

ENCLOSURE 1

**Unified Decommissioning Funding Plan
For
The Pennsylvania State University
Radiation Facilities
At
University Park, Hershey Medical Center,
And Related Campuses**

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Introduction and Executive Summary

These decommissioning funding plans (DFPs) were prepared using NUREG-1757 Volume 3 Rev 1 (2012) as a guidance document. The section designations correspond to the numbering system used in Appendix A.3 of the NUREG.

The Pennsylvania State University comprises 23 major campuses spread across the state as shown in Figure 1 (note that the Penn College of Technology is not under Penn State's Environmental Health and Safety oversight and thus is not counted in the list of supported campuses shown on the map). However, the use of radioactive materials is currently limited to the following 6 locations by either a Pennsylvania Department of Environmental Protection (PA DEP) issued license or by an Nuclear Regulatory Commission (NRC) issued license:

1. University Park Campus (UP) – the main campus (PA and NRC licenses)
2. Penn State Breazeale Nuclear Reactor (PSBNR) at UP (NRC license)
3. Altoona Campus (UP PA license)
4. Harrisburg Campus (UP PA license)
5. Penn State Electro-Optical Center, Freeport (UP PA license)
6. Penn State Hershey Medical Center (PSHMC) (PA license).

Of these six locations, only three regularly utilize radioactive material: University Park, the Hershey Medical Center, and the Breazeale reactor. The Harrisburg campus, while an authorized place of use under the UP PA state license, has only one laboratory that has utilized P-32 on two occasions since November 2013. The Altoona campus has recently terminated licensed activity at its one and only laboratory. The Electro-Optical Center, though approved, has never acquired or used licensed material. An amendment request will be submitted to the PA DEP in the near future requesting that both the Altoona Campus and Electro-Optical Center locations be deleted from the PA-100 license.

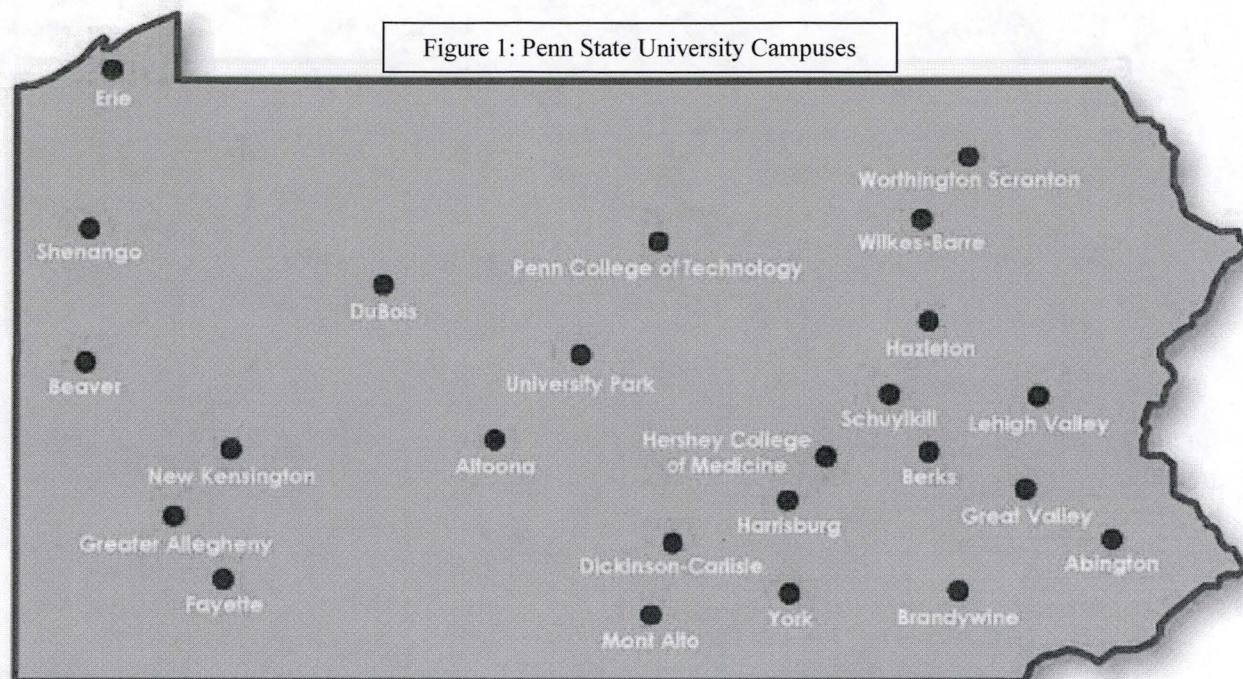
There are five licenses that are held by Penn State University:

