UNIVERSITY *of* MISSOURI

ENVIRONMENTAL HEALTH AND SAFETY

Ms. Christine Lipa
Chief Materials Control, ISFSI, and Decommissioning Branch
Division of Nuclear Materials and Safety
Region III
U.S. Nuclear Regulatory Commission
2443 Warrenville Road
Lisle, Illinois 60532

February 6, 2013

Re: University of Missouri's response to U.S. NRC letter dated November 6th, 2012 (ML12312A095) concerning Pickard Hall Alternate Decommissioning Schedule (Mail Control No. 574562)

Dear Ms. Lipa:

This refers to your letter dated November 6, 2012. Enclosed are our responses to the requests for additional information in regards to Pickard Hall Alternate Decommissioning Schedule. There were several RAI's we were able to provide responses at this time. However, as was discussed with Mr. Lafranzo on January 14, there are several other RAI's that we are requesting an extension for responding too as MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization.

We believe our requests for these extensions are reasonable given that the extensions will enable us to provide more informed responses due to the opportunity to complete a more detailed characterization of Pickard Hall that will ultimately shorten the proposed timeframe of the original alternate schedule request and help us determine if we need to file a new request as part of a Federal Register Notice as was discussed with Mr. Lafranzo.

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

Sincerely,

Jack Crawford
Radiation Safety Officer

Attachments
cc: J. Jones
S. Jurisson
M. Kotlas
S. Engelhardt
RSO File

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University of Missouri's response to U.S. NRC letter dated November 6th, 2012 (ML12312A095) concerning Pickard Hall Alternate Decommissioning Schedule February 6th 2013 (16 pages)

UNIVERSITY OF MISSOURI'S RESPONSE TO U.S. NRC LETTER DATED NOVEMBER 6TH, 2012 (ML12312A095) CONCERNING PICKARD HALL ALTERNATE DECOMMISSIONING SCHEDULE FEBRUARY 6TH 2013

RAI-01a: The licensee should provide specific dates for the proposed Alternate Schedule.

Response: MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

Detail: This relocation will facilitate additional characterization of Pickard Hall and allow MU to provide realistic dates for the proposed alternate schedule. MU hopes to move the PHF&S, the museum operations, and the artifacts to other locations sometime near the end of 2013 or early 2014. This presumes there are no unforeseen complications with work that will need to be completed in the new locations or in moving the artifacts. Once Pickard Hall is unoccupied and empty of contents, MU can better assess the radiological status of the building.

If the NRC is unable to grant an extension until December 2, 2013, MU asks for approval to provide periodic updates on progress with requests for extensions for additional time as needed.

The RAIs, proposed plans, associated dates and reasons for the dates were discussed with Mr. Mike Lafranzo per phone conference call on September 27, 2012.

RAI-01 b: The licensee should provide a description of how the University will begin planning for a proposed schedule for the movement of artifacts located within the museum that would allow for the start of decommissioning.

Response: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

Detail: See response and details provided to RAI-01a.

RAI-01 c: 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.

Response: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

Detail: MU will continue to perform monthly radiological surveillances of Pickard Hall during the time frame of this extension request. This will also include periodic monitoring of the building's physical condition by Campus Facilities (CF) staff and the Pickard Hall building coordinator throughout that period. Any condition that would require modification to the building would be coordinated between CF and Environmental Health and Safety (EHS) Radiation Safety (RS). Once the building is unoccupied and empty of contents, a more detailed assessment of Pickard Hall's physical condition can be performed to provide a more complete answer to this RAI.

RAI-01d: The licensee should discuss the current decommissioning cost estimate and the potential for increased decommissioning costs, if an Alternate Schedule is approved.

Response: A Decommissioning Funding Plan (DFP) dated May 2011, was submitted to NRC representative Ms. Katie Streit on June 11, 2011. Pickard Hall is specifically addressed in Appendix C, page C.16. The DFP has a conservative 25% contingency added to the calculated overall cost. The DFP is reviewed every 3 years and is tied to our licensing renewal. If during the review periods costs are projected to change significantly due to increased costs of fuel, increased waste disposal costs, or for other economic or financial reasons, MU will re-evaluate the DFP to determine if the current cost structure is still accurate or if adjustments are needed. A copy of the DFP is attached as Attachment 1 – MU's DFP, May 2011.

RAI-02a: 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.

Response: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a more complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

Detail: MU has been actively searching for schematics that would allow us to assess and respond to this RAI more completely. The oldest schematics we have are from 1892 and while they show some duct work and some airflow patterns, they do not specifically describe the ducts in question. The other schematics we have located are from a large remodeling project in 1974 that changed the original design to a completely new HVAC system. These schematics do not specifically address the old ductwork with the exception of one central duct on drawing A-2-1 was to be "enclosed existing shaft with existing bricks". See Attachment 2 – Various Schematics of Ductwork for Pickard 1892 (2 drawings), and 1974 (5 drawings).

The only known and visible access to the original ductwork is in the restricted area of the attic. MU does not permit access to those ducts without permission and involvement by EHS Radiation Safety Health Physicists. No construction or demolition activities will be performed that might impact these ducts without further assessment by MU or a qualified consultant in coordination with the NRC. Current radiological surveys of accessible areas

RAI-02b: 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.

Response: MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions" to address this and several other RAIs. MU recognizes that PHF&S, Campus Facilities (CF) personnel and other applicable staff will need to be trained on the new procedures once they are approved.

RAI-02c: 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.

Response: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a more complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

MU continues to conduct regular surveys of the basement areas to evaluate the condition of the contamination and verify that the contamination remains fixed.

Detail: MU requests an extension to answer this RAI for the reasons stated in RAI-01a. With the building unoccupied and empty, the sampling of the basement floor areas will be more complete and reliable and will prevent damage of the artifacts from temporary shifting and relocation during the sampling.

RAI-02d: 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.

Response: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a more complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

RAI-02e: 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.

Response: MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: As stated in the response to RAI-02b, EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions" to address this and several other RAIs.

MU has interim controls in place to control access to the impacted areas of Pickard Hall including training of the PHF&S on these expectations. MU has also established additional administrative controls by working with CF to place work restrictions for Pickard Hall into CF's maintenance work order software system "Maximo" so when CF prints out work orders for Pickard Hall they get a notification message. That message is "CONTACT EHS RADIATION SAFETY

AT 882-5024 BEFORE WORKING ON ANY BLDG COMPONENTS TO INCLUDE CEILINGS, WALLS, FLOORS, DRAINS, HVAC, FURNITURE MOVING, ETC." The length of this message has been developed to accommodate the character limit that is available in the system.

RAI-02f: 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.

Response: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S) and museum operations. This will eventually result in restricted access to the building by EHS RS to staff who are either fully trained as radiation workers or are under the supervision of EHS RS. Please see Attachment 3a – "Radiation Worker Training Status report for Pickard Hall 55555, for the list of PHF&S who have already been trained as Radiation Workers using our current RS program and Attachment 3b – Radiation Safety for new Radiation Workers at MU" which is the RW training outline tailored for them with emphasis on Pickard Halls special conditions. As new graduate students or museum staff are hired and begins work in Pickard Hall they will be trained by EHS RS. Radiation worker training is conducted as part of the training program managed under the conditions of our broad scope license.

RAI-02g: 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.

Response: MU uses the term "invasive activities" to mean an activity that may disturb building surfaces such as drilling, scraping, etc. As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions" to address this and several other RAIs.

RAI-02h: The licensee should provide a description of how and how often the licensee will inspect the integrity of the encapsulant.

Response: MU uses an administrative authorization, identified internally as #55555, to conduct monthly surveillances. During those surveillances we inspect the physical condition of the encapsulant in Pickard Hall during our routine surveillances/monitoring activities and perform surveys for fixed and removable contamination in all areas of the building.

RAI-02i: The licensee should provide a description of what actions the licensee will take if the encapsulant is determined to be compromised.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions" to address this and several other RAIs.

The SOP will include the process for controlling areas where encapsulant has failed. It will also include the process for: 1) re-applying encapsulate in cases where decontamination can be accomplished by nonaggressive means; and 2) in cases where decontamination cannot be accomplished but the area can be controlled and managed for the re-application of a secondary encapsulant.

RAI-02j: The licensee should provide a description of the locations and periodicity of the routine surveillance program that will be used for Pickard Hall.

Response: Please see Attachment 4 – Pickard Hall 55555 January 2013 inspection/survey report. This report has several maps of the areas of Pickard Hall that we physically survey for radiation levels and removable contamination. This surveillance includes the performance of radiation level surveys at the microRem/hr level as well as ~40 removable contamination smear checks which are counted on a sensitive alpha, beta proportional combination NAI gamma counter with triggers for investigation at 200 cpm/100 cm2 for removable beta/gamma and 20 cpm/100 cm2 for removable alpha. MU alternates the locations surveyed by performing a survey of the basement level in one month and a survey of the first and second floors in the alternate month.

RAI-02k: The licensee should provide the type of instruments and capabilities of each instrument that will be used to monitor the building.

Response: MU is using a Ludlum 14C survey meter with a GM pancake 44-9 probe for fixed contamination level readings in CPM, and a Ludlum Model 192 MicroRem meter or similar instrument (Model 9DP) for the ambient radiation levels in uR/hr. The calibration sheets for the most recently used instruments are attached. See Attachment 5 – "Calibrations sheets for most recent used Ludlum's used at Pickard".

RAI-02l: 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.

Response: The geographical area where Pickard Hall sits is listed on the National Register of Historic Places as the "Francis Quadrangle Historic District". Pickard Hall itself, however, is not specifically registered as a national historic location. The statement that Pickard Hall itself was listed as a national historic building was an error and we will remove it from future correspondence.

RAI-02m: 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.

Response: Please refer to the response to RAI-01a. MU anticipates that the relocation of building occupants and contents will progress without unforeseen delays and should be able to provide an update on how operations may be impacted and what a schedule for decommissioning activities may look like by December 2, 2013.

RAI-02n: The licensee should provide legible copy of Attachment 1.

Response: Please see Attachment 6 – Original Attachment 1 - Pickard Hall Radon Monitoring Results.

RAI-03a: 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.

Response: MU contracted Chase Environmental Group Inc. (Chase) to perform these surveys. According to Chase, the large area wipes (LAW) are conducted as a qualitative measurement. Since errors associated with LAWs are large, accurate quantification in conventional units is not feasible. The area of coverage was not accurately measured for each wipe, so results are qualitatively reported as activity per wipe. The 400 ft^2 area referred to in the report is an estimate of the area wiped for the LAW covering the least area.

LAWs are a simple method to provide qualitative removable activity data over large areas – more than 3,000 disc smears would be required to cover an area of 400 ft^2. LAWs are generally more sensitive than disc smears because small amounts of removable activity that may be present over large areas are concentrated on the oil impregnated cloth. LAW results were used as inputs for evaluation of the need for further investigation of areas using disc smears.

Beta measurements that are less impacted by dust loading were also performed on LAWs.

In summary, the LAW used by the consultant was a qualitative measure to indicate what level of further evaluation would be required.

RAI-03b: The licensee should provide documentation regarding efficiency corrections for alpha shielding from dust loading, if applicable.

Response: MU contracted Chase to perform the surveys referenced in this RAI. According to Chase no dust loading corrections are made for LAWs as described above.

RAI-03c: The licensee should provide information that clarifies the statements in Section 9.2.2 in relationship to Appendix F and Appendix G.

Response: MU contracted Chase to perform these surveys. According to Chase, the statement regarding all measurements being less than twice background was in reference to outdoor GPS-based gamma scans only. A new paragraph should have been started with the word "subsequently".

RAI-03d: 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.

Response: MU contracted Chase to perform these surveys. According to Chase, the Gamma scans were used to identify areas with elevated surface exposure rates indicating that residual radioactivity was present. Due to differences in building structural materials, geometry, and other factors, variability is normal. At indoor locations with elevated exposure rates above the normally expected variation, external dose rate measurements were performed. Locations and results of external dose rate measurements are presented in Appendix J and K. Dose rates are compared to annual external doses and occupancy periods at each location in Appendix K. Assessment of the potential for spread of contamination and internal exposures is based on surface contamination measurements.

MU plans to further characterize normally inaccessible areas in coordination with the moving of PHF&S, museum operations, and the artifacts permit. In the meantime MU is controlling exposures by limiting access to these areas and monitoring personnel for external exposures.

RAI-03e: 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.

Response: MU contracted Chase to perform these surveys. According to Chase, as part of the initial project training session, all survey personnel completed practical training on survey techniques, including scan rates. Scan rate training consisted of placing a strip of tape approximately six feet long on the floor marked at every one-second interval (i.e., every 5 inches for a scan rate of 5 inches per second). The survey technician then performed timed scans to practice scanning at the desired rate. Survey technicians were assigned only one type of scan to avoid variable scan rates (i.e., one technician performed all the alpha scans with a 43-37 probe and another technician performed all the beta scans with a different 43-37 probe).

When the scan rate becomes less than about ½"/sec, it is increasingly difficult to attain a steady scan rate. Therefore, at scan rates less of ½"/sec or less, scanning is performed by holding the probe at a fixed location for the desired residence interval. For example, the 43-68 detector width is 8.8 cm (3.5 in), so a scan rate of 0.2 in/sec equates to a residence interval of 17.3 seconds, therefore the surveyor would hold the detector in a fixed position and listen for an audible increase in the count rate for a period of 18 seconds before moving to the next contiguous location.

The 43-68 probe was only used to perform concrete surface measurements in conjunction with concrete scarification at locations where vinyl tile had been removed (six locations with an area of $1ft^2$ each).

RAI-03f: 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.

Response: MU contracted Chase Environmental to perform these surveys. Since MU did not perform these surveys, we did not conduct training on the survey procedure.

According to Chase, the correlation of cpm to pCi/g requires laboratory analysis of soil samples or dose modeling. Modeling heavily depends on the geometry of the source term that cannot be accurately determined within the limitations of this characterization effort. Footnote 8 in the report clarifies that the referenced MDAs are from NUREG 1507 and are specific to the geometry assumptions and survey parameters described in NUREG 1507. Because the source term geometry could not be accurately determined, no attempt was made to determine a correlation between activity concentrations and surface exposure rates.

MU plans to conduct further surface and subsurface characterization that will include laboratory analysis of solid samples to more accurately determine activity concentrations.

RAI-03g: The licensee should provide Chain of Custody Procedure.

Response: The chain of custody procedure used by Chase is attached. Please see Attachment 7 – Chase Environmental Group, Inc - QAP 8.2 Chain-of-Custody Procedure.

RAI-03h: 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 materials 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.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions".

RAI-03i: 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.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions".

The final SOP will address the process to restrict access to areas of known contamination both inside and outside of Pickard Hall. Note that all areas of known contamination are already restricted as per other administrative controls and special conditions in the administrative authorization, identified internally as #55555. Additionally, postings indicate that no one is to enter or disturb any potentially contaminated surfaces without first contacting EHS Radiation Safety (RS). MU Campus Facilities (CF), the museum director, and Pickard Halls' building coordinator are aware of these restrictions and help to maintain the restricted access to those locations.

RAI-03j: The licensee should develop, implement and maintain procedures to limit the intrusion of water into areas where residual radioactivity exists.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions".

Different types of construction methods have been used in several renovations of Pickard Hall over the years that have reduced the likelihood of water intrusion into the building. MU cannot say with absolute certainly that a building of this age is completely protected against water intrusion. The SOP mentioned above will address in more detail some of the steps that have been taken over the years and the actions we plan to take should there be an intrusion of water.

RAI-03k: 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.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions" that will address this issue.

RAI-03l: The licensee should develop, implement and maintain procedures to ensure unauthorized individuals do not gain access to the Feeder or Steam Tunnels.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Details: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions".

The final SOP will address these procedures. Generally, all grated and door entrances to the steam tunnel are securely locked and the keys are secured by Campus Facilities (CF) Energy Management (EM). Additionally, the steam tunnels are equipped with security devices, monitored remotely by CF EM, that sense and warn of the presence of an unauthorized person. If an intrusion would occur CF EM would alert the MU Police Department (MUPD) who would respond to the location of the nearest sensor and take appropriate action. The SOP will address additional coordination with EHS should unauthorized individuals enter the steam tunnel near the areas of Pickard Hall.

RAI-03m: The licensee should provide schematics of known and potentially contaminated drain and sewer lines.

Response: A schematic with notes has been provided with this response. Please see Attachment 8 – Sanitary and Storm Sewer line GIS Map for servicing Pickard Hall.

MU plans to perform additional assessments to determine active pipes and flow paths associated with these sanitary and storm sewer pipes. As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a more complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

Detail: MU is aware of only one sanitary sewer (SS) line (shown in yellow on the map) that originates from inside Pickard Hall and known to be contaminated. This is based on earlier radiological surveys that identified elevated readings near the drain. This drain and a small run of piping was filled in with concrete in a construction project in the 1990's and rendered dormant as part of an earlier water intrusion mitigation activity. The green lines on the attached map are storm sewer runoff lines.

It is our understanding that originally the sanitary sewer line in room 27 started from a drain in that room near the north wall and ran north under the building to tie into an east to west run of

main sanitary sewer line transit. That east to west run of piping ties into other sanitary sewer lines in Francis Quadrangle and continues on to the city of Columbia's water processing plant.

The original northern sanitary sewer lines that ran from Pickard Hall to the first maintenance man hole in the Francis Quadrangle were dug up and replaced in a large construction project in the 1990's that replaced nearly all of the old sewer piping around Pickard Hall including most of the storm sewer lines.

RAI-03n: The licensee should develop, implement and maintain procedures to ensure unauthorized individuals do not gain access to known contaminated drain and sewer lines.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions".

RAI-03o: 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.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions".

RAI-04a: The licensee should develop, implement and maintain procedures to address fire suppression systems in those areas where residual contamination exists.

Response: Pickard Hall is not equipped with fire sprinklers. However, the building is equipped with fire detection and fire extinguishers and should a fire occur we would coordinate the response with the Columbia Fire Department. The Columbia Fire Department has several stations and response to all fires on campus.

Detail: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a more complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

RAI-04b: 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.

Response: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a more complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

RAI-04c: 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)

Response: We request the same extension to this RAI-04b above for the same reasons.

RAI-04d: 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.

Response: As stated in the response to RAI-01a, MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a more complete response to this RAI. We believe this is a reasonable request

since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

RAI-05a: The licensee should provide radiological evaluations of all areas above concerning fixed and removable contamination.

Response: MU is actively pursuing the relocation of Pickard Hall Faculty and Staff (PHF&S), the museum operations, and the artifacts to facilitate additional characterization. MU therefore requests an extension until December 2, 2013 in order to provide a complete response to this RAI. We believe this is a reasonable request since this will enable us to provide a thoroughly investigated plan that will ultimately shorten the proposed timeframe of the original alternate schedule request.

RAI-05b: 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.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions".

CF personnel who service Pickard Hall are aware that all activities that may impact existing conditions must be coordinated with EHS RS. These restrictions are included in training and are listed in the administrative authorization, identified internally as #55555. The work restrictions for Pickard Hall have been inserted into the MU CF maintenance work order software system "Maximo". That message is "CONTACT EHS RADIATION SAFETY AT 882-5024 BEFORE WORKING ON ANY BLDG COMPONENTS TO INCLUDE CEILINGS, WALLS, FLOORS, DRAINS, HVAC, FURNITURE MOVING, ETC." Note that this message has been developed to accommodate the character limit that is available in the system.

RAI-05c: 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.

Response: As stated in the response to RAI-02b, MU requests an extension of 90 days until May 10, 2013 to submit a procedure to address this and several other RAIs.

Detail: EHS RS is currently developing a Standard Operating Procedure (SOP) DRAFT number RSIP-DC-01.00 "Pickard Hall Radiological Status and Restrictions".

-END-

List of Attachments

Attachment 1 – MU's DFP, May 2011 (154 pages)

Attachment 2 – Various Schematics of Ductwork for Pickard Hall (7 pages)

Attachment 3a – Radiation Worker Training Status report for Pickard Hall 55555 (1 page)

Attachment 3b – Radiation Safety for new Radiation Workers at MU (25 pages)

Attachment 4 – Pickard Hall 55555 Jan 2013 inspection/survey report (7 pages)

Attachment 5 – Calibrations sheets for most recent used Ludlum's used at Pickard Hall (4 pages)

Attachment 6 – Original Attachment 1 - Pickard Hall Radon Monitoring Results (3 pages)

Attachment 7 – Chase Environmental Group, Inc - QAP 8.2 Chain-of-Custody Procedure (3 pages)

Attachment 8 – Sanitary and Storm Sewer line GIS Map for servicing Pickard (1 page)

Attachment 1 – MU's DFP, May 2011 (154 pages)

UNIVERSITY OF MISSOURI - COLUMBIA

DECOMMISSIONING FUNDING PLAN

IN SUPPORT OF
NRC LICENSE NO. 24-00513-32

May, 2011

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

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Appendix B – Group 2 Facilities Cost Estimate Tables
Appendix C – Pickard Hall and Schweitzer Hall Cost Estimate Tables
Appendix D – Outdoor Facility Cost Estimate Tables
Appendix E – Statement of Intent and Certification of Financial Assurance

1.0 Introduction

The University of Missouri - Columbia (MU) is required by 10 CFR 30.35(a) to have a decommissioning funding plan (DFP) for their Columbia, MO facilities operated under NRC Broad Scope Type A license number 24-00513-32. MU contracted Chase Environmental Group, Inc. (Chase) to perform an independent decommissioning cost estimate and develop this DFP. Chase developed an order of magnitude cost estimate based on review of facility design features, current/historical processes and current radiological conditions. This estimate is also based upon physical inspection of facilities, interviews with MU personnel and Chase's experience in performing and estimating decommissioning of similar facilities. As a major provider of facility decommissioning services and as an independent radioactive waste broker, Chase possesses highly reliable information on available decommissioning and waste processing options, and their respective costs - this insight is incorporated into the decommissioning cost estimate.

This DFP provides the four components required by NRC's financial assurance regulations for licensees who use a DFP, as described in Appendix A.3.3, Submitting the Required Documentation, of NUREG-1757, Volume 3, *"Consolidated NMSS Decommissioning Guidance, Financial Assurance, Recordkeeping, and Timeliness:"*

- A site-specific cost estimate for decommissioning (see Section 2).
- A description of the means that will be used to adjust the site-specific cost estimate and associated funding levels periodically over the life of the facility (see Section 3).
- A certification by the licensee that financial assurance for decommissioning has been provided in the amount of the decommissioning cost estimate (see Section 4).
- An originally signed duplicate of the financial instrument that provides financial assurance for decommissioning (see Section 4).

2.0 Cost Estimate

The cost estimate is designed to meet the nine evaluation criteria contained in NUREG 1757 listed below:

1. The cost estimate meets the applicable regulatory requirements in 10 CFR.
2. The cost estimate is based on documented and reasonable assumptions.
3. The unit cost factors used in the cost estimate are reasonable and consistent with NRC cost estimation reference documents.
4. The cost estimate includes costs for labor, equipment and supplies, overhead and contractor profit, sampling and laboratory analysis, and miscellaneous expenses (e.g., license fees, insurance, and taxes).
5. The cost estimate applies a contingency factor of at least 25 percent to the sum of all estimated costs.

6. The cost estimate does not take credit for (a) any salvage value that might be realized from the sale of potential assets during or after decommissioning or (b) reduced taxes that might result from payment of decommissioning costs or site control and maintenance costs.
7. The means identified in the DFP for adjusting the cost estimate and associated funding level over the life of the facility and any storage or surveillance period is adequate.
8. The cost estimate reflects decommissioning under appropriate facility conditions (for a DFP, routine facility conditions should be assumed).
9. The cost estimate includes costs for all major decommissioning and site control and maintenance activities specified in Section A.3, including (a) planning and preparation, (b) decontamination and/or dismantling of facility components, (c) packaging, shipment, and disposal of radioactive wastes, (d) a final radiation survey, (e) restoration of contaminated areas on facility grounds (if necessary), and (f) site stabilization and long-term surveillance (if necessary).

Cost estimates were developed using the guidance contained in NUREG-1757 Volume 3, Appendix A.3 using conservative middle-of-the-road assumptions regarding the likely extent and duration of remediation activities. Remediation is assumed to proceed to unrestricted levels with an endpoint criterion of 25 mrem/yr based on the building occupancy scenario of NUREG/CR-5512 for building structures or the residential scenario of NUREG/CR-5512 for outdoor areas. The series of cost estimating tables provided in NUREG-1757 were used to prepare the decommissioning cost estimate. Regulatory aspects and staffing requirements are much different for the various types of facilities operated under the license. For clarity, separate sets of cost tables were developed for three broad categories of facilities and then summed to obtain the overall level of financial assurance required:

- Group 2 facilities (research and medical labs, sealed source areas, radioactive waste storage areas, and incinerator facilities)
- Facilities with historical usage of alpha-emitting radionuclides
- Outdoor facilities

The assumptions and conclusions presented in this cost estimate represent Chase's best professional judgment based upon the information available. In performing this cost estimate, Chase relied upon information obtained from facility personnel and publicly available information. MU's use of radioactive materials spans more than a century. As such, there is uncertainty regarding the history in some areas. Uncertainty is offset in the cost estimate by using conservative assumptions. MU is continuing assessments of residual radioactivity in areas of historical usage to provide a more accurate basis for estimating decommissioning costs. Several buildings at Sinclair Farm have been surveyed for release for demolition and the Schweitzer Hall attic is currently being characterized to plan replacement of the slate roof. Where limited information is

available regarding radiological conditions, conservative assumptions were used to estimate decommissioning costs. As facilities are more thoroughly characterized and areas released, MU will revise the cost estimate as appropriate. It is expected that as more information becomes available, the estimated cost to complete decommissioning will be reduced.

2.1 Facility Descriptions

Licensed activities are, or were, conducted within approximately 100 buildings and six separate outdoor areas at the MU campus. The license typically supports approximately 180 authorized users and approximately 850 trained radiation workers in six different categories of schools. Current authorized users by school are presented in Table 2-1.

Table 2-1 Number of Authorized Users by School

School	AUs
Agriculture, Food & Natural Resources	51
Arts and Sciences	20
Engineering	4
Veterinary Medicine	25
School of Medicine	57
Research and Other	15
No School	11
Total	**183**

Facilities include medical research, hospital, physics, chemistry, geology, waste, incinerator, farm, and disposal facilities. Facilities are sub-divided into five types based on unique characteristics specific to decommissioning:

- Research and Medical Laboratories
- Areas with Historical Usage of Alpha-Emitting Nuclides
- Sealed Source Use and Storage Areas
- Waste Facilities
- Outdoor Facilities

Detailed descriptions of each facility type are provided below.

2.1.1 Research and Medical Laboratories

The majority of work involving unsealed licensed material is in research and medical laboratories. There are approximately 400 laboratories using radioactive materials at any given time and usage is declining. The types of facilities included in the research and medical laboratory category are listed in Table 2-2.

Table 2-2 Research and Medical Laboratory Summary

Facility	Description	Radionuclides
Medical Science Research	Research for diagnostic and therapeutic medicine	Typically high energy beta and gamma emitting nuclides: all are either short-lived (PET nuclides) or sealed sources with no history of leakage
Plant Science	Research using plants for uptake studies	Typically C-14
Life Science Research	Research involving cells, DNA, enzymatic assays, blots, etc.	Typically C-14, H-3, I-125, P-32, P-33, S-35, and short lived gamma emitters as microspheres
Animal Science Research	Research involving animal metabolism, uptake, reproduction, etc.	
Animal Science and Physiology	Research involving animals for human use research applications	
Physics and Chemistry	Physics and experimental chemistry research	Typically long lived beta-gamma emitters or sealed sources

Typical laboratory facilities have ventilated laboratory hoods for control of radioactive and other hazardous vapors and dusts when necessary. Hoods are maintained at negative pressure with face velocities appropriate for each hood design. Tempered outside air is supplied from building heating, ventilation and air conditioning (HVAC) systems. Laboratory air is exhausted through the fume hoods. Exhaust fans are typically located on roof surfaces or in penthouse mechanical rooms. Typical laboratories are fitted with stainless steel or composite material sinks. Wastewater drains connect to the city sanitary system without treatment or retention. All effluents meet the NRC concentration limits of 10 CFR 20, Appendix B. Casework with utilities are provided for bench top operations utilizing portable analytical equipment. A central vacuum system is typically available for each building, but in some cases, portable vacuum pumps are used. Figure 2-1 shows a generalized, typical research laboratory layout.

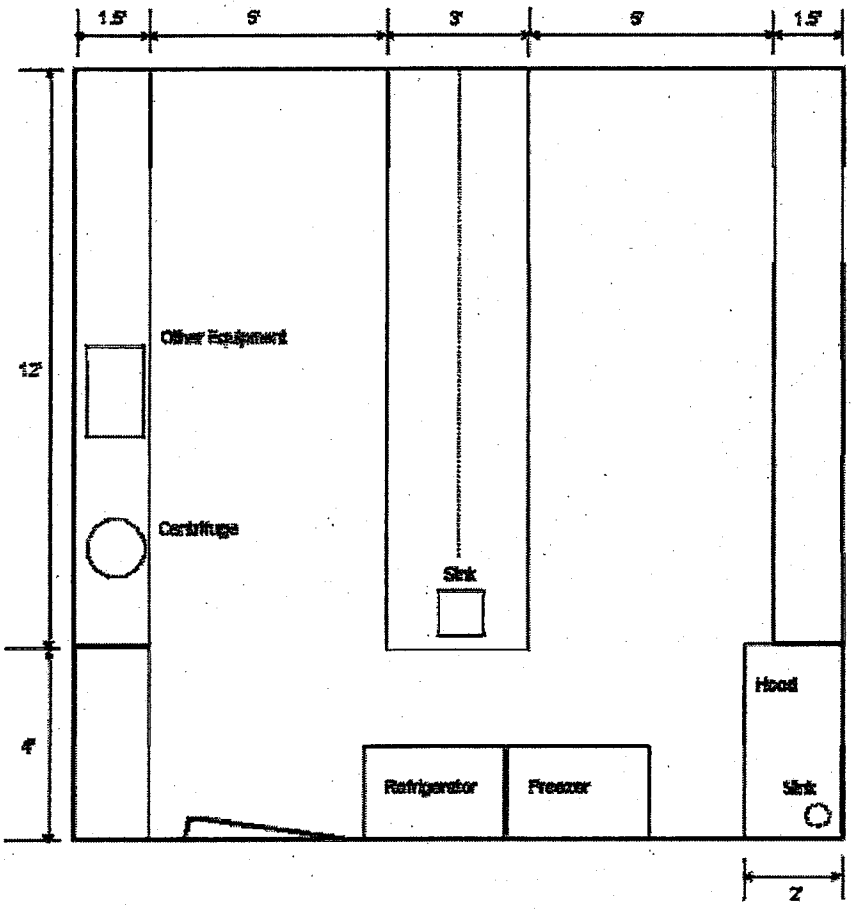


Figure 2-1 Typical Research Laboratory Layout

2.1.2 Areas with Historical Usage of Alpha-Emitting Radionuclides

Two buildings on campus had historical use of uranium, radium and thorium; Pickard Hall and Schweitzer Hall. Due to the restrictive screening values and the nature of decommissioning facilities with dispersible forms of alpha emitting nuclides, these areas are treated separately from other areas.[1]

[1] This category only includes usage from historical operations involving radium and thorium separation. Research labs located in Schweitzer Hall that use or used tracer nuclides for research are captured in the Research and Medical Laboratory category.

