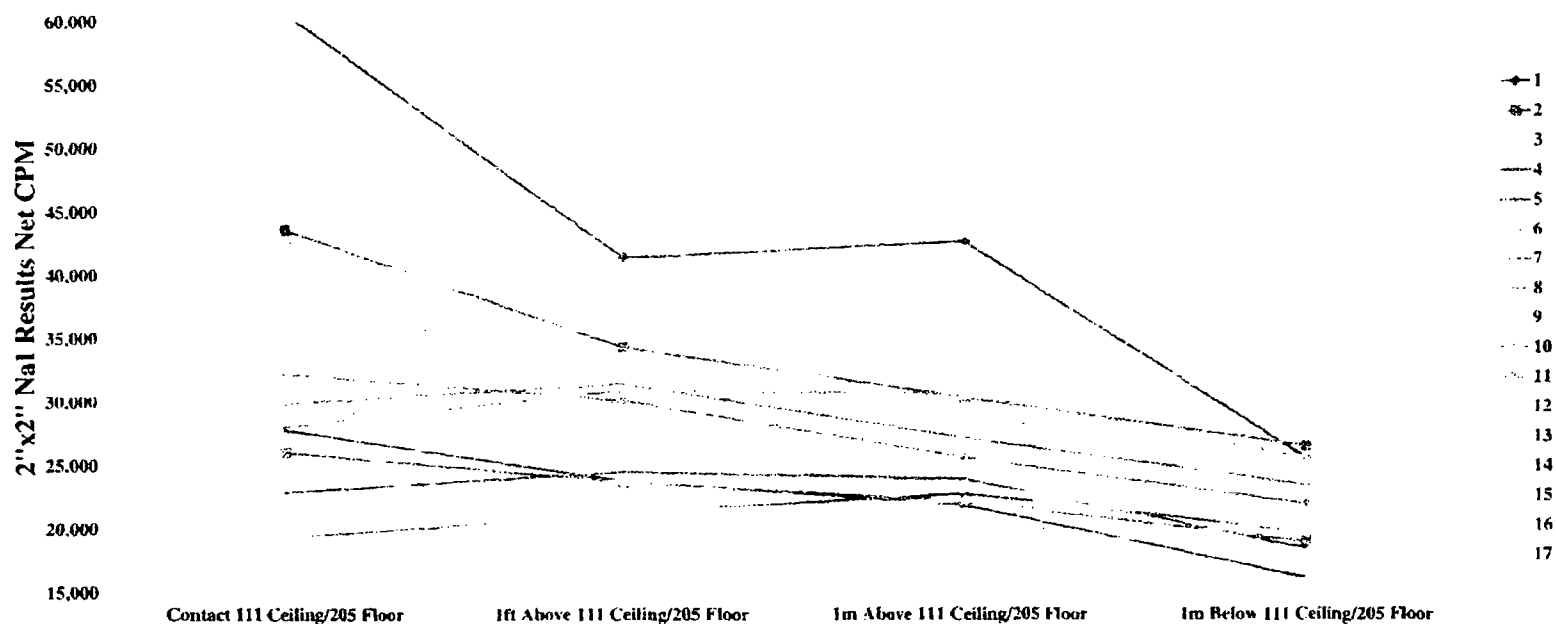
The chart above indicates the source of elevated gamma exposure rate originates in the basement. The results indicate that the count rates for all sample locations in the basement are higher than the count rates above the floor in room 104. The lower count rates in room 104 are consistent with a reduction in source activity due to shielding and distance for a large planar source and the floor does not add to the basement count rates.