License Number	Issuing Agency	Brief Description and Campus Location	DFP Appendix
PA-0100	PA DEP	Broad scope byproduct materials, UP & others	A
PA-0127	PA DEP	Broad scope byproduct materials, PSHMC campus	B
PA-0127A	PA DEP	Self-shielded irradiator license, PSHMC campus	C
SNM-95	NRC	Special Nuclear Materials, UP campus	D
R-2	NRC	Research and Test Reactor license, UP campus	E

Because of the disparate geographical and radioactive material usage differences between the licenses, each has been separated into a self-contained appendix to this document. The PA DEP will want to review Appendix A, B, and C. The NRC will want to review Appendix D and E.

The method for estimating decommissioning costs was changed in December 2012 when an update to 10 CFR 30.35.(e).(1).(i).(A) now requires costs estimates to be based on the cost of an independent contractor to perform all decommissioning activities. The cost estimates in this DFP reflect this change.

Records of information important to the decommissioning of Penn State's licenses are retained at the University Park Environmental Health and Safety offices and at the Health Physics offices at the Hershey Medical Center.



The decommissioning cost estimates for each license, individually and combined, are as follows:

Penn State University Unified Decommissioning Cost Estimate			
License	Type	DFP Appendix	Estimated Cost (\$)
PA-0100	Broad Scope	A	\$3,740,090
PA-0127	Broad Scope	B	\$3,576,307
PA-0127A	Irradiator	C	\$476,558
SNM-95	Special Nuclear Materials	D	\$261,718
R-2	Reactor	E	\$18,558,238
Penn State University TOTAL			\$26,612,911

Basic Assumptions Common to All DFPs

Several assumptions must be made to estimate the cost of decommissioning the facilities under each license. The assumptions common to all licenses are listed below while assumptions specific to a license are contained in that license's appendix.

1. Compliance with 10 CFR 20.1402.

The operations plans and the cost estimates are based upon meeting the release limit of 10 CFR

[REDACTED]

20.1402. This release limit requires that "residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem per year."

2. One license is terminated at a time.

It is very unlikely that multiple, or all, licenses would be terminated at the same time. Because of shifts in the focus of research utilizing radioactive material over time, it is much more probable that only one license would be terminated at any one time. Normally Penn State staff would be available for decommissioning work in these instances; however, this DFP assumes an independent contractor will perform all work.

3. Decommissioning estimates are based on current inventory and use locations.

While each license may allow a larger selection of isotopes and activities than presently in use, this DFP is based on current inventories and use locations. As required by NRC regulations, the DFP will be updated every three years to reflect the future status of inventories and locations.

4. Penn State University will continue a "clean operations" policy.

In accordance with 10 CFR 20.1406(c), Penn State will continue its long-standing policy of maintaining use locations free of contamination. This means that whenever a room, area, or major piece of equipment becomes contaminated, it is cleaned or disposed of, as appropriate, soon after discovery. Penn State can support this assumption by review of many years of survey data that show our laboratories do not have significant contamination issues. This "clean operations" policy is also in effect at the Hershey Medical Center.

5. No remodeling costs are included.

Decommissioning costs do not include removal or disposal of non-radioactive structures or materials beyond that necessary to terminate the radioactive material license. Costs are not included for replacing hoods or bench-tops that were removed due to contamination. No follow-up costs for remodeling and renovation are included in these estimates.