Pickard Hall

Built in 1894 as a Chemistry Building, Pickard Hall is currently being used as the Museum of Art and Archaeology, and houses the Department of Art History and Archaeology. The building, located at 405 S. Ninth in the St. Francis Quadrangle area of the MU campus, has a footprint of 8,400 square feet with approximately 24,600 gross square feet of floor area over three elevations (not including the attic). The museum is located on the first and second floors, and the basement is used for storage of museum artifacts. Additionally, faculty offices are located on the first floor and in the basement. The building is listed on the National Register of Historic Places.

The brick building sits on a stone and mortar foundation. Originally, the building had wooden floors throughout, including the basement. The current basement floor is poured concrete with tile and carpet coverings. It is suspected, but not known for certain, that the concrete floor is original to the building and that the wooden floors were installed on top of the concrete. Floors on the first and second elevations are primarily carpeted with stone/ceramic tiled foyers and restrooms. Interior walls are plaster and sheetrock.

In the early 1900s, a faculty researcher extracted and purified salts of radioactive elements from ores (extracted radium-226 from uranium ores), and conducted research involving Th-232 daughters in basement laboratories until the 1930's. From 1924-1951 Analytical Chemistry moved to the second floor of Schweitzer Hall, leaving organic and physical chemistry to occupy Pickard Hall until 1951, when physical chemistry moved to a new addition at Schlundt Hall. In 1972, remaining chemistry operations were moved from Pickard Hall, and the interior of the facility underwent a major renovation in 1974 to accommodate its current usage. This resulted in minor changes to the layout of the basement. Some windows on the basement and first floors, and all windows on the second floor have been covered on the inside to prevent ultraviolet damage to artifacts. The entire ventilation system has been upgraded since the cessation of use of radioactive materials; some original ventilation ducts remain, but are not in use. Original drains were terminated at floor level and grouted or re-used (subsequently, the sanitary sewer line from the building was removed and replaced with excavated soils re-used as fill). The Museum of Art and Archaeology moved to Pickard in 1976.

Schweitzer Hall

Schweitzer Hall is located on campus at 503 S. College Ave. Built in 1912, it is currently home to the Department of Biochemistry. The building has a footprint of 8,000 square feet, with approximately 24,000 gross square feet of floor area over three elevations, not including the attic. It is brick faced with a slate roof and has sheetrock interior walls.

In 1913, portions of the Chemistry Department moved to Schweitzer Hall from Pickard Hall and subsequently continued research involving separation of Ra-226 from uranium ores. In 1960, the building underwent extensive decontamination for Ra-226, including removal of drain pipes, and again in approximately 1979 to support renovation that included roof decontamination, chimney removal, and rearranging the layout of walls.

Subsequent verification surveys by MU staff did not reveal any residual radioactivity in laboratories or classrooms, but did identify residual radioactivity in the attic and on the roof.

The north end of the Schweitzer attic is known to have been used to solidify and package radioactive waste in the 1960's. The unfinished attic consists of: a solid, poured concrete floor; structural steel support beams added during remodeling for support of the roof structure; wooden rafters, columns and beams overlaid with diagonal wooden roof sheathing; numerous metal ventilation ducting runs; and a mixture of loose and rolled insulation. The finished portion of the attic consists of an added (not original to the building construction) 20' x 70' poured concrete pad, several electrical cabinets, ventilation exhaust fans, and walls and ceiling covered in sheetrock. The roof consists of slate shingles on sloped portions and a synthetic roofing material on the horizontal portion. Gutters are constructed of copper or stone. Brick chimneys penetrate the roof along with approximately 20 metal ventilation exhausts. There are also several old brick ducts in the attic floor that are thought to be terminated fume hood exhaust ducts.

MU is currently planning to replace Schweitzer Hall's roof surface and install a strobic fan exhaust system. Residual radioactivity exists or is expected to exist on accessible attic surfaces, inside brick ducts and chimneys, inside roof drains and on the top surface of the original slate roof. The Schweitzer Hall attic is in the process of being characterized to support planning for roof replacement.

2.1.3 Sealed Source Use and Storage Areas

The majority of radioactive material possessed by MU is present in a few areas where sealed sources of significant activity are used. These areas include the following sources:

- Instrument Calibration Source (0.58 Ci Cs-137)
- 10 CFR 35.400 Medical Sealed Sources (0.96 Ci, Cs-137), License Item D.
- Amersham X2016, 40666F, EON Corp 64-761 177 (~0.7 Ci, Cs-137), License Item O
- Amersham/Searle in a Type X-92 Capsule (0.193 Ci Am-241), License Item Y

2.1.4 Waste Facilities

The 10,000 ft^2 centralized radioactive waste facility is located at 1710 East Campus Loop, just south of Resource Recovery Center. The facility layout is presented in Figure 2-2. The facility is the consolidation center for disposal of all radioactive wastes and mixed wastes. Wastes are received, transferred for incineration, decayed, consolidated, or otherwise prepared for shipment to off-site disposal facilities. Liquid wastes meeting NRC sewer disposal requirements are discharged to the sanitary sewer system via a drain at the facility.

Wastes are shipped for off-site disposal via a waste broker approximately annually. Additionally, a small amount of legacy waste is stored in a 768 ft^2 storage building adjacent to the Research Park Development Building.

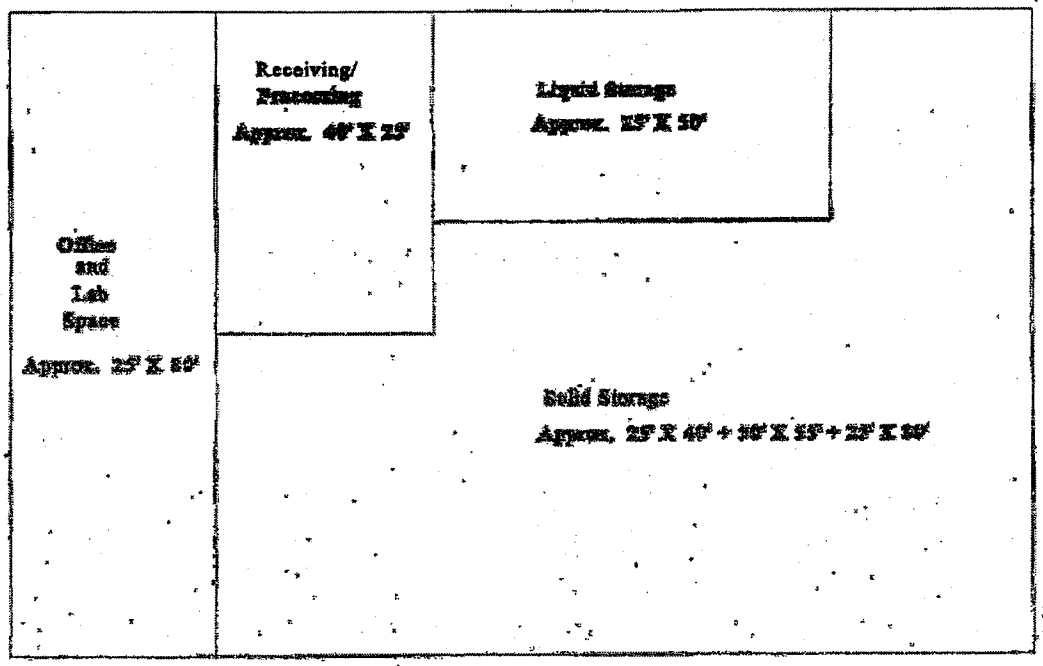


Figure 2-2 Centralized Low Level Radioactive Waste Facility Layout

There are two incineration facilities on campus. The Campus Incinerator, a 12' x 12' unit with two 6' diameter, 12' long chambers, is located at the EH&S Resource Recovery Center and is used for incineration of low level radioactive waste, mainly H-3, C-14, but also Cl-36, Ca-45 and other trace activities. The Veterinary Diagnostic Laboratory Incinerator, a 20' x 20' unit with two chambers, is located at the Veterinary Diagnostic Laboratory and was used for incineration of low level radioactive waste (mainly animal carcasses) containing low levels of H-3, C-14 and short lived beta-gamma emitting isotopes.

Small amounts of waste may be stored in laboratories for short periods of time prior to transfer to the radioactive waste facility. Also, liquid radioactive wastes meeting the effluent sewer disposal criteria may be disposed to the city sanitary system. Room GL-29 of the Main University Hospital Health Sciences Center is used for Decay-in Storage (DIS) of short-lived medical waste.

2.1.5 Outdoor Facilities

2.1.5.1 Sinclair Research Farm

The MU Sinclair Research Farm, located on 543 acres at South Sinclair Road approximately 4.5 miles southwest of the MU campus, was historically used for radioactive materials research, incineration, land disposal, and radioactive materials storage. There are about 25 of the original buildings remaining on site. Most of the remaining buildings were recently surveyed by MU staff with no elevated activity detected. An incineration facility was demolished such that only the concrete pad remains. The Missouri University Research Reactor (MURR) barn was historically used to store contaminated items from the reactor facility, and a small area of contaminated concrete was previously remediated in 2005. All buildings are assumed to meet release criteria without remediation. Trace Analytical operated a for-profit analytical lab at Sinclair and did not use dispersible forms of radioactivity, but historically had a leaking N-63 source.

Two lagoons of two units each are located on site. One lagoon has a potential for C-14 activity via buried piping from rinsing milk, urine, and feces from barn surfaces during C-14 studies. Cl-36 was authorized at the site, but never used. Fields surrounding the lagoons were occasionally sprayed with lagoon water. Lagoons are assumed to be constructed with a compacted clay liner and berm by excavating the native topsoil to the underlying clay and then excavating the clay to form the berms. A sediment layer in each lagoon is assumed to be up to six inches thick.

Phase 1 of the Sinclair Farm characterization is currently being performed. Five Barns and the Necropsy Lab Building have been surveyed for release and are awaiting demolition, pending data validation. Sediment samples were collected at the discharge points from building drains into the lagoon mentioned above and are currently being analyzed by an outside laboratory for C-14, H-3 and gamma spectroscopy.

From 1967 to 1981, a 0.9 acre disposal site was used at Sinclair Farm for disposal of wastes resulting from university research, principally medical research. LLRW consisted primarily of scintillation fluids containing toluene, xylene or dioxane with low levels of radioactivity (predominantly C-14 and H-3). Records indicate that 6,840 gallons of liquid waste with a total of 0.79 curies of activity were accepted and burned during the active disposal period at the site. Solid wastes consisted of paper, plastic, animal bedding and at least 90 large animal carcasses. There were 56 burials totaling 10,412 ft^3 of waste containing 4.5 curies of activity (roughly 53% of the allowable burial limit as then specified in 10 CFR 20.304) performed in trenches 12' deep, 2' to 4' wide, and 5' to 30' long. A minimum of 4' of cover was compacted over the waste after burial. The low level waste consists of mainly H-3 (85%) and C-14 (3.4%). Cows were slaughtered and buried on site and met the requirements of 10 CFR 20.2005, "Disposal of Specific Wastes" (0.05 μCi, or less, of H-3 or C-14 per gram of animal tissue, averaged over the

weight of the entire animal). An incinerator facility was constructed and operated after closure of the burial site. The facility was subsequently dismantled and removed, leaving only a concrete pad.

2.1.5.2 Hinkson Creek Waste Site

The Hinkson Creek Waste Site is a 95' x 65' area up to 8' deep containing radioactive waste buried from about 1964 to 1969 under 10 CFR 10.304. Existing records indicate very low levels of relatively short-lived isotopic activity were buried (P-32, Ca-45 and Se-75).

2.1.5.3 South Farm Site

The South Farm site, located approximately four miles southeast of the campus, was operated from 1967-1978 as an incineration and burial facility for chemical wastes from the university's laboratories. The original disposal area of 100' x 50' was expanded to 200' x 75' in 1974. Wastes also included pesticides and herbicides, organic solvents, acids, bases, explosives, and metals. Wastes included 772 gallons of scintillation fluids, containing a total of 47 mCi of predominantly H-3 and C-14. The site was closed in 1978. Closure included implementation of various erosion control measures, including construction of surface-water diversion structures and the establishment of vegetation on the surface of the disposal area.

Additionally, a study was performed in the early 1970s involving moles tagged with 100 μCi Co-60 pellets. All but one of the pellets were recovered in 1971. The lost pellet was reported missing in July 1971 (nearly eight half-lives ago). After an exhaustive search for the pellet over a five acre area, it was assumed the mole was either taken by a predator, or burrowed deep enough to avoid detection of the source from the surface. Considering the quantity and half-life of the pellet, this area is considered non-impacted for decommissioning and no level of effort is captured in this cost estimate.

2.1.5.4 Bradford Farm

The Bradford Research and Extension Center (BREC) is a 591-acre research farm located eleven miles from the campus. AmBe soil density gauges were placed into 20' deep tubes for soil density measurements. In 1973, there was also a C-14 plant uptake study performed at the site inside a portable 72 cubic foot plastic enclosure. Plants were exposed to 1 mCi of C-14 as CO_2 gas on four occasions. After the study, the plants were removed and disposed as radioactive waste. Because there was no history of leakage from the AmBe sources and the limited scope of the plant uptake study, this area is considered non-impacted for decommissioning.

2.1.5.5 Sanborn Field

Sanborn Field is located on campus and bounded on three sides by Rollins Street, College Avenue and Bouchelle Avenue. C-14 was used for studies involving wheat. The wheat was grown in two gallon containers in a greenhouse and then planted in a 25 square foot area in plot number 10. The study was limited to a soil depth of seven inches and all impacted soils were removed and disposed after the experiment. Due to the limited scope of the study, it is assumed that the area meets the unrestricted release criteria and the level of effort for decommissioning is assumed to consist of collection and analysis of soil samples.

2.1.5.6 Tucker Prairie

Tucker Prairie is a 160 acre research facility located about 16 miles east of Columbia alongside Interstate 70 in Callaway County. In 1976, an experiment was performed to study the carbon cycle in strip mines involving 2 μCi packets of C-14. After the study, all materials were removed and disposed as radioactive waste. Due to the limited scope of the study, Tucker Prairie is considered non-impacted for decommissioning.

2.2 License History

Facilities operate under NRC Type A broad scope medical use license No. 24-00513-32, Issued to the Curators of the University of Missouri, amendment 108 dated February 4, 2011 with an expiration date of January 31, 2014. Licensed material is authorized for usage at the following addresses:

- The University of Missouri-Columbia, Columbia, MO campus, Columbia, MO
- Ellis Fischel Cancer Center, 115 Business Loop 70 West, Columbia, MO
- Missouri's Women's and Children's Hospital, 404 Keene Street, Columbia, MO
- Portable moisture density gauges may be used at temporary job sites anywhere in the US under NRC regulatory jurisdiction

Licensed materials are used in the following general ways:

- Medical procedures permitted by 10 CFR 35.100, 10 CFR 35.200, 10 CFR 35.300, 10 CFR 35.400
- Diagnostic and medical use of sealed sources permitted by 10 CFR 35.500
- Research and development as defined in 10 CFR 30.4
- Instrument calibration
- Student instruction
- Sample analysis
- Sealed sources for calibration and moisture/ density measurements
- Sealed sources for medical and veterinary medical brachytherapy
- Depleted uranium for shielding

- Waste storage, decay and processing; including wastes from other licenses issued to the Curators of the University of Missouri
- Sealed sources for medical radiography in humans
- Ra-226 possession incidental to decommissioning activities
- Disposal by incineration
- Transport of licensed material

A copy of the current radioactive materials license is provided as Appendix A.

2.3 Previous Decommissioning

The NRC concurred with release of the Sinclair Farm Waste Site and Hinkson Creek Waste Site for unrestricted use in a letter dated August 7, 1997 to Susan Langhorst (RSO). Therefore, no level of effort for decommissioning is captured in this cost estimate.

2.4 Radiological Status of Facilities

During operation, accessible building surfaces are maintained less than 200 dpm/100cm^2 removable surface activity. All radioactive materials entering and exiting the site are packaged for shipment according to DOT and IATA requirements. Personnel that enter areas containing dispersible radioactive materials are required to wear appropriate personal protective equipment and monitor themselves for skin/clothing contamination upon exit. Facility personnel conduct routine periodic surveys, which are performed by researchers and radiation safety personnel. Laboratory closeout procedures are used when authorized users cease possession and use of radioactive materials. Uncontained radioactivity in volatile forms is confined to ventilated hoods.

There are several locations with known residual radioactivity that must be remediated in order to achieve unrestricted release. The radiological status of each type of facility is described below.

MU is continuing to make progress accomplishing thorough characterization of indoor and outdoor facilities in a phased approach. For example, MU is currently collecting radiological information at Sinclair Farm buildings, Schweitzer Hall attic, Sinclair Farm lagoons, and outside grounds around the MURR Barn.

2.4.1 Research and Medical Laboratories

Research and medical laboratories are assumed to contain low levels of residual radioactivity with removable contamination less than 200 dpm/100cm^2 as demonstrated by routine survey results. Small, discreet areas of elevated activity on building structural surfaces and in building ventilation, vacuum and drain systems are expected to exist, but at levels less than the NRC Default Screening Values (DSVs). Laboratories are authorized and closed-out with Radiation Safety Committee authorization as needed to support research activities. Estimated decommissioning costs are mainly for planning,

surveying, and reporting. Minor amounts of remediation are assumed for ALARA purposes.

2.4.2 Areas with Historical Usage of Alpha-Emitting Radionuclides

Two buildings have known residual radioactivity above NRC DSVs from historical work involving the separation of alpha-emitting radionuclides from ores containing uranium and thorium, Pickard Hall and Schweitzer Hall.

Pickard Hall

Pickard Hall was characterized for residual radioactivity to the extent possible due to its use as a museum. Characterization results indicate that the nuclides of concern are U-238, Th-232 and their progeny (particularly Ra-226) and that low levels of residual radioactivity exists in the following locations:

- On basement concrete floor surfaces that are covered with vinyl tiles.
- On concrete floor surfaces in basement mechanical rooms. These surfaces were subsequently encapsulated with epoxy paint.
- In the steam tunnel feeder adjacent to Mechanical Room 15. The top foot of soil in the steam tunnel feeder was removed and then geotextile and pavers were placed in the feeder.
- In buried drain lines under the basement floor.
- In a small inaccessible area under the stage in Room 106 – this area is also detectable in the basement ceiling in Room 1B.
- In a small area inside a wall in Room 213.
- In the attic on one small location on the floor and in open joist areas.
- Inside two brick ducts (assumed to be fume hood exhaust ducts) that are open in the attic and likely extend to the basement.
- In soils immediately outside the northwest corner of the building.

Characterization results are available in the Pickard Hall Characterization Survey Report dated July 16, 2010.

Schweitzer Hall

Areas of Schweitzer Hall are known to have or suspected of having elevated residual radioactivity from operations similar to those at Pickard Hall in the following locations:

- On attic concrete floor surfaces
- On roof surfaces
- Inside brick ducts and chimneys
- Inside roof drains

Accessible roof surfaces of Schweitzer Hall were characterized in 2010. The results are available in the Schweitzer Hall Roof Survey Report dated March 3, 2010. MU plans to

replace Schweitzer Hall's roof. As part of the preparation for roof replacement, the University has initiated radiological characterization of attic surfaces and currently inaccessible layers of roofing material. Costs for removal and disposal of the roofing materials are captured in this Plan.

2.4.3 Sealed Source Use and Storage Areas

Sealed source usage areas are not expected to contain residual radioactivity because sources are periodically leak checked and have never indicated leakage. Decommissioning costs are captured for removal and disposal of sources and verification/administration of leak test data.

2.4.4 Waste Facilities

Waste and Incinerator facilities are assumed to meet the NRC DSVs based on routine survey results. Decommissioning costs are mainly for disposal of existing waste as well as planning, surveying, and reporting. Minor amounts of remediation are assumed for ALARA purposes.

2.4.5 Outdoor Facilities

Outdoor areas have not been fully characterized, but are assumed to meet NRC release criteria using a site-specific dose model. Minor amounts of remediation are assumed for ALARA purposes. The level of effort for dose modeling assessments is captured in this estimate. MU will continue to collect radiological information in outdoor facilities in a phased approach and update this DFP as appropriate. Inactive disposal sites and lagoons are also impacted for chemical contaminants and regulated by Missouri Department of Natural resources (MDNR).

2.5 Radiological Release Criteria

Facility release criteria for unrestricted use are those of NRC 10CFR20 Subpart E. Specifically, the facility will be surveyed in accordance with the guidance contained in MARSSIM to demonstrate compliance with the criteria of 10CFR20.1402, "Radiological Criteria for Unrestricted Use." The criteria are that residual radioactivity results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem per year, and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).

2.6 Decommissioning Groups

All indoor facilities, except Pickard Hall and Schweitzer Hall, are expected to be decommissioned using the screening approach because it is expected that residual radioactivity will be surficial (up to a 1 cm depth). These facilities are expected to be decommissioned as Group 2 under NUREG 1757: "Unrestricted Release Using Screening Criteria; No Decommissioning Plan Required." From NUREG 1757: "Group 2 facilities may have residual radiological contamination present in building surfaces and soils. However, licensees are able to demonstrate that their facilities meet the provisions of 10

CFR 20.1402 ("Radiological Criteria for Unrestricted Use") by applying the screening approach dose analysis described in Chapter 6. Additionally, licensees in Group 2 typically possess historical records of material receipt, use, and disposal, such that quantifying past radiological material possession and use may be developed with a high degree of confidence. Furthermore, these licensees have radiological survey records that characterize the residual radiological contamination levels present within the facilities and at their sites. That is, they are able to demonstrate residual radiological contamination levels without more sophisticated survey procedures (greater than those used for operational surveys) or dose modeling. These licensees do not need to use site-specific parameters or establish site-specific DCGLs in order to demonstrate acceptability for release of their sites. For Group 2 facilities, a DP is not required, but licensees will have to demonstrate that the site meets the screening criteria assumptions described in Chapter 6. A DP is not required because worker cleanup activities and procedures are consistent with those approved for routine operations, and no dose analysis is required."

Pickard Hall, Schweitzer Hall, and outdoor areas are assumed to require site-specific DCGLs and/or a dose model and will be decommissioned under a formal decommissioning plan. This will require long (~ 1-2 yr) planning and regulatory review times. These facilities are expected to be decommissioned as Group 4 under NUREG 1757: "Unrestricted Release with Site-Specific Dose Analysis and No Ground Water Contamination; Decommissioning Plan Required." From NUREG 1757: "Group 4 facilities have residual radiological contamination present in building surfaces and soils, but the licensee cannot meet, or chooses not to use, screening criteria, and the ground water is demonstrably not contaminated. The licensees are able to demonstrate that residual radioactive material may remain at their site but within the levels specified in NRC criteria for unrestricted use (10 CFR 20.1402, "Radiological Criteria for Unrestricted Use") by applying site-specific criteria in a comprehensive dose analysis. A site DP is required and should characterize the location and extent of radiological contamination. The DP should also identify the land use, exposure pathways, and critical group for the dose analysis."

2.7 Nuclides of Concern

2.7.1 Research and Medical Laboratories

Research and medical laboratories use tracers and short-lived imaging nuclides. After considering quantities, locations of usage, and the impact of radioactive decay, the nuclides of concern for these types of facilities are typically C-14 and H-3 that have very high DSVs. However, survey design for this cost estimate assumes detection sensitivities of 5,000 dpm/100cm^2 gross total beta activity and 200 dpm/100cm^2 gross removable beta activity to ensure adequate costs are captured for beta-gamma emitting nuclides of concern with more restrictive DSVs. Removable contamination analysis is assumed to be performed by liquid scintillation counting.

2.7.2 Areas with Historical Usage of Alpha-Emitting Radionuclides

The nuclides of concern in Pickard Hall and Schweitzer Hall are natural uranium, natural thorium, and their progeny, particularly Ra-226. Solid samples at Pickard Hall indicate a nuclide distribution of approximately 80% Ra-226 and 20% Th-232, and solid samples of Schweitzer roof materials indicate a distribution almost entirely due to Ra-226 (>90%).

2.7.3 Sealed Source Use and Storage Areas

Nuclides of concern for sealed source areas are Cs-137, Co-60, and Am-241. It may be possible to decommission these areas after removal of sources without performing surveys for residual activity. However, this cost estimate assumes that surface contamination surveys are performed in these areas, but assumes no remediation is required.

2.7.4 Waste Facilities

Radioactive waste facilities could contain any of the nuclides used at any of the facilities. Therefore it is assumed that facilities will be surveyed to demonstrate compliance with the most limiting alpha and beta nuclides possessed on site (assumed to be Th-232 and Co-60).

2.7.5 Outdoor Facilities

The nuclides of concern for impacted outdoor areas are primarily C-14 and H-3. Facilities that have been historically released with NRC concurrence are classified as non-impacted. The area around the MURR Barn is also impacted for fission and activation products.

2.8 Derived Concentration Guideline Levels

The Derived Concentration Guideline Level (DCGL) is the radionuclide-specific surface contamination or volumetric concentration that could result in a dose equal to the release criterion. $DCGL_W$ is the concentration limit if the residual activity is essentially evenly distributed over a large area.

2.8.1 Research and Medical Facilities

DCGLs for research and medical facilities are assumed to be the Default Screening Value (DSV) for the most limiting nuclide for a particular area. The NRC has published default screening values in NUREG 1757 for commonly used radionuclides. The DSV for unlisted nuclides can be calculated using NRC-approved DandD software under default conditions of the building occupancy scenario. Research and medical laboratories are assumed to use the C-14 DSV of 3.7E6 dpm/100cm^2. However, survey design for this plan assumes detection sensitivities of 5,000 dpm/100cm^2 gross total beta activity and 200 dpm/100cm^2 removable activity to ensure adequate costs are captured for beta-gamma emitting nuclides of concern with more restrictive DSVs than C-14.

2.8.2 Areas with Historical Usage of Alpha-Emitting Radionuclides

Areas with a history of using alpha emitting nuclides are assumed to have site-specific DCGLs for surfaces and soils of outside grounds.

2.8.3 Sealed Source Use and Storage Areas

Sealed source areas are assumed to use a gross beta-gamma DCGL equal to the Co-60 DSV of 7.1E3 dpm/100cm^2 and an alpha DCGL based on the Am-241 DSV of 27 dpm/100cm^2.

2.8.4 Waste Facilities

The radioactive waste facility is assumed to use a gross beta-gamma DCGL equal to the Co-60 DSV of 7.1E3 dpm/100cm^2 and a gross alpha DCGL based on the Th-232 DSV of 7.3 dpm/100cm^2.

2.8.5 Outdoor Areas

The nuclides of concern for impacted outdoor areas are primarily C-14 (DSV=12 pCi/g) and H-3 (DSV=110 pCi/g). The area around the MURR Barn will also be impacted for fission and activation products, so other beta-gamma emitter screening values will be used as well. Site-specific DCGLs are assumed to be developed for outdoor areas.

2.9 Equipment and Materials Release Limits

The release criteria specified in FC 83-23, "Guidelines for the Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Byproduct, Source, or Special Nuclear Material Licenses" is assumed to be used for release of loose equipment and materials.

2.10 Area Classifications

For the purpose of decommissioning cost estimation, the guidance in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM), was used to divide the facility into areas with similar contamination potential based on results of radiological surveys, radionuclides used, activities conducted and the potential for tracking residual radioactivity:

- Non-impacted areas (not surveyed) – medical and research laboratory building structural surfaces above a two meter height, outside grounds, and building exteriors.
- Class 1 – areas with historical usage of alpha emitters, areas of known contamination, and lagoon/disposal sites
- Class 2 – medical and research laboratories with a history of radioactive materials usage

- Class 3 (buffer areas) - areas with no history of radioactive materials usage, but bordering Class 1 and Class 2 areas, and sealed source storage areas with no history of leakage.

- Building systems (ventilation, vacuum and drain systems) are not within the scope of MARSSIM, but are assumed to be surveyed at each accessible inlet and inside equipment.

2.11 Cost Estimate Procedure

Because of significant design, regulatory and operational differences, common assumptions and thumb rules cannot be applied to all facilities in the same way. Therefore, facilities have been grouped into three independent projects and separate cost estimates are provided for clarity of presentation. The three separate cost estimates are summed to obtain the required level of financial assurance estimated for the license. Facilities were divided into three categories in order to estimate costs:

- Group 2 facilities (research and medical labs, sealed source areas, radioactive waste storage areas, and incinerator facilities)
- Facilities with residual alpha radioactivity
- Outdoor facilities – disposal sites and farms

To estimate facility decommissioning costs, a bottom-up approach was used consistent with the guidance provided in NUREG 1757. Specifically, a typical layout for each type of facility was obtained and the principal features and equipment identified. The work scope and activity sequence necessary to support unrestricted release of the facility was then developed. A project schedule was created from the activity sequence and expected duration of each task. Cost estimates are based on anticipated time-and-materials rates for goods, labor and services necessary to complete the project.

Overall, conservative assumptions were made concerning the likely extent and duration of necessary remediation activities. Remediation to unrestricted levels (i.e., the facility could be released for any future use without restrictions) was assumed. This assumption means there are no long term costs associated with site surveillance and monitoring following decommissioning.

Contamination present in each building was assumed to be limited to the portions of the building posted and controlled as "radioactive materials" areas. In particular, contamination was presumed not to be present beneath the concrete floors or walls or on the roof or other external surfaces (except for Pickard Hall and Schweitzer Hall). Facility restoration of Group 2 facilities is limited to patching a few openings on roof surfaces as a result of removal of ventilation ducts and fans. Restoration of Group 4 facilities includes only the restoration necessary to place the site in a safe condition (make buildings weather-tight and back-fill excavations).

Schedules of equipment, features and characteristics were developed for each category of facility. The schedules systematically capture the size of each area and key features relevant to estimating decommissioning costs. The schedules for all facility categories were then summed to a total facility schedule.