Room 104 Source Origination Investigation Results Stacked Results

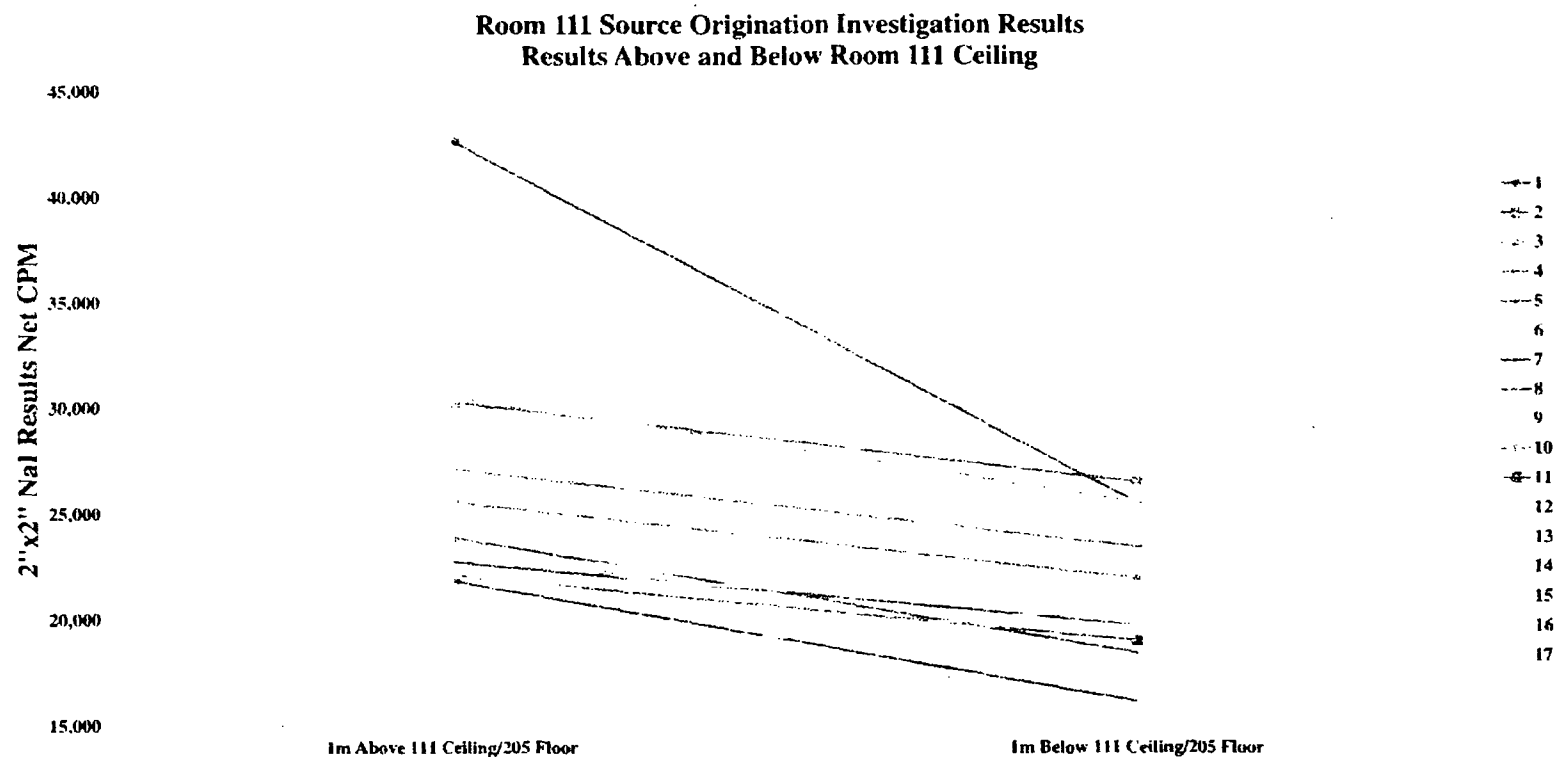


The chart, a stacked chart, displays the trend of the percentage each sample location contributes over the area sampled. Each location is added to the previous to determine the general trend and average relationship between measurements. The results above indicate the source of elevated gamma exposure rate originates in the basement. This trend is used to present the consistency with the stacked results. On average, the stacked results from 1m above the basement floor decrease in count rate to approximately one-quarter the original count rate for every doubling in distance from the source of elevated gamma exposure rate.