6. No credit for salvage.

No credit is taken for salvage of equipment or materials that would likely be sold or transferred to another licensee, nor is credit taken for sale of non-radioactive use items.

7. No license amendments required.

No license amendments are expected for decommissioning. All activities are within the normal scope of tasks currently performed on a regular basis in accordance with established written procedures. If these tasks are performed by Penn State employees or by an outside group, the tasks are expected to be commensurate with normal activities.

8. Vendors will ship Type B materials.

Large activity sources that require Type B shipping containers will be shipped by outside vendors in accordance with the disposal methods currently used. No costs are included for Penn State to write and document a quality assurance plan. The outside vendor(s), specifically licensed to perform this work will perform the packaging and shipping of the material.

9. Decommissioning of buildings.

Buildings in which "... no principal activities under the license have been conducted for a period of 24 months ..." are decommissioned in accordance with 10 CFR 30.36.(d).(3). Generally, it is infrequent that a building that had radioactive material labs is decommissioned because labs do not terminate their use often. When a building is decommissioned its hoods, ducts, and sinks are checked for contamination, all labels and tags are removed, and a report is filed confirming compliance with 10 CFR 20.1402. This building report relies heavily upon the agglomeration of individual room decommissioning reports and is available for inspection. Buildings and spaces previously released by the NRC and PA DEP are not included in these DFP estimates.

10. A licensed radioactive waste site is available.

This DFP must be based upon the assumption that the shipment of radioactive waste is possible. Penn State currently has the ability to store waste for about six years prior to shipping, but decommissioning can only be accomplished if a low-level radioactive waste disposal facility is available.

11. The Department of Energy (DOE) will accept the return of their materials.

Certain sources and materials must be returned to the DOE for disposal. If the DOE refuses to receive this material then long-term storage costs may be significant; these costs are not included in these DFP estimates.

Basic Assumptions Common to Only PA Broad Scope License DFPs

Additional assumptions have been incorporated into the DFPs for Pennsylvania Department of Environmental Protection issued broad scope licenses.

1. Waste 'On-hand' equals one year's waste generation.

This DFP assumes that one year's worth of normal operations waste is already 'On-hand' and waiting disposal at the start of decommissioning. Added to this amount will be the decommissioning waste so that the total amount of radioactive waste will be slightly larger than just from decommissioning activities only.

2. A portion of prior licensee decommissioned use locations are included due to the potential need for additional verification surveys.

Related to assumption 3 above, laboratories and use locations which are no longer authorized for radioactive material work are surveyed and inspected by Radiation Safety staff. Location owners are required to have all radioactive material removed and to clean their facilities and equipment to background levels. Radiation Safety staff then perform a more detailed survey (compared to standard quarterly surveys) to verify the space is releasable. The space is then de-posted and allowed to be used as unrestricted space.

When an entire building no longer has any radioactive material users, it has been Penn State practice over the past several years to then invite the PA DEP to inspect and officially release the building. However, this current practice does not take into account buildings which are not currently being used where the PA DEP has not had the opportunity to perform independent

[REDACTED]

analysis. Therefore, it is possible that a portion of the historical previously released spaces will need additional survey work to verify cleanliness. We assume that up to 25% of licensee released laboratories that are not yet officially released by the PA DEP will require additional survey work. The cost for these additional surveys is included in both broad scope license DFPs.

Reasons for the Differences in Cost Estimates with this DFP

The difference in cost estimates between this 2016 DFP and the 2013 DFP are due to these factors:

1. All costs have been updated to 2016 values.
2. For the Breazeale Reactor Facility, although the facility-specific DFP cost estimate, Appendix E, is in agreement with other reactors, the Georgia Institute of Technology decommissioning cost continues to be the worst case scenario and thus Penn State will continue to use that cost for this DFP.
3. An additional 25% of licensee broad scope released labs (i.e. inactive radioactive material labs) will require confirmatory surveys prior to unconditional. The prior DFPs assumed these labs would not require further attention.