Labor estimates were derived from the expected work scope and a conceptual project plan. A project plan was developed that detailed the sequence of tasks required to decommission the facilities and terminate the radioactive material license. Crew sizes were developed based on the numbers and locations of tasks to be performed. In addition to the actual facility decontamination and decommissioning, labor estimates were made for pre-planning activities and performing the final radiation survey. Since the assumed endpoint of the decontamination effort was unrestricted release of the facility, there was no labor or other costs associated with long term site surveillance and maintenance.

Labor estimates for planning and preparation include time for document preparation, decommissioning plan submittal to regulatory agencies, work plan development, equipment procurement, staff training and mobilization. Pre-planning labor estimates assume straightforward internal and external document, plan, and procedure reviews and approvals.

The duration of field activities for decontaminating and/or dismantling facilities was estimated based on the task sequence and project schedule. Crew sizes and number of workers were limited to those that could be efficiently utilized in the field.

Radioactive waste estimates were based upon the volume and weight of equipment and of material in the laboratories, storage areas, and supporting systems as well as waste generated as a result of remediation of building structures and soils. The site is assumed to have a waste storage inventory similar to that which would be on-site immediately prior to a routine waste shipment. For decommissioning purposes, installed equipment with contamination levels expected to be in excess of release criteria was assumed to be disposed of as radioactive waste rather than being decontaminated and released. This is due to the cost of labor required to decontaminate and survey equipment typically exceeding the cost of disposal. However, costs are captured for decontamination of equipment and surfaces that are below release criteria for ALARA purposes. ALARA is assumed to mean removable contamination on surfaces is remediated (NUREG-1757, Volume 2, Appendix N).

Estimates for the level of effort required for the final radiation survey were based on previous experience with facilities of comparable complexity. As noted above, the assumed endpoint for the facility is license termination and unrestricted release. This implies that removal of all radioactive materials from the facility has been confirmed.

Marketplace rates (including overhead and contractor profit) were obtained for each element of the project including labor, materials, supplies, sampling, construction activities, waste packaging, waste processing and disposal. The unit rates were extended through the estimated quantities to determine total cost for each line item. Costs were summed by each element of the project to determine subtotals by element. Element subtotals were summed to total project cost.

Annual labor rates were estimated for the Project Manager, Health Physics Supervisor, Foreman, Health Physicist, Shipper, Draftsman, Health Physics Technicians, Equipment Operators, Laborers, and Administrative Assistant. Labor rates include base salary and fringe benefits (e.g., vacation, health insurance, etc.). A rate of 50% was applied for overhead costs, consisting of 18% for labor overhead, 15% for general and administrative costs and 10% profit. The base annual labor rate plus the overhead expenses was divided by the number of workdays per year (taken as 260) to determine a daily cost for each category of employee.

Living expenses were taken from current allowable government per diem rates. For the Columbia area, this is $129 per day. Project management and technical staff are paid the daily living allowance since they are assumed to be from outside the local area. Administrative and support staff are not paid a living allowance. The daily living expenses were multiplied by 7 days per week then divided by 5 workdays per week to correctly incorporate living expenses into the daily rate. This is a variation from the NUREG 1757 methodology in that NUREG 1757 format does not explicitly account for living expenses.

The completed cost estimate schedules for Group 2 facilities are included in Appendix B. The completed cost estimate schedules for alpha emitter facilities are included in Appendix C. The completed cost estimate schedules for outdoor facilities are included in Appendix D. The cost estimate summary tables are summed and presented in Section 2.15.

2.12 Project Overviews

Facilities are expected to be decommissioned as three separate projects. Each project is assumed to be performed by a third party, non-local decommissioning contractor that will provide the qualified staff, on-site and off-site labor, materials and equipment needed to complete the project. The projects are assumed to be performed using the contractor's Agreement State license under a reciprocal agreement with the NRC in order to capture costs associated with reciprocity. The projects will be conducted according to the phases described below. A detailed description of each phase follows.

- Historical Site Assessment (HSA) and Scoping Surveys
- Characterization
- Decommissioning Plan and Supporting Documents

- Equipment and Material Removal / Decontamination
- Remediation of Building Structures and Soils of Outside Grounds
- Waste Disposal
- Final Status Surveys and Report

Each of these project elements are described below.

2.12.1 Historical Site Assessment

The purpose of the HSA is to determine the current status of the site including potential, likely, or known sources of radioactive contamination by gathering data from various sources. This data includes physical characteristics of the site as well as information found in site operating records, including radiological surveys. A records review will include: radioactive materials licenses, license applications, amendment requests, Radiation Safety Committee meeting minutes, radiological surveys, radionuclide receipt and distribution records, radioactive waste records, incident reports, decommissioning records, facility renovation records, blueprints, plans and design specifications. Personnel interviews will include radiation safety, maintenance, operations, and facilities personnel. Limited scoping surveys and sampling are assumed to be performed to augment the HSA and help plan characterization.

2.12.2 Characterization

Characterization surveys will be designed to identify areas of elevated activity that require remediation. Building characterization consists primarily of surface scans and smears of building structural surfaces and systems internal surfaces. Outside grounds characterization consists of gamma scans and soil sampling.

2.12.2.1 Group 2 Facilities

Facility survey records are assumed to be sufficient to plan decommissioning for Group 2 facilities.

2.12.2.2 Alpha Emitter Facilities

Existing characterization data and facility routine surveys will be used to plan decommissioning activities, but additional information regarding the activity in soils is required. Additional characterization data will be collected of soils of outside grounds of Pickard and Schweitzer Halls and under the basement slab of Pickard Hall. A track-mounted geoprobe core sampler will be used to collect samples at depths up to two feet below the Pickard Hall basement floor slab and up to twelve feet in the soils of outside grounds around Pickard Hall and Schweitzer Hall. Samples will be analyzed by gamma spectroscopy and/or alpha spectroscopy.

2.12.2.3 Outdoor Areas

Characterization of outdoor areas will be conducted by performing surface gamma scans and collecting soil samples for laboratory analysis. A track-mounted geoprobe core sampler or hand auger will be used to collect soil and sediment samples at depths up to six inches in surface soils, up to two feet in lagoon sediments, and up to twelve feet in burial grounds. Samples will be analyzed by gamma spectroscopy, C-14 and H-3.

2.12.3 Decommissioning Plan and Supporting Documents

The information gained from the HSA and Characterization will be used to develop a Decommissioning Plan (DP) for each project. While a Group 2 decommissioning project does not require a formal DP, a comprehensive plan is assumed to be developed. A formal NRC-approved Decommissioning Plan is required for Group 4 decommissioning projects. The checklists provided in NUREG 1757 Appendix D are used to develop the DPs. Project plans and procedures supporting the DP will also be developed in this phase. Costs have been captured in the planning phases for regulatory discussions, particularly in regards to development of decommissioning plans and site-specific DCGLs for Group 4 facilities.

2.12.4 Equipment and Material Removal / Decontamination

The decommissioning contractor will remove all loose equipment and materials from the facilities such that only permanent fixtures remain (fixtures attached to structural components of the facilities). Loose equipment and materials will be surveyed for release using the release limits of FC 83-23, "Guidelines for the Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Byproduct, Source, or Special Nuclear Material Licenses." Items not meeting FC 83-23 limits are assumed to be disposed as radioactive waste.

2.12.5 Remediation

2.12.5.1 Group 2 Facilities

Remediation of laboratory surfaces is expected to consist of wiping, scrubbing and scouring or removal of surfaces, such as vinyl floor coverings. A small amount of equipment, drains and ventilation systems are assumed to be removed for ALARA purposes. Several small areas of persistent contamination are assumed to be remediated in waste storage areas by removing a thin layer of the concrete floor surface. An average of 150 lb of waste for each of 400 labs, and each of 25 farm buildings is assumed. Additionally, six drums of liquid scintillation vial waste are assumed to be generated from decommissioning activities.

2.12.5.2 Alpha Emitter Facilities

Pickard Hall is assumed to require the following remediation:

- Remove and dispose all insulation and loose materials in the attic.
- Remove attic wooden decking.
- Power plane contaminated wooden structural supports in attic – joists and rafters. Assume up to 1/8" of materials must be removed over 50% of area.
- Remove two contaminated brick ducts from the attic to the basement. The walls will be demolished on each elevation to provide access.
- Demolish small wall area on 2nd floor (room 213).
- Demolish stage area on the 1st floor (room 106).
- Demolish several wall areas in the basement.
- Remove an average of 1/8" of the basement floor surface over an area of 4200 ft^2.
- Remove basement floor slab over an area of 4200 ft^2 to access underlying soils – concrete assumed to be releasable for unrestricted use.
- Remove buried drain lines.
- Remove average of 1 ft depth of soils over an area of 4200 ft^2.
- Remove an additional 1,000 ft^3 of soil in outside grounds.

Schweitzer Hall is assumed to require the following remediation:

- Remove and dispose all insulation and loose materials in the attic (currently being performed, but costs captured in this estimate).
- Remove slate roof and wooden plank roof surfaces.
- Power plane contaminated wooden structural supports – joists and rafters. Assume up to 1/8" of materials must be removed over 50% of area.
- Remove 2400 ft^2 of six inch thick concrete attic floor.
- Remove an additional 1,000 ft^3 of soil in outside grounds.

2.12.5.3 Outdoor Areas

Outdoor areas are assumed to meet release criteria as demonstrated using a site-specific dose model. However, removal and disposal of 40 cubic yards of soils is assumed in order to capture additional costs to offset uncertainty associated with lack of characterization data.

2.12.6 Waste Disposal

Radioactive waste packaging, shipping, processing and disposal costs were determined based upon the expected volume generation and disposal facility waste acceptance criteria. Waste processing activities for soils, slate, and rubble from Pickard Hall and Schweitzer Hall are assumed to take place in Richland, WA. Other waste processing

activities are assumed to take place in Oak Ridge, TN to ensure adequate transportation costs are captured for a number of available processors.

In addition to wastes generated during decommissioning, costs are captured for disposal of sealed sources and existing waste on site at the time of cessation of licensed activities. Disposal cost estimates for sealed sources is based on the assumption that there is no leakage from the sealed sources and no external contamination. Sealed sources will be shipped to a facility for recycling of the sources. The majority of the cost associated with disposal of the sources will be for transportation and disposal. The sources will be placed in a cask and loaded onto a conveyance for transportation to the disposal facility. Transportation and disposal costs for sealed sources are presented in Table 2-3.

Table 2-3 Sealed Source Transportation and Disposal Estimates

Item	Cost Basis	Unit Cost	Qty.	Total
Transportation and Permits	$/mile	$3.80	2850	$10,830
Cask Rental	$/day	$1,800.00	7	$12,600
Recycling Charges	$/item	$8,000.00	1	$8,000
Labor (Engineers)	$/day	$3,667.00	3	$11,001
Labor (Cask Operators)	$/day	$2,250.00	2	$4,500
Labor (Riggers)	$/day	$4,500.00	2	$9,000
			Total:	**$55,931**

The cost for disposal of operational waste at the time of cessation of operations is assumed from a typical annual waste inventory based on average data from waste disposal shipments over the past three years. A breakdown of waste assumed to be on site at cessation of operations is presented in Table 2-4.

Table 2-4 Operational Waste at Cessation of Licensed Activities

Item	Quantity	Unit Rate	Total
Incinerator Ash	7.5 ft^3	$200/$ft^3$	$1,500
Non-Hazardous Liquid Scintillation Vials	7.5 ft^3	$180/$ft^3$	$1,350
Dry Active Waste	500 lb	$6/lb	$3,000
Animal Carcasses	30 lb	$20/lb	$600
Liquids	400 lb	$6/lb	$2,400
		Total:	**$8,850**

2.12.7 Final Status Surveys and Report

Final status surveys are performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use. Final status surveys will be conducted by performing the appropriate combination of scan

surveys, total activity measurements, dose rate measurements, soil samples and removable contamination measurements.

2.12.7.1 Group 2 Facilities

Final status survey will consist of surface scans, static measurements and smears for all areas. Scan percentages are assumed to be: 100% for Class 1 areas, 50% for Class 2 areas, and 10% for Class 3 areas. Fifteen sample locations per survey unit are assumed in medical and research laboratories. For conservatism, each Class 1 and Class 2 room is assumed to be an individual survey unit.

Survey design for building systems is out of the scope of MARSSIM. For the purpose of identifying potential residual contamination within these systems, the following survey protocol is assumed: Surveys of building ventilation and fume hood ventilation consist of scan surveys, total activity measurements, and removable contamination measurements of accessible ventilation exhaust points and at locations of potential collection/buildup. Removable contamination surveys will be taken in sink drains, sink drain traps, floor drains and vacuum pumps/nozzles.

2.12.7.2 Alpha Emitter Facilities

Final status surveys will consist of surface scans, static measurements and smears for all areas. Additionally, soil samples are assumed to be performed for impacted soils. Scan percentages are assumed to be: 100% for Class 1, 50% for Class 2 areas, and 10% for Class 3 areas. 20 sample locations per survey unit are assumed in structure and soil survey units.

2.12.7.3 Outdoor Areas

Final status surveys will consist of surface scans, and soil samples for all areas. Scan percentages are assumed to be: 100% for Class 1 areas, 50% for Class 2 areas, and 10% for Class 3 areas. 20 sample locations per survey unit are assumed in soil survey units.

2.12.8 Schedules

A breakdown of the estimated schedule for each project is presented in Table 2-5.

Table 2-5 Schedule Breakdown[2]

Project Element	Cost Estimate Table[3]	Group 2 Facilities (Weeks)	Alpha Facilities (Weeks)	Outdoor Facilities (Weeks)
Decommissioning Planning	Table 3.6	3	7	7
Characterization Surveys	Table 3.6	1	1	1
Equipment Removal, Remediation, Waste Disposal	Table 3.7 Table 3.14	12	18	1
Final Status Surveys	Table 3.9	13	3	4
Final Status Report	Table 3.9	3	3	2
Restoration	Table 3.8	0.5	2.5	0.5
	Total	**32.5**	**34.5**	**15.5**

2.13 Staffing and Labor

2.13.1 Group 2 Facilities

Full time, on-site staffing is assumed to consist of a Project Manager (PM), a Health Physics Supervisor (HPS), six Health Physics Technicians (HPT), and two Laborers. Part time on-site and off-site support is provided by a Health Physicist, a Shipper, a Draftsman and an Administrative Assistant. The PM is responsible for the overall management of the project and provides the daily interface with MU management, vendors and subcontractors. The PM is also responsible for coordination of decommissioning activities and for arranging any needed support items as well as ensuring that the project is completed within required parameters with respect to cost, timeliness, safety, quality, and compliance. The Health Physics Supervisor provides day-to-day supervision of field operations. Health Physics Technicians provide labor for radiological surveys, remediation, waste packaging, and final status surveys. Laborers are radiation workers that provide labor for decontamination, dismantlement and waste handling activities. The Health Physicist is responsible for developing appropriate techniques, controls, and monitoring for the work being performed. This position is also responsible for ensuring that appropriate instrumentation and procedures are utilized for performing remedial support and final status surveys. The Shipper is responsible for packaging, classifying and shipping all radioactive materials from the project as well as scheduling shipments and ordering shipping containers as necessary. The Draftsman creates, documents and indexes facility drawings and radiation surveys. The administrative assistant provides support to the Project Manager for cost-tracking, timekeeping, procurement and recordkeeping functions.

[2] Project elements are not contiguous and do not include regulatory review periods.
[3] The cost estimate table numbers refer to the tables contained in Appendices B, C and D.

2.13.2 Alpha Emitter Facilities

Full time, on-site staffing is assumed to consist of a Project Manager (PM), a Health Physics Supervisor (HPS), six Health Physics Technicians (HPT), a Foreman, an Equipment Operator and six Laborers. Part time on-site and off-site support is provided by a Structural Engineer, a Health Physicist, a Shipper, a Draftsman and an Administrative Assistant. The functions and responsibilities are the same as above for common positions. The Structural Engineer is a part-time position responsible for evaluating the effect of remediation on the structural integrity of the buildings and stability of outside grounds. The Structural Engineer also designs and inspects shoring of building structures. The Equipment Operator operates heavy equipment required for movement, excavation, and loading of remediation wastes. The Foreman provides day-to-day supervision of the laborer crew. Laborers are radiation workers that provide labor for decontamination, dismantlement, lifting, rigging and waste handling activities.

2.13.3 Outdoor Areas

Full time, on-site staffing is assumed to consist of a Project Manager (PM), a Health Physics Supervisor (HPS), two Health Physics Technicians (HPT), a Foreman, two Equipment Operators and two Laborers. Part time on-site and off-site support is provided by a Structural Engineer, a Health Physicist, a Shipper, a Draftsman and an Administrative Assistant. The functions and responsibilities are the same as above.

2.14 Additional Assumptions

- All labor estimates are expressed in workdays. Workdays are actual days on the job excluding weekends, holidays, etc. Project schedules were based on 5-day workweeks consisting of 8 hours per day.

- No credit is taken in these estimates for any salvage value of any material or equipment.

- It is assumed that all facilities are decontaminated for unrestricted use and are not demolished.

- Inventories of materials and wastes at the time of decommissioning will be in amounts consistent with routine facility conditions over time.

- Decommissioning activities take place immediately on cessation of operations without multiyear storage-for-decay periods.

- Work will be performed by an independent third-party contractor. All labor, services, equipment and supply costs are based on third party costs.

- Activities will be conducted under the contractor's Agreement State license utilizing a reciprocal agreement with the NRC.

- Group 4 activities will be conducted under the contractor's Agreement State license over a period of two years (long development and regulatory review periods are assumed) such that two annual reciprocity fees are captured.
- Group 2 activities will be conducted under the contractor's Agreement State license and can be completed in a single year.
- The licensee operated the facility according to all license conditions and industry standard radiological practices.
- There is no contamination on the external surfaces of Group 2 buildings, including the roof.
- There is no contamination of building structural surfaces in laboratories above a two-meter height.
- There are no subsurface drain lines in Group 2 facilities that must be remediated.
- Radioactive wastes from consumables used in the decommissioning process are captured in waste estimates under Dry Active Waste (DAW).
- Building footers will not be impacted to a degree that would require building demolition.
- No structural engineering or shoring is required during demolition work. However, costs are captured for a Structural Engineer's evaluation.
- Groundwater is not impacted.
- No costs are captured for removing museum items or protection of museum artifacts.
- Museum artifacts are assumed to have no salvage value used to offset decommissioning costs.

2.15 Cost Estimate Results

The overall estimated cost to achieve unrestricted release of the facility is $9,046,453 including a contingency of 25%. Table A.3.18 data from each of the independent cost estimates were summed and presented in Table 2-6 below.

Table 2-6 Total Decommissioning Cost Breakdown

Task/Component	Cost	Percentage
Planning and Preparation	$359,380	5.0%
Decontamination and/or Dismantling of Radioactive Facility	$1,723,199	23.8%
Restoration of Contaminated Areas on Facility Grounds	$84,420	1.2%
Final Radiation Survey	$806,180	11.1%
Packing Material Costs	$29,080	0.4%
Shipping Costs	$179,831	2.5%
Waste Disposal Costs	$3,337,920	46.1%
Equipment/Supply Costs	$416,152	5.8%
Laboratory Costs	$291,000	4.0%
Miscellaneous Costs	$10,000	0.1%
SUBTOTAL	**$7,237,162**	**100.0%**
25% Contingency	$1,809,291	25.0%
TOTAL DECOMMISSIONING COST ESTIMATE	**$9,046,453**	**125.0%**

3.0 Periodic Adjustment of Decommissioning Cost Estimate and Funding Levels

The decommissioning cost estimate will be updated with the current prices of goods and services at least every three years, and the decommissioning funding will be adjusted as needed at that time. Additionally, annually, as part of the annual program review, the Radiation Safety Committee will review the need for updating based on operational changes such as adding or deleting facilities as well as significant changes in quantities, usage, and/or radiological conditions.

4.0 Certification of Financial Assurance and Financial Instrument

A copy of the Statement of Intent that provides financial assurance for decommissioning is attached as Appendix E.

5.0 References

- 10 CFR 20, Standards For Protection Against Radiation
- NUREG-1757, Volume 1, Rev. 2 "Consolidated NMSS Decommissioning Guidance: Decommissioning Process for Materials Licensees," September, 2006
- NUREG-1757, Volume 2, Rev. 1 "Consolidated NMSS Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria," September, 2006

- NUREG-1757, Volume 3 "Consolidated NMSS Decommissioning Guidance: Financial Assurance, Recordkeeping, and Timeliness," September, 2003
- NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM)
- NUREG/CR-6477, "Revised Analyses of Decommissioning Reference, Non-Fuel-Cycle Facilities," December 2002
- NUREG-1505, Revision 1, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys," June 1998
- NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," June 1998
- NUREG/CR-5512, "Residual Radioactivity from Decommissioning: Parameter Analysis," August 1999.
- NUREG-1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination," July 1998
- ANL/EAD/03-1 "User's Manual for RESRAD-BUILD Version 3," June 2003
- "Decommissioning Health Physics, A Handbook for MARSSIM Users," Abelquist, 2001
- "Handbook of Health Physics and Radiological Health", 3rd Edition, 1998
- FC 83-23, "Guidelines for the Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Byproduct, Source, or Special Nuclear Material Licenses."
- Pickard Hall Characterization Survey Report, July 16, 2010 (ML102800311, ML102800322, ML102800330, ML102800336, ML102800398, ML102800412, ML102800427, ML102800430, ML102800436, ML102800441, ML102800450, ML102800452, ML102800455, ML102800458, ML102800463, ML102800467, and ML102800563)
- Schweitzer Hall Roof Survey Report, March 3, 2010

A.3.4 FACILITY DESCRIPTION SUMMARY

Radioactive Material license numbers and types (i.e., Byproduct, Source):
See DFP text.
Types and quantities of materials authorized under the licenses listed above:
See DFP text.
Description of how licensed materials are used:
See DFP text.
Description of facility, including buildings, rooms, grounds, and description of where particular types of materials are used:
See DFP text.
Quantities of materials or waste accumulated before shipping or disposal
See DFP text.

A.3.5 NUMBER AND DIMENSIONS OF FACILITY COMPONENTS

Use this table to summarize relevant features of the facility. Copy and complete the table as necessary for each room, laboratory, or area.				
Name of room, laboratory, or area:	Area 1: Research and Medical Laboratories (400 Laboratories)			
Level of Contamination:	MARSSIM Class 2			
Component	Number of Components	Dimensions of Component (specify units)	Total Dimensions (specify units)	
Glove Boxes				ft^3
Fume Hoods	400	144	57,600	ft^3
Lab Benches	400	270	108,000	ft^3
Sinks	800	8	6,400	ft^3
Drains	800	3.75	3,000	ft^3
Floors	400	256	102,400	ft^2
Walls	400	640	256,000	ft^2
Ceiling	400	256	102,400	ft^2
Ventilation/Ductwork	400	30	12,000	ft^3
Hot Cells				ft^3
Equipment/Materials	400	7.5	3,000	ft^3
Soil Plots				ft^2
Storage Tanks				ft^3
Storage Areas				ft^3
Radwaste Areas				ft^3
Scrap Recovery Areas				ft^3
Maintenance Shop				ft^3
Equipment Decon Areas				ft^3
Other (specify)				ft^3
Other (specify)				ft^3

A.3.5 NUMBER AND DIMENSIONS OF FACILITY COMPONENTS (Cont'd)

Name of room, laboratory, or area:	Area 2: Farm Buildings (25 Buildings)			
Level of Contamination:	MARSSIM Class 2			
Component	Number of Components	Dimensions of Component (specify units)	Total Dimensions (specify units)	
Glove Boxes				ft^3
Fume Hoods				ft^3
Lab Benches				ft^3
Sinks	50	8	400	ft^3
Drains	250	3.75	937.5	ft^3
Floors	25	5,000	125,000	ft^2
Walls	25	6,000	150,000	ft^2
Ceiling	25	5,000	125,000	ft^2
Ventilation/Ductwork	100	30	3,000	ft^3
Hot Cells				ft^3
Equipment/Materials	25	7.5	187.5	ft^3
Soil Plots				ft^2
Storage Tanks				ft^3
Storage Areas				ft^3
Radwaste Areas				ft^3
Scrap Recovery Areas				ft^3
Maintenance Shop				ft^3
Equipment Decon Areas				ft^3
Other (specify)				ft^3
Other (specify)				ft^3

A.3.5 NUMBER AND DIMENSIONS OF FACILITY COMPONENTS (Cont'd)

Name of room, laboratory, or area:	Area 3: Radioactive Waste Areas (satellite collection areas included with labs)			
Level of Contamination:	MARSSIM Class 1			
Component	Number of Components	Dimensions of Component (specify units)	Total Dimensions (specify units)	
Glove Boxes				ft^3
Fume Hoods	2	144	288	ft^3
Lab Benches	2	270	540	ft^3
Sinks	6	8	48	ft^3
Drains	10	3.75	38	ft^3
Floors	2	256	512	ft^2
Walls	2	640	1,280	ft^2
Ceiling	2	256	512	ft^2
Ventilation/Ductwork	6	30	180	ft^3
Hot Cells				ft^3
Equipment/Materials	2	96	192	ft^3
Soil Plots				ft^2
Storage Tanks				ft^3
Storage Areas				ft^3
Radwaste Areas				ft^3
Scrap Recovery Areas				ft^3
Maintenance Shop				ft^3
Equipment Decon Areas				ft^3
Other (specify)				ft^3
Other (specify)				ft^3

A.3.6 PLANNING AND PREPARATION

(Work Days)

Estimate the number of workdays, by specific labor category, that will be required to complete planning and preparation activities. Include all labor categories, including Supervisor, Foreman, Craftsman, Technician, Health Physicist, Laborer, Clerical, and others as needed.

Activity	(1) Project Mgr	(1) HPS	(1) Health Physicist/ (1) Shipper	(6) HPT's / (1) Draftsman	(2) Laborer	Clerical
Preparation of Documentation for Regulatory Agencies	2	0	1	2	0	1
Submittal of Decommissioning Plan						
Development of Work Plans	10	5	1	0	0	5
Procurement of Special Equipment	1	1	0	0	0	1
Staff Training	1	1	1	6	2	0
Characterization of Radiological Condition (including sampling, soil and tailings analysis, or groundwater analysis, if applicable)	5	5	0	10	0	0
Other (specify) Mobilization	1	1	1	6	0	0
TOTALS	20	13	4	24	2	7

A.3.7 DECONTAMINATION OR DISMANTLING OF RADIOACTIVE FACILITY COMPONENTS (Work Days)

Estimate the number of workdays, by specific labor category, that will be required to complete decontamination and/or dismantling activities for each facility component. Copy and complete this table as necessary for each room, laboratory, or area. Rooms, laboratories, or areas with similar levels of

Name of room, laboratory, or area: Research and Medical Labs, Radwaste Areas, Farm Buildings

Level of Contamination: From background levels to DCGLs

Component	Decon Method	(1) Project Mgr	(1) HPS	(1) Health Physicist/ (1) Shipper	(6) HPT's / (1) Draftsman	(2) Laborer	Clerical
Glove Boxes							
Fume Hoods/ Hot Cells	Decon				120	20	
Lab Benches	Decon				60	10	
Sinks	Decon						
Drains	Remove/Disp				120	20	
Floors	Decon				60	10	
Walls	Decon				60	10	
Ceilings							
Ventilation/Ductwork	Remove/Disp				120	20	
Hot Cells							
Equipment/Materials	Sur/Rem/Disp				102	34	
Soil Plots							
Storage Tanks							
Storage Areas							
Radwaste Areas							
Scrap Recovery Areas							
Maintenance Shop							
Equipment Decon Areas							
Other (specify) Shipping				10			
Other (specify) Supervision		62	62				
TOTALS		62	62	10	642	124	

A.3.8 RESTORATION OF CONTAMINATED AREAS ON FACILITY GROUNDS (Work Days)

Estimate the number of work days, by specific labor category, that will be required to restore contaminated areas on the facility grounds.

Activity	(1) Project Mgr	(1) HPS	(1) Health Physicist/ (1) Shipper	(6) HPT's / (1) Draftsman	(2) Laborer	Clerical
Restore Roof Penetrations	2	2			4	
TOTALS	2	2	0	0	4	0

A.3.9 FINAL RADIATION SURVEY

(Work Days)

Estimate the number of work days, by specific labor category, that will be required to conduct a final radiation survey.

Activity	(1) Project Mgr	(1) HPS	(1) Health Physicist/ (1) Shipper	(6) HPT's / (1) Draftsman	(2) Laborer	Clerical
FSS Setup	10	5		10		5
Survey Packages	10	5		10		5
Class 2 Research Labs	40	40		240		40
Class 2 Farm Buildings	10	10		60		10
Class 1 Waste Storage Area	5	5		30		5
Class 3 Buffer Areas	10	10		60		10
Report	15		3	3		3
TOTALS	100	75	3	413	0	78

A.3.10 SITE STABILIZATION AND LONG-TERM SURVEILLANCE (Work Days)

Estimate the number of work days, by specific labor category, that will be required to complete site stabilization and long-term surveillance activities.

Activity	(1) Project Mgr	(1) HPS	(1) Health Physicist/ (1) Shipper	(6) HPT's / (1) Draftsman	(2) Laborer	Clerical
None - Unrestricted Release						
TOTALS	0	0	0	0	0	0

A.3.11 TOTAL WORK DAYS BY LABOR CATEGORY

Enter the total work days for each specific labor category from the applicable table above (i.e., from the bottom rows of Tables A.3.6 through A.3.10).

Task	(1) Project Mgr	(1) HPS	(1) Health Physicist/ (1) Shipper	(6) HPT's / (1) Draftsman	(2) Laborer	Clerical
Planning and Preparation (TOTALS from Table A.3.6)	20	13	4	24	2	7
Decontamination and/or Dismantling of Radioactive Facility Components (Sum of TOTALS from all copies of Table A.3.7)	62	62	10	642	124	0
Restoration of Contaminated Areas on Facility Grounds (TOTALS from Table A.3.8)	2	2	0	0	4	0
Final Radiation Survey (TOTALS from Table A.3.9)	100	75	3	413	0	78
Site Stabilization and Long-Term Surveillance (TOTALS from Table A.3.10)	0	0	0	0	0	0

A.3.12 WORKER UNIT COST SCHEDULE

Estimate labor costs (including salary, fringe benefits, and corporate overhead). Include all appropriate labor categories, including Supervisor, Foreman, Craftsman, Technician, Health Physicist, Laborer, Clerical, and others as needed.						
Labor Cost Component	(1) Project Mgr	(1) HPS	(1) Health Physicist/ (1) Shipper	(6) HPT's / (1) Draftsman	(2) Laborer	Clerical
Salary & Fringe ($/year)	$175,000	$150,000	$135,000	$105,000	$65,000	$45,000
Overhead Rate (%)	50%	50%	50%	50%	50%	50%
Total Cost Per Year	$262,500	$225,000	$202,500	$157,500	$97,500	$67,500
Living Expenses (PD*7/5)[1]	$181	$181	$181	$181	0	0
Total Cost Per Work Day[2]	$1,190	$1,046	$959	$786	$375	$260

[1] Per Diem Rate: $129 per day.