Room 111 Source Origination Investigation Results All Results

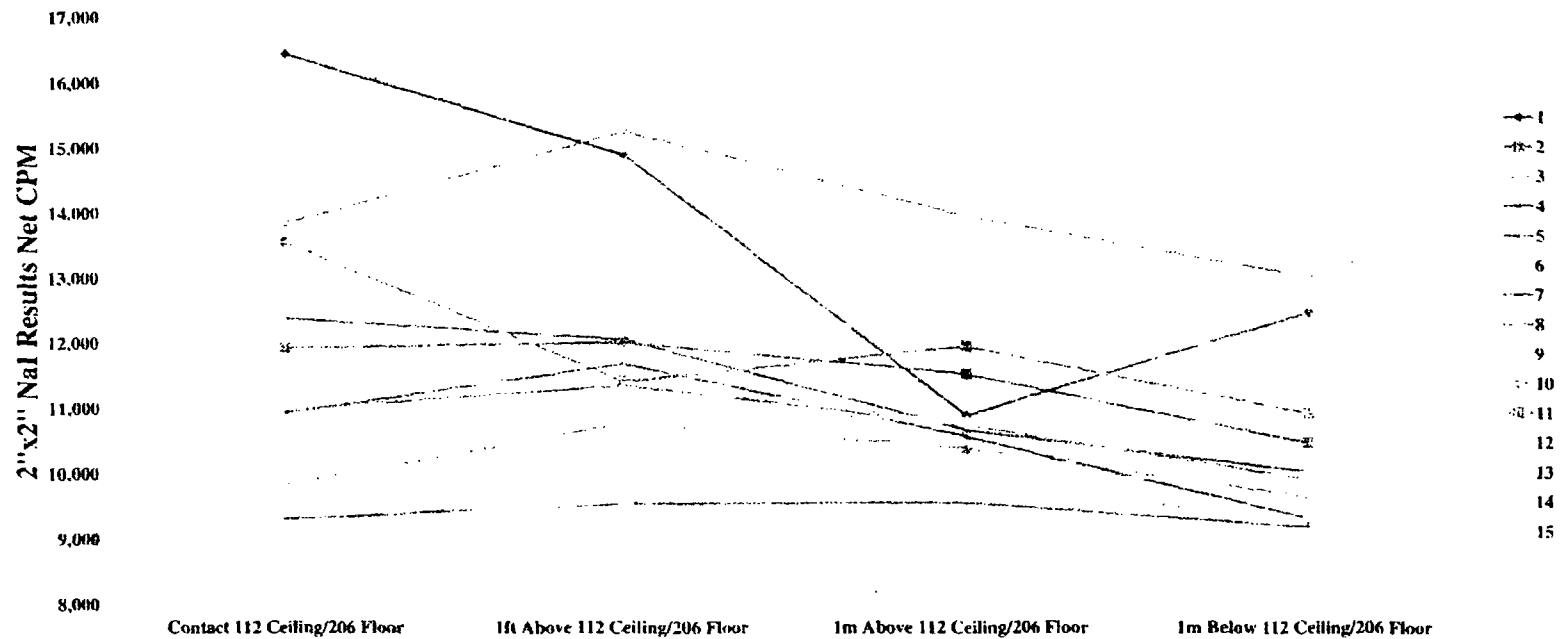


The chart above indicates the source of elevated gamma exposure rate is inconclusive. The count rate fluctuates slightly for the count rates at or above the room 111 ceiling. Probe orientation varies due to access limitations, so variability was expected. All but one sample location display lower count rates below the room 111 ceiling when compared to the count rates above the ceiling. A more accurate representation of these results follows.