APPENDIX D – University Park SNM-95 NRC License

Section A.3.4 Facility Description

License Numbers and Types

The Pennsylvania State University maintains license number SNM-95 issued by the Nuclear Regulatory Commission a Special Nuclear Materials (SNM) license.

Types and Quantities of Materials Authorized

The following are the licensed materials and quantities permitted under SNM-95:

Table 1 – SNM-95 License Summary			
Line Item	Isotope	Form	Allowed Quantity
A	Uranium enriched in the U-235 isotope	Any	[REDACTED]
B	Deleted by Amendment 1	--	[REDACTED]
C	Uranium-233	Any	[REDACTED]
D	Plutonium-239	Encapsulated Pu-Be sources	[REDACTED]
E	Plutonium-239	Plated alpha sources or fission foils	[REDACTED]
F	Deleted by Amendment 1	--	[REDACTED]
G	Deleted by Amendment 1	--	[REDACTED]
H	Requested to be deleted in License Renewal Submission dated November 5, 2014	--	[REDACTED]
I	Fission product samples	Non-dispersible solid or liquid	[REDACTED]

Description of How Licensed Materials Are Used

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Line item H has been requested to be removed from the license in our license renewal submission dated November 4, 2014. Penn State never received any of the material as originally planned and sees no expected need in the foreseeable future. These items will not be considered in this funding plan estimate.

[REDACTED]

[REDACTED]

Routine surveys are performed by Radiation Protection staff once per calendar quarter to assure that safe working conditions are maintained. Normal operating procedures require that radioisotope laboratories minimize contamination. Typically, surveys show no removable contamination above background (approximately $< 50 \text{ dpm}/100\text{cm}^2$) on surfaces and equipment using liquid scintillation counting (LSC) and Geiger meters. Penn State maintains a “no contamination” policy and any finding above background is promptly addressed and decontaminated.

Because of this continuous characterization of the radiation environment, normal decommissioning typically requires only the removal of radioactive materials, or solutions, and radioactive waste consisting of paper, plastic, and glass lab ware followed by appropriate surveys of the facility and equipment. Decommissioning surveys are a routine part of the radiation safety program when authorized users either relocate or terminate.

Description of Facilities

The Pennsylvania State University is a large educational institution serving more than 45,000 students and more than 2500 faculty. Research under this license takes place in three (3) buildings exclusively at the University Park (UP) campus. Some buildings share both educational and research missions; others are designed as research laboratory buildings. Within a building, the use of radioactive material can be in many or just a few locations as approved by the University Isotopes Committee. As the type and emphasis of research changes over time, the occupancy of a building may also change and interior spaces are often remodeled.

[REDACTED]

Table 2 – Buildings and Rooms			
Campus	Building	Use	Number of Unsealed Rooms
UP	[REDACTED]	[REDACTED]	1

UP				
UP				
TOTAL Rooms				

Within any given approved laboratory space, researchers are encouraged to limit work with radioactivity to as small an area as possible, e.g. one bench top. Individual instruments and equipment that are used to store or process radioactive samples are labeled with a Caution Radioactive Material label.

In summary, standard operating procedure is to protect the bench surfaces from contamination with absorbent material. Generally, no liquids are disposed of via laboratory sinks but are collected for disposal by Radiation Protection staff. Only accidental or incidental (e.g. glassware washing, etc.) discharge via a laboratory sink is permitted unless sink disposal is approved by the University Isotopes Committee (UIC).

Currently all SNM radioactive material use at UP is in traditional laboratory setting (i.e. dedicated rooms or spaces with rooms having walls and doors). To simplify estimating the decommissioning costs, a Reference Laboratory (RL) will be defined. This generic laboratory consists of a single room used for performing research with radioactive materials as well as non-radiological research. Actual room sizes vary between approximately 100 ft² to 1500 ft² and the RL will be assumed to be 600 ft² (20 ft wide by 30 ft deep by 10 ft high). Section A.3.5 contains more detail as to the contents of a RL.

Radioactive Waste On-Hand Before Decommissioning

At the present time there no SNM waste on hand. Due to the limited quantities in possession currently, SNM waste On-Hand at the time of decommissioning will be treated as zero. The information provided below is almost entirely other byproduct waste disposal. The information provided below is included as reference only and consideration as to typical types, volumes, and cost of disposal.