[2] Based on 260 work days per year (e.g., 260).

A.3.13 TOTAL LABOR COSTS BY MAJOR DECOMMISSIONING TASK

Multiply the estimated work days for each specific labor category (from Table A.3.11) by the total cost per work day for the corresponding labor category (from Table A.3.12), and enter the results in the table below. Then, add across all labor categories to determine the total labor costs for each

Task	(1) Project Mgr	(1) HPS	(1) Health Physicist/ (1) Shipper	(6) HPT's / (1) Draftsman	(2) Laborer	Clerical	Total Labor Cost
Planning and Preparation	$23,804	$13,598	$3,838	$18,873	$750	$1,817	$62,680
Decontamination or Dismantling of Radioactive Facility Components	$73,793	$64,851	$9,594	$504,849	$46,500	$0	$699,588
Restoration of Contaminated Areas on Facility Grounds	$2,380	$2,092	$0	$0	$1,500	$0	$5,972
Final Radiation Survey	$119,022	$78,449	$2,878	$324,770	$0	$20,250	$545,369
Site Stabilization and Long-Term Surveillance	$0	$0	$0	$0	$0	$0	$0

A.3.14 PACKAGING, SHIPPING, AND DISPOSAL OF RADIOACTIVE WASTES (Excluding Labor Costs)

(a) Packing Material Costs

Estimate the types and volumes of waste expected to be generated, along with the number and types of containers required for packaging the waste. Multiply the number of containers required by the unit cost per container.

Waste Type	Volume (ft^3)	Number of Containers	Type of Containers	Unit Cost of Container	Total Packaging Costs
DAW/PPE from Decomm.	3188	119	1 m^3 Sacks	$80	$9,520
LSC Vials	45	6	Drum	$70	$420
All DAW/PPE/LSC Vials	2,560	2	Rented Seavan	$2,000	$4,000
TOTAL					$13,940

(b) Shipping Costs

Estimate the number of truckloads of waste expected to be shipped. Multiply shipping costs per mile (including truckload costs, surcharges, and overweight charges) by the total distance shipped.

Waste Type	Number of Truckloads	Unit Cost ($/mile/truckload)	Surcharges ($/mile)	Overweight Charges($/mile)	Distance Shipped (miles)	Total Shipping Costs
DAW/PPE from Decomm.	1.5	$3.50	0	0	600	$3,150
LSC Vials	0.25	$3.50	0	0	600	$525
Annual Waste Inventory	0.25	$3.50	0	0	600	$525
Self-Shielded Irradiator	1					$55,931
TOTAL	3					$60,131

(c) Waste Disposal Costs

Estimate the volume of waste to be disposed. Multiply the volume of waste disposed by the unit disposal cost (including any volume-based surcharges). Add any surcharges that are based on the number of containers of waste.

Waste Type	Disposal Volume (ft3)	Density (lb/ft3)	Disposal Mass (lbs)	Unit Cost ($/lb)	Surcharges ($/$ft^3$ or $/container)	Total Disposal Costs
DAW/PPE from Decomm.	3,188	20	63,750	6.00	0	$382,500
LSC Vials	45	40	1,800	5.00	0	$9,000
Annual Waste Inventory	885	10	8,850	6.00	0	$53,100
TOTAL	3,233					$444,600

A.3.15 EQUIPMENT/SUPPLY COSTS (Excluding Containers)

Estimate the quantity of equipment and supplies required for decommissioning and multiply that quantity by the appropriate unit costs.			
Equipment/Supplies	Quantity	Unit Cost	Total Equipment/Supply Cost
Protective Clothing (per dress-out)	144	$8	$1,152
Instrumentation Rental (per week)	15	$2,000	$30,000
Misc Tools (per week)	15	$1,000	$15,000
LSC Supplies (per sample)	15,000	$1	$15,000
Consumables (per week)	15	$1,000	$15,000
TOTAL			$76,152

A.3.16 LABORATORY COSTS

If applicable, estimate costs for analyses to be performed by an independent third-party laboratory.			
Activity	Quantity	Unit Cost	Total Item Cost
Sampling			
Transport of Samples			
Testing and Analysis			
Other (specify)			
TOTAL			

A.3.17 MISCELLANEOUS COSTS

Estimate any other applicable costs.	
Activity	Total Cost
License Fees (reciprocity)	$2,000
Insurance (included in unit rates)	
Taxes (included in unit rates)	
Other (specify)	
TOTAL	$2,000

A.3.18 TOTAL DECOMMISSIONING COSTS

Enter the total costs reported in Tables A.3.13, A.3.14(a)-(c), A.3.15, A.3.16, and A.3.17 into the appropriate cells below, and add then to obtain a subtotal. Add to the subtotal a contingency allowance in		
Task/Component	Cost	Percentage
Planning and Preparation (from Table A.3.13)	$62,680	3.3%
Decontamination and/or Dismantling of Radioactive Facility (From Table A.3.13)	$699,588	36.6%
Restoration of Contaminated Areas on Facility Grounds (From Table A.3.13)	$5,972	0.3%
Final Radiation Survey (From Table A.3.13)	$545,369	28.5%
Packing Material Costs (TOTAL from Table A.3.14(a))	$13,940	0.7%
Shipping Costs (TOTAL from Table A.3.14(b))	$60,131	3.1%
Waste Disposal Costs (TOTAL from Table A.3.14(c))	$444,600	23.3%
Equipment/Supply Costs (TOTAL from Table A.3.15)	$76,152	4.0%
Laboratory Costs (TOTAL from Table A.3.16)	$0	0.0%
Miscellaneous Costs (TOTAL from Table A.3.17)	$2,000	0.1%
SUBTOTAL	$1,910,432	100.0%
25% Contingency	$477,608	25.0%
TOTAL DECOMMISSIONING COST ESTIMATE	$2,388,040	125.0%

A.3.4 FACILITY DESCRIPTION SUMMARY

Radioactive Material license numbers and types (i.e., Byproduct, Source):
See DFP text.
Types and quantities of materials authorized under the licenses listed above:
See DFP text.
Description of how licensed materials are used:
See DFP text.
Description of facility, including buildings, rooms, grounds, and description of where particular types of materials are used:
See DFP text.
Quantities of materials or waste accumulated before shipping or disposal
See DFP text.

A.3.5 NUMBER AND DIMENSIONS OF FACILITY COMPONENTS

Use this table to summarize relevant features of the facility. Copy and complete the table as necessary for each room, laboratory, or area.				
Name of room, laboratory, or area:	Area 1: Pickard Hall			
Level of Contamination:	MARSSIM Class 1			
Component	Number of Components	Dimensions of Component (specify units)	Total Dimensions (specify units)	
Glove Boxes				ft^3
Fume Hoods				ft^3
Lab Benches				ft^3
Sinks				ft^3
Drains	10	3.75	38	ft^3
Floors	1	33,600	33,600	ft^2
Walls	1	134,400	134,400	ft^2
Ceiling	1	33,600	33,600	ft^2
Ventilation/Ductwork	7	60	420	ft^3
Hot Cells				ft^3
Equipment/Materials	1	96	96	ft^3
Soil Plots				ft^2
Storage Tanks				ft^3
Storage Areas				ft^3
Radwaste Areas				ft^3
Scrap Recovery Areas				ft^3
Maintenance Shop				ft^3
Equipment Decon Areas				ft^3
Other (specify) Roof	1	12,600	12,600	ft^2
Other (specify)				ft^3

A.3.5 NUMBER AND DIMENSIONS OF FACILITY COMPONENTS (Cont'd)

Name of room, laboratory, or area:	Area 2: Schweitzer Hall			
Level of Contamination:	MARSSIM Class 1			
Component	Number of Components	Dimensions of Component (specify units)	Total Dimensions (specify units)	
Glove Boxes				ft^3
Fume Hoods				ft^3
Lab Benches				ft^3
Sinks				ft^3
Drains	2	3.75	8	ft^3
Floors	1	9,900	9,900	ft^2
Walls	1	4,950	4,950	ft^2
Ceiling	1	9,900	9,900	ft^2
Ventilation/Ductwork	2	60	120	ft^3
Hot Cells				ft^3
Equipment/Materials	1	96	96	ft^3
Soil Plots				ft^2
Storage Tanks				ft^3
Storage Areas				ft^3
Radwaste Areas				ft^3
Scrap Recovery Areas				ft^3
Maintenance Shop				ft^3
Equipment Decon Areas				ft^3
Other (specify) Roof	1	14,850	14,850	ft^3
Other (specify)				ft^3

A.3.6 PLANNING AND PREPARATION

(Work Days)

Estimate the number of workdays, by specific labor category, that will be required to complete planning and preparation activities. Include all labor categories, including Supervisor, Foreman, Craftsman, Technician, Health Physicist, Laborer, Clerical, and others as needed.

Activity	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(6) HPT's or (1) Draftsman or (2) Equipment Operators	(6) Laborer	Clerical
Preparation of Documentation for Regulatory Agencies	2	0	1	2	0	1
Submittal of Decommissioning Plan	20	10	10	20	0	10
Development of Work Plans	10	5	5	10	0	5
Procurement of Special Equipment	4	4	0	0	0	1
Staff Training	1	2	2	8	6	0
Characterization of Radiological Condition (including sampling, soil and tailings analysis, or groundwater analysis, if applicable)	5	5	0	10	0	0
Other (specify) Mobilization	1	1	1	6	0	0
TOTALS	43	27	19	56	6	17

A.3.7 DECONTAMINATION OR DISMANTLING OF RADIOACTIVE FACILITY COMPONENTS (Work Days)

Estimate the number of workdays, by specific labor category, that will be required to complete decontamination and/or dismantling activities for each facility component. Copy and complete this table as necessary for each room, laboratory, or area. Rooms, laboratories, or areas with similar levels of

Name of room, laboratory, or area: Pickard Hall and Schweitzer Hall

Level of Contamination: From background levels to above DCGLs

Component	Decon Method	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(6) HPT's or (1) Draftsman or (2) Equipment Operators	(6) Laborer	Clerical
Pickard Hall							
Drains	Remove/Disp				40	30	
Floors	Scabble/Rem				80	60	
Walls	Remove/Disp				20	15	
Ceilings	Plane Attic				60	45	
Ventilation/Ductwork	Remove/Disp				60	45	
Equipment/Materials	Sur/Rem/Disp				8	6	
Soil Plots	Rem Soil				60	45	
Schweitzer Hall							
Drains	Remove/Disp				16	12	
Floors	Scabble/Rem				40	30	
Walls	Remove/Disp				8	6	
Ceilings	Plane Attic				60	45	
Roof	Remove/Disp						
Ventilation/Ductwork	Remove/Disp				60	45	
Equipment/Materials	Sur/Rem/Disp				8	6	
Soil Plots	Rem Soil				20	15	
Other (specify) Shipping				90			
Other (specify) Supervision		90	180				90
TOTALS		90	180	90	540	405	90

A.3.8 RESTORATION OF CONTAMINATED AREAS ON FACILITY GROUNDS (Work Days)

Estimate the number of work days, by specific labor category, that will be required to restore contaminated areas on the facility grounds.

Activity	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(6) HPT's or (1) Draftsman or (2) Equipment Operators	(6) Laborer	Clerical
Restore Roof	10	10		10	60	
Backfill Excavations	3	3		6	18	
TOTALS	13	13	0	16	78	0

A.3.9 FINAL RADIATION SURVEY

(Work Days)

Estimate the number of work days, by specific labor category, that will be required to conduct a final radiation survey.

Activity	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(6) HPT's or (1) Draftsman or (2) Equipment Operators	(6) Laborer	Clerical	
FSS Setup	5	2		2		2	
Survey Packages	5	2		2		2	
Structures	10	10		60		10	10 days
Soils	5	5		30		5	5 Days
Report	15		3	3		3	
TOTALS	40	19	3	97	0	22	

A.3.10 SITE STABILIZATION AND LONG-TERM SURVEILLANCE
(Work Days)

Estimate the number of work days, by specific labor category, that will be required to complete site stabilization and long-term surveillance activities.

Activity	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(6) HPT's or (1) Draftsman or (2) Equipment Operators	(6) Laborer	Clerical
None - Unrestricted Release						
TOTALS	0	0	0	0	0	0

A.3.11 TOTAL WORK DAYS BY LABOR CATEGORY

Enter the total work days for each specific labor category from the applicable table above (i.e., from the bottom rows of Tables A.3.6 through A.3.10).

Task	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(6) HPT's or (1) Draftsman or (2) Equipment Operators	(6) Laborer	Clerical
Planning and Preparation (TOTALS from Table A.3.6)	43	27	19	56	6	17
Decontamination and/or Dismantling of Radioactive Facility Components (Sum of TOTALS from all copies of Table A.3.7)	90	180	90	540	405	90
Restoration of Contaminated Areas on Facility Grounds (TOTALS from Table A.3.8)	13	13	0	16	78	0
Final Radiation Survey (TOTALS from Table A.3.9)	40	19	3	97	0	22
Site Stabilization and Long-Term Surveillance (TOTALS from Table A.3.10)	0	0	0	0	0	0

A.3.12 WORKER UNIT COST SCHEDULE

Estimate labor costs (including salary, fringe benefits, and corporate overhead). Include all appropriate labor categories, including Supervisor, Foreman, Craftsman, Technician, Health Physicist, Laborer, Clerical, and others as needed.

Labor Cost Component	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(6) HPT's or (1) Draftsman or (2) Equipment Operators	(6) Laborer	Clerical
Salary & Fringe ($/year)	$175,000	$150,000	$135,000	$105,000	$65,000	$45,000
Overhead Rate (%)	50%	50%	50%	50%	50%	50%
Total Cost Per Year	$262,500	$225,000	$202,500	$157,500	$97,500	$67,500
Living Expenses (PD*7/5)[1]	$181	$181	$181	$181	0	0
Total Cost Per Work Day[2]	$1,190	$1,046	$959	$786	$375	$260

[1] Per Diem Rate: $129 per day.

[2] Based on 260 work days per year (e.g., 260).

A.3.13 TOTAL LABOR COSTS BY MAJOR DECOMMISSIONING TASK

Multiply the estimated work days for each specific labor category (from Table A.3.11) by the total cost per work day for the corresponding labor category (from Table A.3.12), and enter the results in the table below. Then, add across all labor categories to determine the total labor costs for each

Task	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(6) HPT's or (1) Draftsman or (2) Equipment Operators	(6) Laborer	Clerical	Total Labor Cost
Planning and Preparation	$51,179	$28,242	$18,229	$44,037	$2,250	$4,413	$148,350
Decontamination or Dismantling of Radioactive Facility Components	$107,119	$188,277	$86,350	$424,639	$151,875	$23,365	$981,627
Restoration of Contaminated Areas on Facility Grounds	$15,473	$13,598	$0	$12,582	$29,250	$0	$70,903
Final Radiation Survey	$47,609	$19,874	$2,878	$76,278	$0	$5,712	$152,350
Site Stabilization and Long-Term Surveillance	$0	$0	$0	$0	$0	$0	$0

A.3.14 PACKAGING, SHIPPING, AND DISPOSAL OF RADIOACTIVE WASTES (Excluding Labor Costs)

(a) Packing Material Costs

Estimate the types and volumes of waste expected to be generated, along with the number and types of containers required for packaging the waste. Multiply the number of containers required by the unit cost per container.

Waste Type	Volume (ft^3)	Number of Containers	Type of Containers	Unit Cost of Container	Total Packaging Costs
DAW/PPE	162	6	1 m^3 Sacks	$80	$480
Wood Floor, Roof	7680	3	Rented Seavan	$2,000	$6,000
Soil, Slate and Rubble	8100	15	Rented Roll-Off	$500	$7,500
TOTAL					$13,980

(b) Shipping Costs

Estimate the number of truckloads of waste expected to be shipped. Multiply shipping costs per mile (including truckload costs, surcharges, and overweight charges) by the total distance shipped.

Waste Type	Number of Truckloads	Unit Cost ($/mile/truckload)	Surcharges ($/mile)	Overweight Charges($/mile)	Distance Shipped (miles)	Total Shipping Costs
DAW/PPE	1	$3.50	0	0	600	$2,100
Wood Floor, Roof	3	$3.50	0	0	600	$6,300
Soil, Slate and Rubble	15	$3.50	0	0	2000	$105,000
TOTAL	19					$113,400

(c) Waste Disposal Costs

Estimate the volume of waste to be disposed. Multiply the volume of waste disposed by the unit disposal cost (including any volume-based surcharges). Add any surcharges that are based on the number of containers of waste.

Waste Type	Disposal Volume (ft3)	Density (lb/ft3)	Disposal Mass (lbs)	Unit Cost ($/lb)	Surcharges ($/$ft^3$ or $/container)	Total Disposal Costs
DAW/PPE	162	20	3,240	6.00	0	$19,440
Wood Floor, Roof	1960	60	117,600	6.00	0	$705,600
Soil, Slate and Rubble	7980	105	837,900	2.00	0	$1,675,800
TOTAL	2,122					$2,400,840

A.3.15 EQUIPMENT/SUPPLY COSTS (Excluding Containers)

Estimate the quantity of equipment and supplies required for decommissioning and multiply that quantity by the appropriate unit costs.

Equipment/Supplies	Quantity	Unit Cost	Total Equipment/Supply Cost
Protective Clothing (per dress-out)	3600	$8	$28,800
Instrumentation Rental (per week)	22	$2,000	$44,000
Misc Tools (per week)	22	$1,000	$22,000
Heavy Equipment Rental	18	$10,000	$180,000
Consumables (per week)	22	$1,000	$22,000
TOTAL			$296,800

A.3.16 LABORATORY COSTS

If applicable, estimate costs for analyses to be performed by an independent third-party laboratory.			
Activity	Quantity	Unit Cost	Total Item Cost
Sampling			Labor captured in remediation / FSS
Transport of Samples	10	$500	$5,000
Testing and Analysis (gamma)	200	$150	$30,000
Testing and Analysis (alpha)	20	$300	$6,000
Other (specify)			
TOTAL			$41,000

A.3.17 MISCELLANEOUS COSTS

Estimate any other applicable costs.	
Activity	Total Cost
License Fees (2 yrs reciprocity)	$4,000
Insurance (included in unit rates)	
Taxes (included in unit rates)	
Other (specify)	
TOTAL	$4,000

A.3.18 TOTAL DECOMMISSIONING COSTS

Enter the total costs reported in Tables A.3.13, A.3.14(a)-(c), A.3.15, A.3.16, and A.3.17 into the appropriate cells below, and add then to obtain a subtotal. Add to the subtotal a contingency allowance in		
Task/Component	Cost	Percentage
Planning and Preparation (from Table A.3.13)	$148,350	3.5%
Decontamination and/or Dismantling of Radioactive Facility (From Table A.3.13)	$981,627	23.2%
Restoration of Contaminated Areas on Facility Grounds (From Table A.3.13)	$70,903	1.7%
Final Radiation Survey (From Table A.3.13)	$152,350	3.6%
Packing Material Costs (TOTAL from Table A.3.14(a))	$13,980	0.3%
Shipping Costs (TOTAL from Table A.3.14(b))	$113,400	2.7%
Waste Disposal Costs (TOTAL from Table A.3.14(c))	$2,400,840	56.8%
Equipment/Supply Costs (TOTAL from Table A.3.15)	$296,800	7.0%
Laboratory Costs (TOTAL from Table A.3.16)	$41,000	1.0%
Miscellaneous Costs (TOTAL from Table A.3.17)	$4,000	0.1%
SUBTOTAL	$4,223,250	100.0%
25% Contingency	$1,055,813	25.0%
TOTAL DECOMMISSIONING COST ESTIMATE	$5,279,063	125.0%

A.3.4 FACILITY DESCRIPTION SUMMARY

Radioactive Material license numbers and types (i.e., Byproduct, Source):
See DFP text.
Types and quantities of materials authorized under the licenses listed above:
See DFP text.
Description of how licensed materials are used:
See DFP text.
Description of facility, including buildings, rooms, grounds, and description of where particular types of materials are used:
See DFP text.
Quantities of materials or waste accumulated before shipping or disposal
See DFP text.

A.3.5 NUMBER AND DIMENSIONS OF FACILITY COMPONENTS

Use this table to summarize relevant features of the facility. Copy and complete the table as necessary for each room, laboratory, or area.				
Name of room, laboratory, or area:	Area 1: Sinclair Farm			
Level of Contamination:	MARSSIM Class 2			
Component	Number of Components	Dimensions of Component (specify units)	Total Dimensions (specify units)	
Glove Boxes				ft^3
Fume Hoods				ft^3
Lab Benches				ft^3
Sinks				ft^3
Drains				ft^3
Floors				ft^2
Walls				ft^2
Ceiling				ft^2
Ventilation/Ductwork				ft^3
Hot Cells				ft^3
Equipment/Materials				ft^3
Soil Plots				ft^2
Storage Tanks				ft^3
Storage Areas				ft^3
Radwaste Areas				ft^3
Scrap Recovery Areas				ft^3
Maintenance Shop				ft^3
Equipment Decon Areas				ft^3
Other (specify) Lagoons	2	2	4	acre
Other (specify) Impacted Grounds	1	100	100	acre

A.3.5 NUMBER AND DIMENSIONS OF FACILITY COMPONENTS (Cont'd)

Name of room, laboratory, or area:	Area 2: South Farm			
Level of Contamination:	MARSSIM Class 2			
Component	Number of Components	Dimensions of Component (specify units)	Total Dimensions (specify units)	
Glove Boxes				ft^3
Fume Hoods				ft^3
Lab Benches				ft^3
Sinks				ft^3
Drains				ft^3
Floors				ft^2
Walls				ft^2
Ceiling				ft^2
Ventilation/Ductwork				ft^3
Hot Cells				ft^3
Equipment/Materials				ft^3
Soil Plots				ft^2
Storage Tanks				ft^3
Storage Areas				ft^3
Radwaste Areas				ft^3
Scrap Recovery Areas				ft^3
Maintenance Shop				ft^3
Equipment Decon Areas				ft^3
Other (specify) Burial Site	1	0.34	0.34	acre
Other (specify) Impacted Grounds	1	5	5	acre

A.3.6 PLANNING AND PREPARATION

(Work Days)

Estimate the number of workdays, by specific labor category, that will be required to complete planning and preparation activities. Include all labor categories, including Supervisor, Foreman, Craftsman, Technician, Health Physicist, Laborer, Clerical, and others as needed.

Activity	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(2) HPT's or (1) Draftsman or (2) Equipment Operators	(2) Laborer	Clerical
Preparation of Documentation for Regulatory Agencies	2	0	1	2	0	1
Submittal of Decommissioning Plan	20	10	10	20	0	10
Development of Work Plans	10	5	5	10	0	5
Procurement of Special Equipment	4	4	0	0	0	1
Staff Training	1	2	2	8	6	0
Characterization of Radiological Condition (including sampling, soil and tailings analysis, or groundwater analysis, if applicable)	5	5	0	10	0	0
Other (specify) Mobilization	1	1	1	6	0	0
TOTALS	43	27	19	56	6	17

A.3.7 DECONTAMINATION OR DISMANTLING OF RADIOACTIVE FACILITY COMPONENTS (Work Days)

Estimate the number of workdays, by specific labor category, that will be required to complete decontamination and/or dismantling activities for each facility component. Copy and complete this table as necessary for each room, laboratory, or area. Rooms, laboratories, or areas with similar levels of							
Name of room, laboratory, or area:		Outdoor Areas					
Level of Contamination:		From background levels to DCGLs					
Component	Decon Method	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(2) HPT's or (1) Draftsman or (2) Equipment Operators	(2) Laborer	Clerical
Glove Boxes							
Fume Hoods/ Hot Cells							
Lab Benches							
Sinks							
Drains							
Floors							
Walls							
Ceilings							
Ventilation/Ductwork							
Hot Cells							
Equipment/Materials							
Soil Plots	Rem/Dispose				20	10	
Storage Tanks							
Storage Areas							
Radwaste Areas							
Scrap Recovery Areas							
Maintenance Shop							
Equipment Decon Areas							
Other (specify) Shipping				5			
Other (specify) Supervision		5	10				5
TOTALS		5	10	5	20	10	5

A.3.8 RESTORATION OF CONTAMINATED AREAS ON FACILITY GROUNDS (Work Days)

Estimate the number of work days, by specific labor category, that will be required to restore contaminated areas on the facility grounds.						
Activity	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(2) HPT's or (1) Draftsman or (2) Equipment Operators	(2) Laborer	Clerical
Grade Excavations	2	2		2	4	
TOTALS	2	2	0	2	4	0

A.3.9 FINAL RADIATION SURVEY

(Work Days)

Estimate the number of work days, by specific labor category, that will be required to conduct a final radiation survey.						
Activity	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(2) HPT's or (1) Draftsman or (2) Equipment Operators	(2) Laborer	Clerical
FSS Setup	5	2		2		2
Survey Packages	5	2		2		2
Soils Surveys/Sampling	15	15		30	30	15
Report	10		2	2		2
TOTALS	35	19	2	36	30	21

A.3.10 SITE STABILIZATION AND LONG-TERM SURVEILLANCE
(Work Days)

Estimate the number of work days, by specific labor category, that will be required to complete site stabilization and long-term surveillance activities.

Activity	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(2) HPT's or (1) Draftsman or (2) Equipment Operators	(2) Laborer	Clerical
None - Unrestricted Release						
TOTALS	0	0	0	0	0	0

A.3.11 TOTAL WORK DAYS BY LABOR CATEGORY

Enter the total work days for each specific labor category from the applicable table above (i.e., from the bottom rows of Tables A.3.6 through A.3.10).

Task	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(2) HPT's or (1) Draftsman or (2) Equipment Operators	(2) Laborer	Clerical
Planning and Preparation (TOTALS from Table A.3.6)	43	27	19	56	6	17
Decontamination and/or Dismantling of Radioactive Facility Components (Sum of TOTALS from all copies of Table A.3.7)	5	10	5	20	10	5
Restoration of Contaminated Areas on Facility Grounds (TOTALS from Table A.3.8)	2	2	0	2	4	0
Final Radiation Survey (TOTALS from Table A.3.9)	35	19	2	36	30	21
Site Stabilization and Long-Term Surveillance (TOTALS from Table A.3.10)	0	0	0	0	0	0

A.3.12 WORKER UNIT COST SCHEDULE

Estimate labor costs (including salary, fringe benefits, and corporate overhead). Include all appropriate labor categories, including Supervisor, Foreman, Craftsman, Technician, Health Physicist, Laborer, Clerical, and others as needed.

Labor Cost Component	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(2) HPT's or (1) Draftsman or (2) Equipment Operators	(2) Laborer	Clerical
Salary & Fringe ($/year)	$175,000	$150,000	$135,000	$105,000	$65,000	$45,000
Overhead Rate (%)	50%	50%	50%	50%	50%	50%
Total Cost Per Year	$262,500	$225,000	$202,500	$157,500	$97,500	$67,500
Living Expenses (PD*7/5)[1]	$181	$181	$181	$181	0	0
Total Cost Per Work Day[2]	$1,190	$1,046	$959	$786	$375	$260

[1] Per Diem Rate: $129 per day.

[2] Based on 260 work days per year (e.g., 260).

A.3.13 TOTAL LABOR COSTS BY MAJOR DECOMMISSIONING TASK

Multiply the estimated work days for each specific labor category (from Table A.3.11) by the total cost per work day for the corresponding labor category (from Table A.3.12), and enter the results in the table below. Then, add across all labor categories to determine the total labor costs for each

Task	(1) Project Mgr or (1) Structural Engineer	(1) HPS or (1) Foreman	(1) Health Physicist or (1) Shipper	(2) HPT's or (1) Draftsman or (2) Equipment Operators	(2) Laborer	Clerical	Total Labor Cost
Planning and Preparation	$51,179	$28,242	$18,229	$44,037	$2,250	$4,413	$148,350
Decontamination or Dismantling of Radioactive Facility Components	$5,951	$10,460	$4,797	$15,727	$3,750	$1,298	$41,984
Restoration of Contaminated Areas on Facility Grounds	$2,380	$2,092	$0	$1,573	$1,500	$0	$7,545
Final Radiation Survey	$41,658	$19,874	$1,919	$28,309	$11,250	$5,452	$108,461
Site Stabilization and Long-Term Surveillance	$0	$0	$0	$0	$0	$0	$0

A.3.14 PACKAGING, SHIPPING, AND DISPOSAL OF RADIOACTIVE WASTES (Excluding Labor Costs)

(a) Packing Material Costs

Estimate the types and volumes of waste expected to be generated, along with the number and types of containers required for packaging the waste. Multiply the number of containers required by the unit cost per container.

Waste Type	Volume (ft^3)	Number of Containers	Type of Containers	Unit Cost of Container	Total Packaging Costs
DAW/PPE	54	2	1 m^3 Sacks	$80	$160
Soil	1080	2	Rented Roll-Off	$500	$1,000
TOTAL					$1,160

(b) Shipping Costs

Estimate the number of truckloads of waste expected to be shipped. Multiply shipping costs per mile (including truckload costs, surcharges, and overweight charges) by the total distance shipped.

Waste Type	Number of Truckloads	Unit Cost ($/mile/truckload)	Surcharges ($/mile)	Overweight Charges($/mile)	Distance Shipped (miles)	Total Shipping Costs
DAW/PPE	1	$3.50	0	0	600	$2,100
Soil	2	$3.50	0	0	600	$4,200
TOTAL	3					$6,300

(c) Waste Disposal Costs

Estimate the volume of waste to be disposed. Multiply the volume of waste disposed by the unit disposal cost (including any volume-based surcharges). Add any surcharges that are based on the number of containers of waste.

Waste Type	Disposal Volume (ft3)	Density (lb/ft3)	Disposal Mass (lbs)	Unit Cost ($/lb)	Surcharges ($/$ft^3$ or $/container)	Total Disposal Costs
DAW/PPE	54	20	1,080	6.00	0	$6,480
Soil	1080	90	97,200	5.00	0	$486,000
TOTAL	54					$492,480

A.3.15 EQUIPMENT/SUPPLY COSTS (Excluding Containers)

Estimate the quantity of equipment and supplies required for decommissioning and multiply that quantity by the appropriate unit costs.