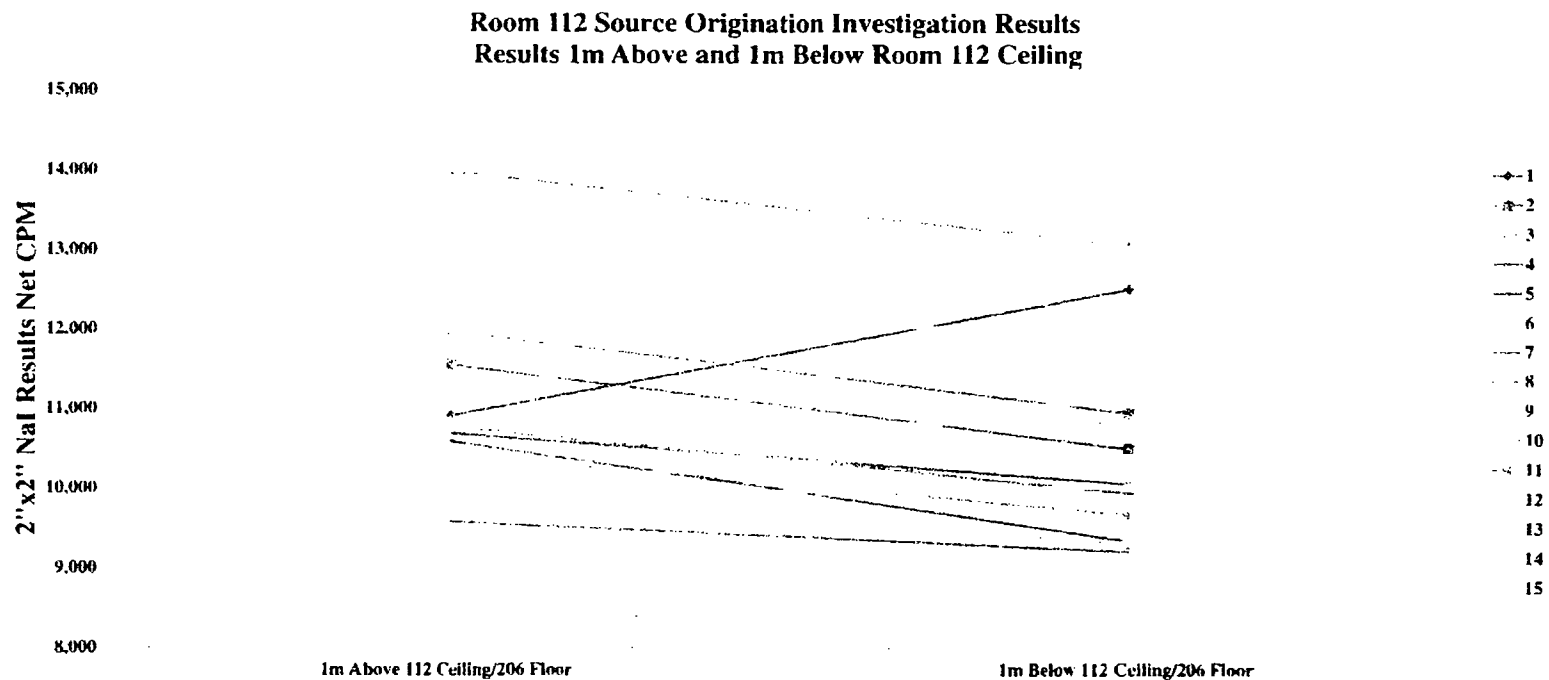


The chart above indicates the source of elevated gamma exposure rate originates above room 111's ceiling. All but one sample location (#17) displayed lower count rates below the room 111 ceiling when compared to the count rates above the ceiling consistent with a reduction in source activity due to shielding and distance. The one outlier result (#17) can be attributed to geometrical variations.

Room 112 Source Origination Investigation Results All Results



The chart above indicates the source of elevated gamma exposure rate is inconclusive. Count rate fluctuations can be attributed to the inherent characteristics of sodium iodide probe detection sensitivities at certain angles, natural instrument and background fluctuations, and varying materials. The overall net cpm range is 9K to 16.5K, with a mean of 11.2K. The variation is within the normal variations of the instrument due to background fluctuations and instrument response variations.



The chart above indicates the source of elevated gamma exposure rate origination is inconclusive. Count rate fluctuations can be attributed to the inherent characteristics of sodium iodide probe detection sensitivities at certain angles, natural instrument and background fluctuations, and varying materials. The overall net cpm range for 1m below the room 112 ceiling is 9K to 13K, with a mean of 10.5K. The variation is within the normal variations of the instrument due to background fluctuations and instrument response variations. The overall net cpm range for 1m above the room 112 ceiling is 9.5K to 14K, with a mean of 11K. The variation is within the normal variations of the instrument due to background fluctuations and instrument response variations.