Equipment/Supplies	Quantity	Unit Cost	Total Equipment/Supply Cost
Protective Clothing (per dress-out)	400	$8	$3,200
Instrumentation Rental (per week)	5	$2,000	$10,000
Misc Tools (per week)	5	$1,000	$5,000
Heavy Equipment Rental	2	$10,000	$20,000
Consumables (per week)	5	$1,000	$5,000
TOTAL			$43,200

A.3.16 LABORATORY COSTS

If applicable, estimate costs for analyses to be performed by an independent third-party laboratory.			
Activity	Quantity	Unit Cost	Total Item Cost
Sampling			Labor captured in remediation / FSS
Transport of Samples	20	$500	$10,000
Testing and Analysis (gamma)	600	$150	$90,000
Testing and Analysis (C-14/H-3)	600	$250	$150,000
Other (specify)			
TOTAL			$250,000

A.3.17 MISCELLANEOUS COSTS

Estimate any other applicable costs.	
Activity	Total Cost
License Fees (2 yrs reciprocity)	$4,000
Insurance (included in unit rates)	
Taxes (included in unit rates)	
Other (specify)	
TOTAL	$4,000

A.3.18 TOTAL DECOMMISSIONING COSTS

Enter the total costs reported in Tables A.3.13, A.3.14(a)-(c), A.3.15, A.3.16, and A.3.17 into the appropriate cells below, and add then to obtain a subtotal. Add to the subtotal a contingency allowance in		
Task/Component	Cost	Percentage
Planning and Preparation (from Table A.3.13)	$148,350	13.4%
Decontamination and/or Dismantling of Radioactive Facility (From Table A.3.13)	$41,984	3.8%
Restoration of Contaminated Areas on Facility Grounds (From Table A.3.13)	$7,545	0.7%
Final Radiation Survey (From Table A.3.13)	$108,461	9.8%
Packing Material Costs (TOTAL from Table A.3.14(a))	$1,160	0.1%
Shipping Costs (TOTAL from Table A.3.14(b))	$6,300	0.6%
Waste Disposal Costs (TOTAL from Table A.3.14(c))	$492,480	44.6%
Equipment/Supply Costs (TOTAL from Table A.3.15)	$43,200	3.9%
Laboratory Costs (TOTAL from Table A.3.16)	$250,000	22.7%
Miscellaneous Costs (TOTAL from Table A.3.17)	$4,000	0.4%
SUBTOTAL	$1,103,480	100.0%
25% Contingency	$275,870	25.0%
TOTAL DECOMMISSIONING COST ESTIMATE	$1,379,350	125.0%

Office of the Vice Chancellor
for Administrative Services

University of Missouri-Columbia

319 Jesse Hall
Columbia, MO 65211-1250

PHONE (573) 882-4097
FAX (573) 884-4847

June 1, 2011

TO: U.S. Nuclear Regulatory Commission
U.S. NRC Region III
801 Warrenville Road
Lisle, Illinois 60532

STATEMENT OF INTENT

As Vice Chancellor of Administrative Services of the University of Missouri, I exercise express authority and responsibility to request from the Board of Curators of the University of Missouri funds for decommissioning activities associated with operations authorized by U.S. Nuclear Regulatory Commission Material License No. 24-00513-32. This authority is established by the Collected Rules and Regulations of the University of Missouri. Within this authority I intend to request that funds be made available when necessary in the amount of $9,046,453.00 (Nine Million Forty-Six Thousand Four Hundred Fifty-Three Dollars) to decommission the properties owned by the University of Missouri. I intend to request and obtain these funds sufficiently in advance of decommissioning to prevent delay of required activities.

A copy of the University's Collected Rules and Regulations Section 70.010 is attached as evidence that I am authorized to represent the University of Missouri in this transaction.

Sincerely,

Jacquelyn K. Jones
Vice Chancellor for Administrative Services

Attachment: As Stated

AN EQUAL OPPORTUNITY/ADA INSTITUTION

University of Missouri System
COLUMBIA | KANSAS CITY | ROLLA | ST. LOUIS

Chapter 70: Execution of Instruments

70.010 General Execution of Corporate or Board Instruments

172.390, R.S.Mo. 1959; Bd. Min. 4-11-58, p. 12,512; Amended 5-20-77, p. 37,690 and 3-28-80, p. 38,100; Revised Bd. Min. 6-14-85; 1-21-98, Revised Bd. Min. 5-5-06.

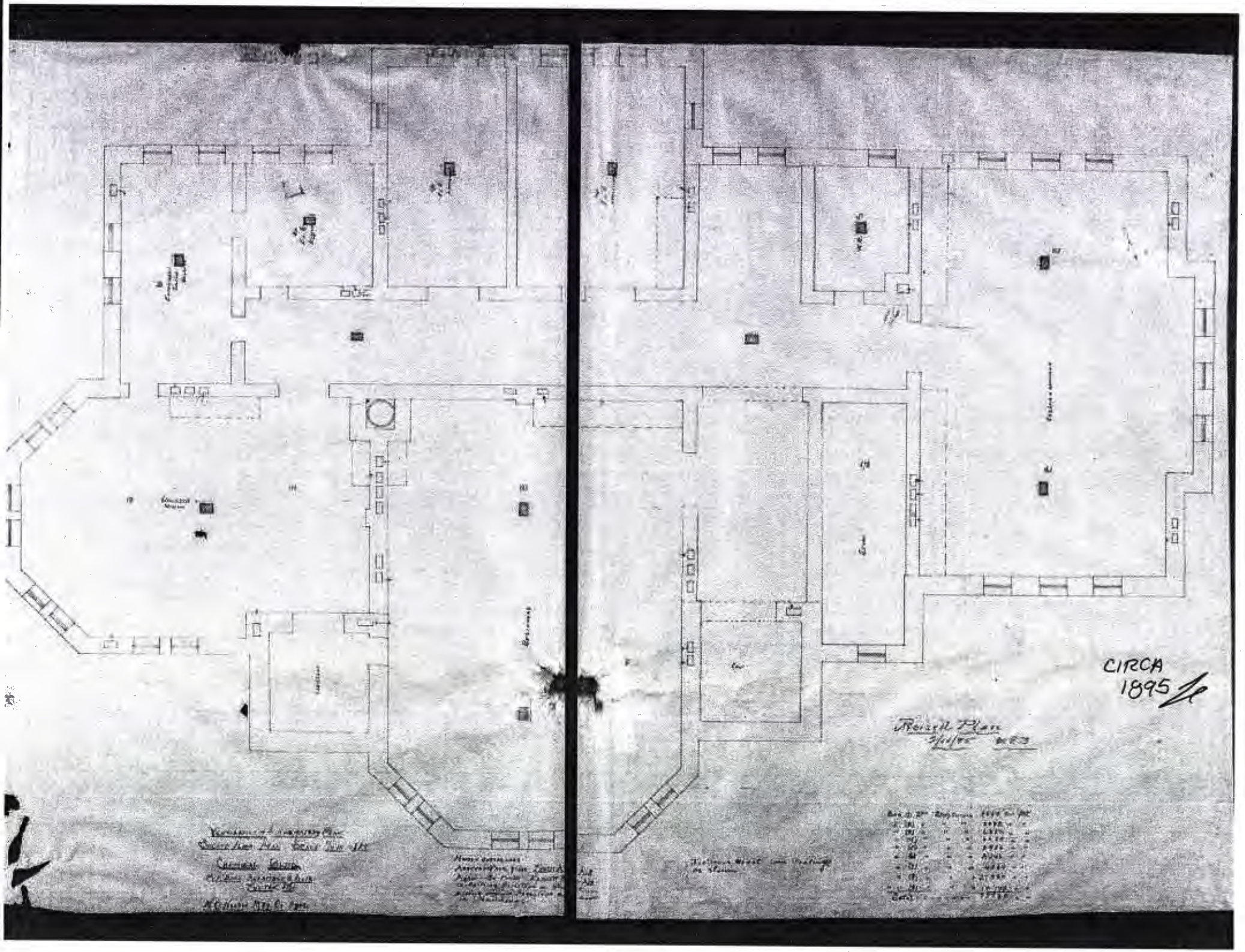
A. **All Instruments**—All instruments affecting The Curators of the University of Missouri, the Board of Curators of the University of Missouri, or the University generally shall be executed on behalf thereof as provided in this section unless execution thereof shall have otherwise been specifically provided for and directed by the Board.

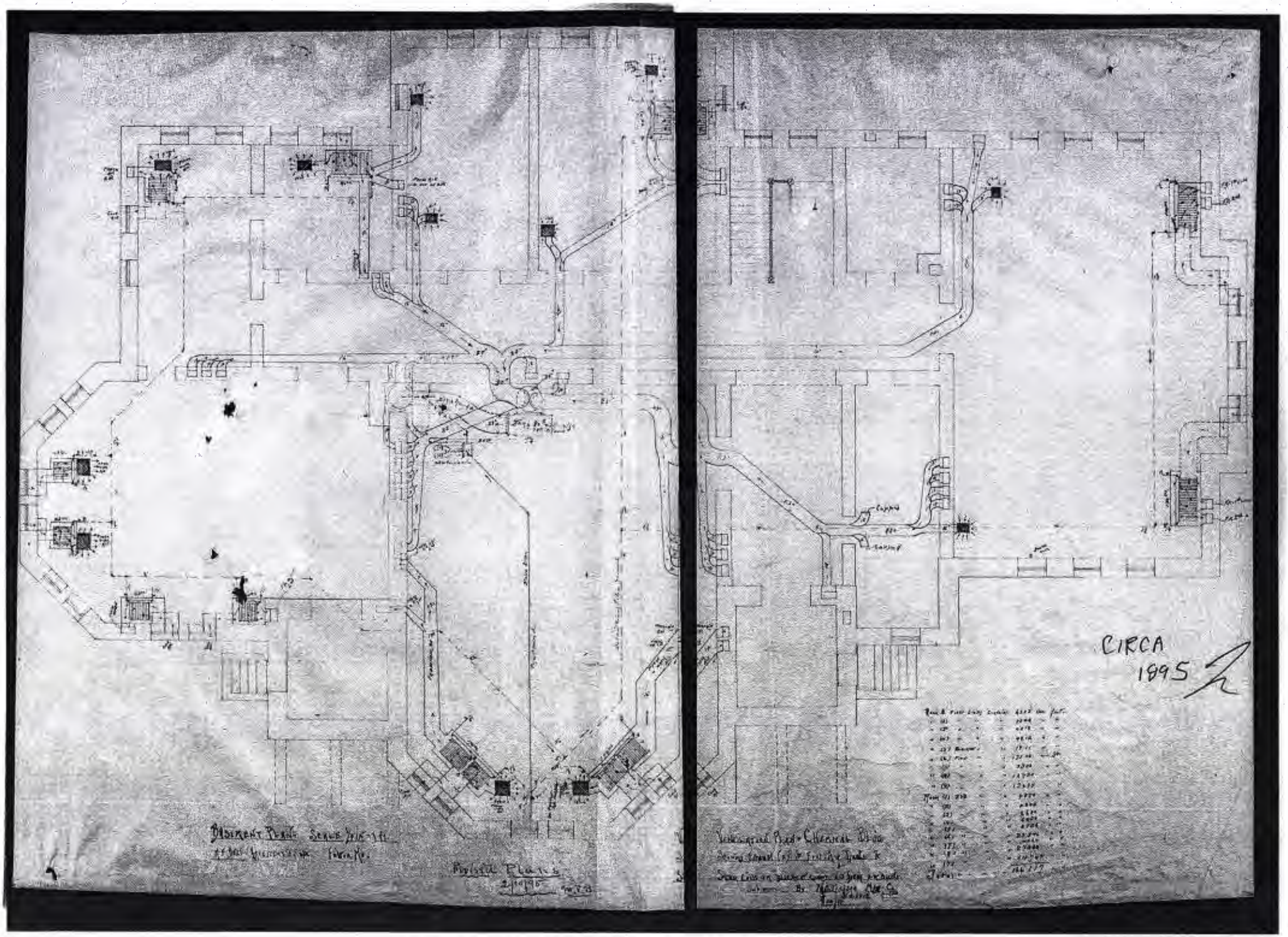
B. **Real Estate**

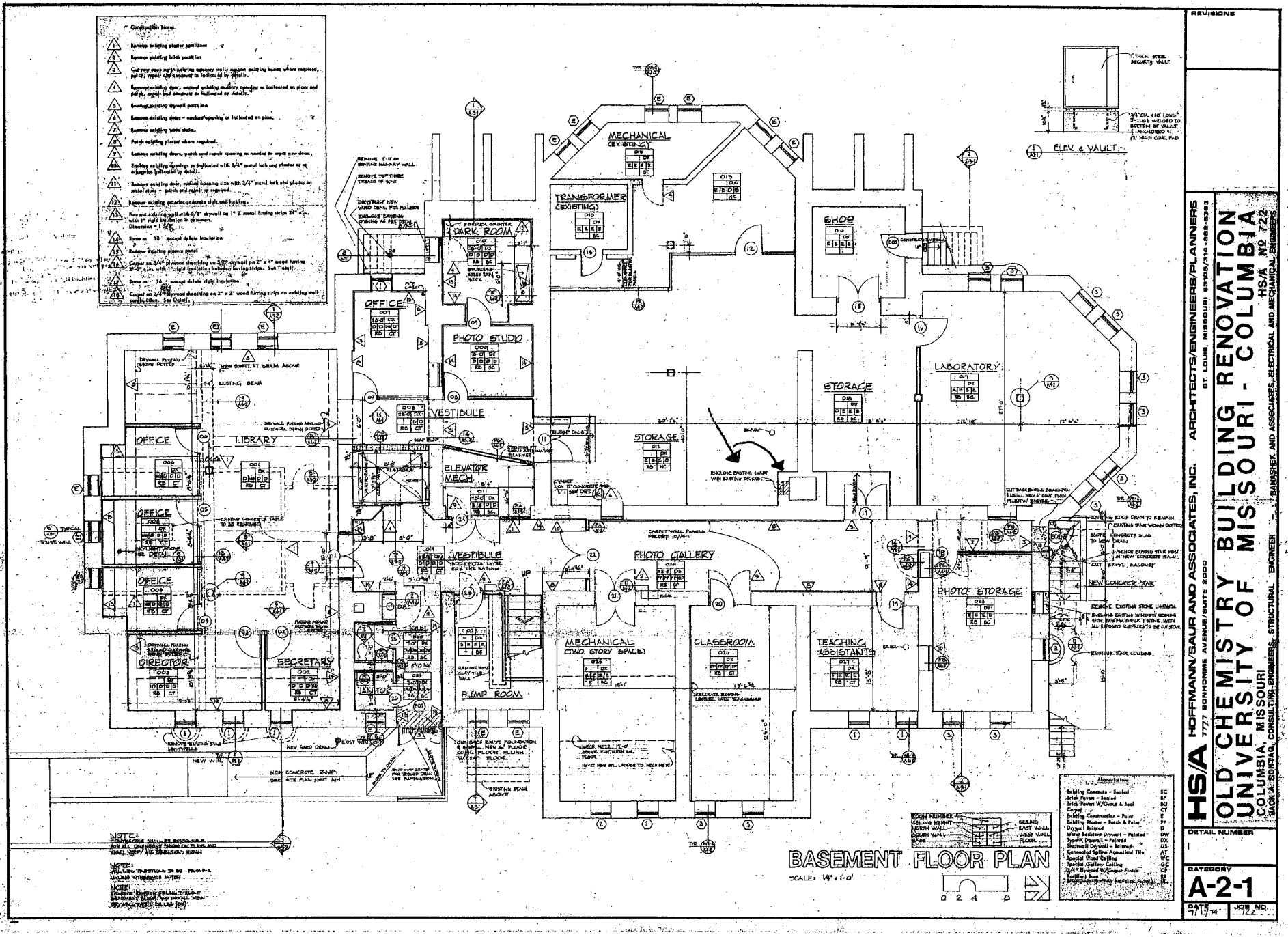
1. Any of the lands donated by the Atlantic & Pacific Railroad Company to the State of Missouri by deed dated the sixteenth day of February, 1871, and all other lands conveyed by corporations or individuals to the State of Missouri for sale in aid of the state university, may be sold and conveyed by the board of curators, and deeds of conveyance to same shall be executed by the president of the board, signed by him, with the seal of the corporation attached thereto, and attested by the secretary of the board; and provided further, that any conveyances of such lands heretofore made by said board in accordance with the provisions of this section shall divest the State of Missouri of all title to the same and vest said title in the grantees, their heirs and assigns forever.
2. Instruments conveying title to real estate owned by The Curators of the University of Missouri shall, upon approval of same by the Board of Curators or University President as delegated by the Board, be executed in the name of The Curators of the University of Missouri and signed by the President of the University or his/her designee, with the corporate seal affixed, attested by the Secretary.

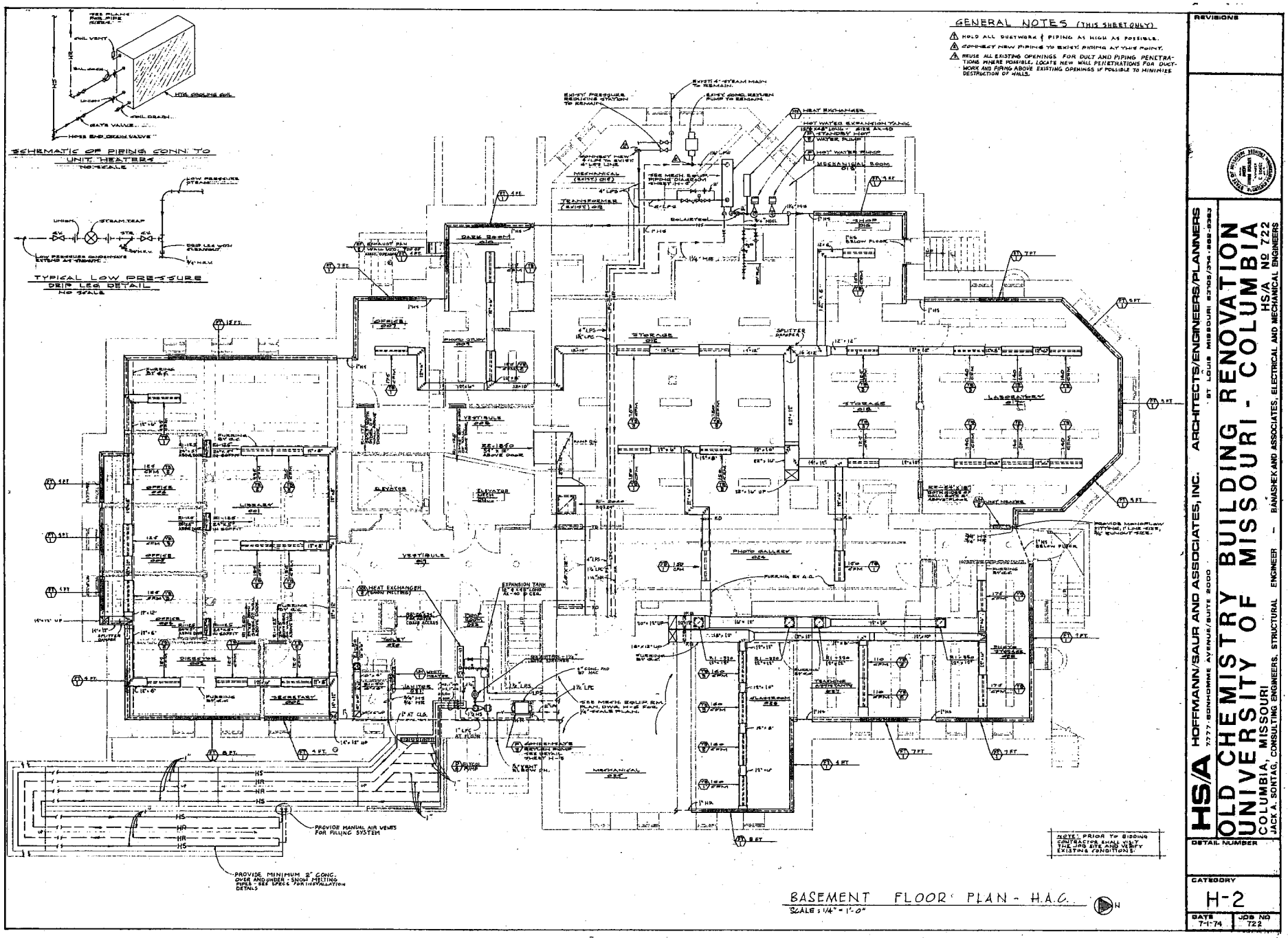
C. **All Contracts, Other Instruments and Agreements**—All contracts and other instruments and agreements of The Curators of the University of Missouri shall be executed in the name of The Curators of the University of Missouri and signed by the President thereof, the President of the University, the Vice President for Finance and Administration, or such other officer as may be specifically designated by the Board, and the corporate seal may be affixed, attested by the Secretary. The named officers

Attachment 2 – Various Schematics of Ductwork for Pickard Hall (7 pages)


CIRCA
1895


CIRCA
1895


BASEMENT FLOOR PLAN
SCALE: 1/4" = 1'-0"
MECHANICAL (EXISTING)
TRANSFORMER (EXISTING)
SHOP
PARK. ROOM
OFFICE
PHOTO STUDIO
VESTIBULE
LIBRARY
ELEVATOR MECH.
STORAGE
LABORATORY
PHOTO GALLERY
PHOTO STORAGE
MECHANICAL (TWO STORY SPACE)
CLASSROOM
TEACHING ASSISTANTS
DIRECTOR
SECRETARY
JANITOR
TOILET
PUMP ROOM
ELEV. & VAULT
NEW CONCRETE RAMP
NEW CONCRETE STAIR
REMOVE EXISTING STONE LINTHWALL
REMOVE EXISTING STONE COLUMNS
EXISTING STONE COLUMNS
EXISTING STONE LINTHWALL
EXISTING STONE ABOVE
EXISTING CONCRETE TABLE TO BE REMOVED
NEW CONCRETE SLAB TO MEET EXISTING
NEW CONCRETE STAIR
NEW CONCRETE WALL
NEW CONCRETE RAMP
NEW WIN.
NEW OVHD DOOR
NEW SUPPORT AT BEAM ABOVE
EXISTING BEAM
EXISTING ROOF DRAIN TO REMAIN
EXISTING STONE WALL TO REMAIN
EXISTING CONCRETE WALL TO REMAIN
EXISTING CONCRETE FLOOR TO REMAIN
EXISTING WINDOW TO REMAIN
EXISTING DOOR TO REMAIN
EXISTING STAIR TO REMAIN
EXISTING ELEVATOR TO REMAIN
EXISTING CONCRETE BEAM TO REMAIN
EXISTING CONCRETE COLUMN TO REMAIN
EXISTING CONCRETE WALL TO REMAIN
EXISTING CONCRETE FLO



RC 020 H02 74 00

237

RC 020 H03 74 00

GENERAL NOTES: (THIS SHEET ONLY)

1. HOLD ALL DUCTWORK AND PIPING AS HIGH AS POSSIBLE.
2. REUSE ALL EXISTING OPENINGS FOR DUCT AND PIPING PENETRATIONS WHERE POSSIBLE. LOCATE NEW WALL PENETRATIONS FOR DUCTWORK AND PIPING ABOVE EXISTING OPENINGS IF POSSIBLE TO MINIMIZE DESTRUCTION OF WALLS
3. PROVIDE ACCESS PANELS FOR ALL FIRE DAMPERS
4. SEE MECH. REFLECTED CEILING PLAN FOR EXACT LOCATION OF CEILING DIFFUSERS
5. MAC TO PROVIDE 24"x36" CEILING ACCESS PANELS FOR ACCESS TO EACH TERMINAL BOX AND SPLITTER DAMPER.
6. PROVIDE AIRFOIL ACOUSTITURN AIRFOIL TURNING VANES AT LOCATIONS SHOWN.

SECTION "C"-"C"
SCALE: 1/4" = 1'-0"

FIRST FLOOR PLAN - H.A.C.
SCALE: 1/4" = 1'-0"

NOTE: PRIOR TO BIDDING CONTRACTOR SHALL VISIT THE JOB SITE AND VERIFY EXISTING CONDITIONS.

REVISIONS

HS/A HOFFMANN/SAUR AND ASSOCIATES, INC. ARCHITECTS/ENGINEERS/PLANNERS
7777 BONHOMME AVENUE/SUITE 2000 ST. LOUIS, MISSOURI 63105/314-862-6363

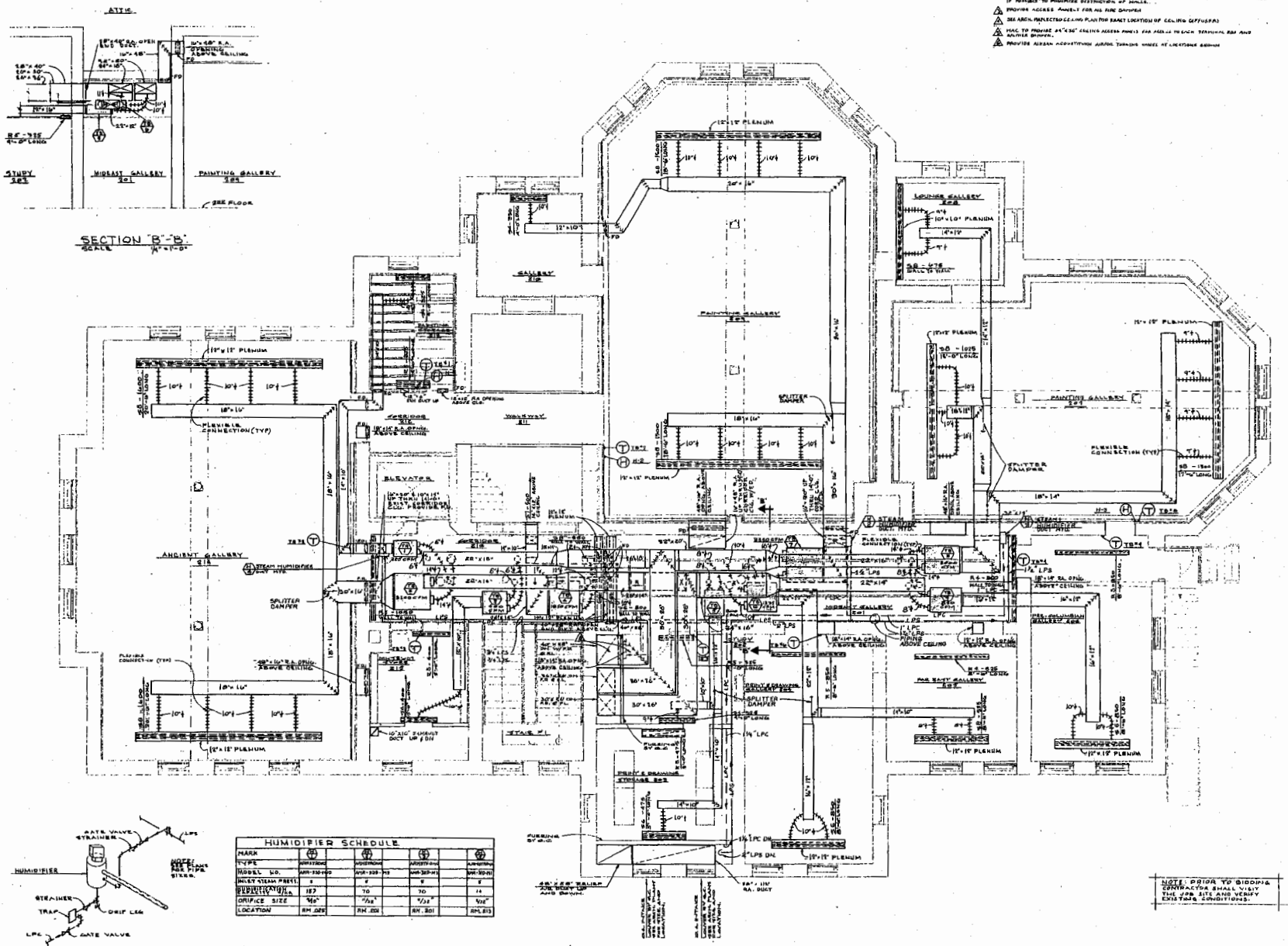
OLD CHEMISTRY BUILDING RENOVATION
UNIVERSITY OF MISSOURI - COLUMBIA
COLUMBIA, MISSOURI HS/A Nº 722
JACK A. SONTAG, CONSULTING ENGINEERS, STRUCTURAL ENGINEER - BANASHEK AND ASSOCIATES, ELECTRICAL AND MECHANICAL ENGINEERS

DETAIL NUMBER

CATEGORY H-3

DATE 7-1-74 JOB NO 722

RC 020 H04 74 00



PIPING CONNECTIONS TO HUMIDIFIERS
NO SCALE

HUMIDIFIER SCHEDULE

MARK					
TYPE	ARMSTRONG	ARMSTRONG	ARMSTRONG	ARMSTRONG	ARMSTRONG
MODEL NO.	AHR-250-MD	AHR-350-MD	AHR-350-MD	AHR-350-MD	AHR-350-MD
INLET STEAM PRESS.	5	5	5	5	5
CAPACITY LB/HR	187	70	70	70	14
ORIFICE SIZE	9/64"	7/64"	7/64"	7/64"	5/64"
LOCATION	RM. 205	RM. 206	RM. 201	RM. 201	RM. 213

NOTE: PRIOR TO BIDDING CONTRACTOR SHALL VISIT THE JOB SITE AND VERIFY EXISTING CONDITIONS.

REVISIONS

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7777 BONHOMME AVENUE/SUITE 2000 ST. LOUIS, MISSOURI 63105/314-862-6363

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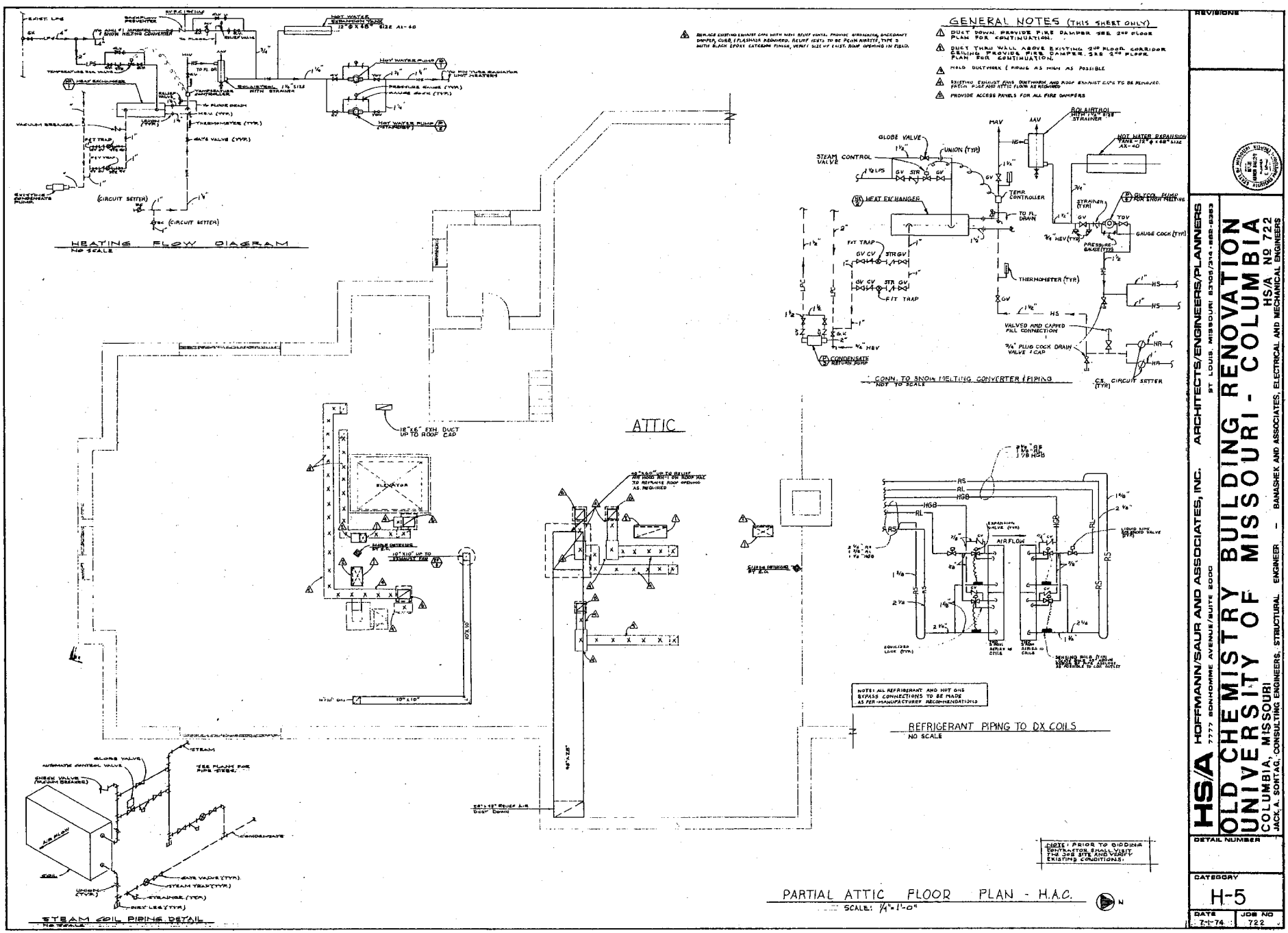
UNIVERSITY OF MISSOURI - COLUMBIA
COLUMBIA, MISSOURI HS/A Nº 722
JACK A. SONTAG, CONSULTING ENGINEERS, STRUCTURAL ENGINEER - BANASHEK AND ASSOCIATES, ELECTRICAL AND MECHANICAL ENGINEERS

DETAIL NUMBER

CATEGORY H-4

DATE 7-1-74 JOB NO 722

RC 020 H05 74 00



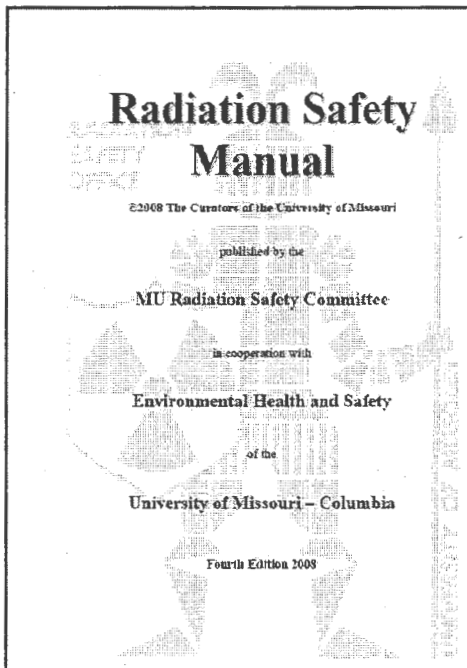
7577

Attachment 3a – Radiation Worker Training Status report for Pickard Hall 55555 (1 page)

ORIGINAL TRAIN DATE

Name	Start	Last Training	Training Date	Training Due
Alex Barker	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Amanda Maloney	09/12/11	INTRO. TO RAD SAFETY AT MU	09/08/11	09/08/14
Anne Stanton	11/04/11	INTRO. TO RAD SAFETY AT MU	11/03/11	11/03/14
Antone Pierucci	08/28/12	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Barbara Smith	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Brandy Tumnire	09/19/12	INTRO. TO RAD SAFETY AT MU	09/18/12	09/18/15
Bruce Cox	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Carol Geisler	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Cathy Asbury	12/20/11	INTRO. TO RAD SAFETY AT MU	12/20/11	12/20/14
Cathy Callaway	12/15/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Christina Schappe	07/11/11	INTRO. TO RAD SAFETY AT MU	09/12/11	09/12/14
Christopher Ruff	10/04/11	INTRO. TO RAD SAFETY AT MU	10/01/11	10/01/14
Danielle Gibbons	08/28/12	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Devyn Hunter	08/28/12	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Donna Dare	09/19/12	INTRO. TO RAD SAFETY AT MU	09/18/12	09/18/15
Emani Castro	09/24/12	INTRO. TO RAD SAFETY AT MU	09/20/12	09/20/15
George Szabo	12/15/09	INTRO. TO RAD SAFETY AT MU	09/12/11	09/12/14
James Van Dyke	12/20/11	INTRO. TO RAD SAFETY AT MU	12/20/11	12/20/14
Jeffrey Wilcox	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Jillian Hartke	02/07/11	INTRO. TO RAD SAFETY AT MU	09/12/11	09/12/14
JosephKidd	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
June Davis	11/04/11	INTRO. TO RAD SAFETY AT MU	11/03/11	11/03/14
Katharine Mascari	08/28/12	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Katherine Iselin	08/28/12	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Kathleen Slane	11/04/11	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Kenyon Reed	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Kristen Harris	11/04/11	INTRO. TO RAD SAFETY AT MU	11/03/11	11/03/14
Kristie Lee	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Kristin Schwain	11/04/11	INTRO. TO RAD SAFETY AT MU	11/03/11	11/03/14
Linda Garrison	12/20/11	INTRO. TO RAD SAFETY AT MU	12/20/11	12/20/14
Lorenz Lepper	02/07/11	INTRO. TO RAD SAFETY AT MU	09/12/11	09/12/14
Lorinda Roorda	08/28/12	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Lucas Gabel	07/11/11	INTRO. TO RAD SAFETY AT MU	07/05/11	07/05/14
Marcus Rautman	11/04/11	INTRO. TO RAD SAFETY AT MU	11/03/11	11/03/14
Mary Conley	11/04/11	INTRO. TO RAD SAFETY AT MU	10/25/11	10/25/14
Michael Yonan	12/20/11	INTRO. TO RAD SAFETY AT MU	12/20/11	12/20/14
Nancy Alexander	11/14/11	INTRO. TO RAD SAFETY AT MU	11/03/11	11/03/14
Norman Land	12/14/09	INTRO. TO RAD SAFETY AT MU	09/12/11	09/12/14
Paul Stebbing	12/14/09	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Rebecca Pursley	08/28/12	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Ryan Johnson	09/12/11	INTRO. TO RAD SAFETY AT MU	09/08/11	09/08/14
Sarah Jones	11/04/11	INTRO. TO RAD SAFETY AT MU	11/03/11	11/03/14
Sarah Williams	08/28/12	INTRO. TO RAD SAFETY AT MU	08/22/12	08/22/15
Shelby Wolfe	09/12/11	RAD SAFETY AT MU - REFRESHER	11/03/11	11/03/14
Susan Langdon	05/25/11	INTRO. TO RAD SAFETY AT MU	11/03/11	11/03/14
Susan Lowrey	12/27/11	INTRO. TO RAD SAFETY AT MU	12/20/11	12/20/14
Wayne Mehrhoff	12/14/09	INTRO. TO RAD SAFETY AT MU	08/19/11	08/19/14

Attachment 3b – Radiation Safety for new Radiation Workers at MU (25 pages)



http://ehs.missouri.edu/rad

NRC

Nuclear Regulatory Commission

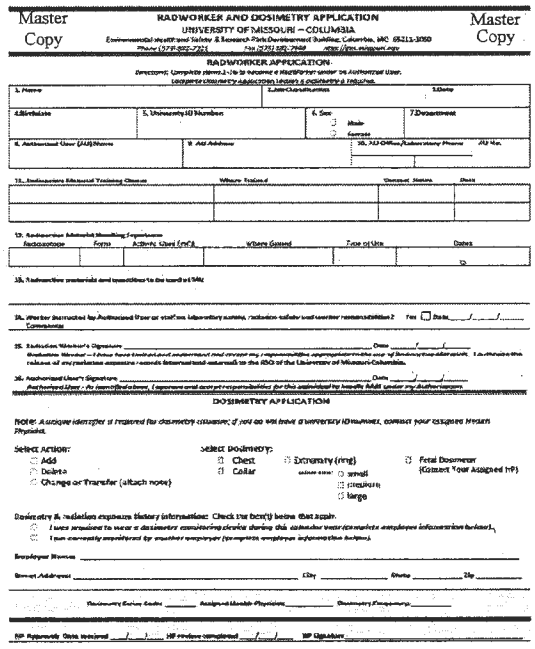
BECOMING

A

RADIATION

WORKER

R A D I A T I O N



RADWORKER AND DOSIMETRY APPLICATION
UNIVERSITY OF MISSOURI – COLUMBIA
Master Copy
Master Copy
RADWORKER APPLICATION
DOSIMETRY APPLICATION

W O R K E R

Safety Responsibilities

Radiation Safety Committee

- **Comprised of members representing departments where radiation or radioactivity is used**
- **Shall approve all use of radioactive materials and radiation producing equipment within the university**
- **Establish and review an effective, safe Radioactive Protection plan in compliance with MU's NRC license and the Radiation Safety Manual**
- **Review the activities of the Radiation Safety Office**

Safety Responsibilities

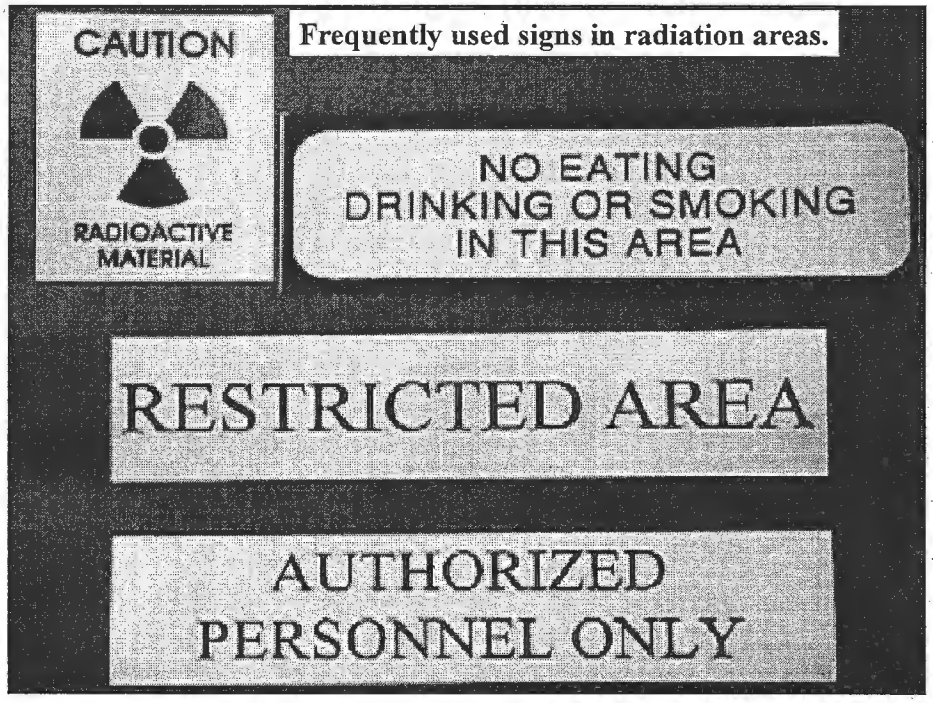
Radiation Safety Officer

- Has been delegated authority to ensure the implementation of the Radiation Protection Program and is responsible for the day to day conduct of the program
- Is a member of the RSC, and brings issues of compliance, efficiency and safety to the committee for resolution
- Provides technical assistance and guidance to all users of radioactive material or radiation producing equipment

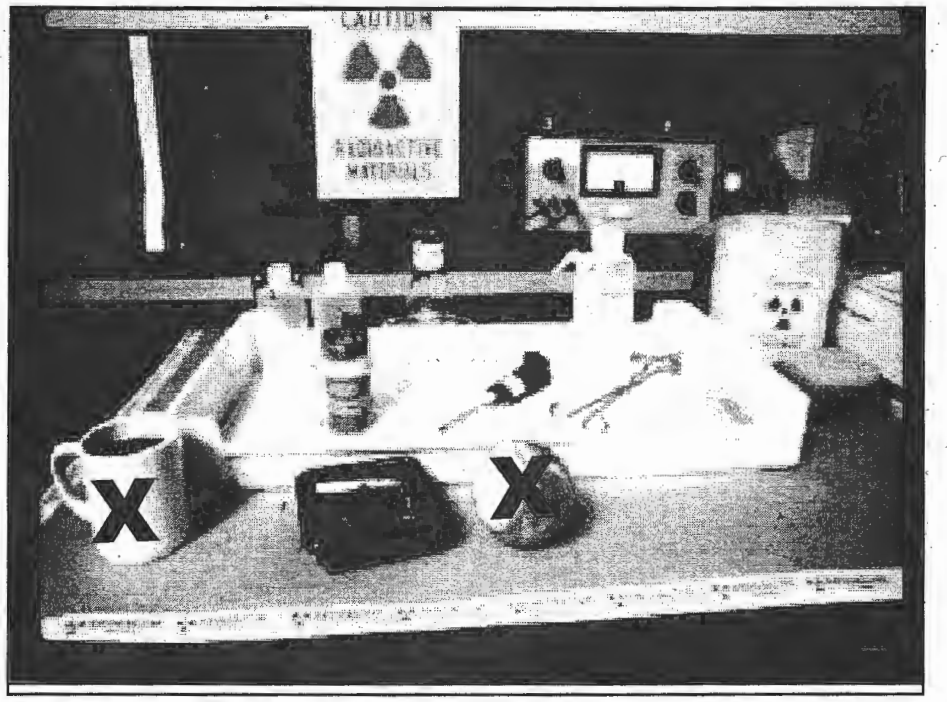
Safety Responsibilities

Authorized User

- Individuals authorized by the RSC to use radiation producing equipment or possess radioactive material, and supervise their use
- Responsible for compliance with all guidelines, policies, and safety procedures set forth in MU's Radiation Safety Manual and Broad scope License
- Supervisory person directly responsible for training and safety in the lab

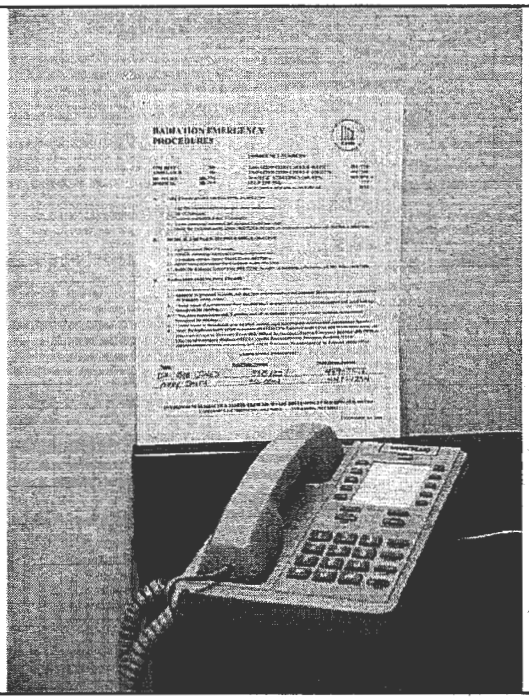


Frequently used signs in radiation areas.



Security of Radioactive Material

- Restricted Area
  - **All** material is required to be attended or locked up.
- Unrestricted Area
  - **All** material, if not in locked storage, must be attended .

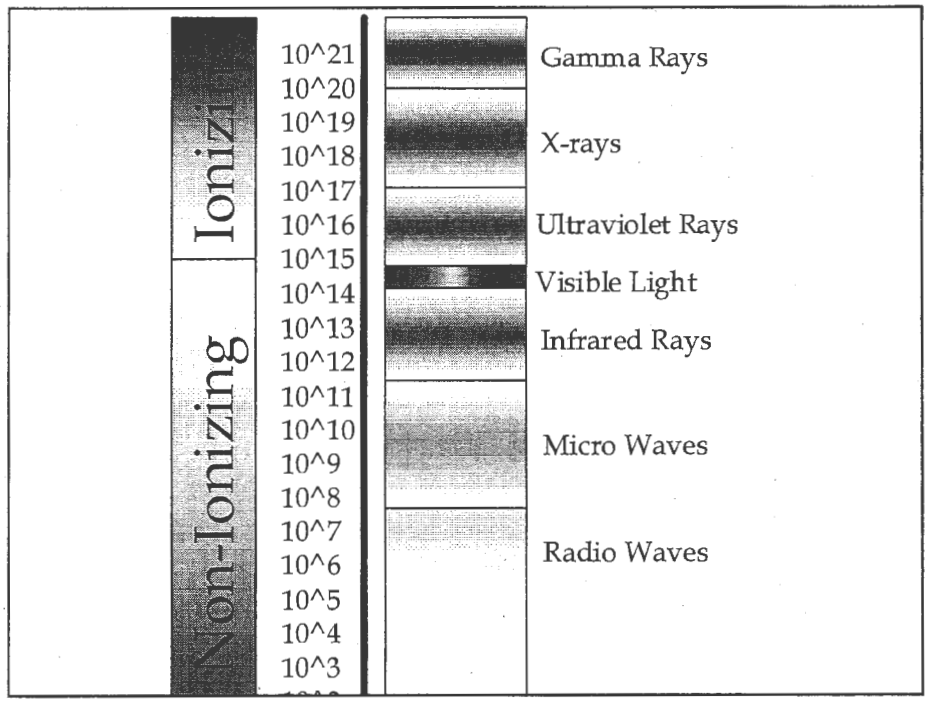


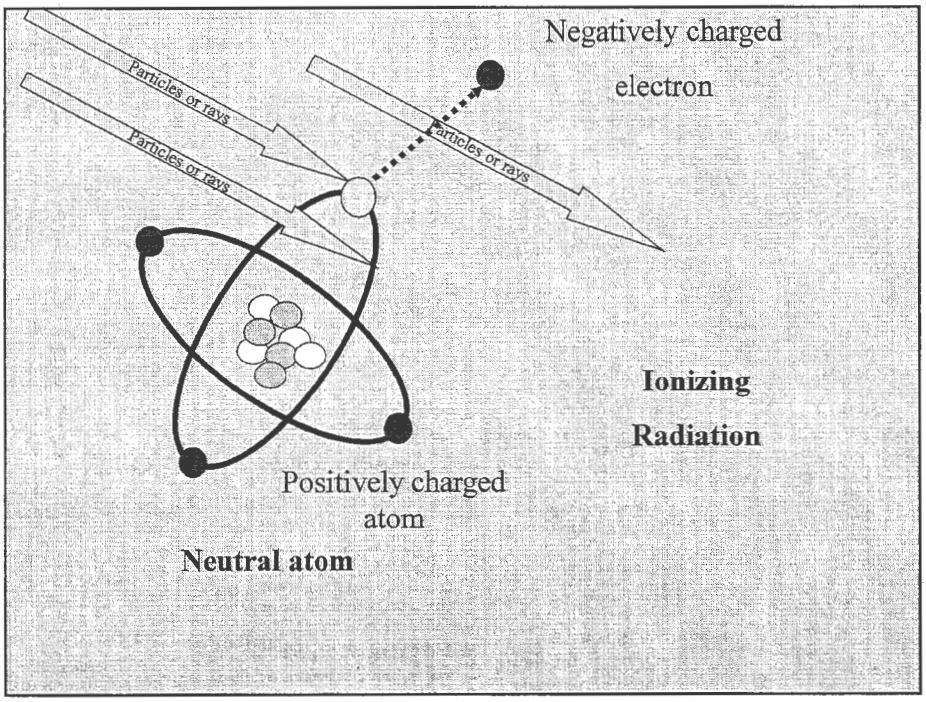
Emergency Procedures

- Fire emergencies with radiation
- Medical emergencies with radiation
- Radiation only
- Laboratory contact personnel
- During business hours call Radiation Safety at 882-7221
- After hours call MU Police at 882-7201

NRC FORM 3 NOTICE TO EMPLOYEES

- Spells out rights as a Rad Worker
- Rights are listed in 10 CFR
- How to report a violation
- For MU 10 CFR , NRC License, and NRC inspection can be viewed at the Radiation Safety Office


Ionizi
Non-Ionizing
10^21
10^20
10^19
10^18
10^17
10^16
10^15
10^14
10^13
10^12
10^11
10^10
10^9
10^8
10^7
10^6
10^5
10^4
10^3
Gamma Rays
X-rays
Ultraviolet Rays
Visible Light
Infrared Rays
Micro Waves
Radio Waves


Negatively charged
electron
Particles or rays
Particles or rays
Particles or rays
Ionizing
Radiation
Positively charged
atom
Neutral atom

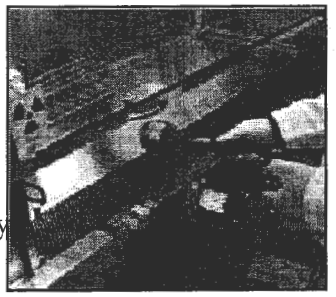
Definitions

Radioactivity

- That property of certain unstable material where ionizing radiation is spontaneously emitted

Contamination

- Deposition of radioactive material in any place where it is not desired, and particularly in any place where its presence may be harmful



Radioactivity Basics

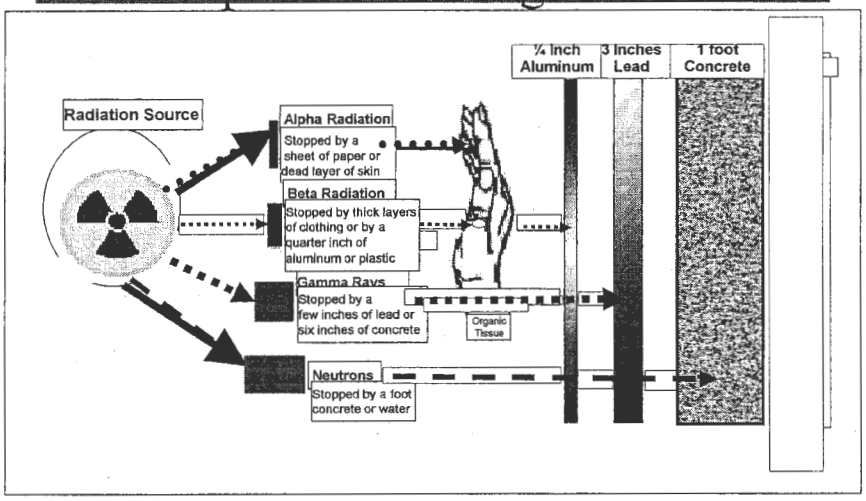
Radioactivity – The spontaneous nuclear transformation of an unstable atom that often results in the release of radiation, also referred to as disintegration or decay.

Units

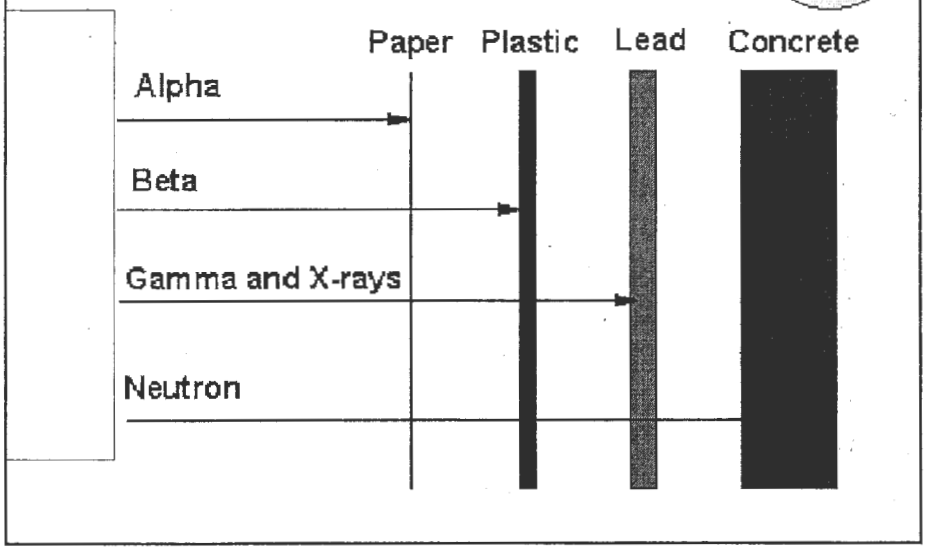
Curie (Ci) the activity in one standard gram of Radium = 3.7×10^{10} disintegrations per second

Becquerel (Bq) 1 disintegration per second – International Units (SI)

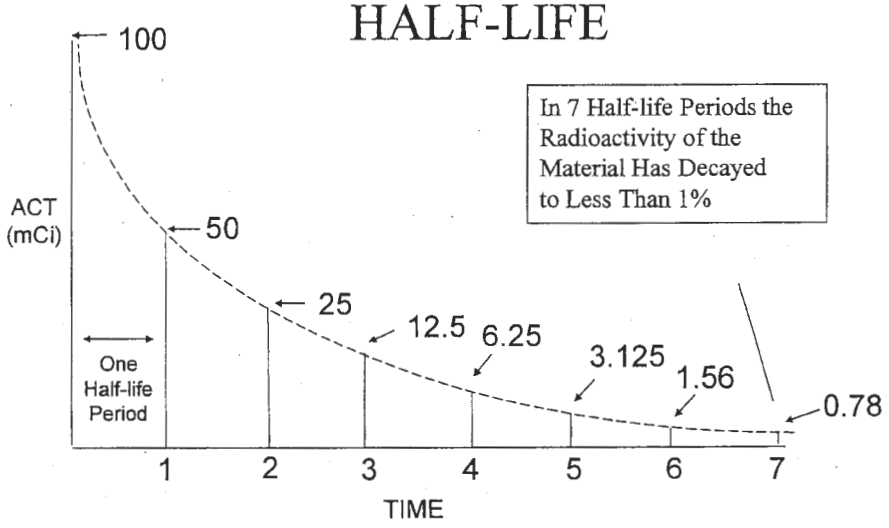
Comparison of Ionizing Radiation and acceptable shielding



Penetrating Distances



HALF-LIFE



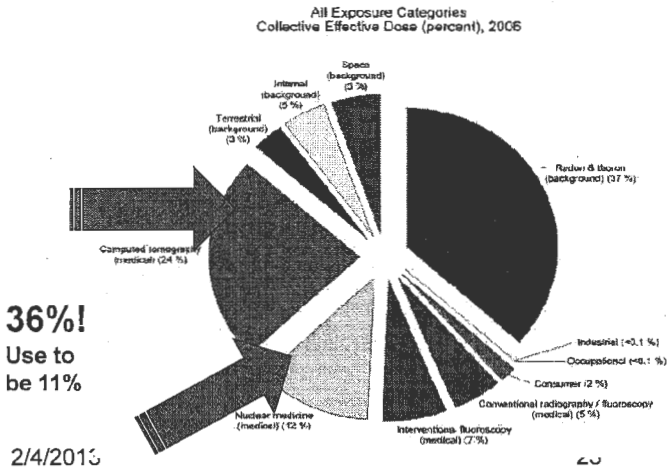
DEFINITION: TIME FOR 1/2 THE ATOMS TO DECAY AWAY

Average Annual Radiation Exposure in the U.S. (Approximate)

Man Made Sources	
X-Rays	39
Medical Studies (CT/Nuc)	~(275)
Consumer Products	10
Other	2
TOTAL Man Made	*326*
Natural Sources	
Radon	~200
Own Body	40
Sun	26
Earth	28
TOTAL Natural	*~294*

Combined Total (Old - 1980) = ***360 mRem***

Average Annual Radiation Exposure in the U.S. (NEW)
(Approximate)

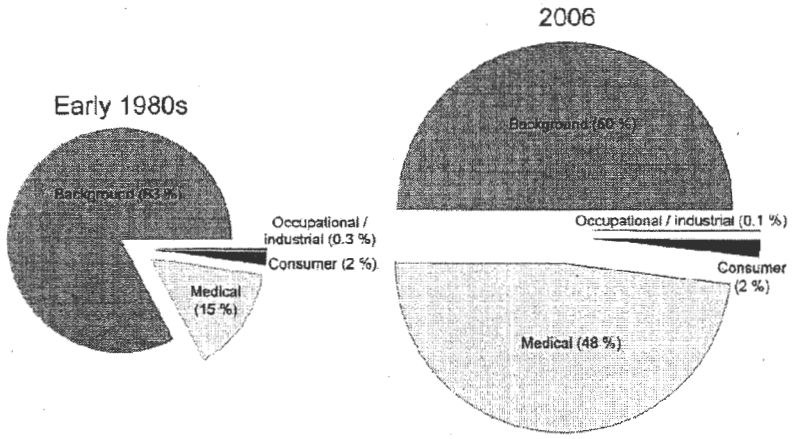


36%!
Use to be 11%

2/4/2013

2008 NCRP Annual Report and the Press Release for NCRP Report No. 160 on *Ionizing Radiation Exposure of the Population of the United States.*

NCRP Report No. 160, *Ionizing Radiation Exposure of the Population of the United States*



	Early 1980s	2006
Collective effective dose (person-Sv)	835,000	1,870,000
Effective dose per individual in the U.S. population (mSv)	3.6	6.2

Radiation effects on the Cell

- **Indirect Effect** - radiation that interacts with the water of the cytoplasm of the cell, not the nucleus, and breaks the bonds holding the molecules together forming hydrogen ions and hydroxyls. These molecular fragments may recombine and form water or may form to make other substances like hydrogen peroxide.

Direct effect

- Direct effect can cause immediate damage to the most important part of the cell, the genetic material.
- Damage to genetic material can cause immediate problems to the cell and to the daughter cells it creates.
- Damage to genetic material is highly dependent on the cell cycle.

Radiation Exposure Limits (PART 19)

For Occupationally Exposed Individuals

GENERAL RADIATION EXPOSURE GUIDES †

Type of Exposure	Annual Limit *
Whole body (head & trunk), active blood forming organs, gonads	5 rem/year, total effective dose equivalent
Lens of eye	15 rem/year
Extremities	50 rem/year
Skin	50 rem/year

† Based on USNRC Regulations, Title 10, Part 20, Code of Federal Regulations and adopted by many states. Limits on declared pregnant workers and minors will differ; see 10CFR20 for details. Certain states and other regulatory agencies may adhere to different limits.
* Note: 1 rem = 1,000 mrem

Whole Body = 5,000 mrem
Lens of Eye = 15,000 mrem
Skin of WB = 50,000 mrem
Extremity = 50,000 mrem

10%

AT MU we have new Dosimetry

New Dosimetry by Mirion

MIRION TECHNOLOGIES

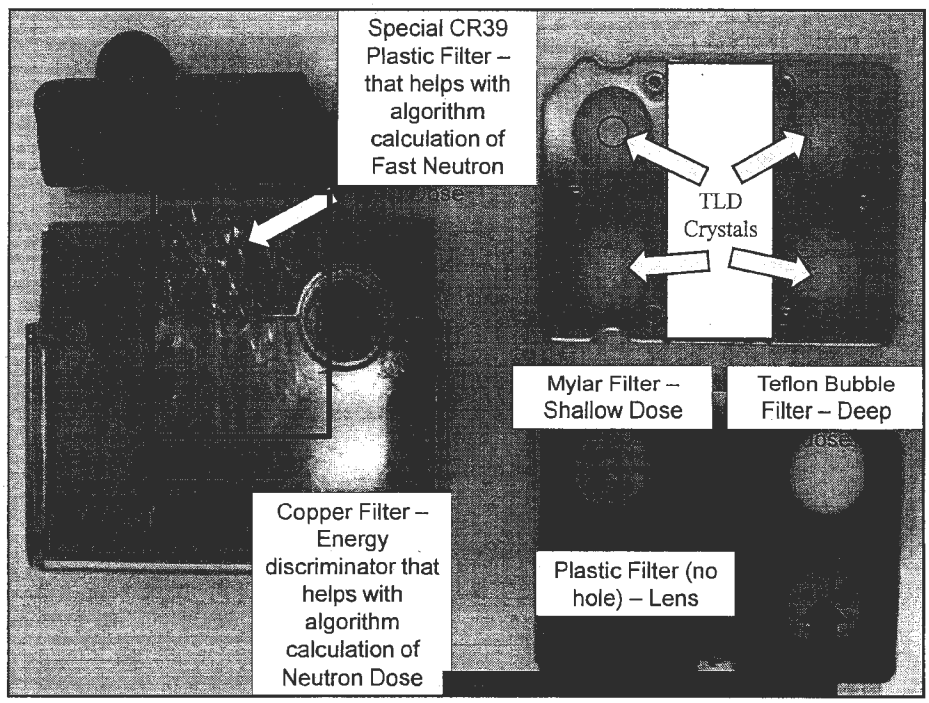
TLD – Thermoluminescent Dosimetry

Requirement of Dosimetry

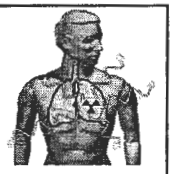
- Adult Workers
  - 10% of any applicable limit
- Declared Pregnant Workers
  - 100 mrem over course of pregnancy
- Minors
  - DDE of 100 mrem
  - LDE of 150 mrem
  - SDE of 500 mrem
- High Radiation Area (>100 mR/hr)

To Assure Accurate Dosimeter Readings:

- wear badge at sternum level
- keep badge away from heat sources
- store badge away from radiation sources
- do not wear your badge when having personal medical or dental x-rays
- notify the Radiation Safety Staff if anything unusual happens to your dosimeter
- only wear the dosimetry assigned to you
- assigned dosimetry should be worn at only one institution



Dosimetry Continued



- If you are assigned dosimtery from the university which is used to monitor your work related occupational exposure to ionizing radiation, and you plan to receive a diagnostic or therapeutic treatment with RAM (radiopharmaceuticals) then you MUST inform the RS Office PRIOR to the treatment so we can advise you on the particulars associated with how we are going to continue to monitor your occupational exposure without it being affected by the radiation from your treatment or scan.
- Dosimetry issued by the RS Office of the University of Missouri should also not to be worn home, to the store, to lunch etc but rather kept at work to be donned and doffed when you are working around sources of ionizing radiation unless prior arrangements have been made with RS.

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Dosimetry Continued

- Do not store your personal dosimeter close to sources of radiation. If you leave them on your lab coat or desk drawer as an example make for sure they are reasonably away from sources of ionizing radiation. In other words don't store you dosimeter near the Radioactive Waste storage containers.
- Ensure that you are wearing YOUR assigned dosimeter, wearing it correctly as identified on the dosimeter itself, "Chest", "Collar", and wearing the correct color and date on dosimeter associated with wear period. If you questions concerning this call EHS RS at 882-7018.

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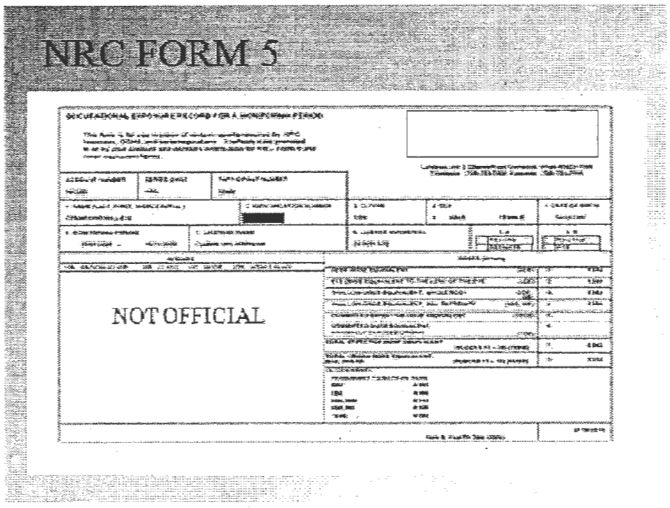
Measure Your Radiation Dose -Dosimeters-

Used to measure the occupational dose equivalent from x-ray, gamma, and high energy beta emitters. Dosimeters cannot detect radiation from low energy beta emitters.

	Global Whole Body	Ring Dosimeter	Fetal Dosimeter
Measures...	Whole body exposure	Extremity exposure	Exposure to a fetus
Is worn...	On the torso between the neck and waist	On either hand under the gloves with the name facing the radiation source	At the waist line
Can detect...	X-rays & gamma rays	X-rays & gamma rays	
	High energy beta emitters	High energy beta emitters	



Your official dose report is provided IAW the law at least once a year if you receive greater than 100 mRem as part of your occupational dose. You can request it more often if you want it. But we HAVE to provide it at least annually.

MU Radiation Safety Program
2009 Annual Dose Data

10%	**5,000mrem**
Dose mrem	Whole Body
Minimal	169
1-100	102
101-200	2
201-500	3
501-1000	1
1001-2000	0
2001-3000	0

Risk in Focus

CAUSE	**DAYS**
SMOKING 1 PACK OR MORE OF CIGARETTES/DAY (MALE)	2409
DRIVING A SMALL CAR	290
DRIVING A LARGE CAR	145
AVERAGE EXPOSURE FROM NATURAL RADIATION	**39**
PARACHUTING	25
CONTINUOUS EXPOSURE TO 100 MREM/YR/ LIFE	**10**
SMOKE DETECTORS	-9
SEAT BELTS	-69

Bottom Half of The Form

is for requesting dosimetry.

Previous dose history can be requested.

New dosimeters are issued quarterly.

There is an extra charge for late and lost dosimetry.

DOSIMETRY APPLICATION

Note: A unique identifier is required for dosimetry issuance; if you do not have a University ID number, contact your assigned Health Physicist.

Select Action:
- ☐ Add
- ☐ Delete
- ☐ Change or Transfer (attach note)

Select Dosimetry:
- ☐ Chest
- ☐ Collar
- ☐ Extremity (ring) select size: ☐ small ☐ medium ☐ large
- ☐ Fetal Dosimeter (Contact Your Assigned HP)

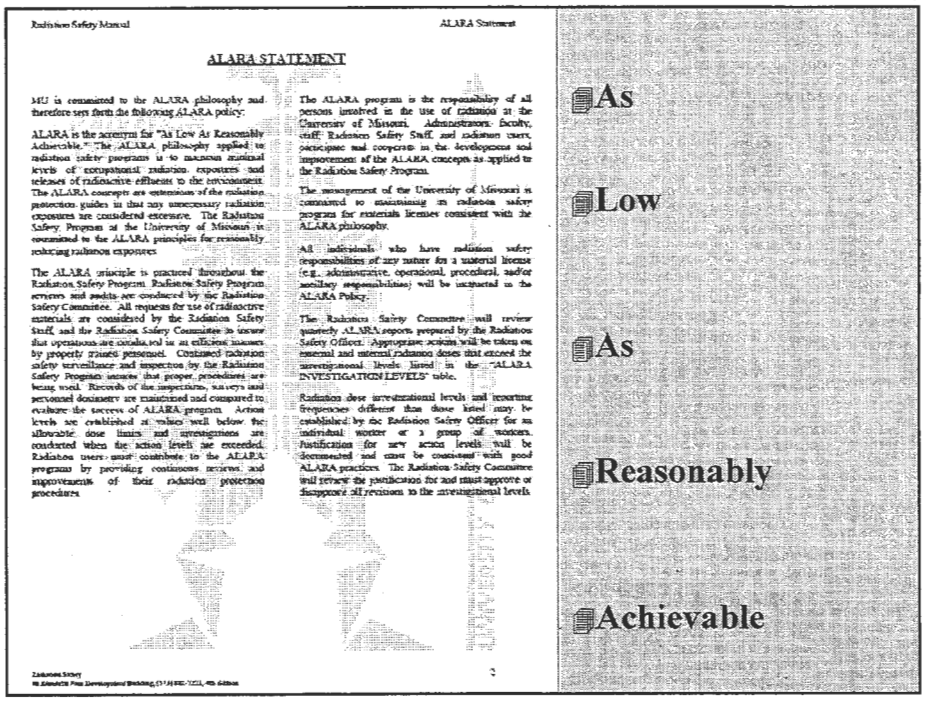
Dosimetry & radiation exposure history information: Check the box(s) below that apply.
- ☐ *I was required to wear a dosimetry monitoring device during this calendar year. Complete employer information below.*
- ☐ *I am currently monitored by another employer (complete employer information below).*

Employer Name: _____

Street Address: _____ City _____ State _____ Zip _____

Dosimetry Series Codes _____ Assigned Health Physicists _____ Dosimetry Frequency _____

HP Approval: Date received ___/___/___ HP review completed ___/___/___ HP Signature _____



Radiation Safety Manual — ALARA Statement

ALARA STATEMENT

MU is committed to the ALARA philosophy and therefore sets forth the following ALARA policy:

ALARA is the acronym for "As Low As Reasonably Achievable." The ALARA philosophy applied to radiation safety programs is to maintain minimal levels of occupational radiation exposures and releases of radioactive effluents to the environment. The ALARA concepts are extensions of the radiation protection guides in that any unnecessary radiation exposures are considered excessive. The Radiation Safety Program at the University of Missouri is committed to the ALARA principles for reasonably reducing radiation exposures.

The ALARA principle is practiced throughout the Radiation Safety Program. Radiation Safety Program reviews and audits are conducted by the Radiation Safety Committee. All requests for use of radioactive materials are considered by the Radiation Safety Staff, and the Radiation Safety Committee to ensure that operations are conducted in an efficient manner by properly trained personnel. Continued radiation safety surveillance and inspection by the Radiation Safety Program ensures that proper procedures are being used. Records of the inspections, surveys and personnel dosimetry are maintained and compared to evaluate the success of ALARA program. Action levels are established at values well below the allowable dose limits and investigations are conducted when the action levels are exceeded. Radiation users must contribute to the ALARA programs by providing continuous review and improvements of their radiation protection procedures.

The ALARA program is the responsibility of all persons involved in the use of radiation at the University of Missouri. Administrators, faculty, staff, Radiation Safety Staff, and radiation users, participate and cooperate in the development and improvement of the ALARA concepts as applied to the Radiation Safety Program.

The management of the University of Missouri is committed to maintaining an radiation safety program for materials licenses consistent with the ALARA philosophy.

All individuals who have radiation safety responsibilities of any nature for a material license (e.g., administrative, operational, procedural, and/or auxiliary responsibilities) will be instructed in the ALARA Policy.

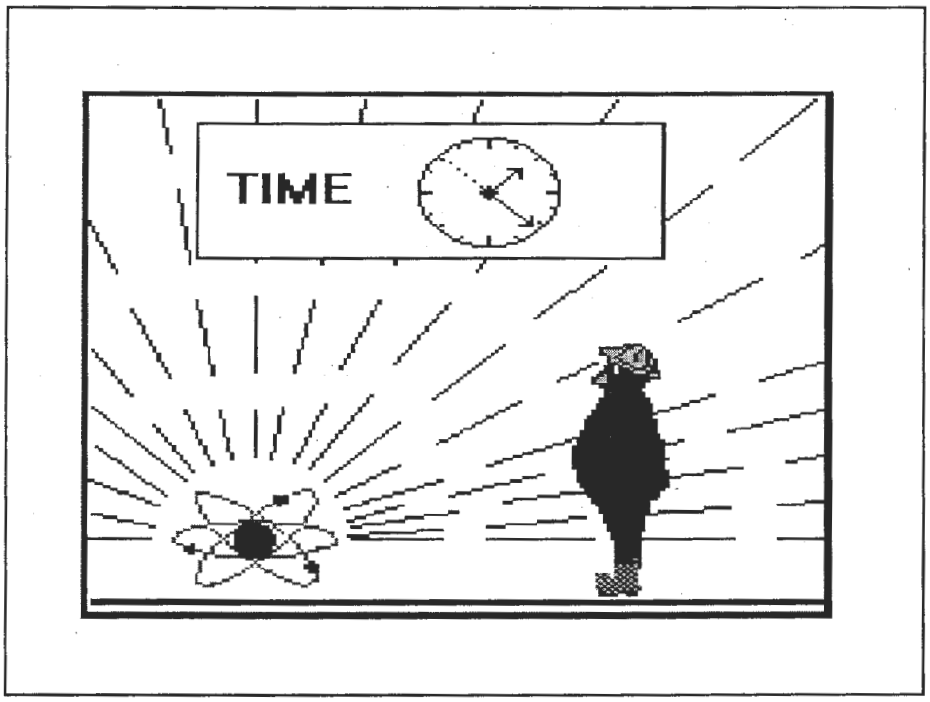
The Radiation Safety Committee will review quarterly ALARA reports prepared by the Radiation Safety Officer. Appropriate actions will be taken on external and internal radiation doses that exceed the investigational levels listed in the "ALARA INVESTIGATION LEVELS" table.

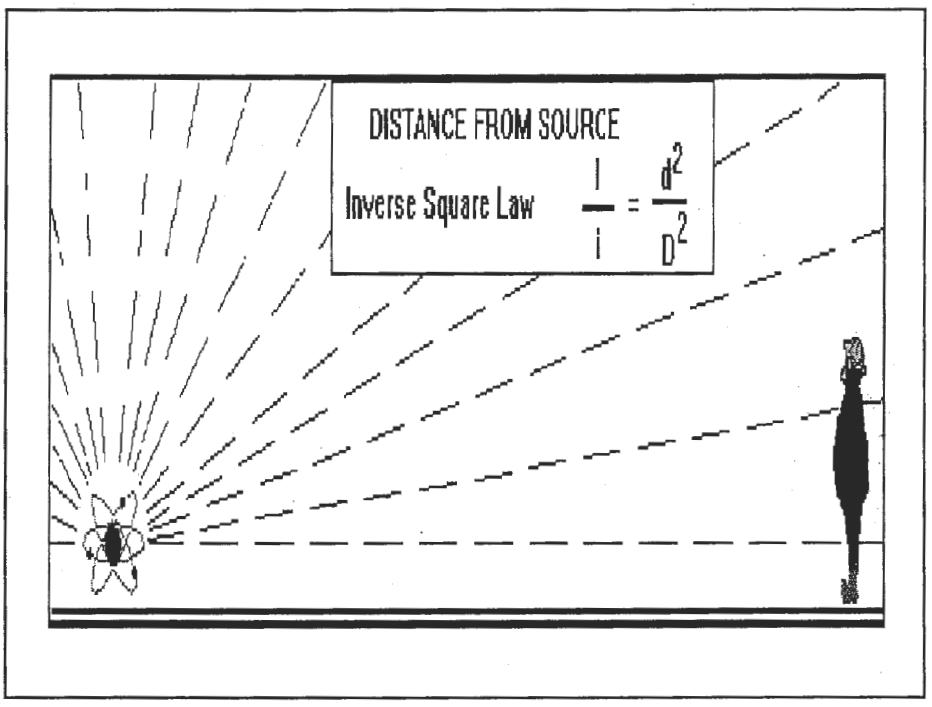
Radiation dose investigational levels and reporting frequencies different than those listed may be established by the Radiation Safety Officer for an individual worker or a group of workers. Justification for new action levels will be documented and must be consistent with good ALARA practices. The Radiation Safety Committee will review the justification for and must approve or disapprove all revisions to the investigational levels.

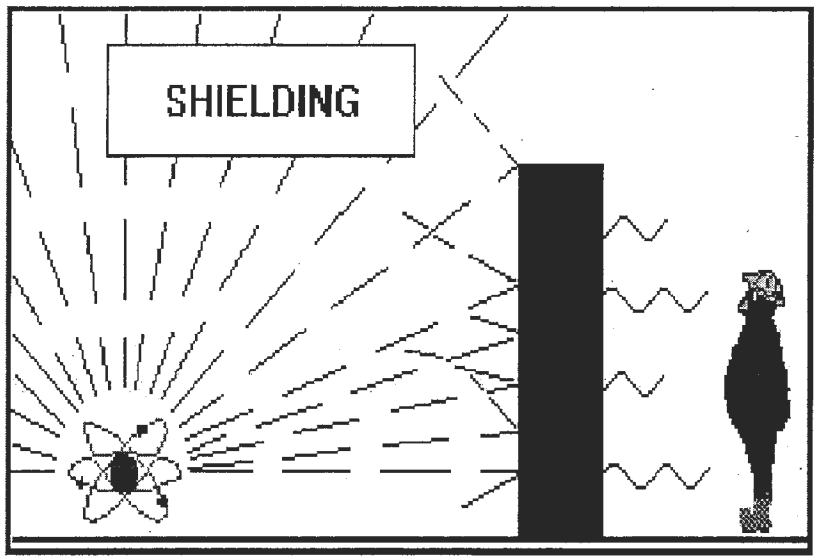
Radiation Safety

3

- As
- Low
- As
- Reasonably
- Achievable


TIME

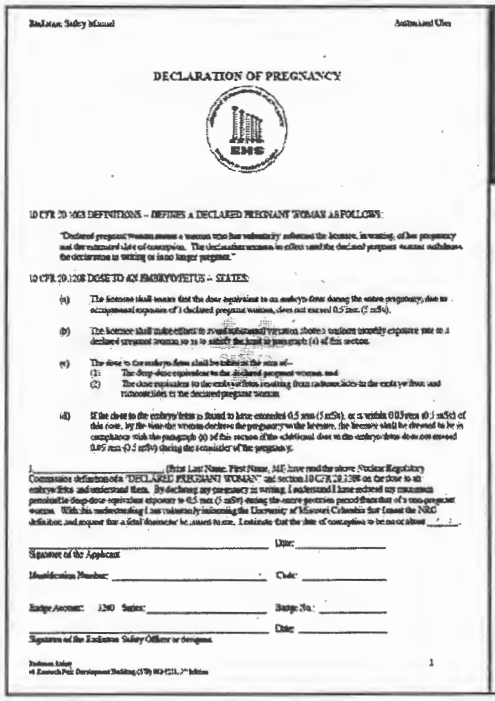

DISTANCE FROM SOURCE
Inverse Square Law
I/i = d²/D²



ALARA LEVELS

Monthly and Quarterly

- DDE - 100 mrem * Whole Body
- LDE - 300 mrem * Lens of Eye
- SDE - 400 mrem * Skin Whole Body
- SDE-ME - 400 * Extremity



DECLARATION OF PREGNANCY

10 CFR 20.1003 DEFINITIONS – DEFINES A DECLARED PREGNANT WOMAN AS FOLLOWS:

"Declared pregnant woman means a woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant."

10 CFR 20.1208 DOSE TO AN EMBRYO/FETUS -- STATES:

(a) The licensee shall ensure that the dose equivalent to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv).

(b) The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section.

(c) The dose to the embryo/fetus shall be taken as the sum of–
(1) The deep-dose equivalent to the declared pregnant woman, and
(2) The dose equivalent to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

(d) If the dose to the embryo/fetus is found to have exceeded 0.5 rem (5 mSv), or is within 0.05 rem (0.5 mSv) of this rule, by the time the woman declares the pregnancy to the licensee, the licensee shall be deemed to be in compliance with the paragraph (a) of this section if the additional dose to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

I, _____ (Print Last Name, First Name, MI) have read the above Nuclear Regulatory Commission definition of a "DECLARED PREGNANT WOMAN" and section 10 CFR 20.1208 on dose to an embryo/fetus and understand them. By declaring my pregnancy in writing, I understand I have reduced my maximum permissible deep-dose equivalent exposure to 0.5 rem (5 mSv) during the entire gestation period than that of a non-pregnant woman. With this understanding I am voluntarily informing the University of Missouri-Columbia that I meet the NRC definition and request that a fetal dosimeter be issued to me. I estimate that the date of conception to be most about ___/___/___.

_____ Date: _____
Signature of the Applicant

Identification Number: _____ Clock: _____

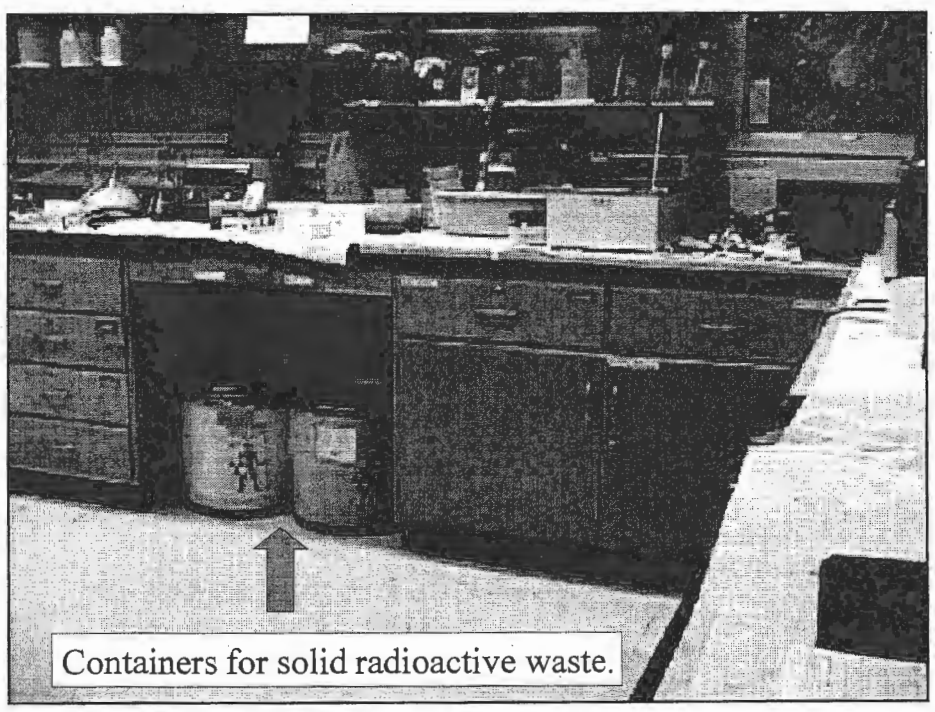
Badge Account: 1260 Series: _____ Badge No.: _____

_____ Date: _____
Signature of the Radiation Safety Officer or designee

1

Declaration

- 10 CFR 20.1003 states: A "…declared pregnant woman means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception."
  - **500 mRem during gestation period**



Containers for solid radioactive waste.

Working in Pickard – things to know

- Do not disturb surfaces
- Call EHS if CF needs to make a repair or amendment that will disturb a surface
- For entry into artifact storage 12 - Staff without dosimetry must be escorted
- Posted areas (room17, 27, 12) are no eating drinking areas
- Postings are on the rise
- Call EHS with questions
- Direct questions form the public to EHS or Christian Basi 2-4430
- Security
  - Security guards in the galleries
  - Physical barriers in place
  - Prevent disturbance, removal, or access to contamination.

EHS: Contact 573-529-2385
Jack Crawford, Radiation Safety Officer
Mary Aldrich, Health Physicist
David Burgess, Health Physicist

Attachment 4 – Pickard Hall 55555 Jan 2013 inspection/survey report (7 pages)

Attachment 4 – Pickard Hall 55555 Jan 2013 inspection/survey report (7 pages)

UNIVERSITY OF MISSOURI - COLUMBIA
AUTHORIZATION INSPECTION REPORT

This is a summary of the authorization inspection conducted on the date indicated below. The status of the numbered items below indicates your authorization's compliance with the MU Campus Radiation Safety Program: an S - Satisfactoryl a U = Unsatisfactory; or an N = Not applicable or not checked. For unsatisfactory items a re-inspection date may be listed below; for those unsatisfactory items which also require a response by the authorized user, the response guidelines and a response due date will also be listed.

AUTHORIZED USER: Willie M Crawford **AU NUMBER:** 55555 **EXPIRATION DATE:** 01/12/2013
INSPECTION DATE: 01/07/2013 **RISK CATEGORY:** I

ROOM(S) AND BUILDING:

106 stage PICKARD HALL
12 PICKARD HALL
12A PICKARD HALL
13 PICKARD HALL
15 PICKARD HALL
17 PICKARD HALL
17A PICKARD HALL
1B PICKARD HALL
1st floor PICKARD HALL
205 PICKARD HALL
206 PICKARD HALL
213 PICKARD HALL
23 PICKARD HALL
25 PICKARD HALL
27 PICKARD HALL
2nd floor PICKARD HALL
Attic PICKARD HALL
C000C hall PICKARD HALL
C101-Ciel PICKARD HALL
Feeder ST PICKARD HALL

* Inactive Room

INSPECTION CONTACT(S): Donna Dare

A. [S] **Records of Receipts, Inventory, and Transfers**
B. [S] **Survey Documentation**
C. [S] **Radionuclide Waste Disposal**
D. [S] **Posting and Labeling**
E. [S] **Radionuclide Use and Storage**
F. [S] **Safety and Prudent Practice**
G. [S] **Training**
H. [N] **Other Inspection Items:**
I. [S] **Performance Based Evaluations(s)**

J. [S] **Radiation Survey Results- See Attached EHS/RSO Survey Form(s)**
All survey results were within limits for removable contamination; radiation levels were largely consistent with previous surveys.

Overall Inspection Results: Satisfactory

Deficiencies Found:
None.

UNIVERSITY OF MISSOURI - COLUMBIA
AUTHORIZATION INSPECTION REPORT

This is a summary of the authorization inspection conducted on the date indicated below. The status of the numbered items below indicates your authorization's compliance with the MU Campus Radiation Safety Program: an S - Satisfactoryl a U = Unsatisfactory; or an N = Not applicable or not checked. For unsatisfactory items a re-inspection date may be listed below; for those unsatisfactory items which also require a response by the authorized user, the response guidelines and a response due date will also be listed.

Comments and Recommendations:

This inspection is conducted to ensure the radiation safety group regularly reviews Pickard Hall for radiation safety program issues and conducts a regular survey. The inspection shall review the controls that have been put into place and shall evaluate whether they are still functional and useful; changes over time may be required and should be brought to the RSO for consideration.

General statements:

Maintenance or other work in the museum that might disturb surfaces (nailing/drilling into walls, floors etc.) must be coordinated with Museum and EHS staff. Maintenance workers must be escorted into restricted areas by Radiation Safety staff.

Staff in Pickard Hall are trained as radiation workers and staff with office or primary duties on the basement level are provided with dosimetry.

During this inspection it appeared that all work projects with the potential to disturb building surfaces are being routed through EHS for evaluation.

Surveys were limited to the first and second floors during this month's inspection.

EHS attempted to select survey points that would allow for better reproducibility and therefore better trending.

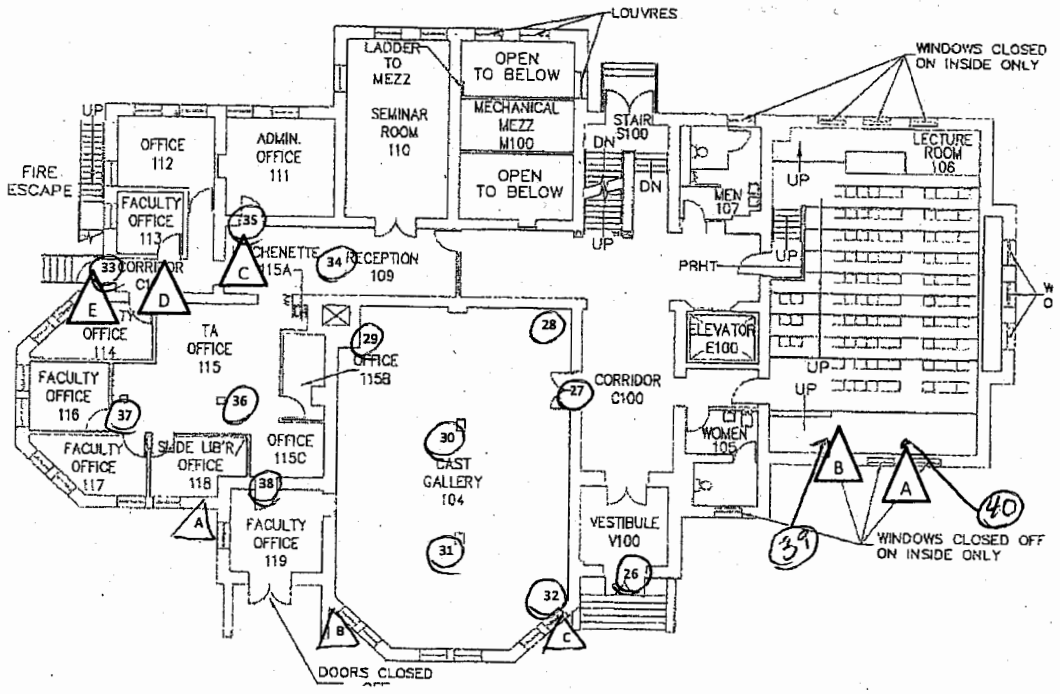
CC:
Alex Barker, Museum Director, Co-authorization #01041
Bruce Cox, Assistant Director, Museum Operations.
Susan Langdon, PhD. Chair Department of Art History & Archeology

Assigned HP Review Comments(optional):

Report Date: 01/10/2013 Inspected By: Mary Aldrich Assigned HP: Mary Aldrich

UNIVERSITY OF MISSOURI
RADIATION AND AREA CONTAMINATION SURVEY

Room & Building: Pickard Floor 1 | Authorized User: RSO | Authorization #: 55555



Not To Scale

Radiation Survey			Denotes Location						Contamination Survey	Denotes Location
☐ Dose rates less than 0.03 mR/hr, except:									☐ Removable activity less than:	
Surveys performed with GM and MN 192.									200 dpm/100cm2 beta/gamma	
	uR/hr	cpm		uR/hr	cpm		uR/hr	cpm	20 dpm/100cm2 alpha	
26	12	40	36	9	40	A	12	40 *		
27	22	40	37	5	40	B	13	40 *		
28	20	4	38	11	40	C	12	40 *	POSTINGS ARE LOCATED AT:	
29	25	40	39	10	40				A wall 106	C ceiling access
30	18	40	40	10	40				B lecturn base 106	D ceiling access
31	18	40								E ceiling access
32	15	40								
33	10	40								
34	11	40								
35	15	40								
Instrument: Ludlum MN: 14C; SN: 92302 Cal. Date: 10/8/12; MN: 192, SN: 294944 Cal. Date: 10/3/12									Instrument: Gamma 5000	

NOTES: locations are generally in corners, dead center doorways for reproducability. Classes in session, therefore several areas were not attempted.

* Dose rate measurements only at this location, no wipe test conducted in outdoor areas.

Date 11/7/12 By [signature] Assigned HP or Radiation Safety Officer

13 mR/hr

4/7

University of Missouri-Columbia
G-5000W Standard Four Activity Analysis Report

Machine Name: PEPPER MILL 2 **Group Date/Time** 2013/01/07 13:01:33.00
USER ID: RSO **System Serial #:** 2000-120399

Sample Position	Sample Ident	Sample Type	Elapsed Count Time	Alpha Counts	Alpha DPM	Beta Counts	Beta DPM	Gamma Counts	Gamma DPM
1	BKG	AutoBkg ABG	1 Min 0 Sec	1	1.00	26	26.0	207	207.0
2	wipe test	tamination_E	1 Min 0 Sec	0	0.0	33	52.239	215	50.0
3	wipe test	tamination_E	1 Min 0 Sec	0	0.0	20	0.0	203	0.0
4	wipe test	tamination_E	1 Min 0 Sec	0	0.0	24	0.0	197	0.0
5	wipe test	tamination_E	1 Min 0 Sec	0	0.0	18	0.0	199	0.0
6	wipe test	tamination_E	1 Min 0 Sec	1	0.0	22	0.0	207	0.0
7	wipe test	tamination_E	1 Min 0 Sec	0	0.0	26	0.0	224	106.25
8	wipe test	tamination_E	1 Min 0 Sec	0	0.0	25	0.0	207	0.0
9	wipe test	tamination_E	1 Min 0 Sec	2	4.034	33	52.239	199	0.0
10	wipe test	tamination_E	1 Min 0 Sec	1	0.0	19	0.0	240	206.25 SA
11	wipe test	tamination_E	1 Min 0 Sec	0	0.0	20	0.0	206	0.0
12	wipe test	tamination_E	1 Min 0 Sec	0	0.0	30	29.851	212	31.25
13	wipe test	tamination_E	1 Min 0 Sec	0	0.0	18	0.0	214	43.75
14	wipe test	tamination_E	1 Min 0 Sec	0	0.0	24	0.0	189	0.0
15	wipe test	tamination_E	1 Min 0 Sec	0	0.0	32	44.776	213	37.5
16	wipe test	tamination_E	1 Min 0 Sec	1	0.0	23	0.0	185	0.0

Collected By: MRead **Date:** 1/7/13

Approved BY: _____ **Date:** _____

5/7

University of Missouri-Columbia
G-5000W Standard Four Activity Analysis Report

Machine Name: PEPPER MILL 2
USER ID: RSO

Group Date/Time 2013/01/07 16:31:08.00
System Serial #: 2000-120399

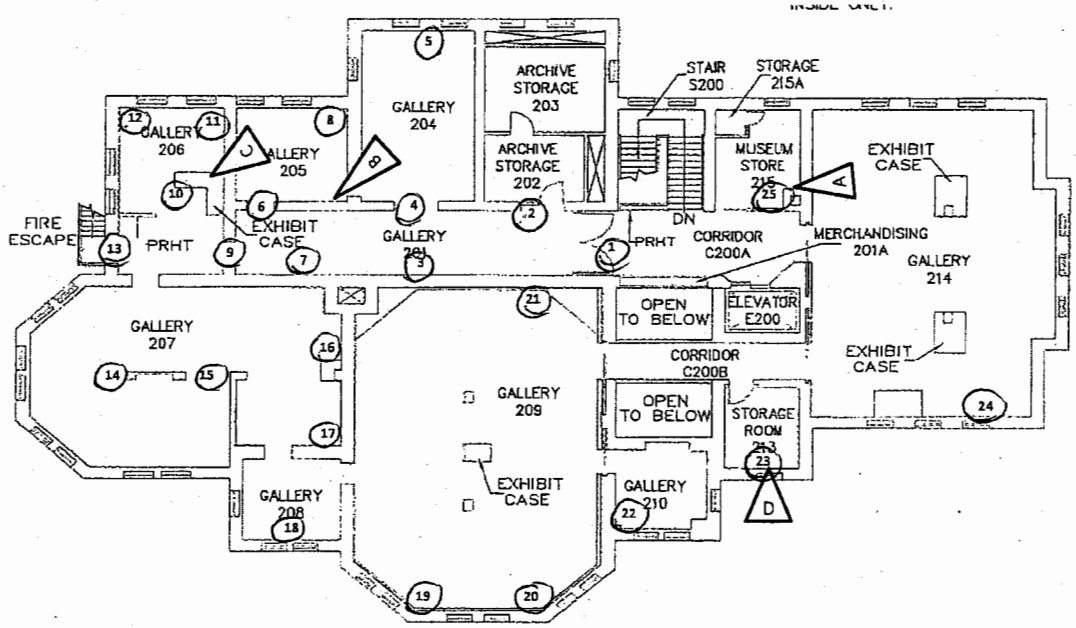
Sample Position	Sample Ident	Sample Type	Elapsed Count Time	Alpha Counts	Alpha DPM	Beta Counts	Beta DPM	Gamma Counts	Gamma DPM
1	BKG	AutoBkg ABG	1 Min 0 Sec	0	0.0	22	22.0	218	218.0
10	wipe test	tamination_E	1 Min 0 Sec	0	0.0	19	0.0	228	62.5

Collected By: _____ **Date:** 1/7/13

Approved BY: _____ **Date:** _____

UNIVERSITY OF MISSOURI
RADIATION AND AREA CONTAMINATION SURVEY

Room & Building: Pickard Floor 2 | Authorized User: RSO | Authorization #: 55555



Not To Scale

Radiation Survey			Denotes Location				Contamination Survey	Denotes Location
☐ Dose rates less than 0.03 mR/hr, except:			8, 23				☐ Removable activity less than:	
Surveys performed with GM and MN 192.							200 dpm/100cm2 beta/gamma	
	uR/hr	cpm		uR/hr	cpm		20 dpm/100cm2 alpha	
1	15	40	11	22	40	21	20	40
2	18	40	12	20	40	22	21	40
3	20	40	13	12	40	23	120*	350
4	18	40	14	17	40	24	13	40
5	18	30	15	12	40	25	15	40
6	28	60	16	15	40			
7	20	40	17	19	40			
8	34	60	18	18	40			
9	16	40	19	19	40			
10	15	40	20	17	40			

POSTINGS ARE LOCATED AT:
- A ladder to attic
- B wall 20S
- C wall 206
- D wall 213

Instrument: Ludlum MN: 14C; SN: 92302 Cal. Date: 10/8/12; MN: 192, SN: 294944 Cal. Date: 10/3/12

Instrument: Gamma 5000

NOTES: locations are generally in corners, dead center doorways for reproducability. 18 is dead center of the walls, 23 is on a marked area of wall. 25 is at ladder
* survey point moved lower on wall below sign for higher reading, confirmed 90 mR/hr reading in November 2012 (closer to sign)

Date 1/8/13 By _____ Assigned HP or Radiation Safety Officer

7/7

University of Missouri-Columbia
G-5000W Standard Four Activity Analysis Report

Machine Name: PEPPER MILL 2
USER ID: RSO

Group Date/Time 2013/01/09 08:25:38.00
System Serial #: 2000-120399

Sample Position	Sample Ident	Sample Type	Elapsed Count Time	Alpha Counts	Alpha DPM	Beta Counts	Beta DPM	Gamma Counts	Gamma DPM
1	BKG	AutoBkg ABG	1 Min 0 Sec	5	5.0	35	35.0	211	211.0
2	wipe test	tamination_E	1 Min 0 Sec	2	0.0	20	0.0	223	75.0
3	wipe test	tamination_E	1 Min 0 Sec	0	0.0	33	0.0	209	0.0
4	wipe test	tamination_E	1 Min 0 Sec	0	0.0	18	0.0	184	0.0
5	wipe test	tamination_E	1 Min 0 Sec	0	0.0	26	0.0	220	56.25
6	wipe test	tamination_E	1 Min 0 Sec	0	0.0	31	0.0	224	81.25
7	wipe test	tamination_E	1 Min 0 Sec	0	0.0	21	0.0	219	50.0
8	wipe test	tamination_E	1 Min 0 Sec	0	0.0	24	0.0	228	106.25
9	wipe test	tamination_E	1 Min 0 Sec	0	0.0	22	0.0	216	31.25
10	wipe test	tamination_E	1 Min 0 Sec	0	0.0	24	0.0	242	193.75
11	wipe test	tamination_E	1 Min 0 Sec	1	0.0	24	0.0	212	6.25
12	wipe test	tamination_E	1 Min 0 Sec	0	0.0	19	0.0	206	0.0
13	wipe test	tamination_E	1 Min 0 Sec	1	0.0	24	0.0	229	112.5
14	wipe test	tamination_E	1 Min 0 Sec	0	0.0	31	0.0	215	25.0
15	wipe test	tamination_E	1 Min 0 Sec	0	0.0	25	0.0	194	0.0
16	wipe test	tamination_E	1 Min 0 Sec	0	0.0	17	0.0	218	43.75
17	wipe test	tamination_E	1 Min 0 Sec	1	0.0	16	0.0	218	43.75
18	wipe test	tamination_E	1 Min 0 Sec	0	0.0	15	0.0	212	6.25
19	wipe test	tamination_E	1 Min 0 Sec	0	0.0	21	0.0	196	0.0
20	wipe test	tamination_E	1 Min 0 Sec	0	0.0	30	0.0	230	118.75
21	wipe test	tamination_E	1 Min 0 Sec	0	0.0	21	0.0	212	6.25
22	wipe test	tamination_E	1 Min 0 Sec	1	0.0	19	0.0	195	0.0
23	wipe test	tamination_E	1 Min 0 Sec	0	0.0	19	0.0	209	0.0
24	wipe test	tamination_E	1 Min 0 Sec	0	0.0	19	0.0	212	6.25
25	wipe test	tamination_E	1 Min 0 Sec	0	0.0	18	0.0	222	68.75
26	wipe test	tamination_E	1 Min 0 Sec	0	0.0	15	0.0	212	6.25

Collected By: _____ **Date:** 1/9/13

Approved BY: _____ **Date:** _____

University of Missouri - Columbia Environmental Health & Safety Radiation Safety Office

Authorization Inspection Check List

(Heading Boxes: S - Satisfactory, U - Unsatisfactory, N - Not Applicable. Numbered Items: Check deficient items)

Authorized User: Crawford **AU#** 55555 **Individual Contacted:** ~~L. Toepper~~ Donna Dare

Building: Pickard **Rooms:** see auth / insp report

[N] Receipt, Inventory and Transfer

____1. Radionuclide Shipment Receipt Log Incomplete
____2. Use of radionuclides inadequately recorded
____3. Inventory records incorrect / incomplete
____4. Transfer(s) performed improperly

[N] Survey Meter and Survey Documentation

____5. Survey Meter Functional Checks
  ____A. Battery Check
  ____B. Response Check
  ____C. Past calibration date.
____6. Survey frequency not adequate (see Table 1)
____7. Area survey map inadequate
____8. Meter survey inadequate
  ____A. Meter survey not performed
  ____B. Meter results not in mR/hr
____9. Contamination survey(s) inadequate
  ____A. Swipe survey not performed / documented
  ____B. Results not in dpm and not converted.
  ____C. LSC past calibration date.
  ____D. Swipe locations not indicated.
____10. Corrective Action(s) not taken Table 2 / Table 3

[N] Radionuclide Waste Disposal

____11. Waste disposal records not kept
____12. Solid Waste not stored properly
____13. Liquid Waste not stored properly
  ____A. No secondary containment
  ____B. Not capped
  ____C. Funnels not stored properly
____14. Improper disposal of waste
  ____A. Sink disposal
  ____B. In Bio/regular trash
____15. No RML label or improperly filled out
____16. Waste not picked up or request not submitted within 6 months of start date.

[S] Posting and Labeling

____17. NRC Form 3 not posted
____18. Restricted area warning signs inadequate
____19. Food items for experimental use not labeled
____20. Emergency Procedures not posted / filled out
____21. Isotope equipment/containers/storage unlabeled

[S] Radionuclide Use and Storage

____22. Isotope improperly stored or shielded
____23. Radioactive Material unsecured or unattended
____24. Unlocked storage in unrestricted area

[S] Safety and Prudent Practices

____25. Fume Hood Flow Check performed within yearly periodicity
____26. Evidence of food or drink in restricted area
____27. Protective clothing not used
____28. Open toed shoes worn in lab
____29. Assigned dosimetry not properly worn

[S] Training

____30. AU, RW, AW training adequate and timely

[N] Other Inspection Items

____31. _____

[S] Initial Survey Results

____32. Exposure rate in excess of Table 3
____33. Removable contamination in excess of Table 2

[N] Performance-Based Evaluation

Comments / Communications:

insp started
1/7/13 @ Floor 1
1/8/13 @ Floor 2

(Put additional comments on the back of this form)

Initial Inspection Results: (CIRCLE ONE)

Excellent E

Satisfactory (S)

Deficiency level: A B C D

Donna Dare 1/8/13
Authorized User or Representative Date

[signature] 1/8/13
EH&S Inspector Date

Initial inspection results may be modified upwards or downwards by the Assigned Health Physicist.

Health Physicist final review:

HP Compliance Level Date: / /

Revision 02/2008

Attachment 5 – Calibrations sheets for most recent used Ludlum's used at Pickard Hall (4 pages)

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
501 Oak Street
325-235-5494
Sweetwater, TX 79556, U.S.A.

☐ 231 Sam Rayburn Parkway
865-270-8962
Lenoir City, TN 37771, U.S.A.

CUSTOMER UNIV OF MISSOURI ENV HEALTH ORDER NO. 20208275

Ludlum Measurements, Inc. Model 192 Micro R Serial No. 294944

NA Model NA Serial No. NA

Cal. Date 3-Oct-12 Cal Due Date 3-Oct-13 Cal. Interval 1 Year Meterface 202-333

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 32 % Alt 704.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-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 ☑ Geotropism
☑ 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 600 V Input Sens. 30 mV Det. Oper. NA V at NA mV Threshold Dial Ratio NA = NA mV

☐ HV Readout (2 points) Ref./Inst. NA / NA V Ref./Inst. NA / NA V

COMMENTS:
Alarm is range dependent. (alarm set to full scale).

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
x1000	4000 µR/hr	NA	4
x1000	1000 µR/hr		0.99
x100	400 µR/hr= 295000cpm		4
x100	100 µR/hr		1.1
x10	25900 cpm		4
x10	6480 cpm		1
x1	2590 cpm		4
x1	648 cpm		1
NA	NA		NA
NA	NA		NA

*Uncertainty within ± 10% C.F. within ± 20% X10,X1 **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	NA	NA	NA	Log Scale	NA	NA	NA

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 N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 059 ☐ 280 ☑ 720 ☐ 734 ☐ 781 ☐ 1131 ☐ 1616 ☐ 1696 ☐ 5105 ☐ 5717CO ☐ 5719CO
☐ 60646 ☐ 70897 ☐ 73410 ☐ E551 ☐ E552 ☐ G112 ☐ M565 ☐ S-394 ☐ S-1054 ☐ T-304 ☐ T879 ☐ T10081 ☐ T10082 ☐ Y982

☐ Alpha S/N ☐ Beta S/N ☐ Other

☐ 500 S/N 38120 ☐ Oscilloscope S/N ☑ Multimeter S/N 84260131

Calibrated By: Leann Ortega Date 3-Oct-12

Reviewed By: Diana Ahart Date 3 Oct 12

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
501 Oak Street
325-235-5494
Sweetwater, TX 79556, U.S.A.
☐ 231 Sam Rayburn Parkway
865-270-8962
Lenoir City, TN 37771, U.S.A.

CUSTOMER UNIV OF MISSOURI ORDER NO. 20204392/380793

Ludlum Measurements, Inc. Model 9DP Serial No. 250003027

Mfg. _____ Model _____ Serial No. _____

Cal. Date 15-Sep-12 Cal Due Date 15-Sep-13 Cal. Interval 1 Year Meterface R/hr

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 44 % Alt 698.8 mm Hg

☐ New Instrument Instrument Received ☐ Within Toler. +-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 ☐ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 7.2 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 _____ V Input Sens. _____ mV Det. Oper. _____ V at _____ mV Threshold Dial Ratio _____ = _____ mV

☐ HV Readout (2 points) Ref./Inst. _____ / _____ V Ref./Inst. _____ / _____ V

COMMENTS:

Instrument is Auto-Ranging.
Peak Dose Rate & Integrated Dose are the available functions.
All undocumented features are currently set to off (0).

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
Auto	4 R/hr	N/A	4.00 R/hr
Auto	1 R/hr		0.95
	400 mR/hr		400 mR/hr
	100 mR/hr		99.7
	40 mR/hr		40.0
	10 mR/hr		9.99
	4 mR/hr		4.00
	1 mR/hr		1.01
	400 µR/hr		400 µR/hr
	100 µR/hr		94.0

*Uncertainty within ± 10% C.F. within ± 20% Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

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 N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☑ 059 ☑ 280 ☐ 720 ☐ 734 ☐ 781 ☐ 1131 ☐ 1616 ☐ 1696 ☑ 5105 ☐ 5717CO ☐ 5719CO
☐ 60646 ☑ 70897 ☐ 73410 ☐ E551 ☐ E552 ☐ G112 ☐ M565 ☐ S-394 ☐ S-1054 ☐ T-304 ☐ T879 ☐ T10081 ☐ T10082 ☐ Y982

☐ Alpha S/N _____ ☐ Beta S/N _____ ☐ Other _____

m 500 S/N _____ ☐ Oscilloscope S/N _____ ☑ Multimeter S/N 15060230

Calibrated By: James McBee Date 15SEP12

Reviewed By: Mark H Date 17 Sep 12

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: _____

UNIVERSITY OF MISSOURI - COLUMBIA
RADIATION SAFETY OFFICE
SURVEY INSTRUMENT CALIBRATION SHEET

User:	**RSO**			
Building:	**8 RPDB**			
Room:	**Mary**	**Instrument Background:**	0.015	**mR/Hr**
Manufacture:	LUDLUM		50	**CPM**
Model:	Model 14C			
Serial No.:	**92302**			
Shield:	Fixed			
Probe:	44-9 & Internal	Window Facing Beam Port		
Cs-137 Calibrator, Model: 28-6A, SN: 5071				

EFFICIENCIES IN %

Measured	
C-14 @ 1 cm:	1.47
IPL, # 1094-21	
Si-32 @ 1 cm:	23.11
IPL,# 548-6	
Interpolated	
S-35 @ 1 cm:	2.1
P-32 @ 1 cm:	23.1
P-33 @ 1 cm:	5.7
Ca-45 @ 1cm:	6.0
Tc-99 @ 1cm:	7.2
Cl-36 @ 1cm:	15.2
GROSS CPM	
C-14 @ 1 cm:	8500
Si-32 @ 1 cm:	24000

CALIBRATION POINTS mR/hr	ATTENUATOR	DISTANCE cm	SCALE X	INSTRUMENT RESPONSE mR/hr	POINT CORRECTION FACTORS	AVERAGE CORRECTION FACTORS
0.05	X2000	138	0.1	0.06	1.11	
0.15	X2000	80	0.1	0.16	1.03	1.07
0.5	X200	141	1	0.5	1.00	
1.5	X200	82	1	1.5	1.00	1.00
5	X20	142	10	5	1.00	
15	X20	82	10	15	1.00	1.00
50	X2	145	100	50	1.00	
150	X2	84	100	150	1.00	1.00
			1000	Not Calibrated for this range.		
			1000	Not Calibrated for this range.		

Check Source Response: 7.00 **mR/hr** **Battery Check:** OK

Comments: **Do not use X1000 setting.**

Signature of Calibrator: **Date:** 10/8/2012

EHS/RSO10(6/97)

SOURCE CK:	7.00 mR/hr
Calibrated:	10/8/2012
Do not use X1000 setting.	

USER:	RSO	P-32 Eff (%):	23.1
INSTRUMENT:	LUDLUM MOD 3	C-14 Eff (%):	1.5
SERIAL # (sn):	92302	Cs-137 sn:	5071
WINDOW:	Fixed	GEOMETRY:	II
SOURCE CK:	7.00		
SCALE	**AVG CORR FAC**		
0.1	1.07	BATT:	OK
1	1.00		
10	1.00	CAL DATE:	10/8/2012
100	1.00		
INITIALS:		DUE DATE:	10/8/2013

Attachment 6 – Original Attachment 1 - Pickard Hall Radon Monitoring Results (3 pages)

Attachment 1 – Pickard Hall Radon Monitoring Results

Radon Monitoring Report

EHS UNIVERSITY OF MISSOURI
ATTN: ROSE LEYKAMP
8 RESEARCH PARK DEV BUILDING
COLUMBIA, MO 65211

LANDAUER

Landauer, Inc 2 Science Road Glenwood Illinois 60425
Telephone (800) 528-8327 Facsimile (708) 755-70

Acct. No. 0410211

PROGRAM NAME: PICKARD

Detector Number	Detector Type	Starting Date	Ending Date	Field Data / Comments	Exposure pCi/l-days	Avg. Radon Conc pCi/l	
4741886	DRN	21-NOV-08	24-FEB-09	RM 3	35.0 ±5.18	0.6 ±0.05	
4741887	DRN	21-NOV-08	24-FEB-09	RM 26	104.5 ±8.3	1.1 ±0.09	
4741895	DRN	19-NOV-08	24-FEB-09	RM 17A	204.0 ±12.8	2.1 ±0.13	
4741904	DRN	21-NOV-08	24-FEB-09	RM 7	61.3 ±5.62	0.6 ±0.06	
4741918	DRN	19-NOV-08	24-FEB-09	RM 17	227.4 ±13.7	2.3 ±0.14	
4741929	DRN	19-NOV-08	24-FEB-09	RM 6	160.5 ±11.0	1.7 ±0.11	
4741959	DRN	21-NOV-08	24-FEB-09	RM 12	292.3 ±15.9	3.1 ±0.17	
4741974	DRN	19-NOV-08	24-FEB-09	RM 5	129.8 ±9.5	1.3 ±0.10	
4741977	DRN	19-NOV-08	24-FEB-09	RM 18, 18A, 16	215.7 ±13.2	2.2 ±0.14	
4741988	DRN	21-NOV-08	24-FEB-09	RM 27	380.1 ±18.6	4.0 ±0.20	

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EHS

RELATED ONLY TO MONITORS
VED BY LANDAUER.

QC Release	Process No	Report Date	Date Received
DRB	AZ1617	12-MAR-09	27-FEB-09

Radon Monitoring Report

EHS UNIVERSITY OF MISSOURI
ATTN: ROSE LEYKAMP
8 RESEARCH PARK DEV BUILDING
COLUMBIA, MO 65211

LANDAUER

Landauer, Inc 2 Science Road Glenwood, Illinois 60425
Telephone: (800) 528-8327 Facsimile: (708) 755-70

Acct. No. 0410211

PROGRAM NAME: PICKARD

Detector Number	Detector Type	Starting Date	Ending Date	Field Data / Comments	Exposure pCi/l-days	Avg. Radon Conc pCi/l
4741991	DRN	21-NOV-08	24-FEB-09	RM 2	124.6 ±9.3	1.3 ±0.10
4742006	DRN	19-NOV-08	24-FEB-09	RM 28	246.5 ±14.4	2.5 ±0.15
4742009	DRN	19-JAN-08	24-FEB-09	RM 1A	107.7 ±8.4	0.3 ±0.02
4742019	DRN	21-NOV-08	24-FEB-09	RM 4	119.3 ±9.0	1.3 ±0.10
4742030	DRN	21-NOV-08	24-FEB-09	RM 9	97.1 ±7.85	1.0 ±0.08

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RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER.

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

Radon Monitoring Report

SNS UNIVERSITY OF MO
B RESEARCH PA DEV BLDG
COLUMBIA, MO 65211

LANDAUER

Landauer Inc 2 Science Road Glenwood Illinois 60425-1586
Telephone: (800) 323-8327 Facsimile: (708) 755-7048

Acct. No. 0411711

Detector Number	Detector Type	Starting Date	Ending Date	Field Data / Comments	Exposure pCi/l-days	Avg. Radon Conc. pCi/l
4741989	DRN	17-JUL-09	07-DEC-09	PICKARD 13 MBAS	1039.1 ±31.9	7.3 ±0.22
4741900	DRN	21-NOV-08	07-DEC-09	PICKARD 12 ONE YEAR	1127.4 ±33.4	3.0 ±0.09
4741906	DRN	19-NOV-08	08-DEC-09	PICKARD 29 ONE YEAR	903.5 ±29.5	2.4 ±0.08
4741942	DRN	21-NOV-08	08-DEC-09	PICKARD 27-ONE YEAR	1193.7 ±34.5	3.1 ±0.09

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DEC 22 2009
EHS

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RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER.

QC Release	Process No	Report Date	Date Received
DRB	A21795	15-DEC-09	09-DEC-09

Attachment 7 – Chase Environmental Group, Inc - QAP 8.2 Chain-of-Custody Procedure (3 pages)

CHAIN-OF-CUSTODY

1.0 PURPOSE

This Quality Assurance Procedure (QAP) establishes the methods, responsibilities and requirements for item identification and control.

2.0 APPLICABILITY

This QAP applies to items, such as samples, specimens or test materials used in experimentation or testing, when the validity of the corresponding data or results depends on maintaining accurate identification and traceability of the items.

3.0 INSTRUCTIONS

3.1 Periodic surveillances shall be performed by the Project Manager to ensure that item control and identification comply with the following requirements.

Sample Preservation

3.1.1 The Sampling Technician shall ensure that samples will be properly prepared for transportation to the laboratory by refrigeration and chemical preservation, if necessary. The Sample Technician shall verify that the laboratory providing sample containers has added any necessary chemical preservatives to the sealed containers provided.

Container Label

3.1.2 The Sampling Technician shall ensure that all sample container lids will be sealed with tape and a label will be firmly attached to the container side (not lid). The following information will be legibly and indelibly written on the label:

- Facility name;
- Monitor well and sample location number (if applicable);
- Sampling date;
- Sampling time; and
- Sample collector's initials.

Sample Shipment

3.1.3 The Sampling Technician shall ensure that the following packaging and labeling requirements for nonhazardous sample materials are appropriate for shipping:

- Package sample so that it does not leak, spill, or vaporize from its packaging;
- Label package with:
  - Sample collector's name, address, and telephone number;
  - Laboratory's name, address, and telephone number;

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- Description of sample;
- Quantity of sample; and
- Date of shipment.

If the materials to be shipped are considered hazardous or if their nature is uncertain, the samples will be appropriately labeled and will be transported by sampling personnel directly to the analytical facility or will be shipped using a carrier licensed to transport hazardous materials.

Sampling Records

3.1.4 The Sampling Technician shall ensure that detailed records are maintained during sampling. These records will include the information listed below applicable:

- Sample location (facility name);
- Sample identification (location or boring number and sample number);
- Sample location map or detailed sketch;
- Date and time of sampling;
- Sampling method;
- Field observation of :
  - Sample appearance,
  - Sample odor,
- Weather conditions;
- Sampler's identification; and
- Any other significant information.

Chain-of-Custody

3.1.5 The Sampling Technician shall ensure that the chain-of custody measures are followed to establish a written record concerning sample custody during movement between the sampling site and the testing laboratory. Each shipping container will have a chain-of-custody form (see example Exhibit 1) completed by the site sampling personnel packing the samples. The chain-of-custody form for each container will be completed in triplicate and sealed in the container. One copy of this form will be maintained at the site, and the other two copies at the laboratory. One of the laboratory copies will become a part of the permanent record for the sample and will be returned with the sample analyses to Chase.

3.2 All completed sampling documentation (log books, etc.) and chain-of-custody records shall be processed as quality assurance records

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4.0 EXHIBITS

1. Chain of Custody Form (Example)

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CHAIN-OF-CUSTODY

Chain of Custody Record No.

Chase Environmental Group, Inc.

| | | |

QUALITY ASSURANCE PROCEDURES MANUAL

QAP 8.2

CHAIN-OF-CUSTODY

Revision Number	Effective Date	Quality Assurance Approval	Management Approval

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Attachment 8 – Sanitary and Storm Sewer line GIS Map for servicing Pickard (1 page)

Legend

- GIS.City_Sanitary_Features_1
- GIS.MU_Sanitary_Features_1
- GIS.City_Sanitary_Lines_1
- GIS.MU_Sanitary_Lines_1
- Storm Polys
- Storm Lines