All wastes with less than or equal to 120 day half-life are held for decay for at least 10 half-lives, then surveyed and released as non-radioactive waste. Liquid wastes with half-lives greater than 120 days are disposed via sanitary sewer by Radiation Protection staff to ensure that legal release limits are not exceeded. All other long lived wastes are shipped to an appropriate waste disposal facility.

There are no SNM wastes on-hand prior to decommissioning. Since some wastes will be generated during decommissioning, the wastes costs are based on the prior six years of waste shipment data provided in Table 3 below:

Table 3 – Waste History						
Year	Number, Type of Container (Waste Type)	Isotopes	Total Activity (mCi)	Total Volume (Unit Volume)	Weight	Cost
2011		H-3, C-14, U(Nat), Fe-55, Cs-137, Co-60, Na-	72.6 mCi			\$3,138

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		22, Zn-65, Ca-45				
		H-3,C-14,Cs- 137,Co-60, Ni-63, Cr-51, Co-58, Mn- 54, Zn-65	1.8 mCi			\$1,360
		Fe-55	0.02 mCi			\$1,905
					TOTAL	\$6,403
2012		H-3, C-14, Co-60,Cs- 137, Fe-55, U(Nat), Zn- 65, Eu-152, Eu-154, Eu- 155, Ra-226, U-238, Sr-90	9.4			\$4,391
		Co-60, Cs- 137, Eu-152, Eu-154	1.7 mCi			\$1,001
		Fe-55	0.02 mCi			\$1,428
					TOTAL	\$6,820
2013		C-14, H-3, Fe-55, U(Nat), Zn- 65, Co-60, Cs-137	12.2 mCi			\$6,396
		Fe-55	0.2 mCi			\$1,002
		H-3	0.2 mCi			\$1,102
					TOTAL	\$8,500
2014		H-3, C-14, U- Nat, Fe-55,	19.4 mCi			\$3,522

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		Co-60, Zn-65, Ca-45, Th-Nat				
		H-3, C-14, Co-57, Co-60, Fe-55, Cs-137, Mn-54, U-Nat	0.95 mCi			\$910
		Fe-55	0.005 mCi			\$ 289
		C-14, H-3, Co-60, Cs-137	5.2 mCi			\$7,937
		Eu-154, Cs-137, Co-60, Na-22, Cs-137, Co-60	0.02 mCi			\$2,371
		U-Nat Contaminated Asbestos				\$12,118
		Ra-226, Cs-137	0.07 mCi			\$1,080
					TOTAL	\$28,227
2015	None	None	None	None	None	\$0.00
2016**		H-3, C-14, U-nat, Fe-55, Ca-45, Co-60, Zn-65, Cs-137, Na-22, Mn-54, Sb-124, Mn-54, Ba-133, Ni-63	37.5 mCi			\$9,075
		Co-57, Co-60, Cs-137, Co-58, Mn-54, Zn-65,	2.2 mCi			\$1,970

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		Fe-55, Ni-63				
		Fe-55, Ca-45	1.2 mCi			\$2,212
	1 LSC Standard	Ba-133	0.02 mCi			\$500
					Total	\$13,757

* Dry Active Waste (DAW)

** Table 3 includes waste data for the year 2016 even though this waste has not yet been shipped off site, and will not be shipped until 2017 at the earliest. The information is included because the waste is prepared for shipment and disposal costs have been based on current pricing provided by our Low Level Radioactive Waste (LLRW) broker (see Table 7).

The cost per waste type is provided in Table 4:

Table 4 – Waste Cost History			
Year Waste Broker	Waste Type	Cost per Cubic Foot	Cost per Pound
2011	Dry Active Waste	\$40.22	\$5.40
Ecology Services, Inc.	Metals	\$181.33	\$6.60
	LSC Vials	\$92.93	\$6.50
2012	Dry Active Waste	\$35.12	\$4.48
Ecology Services, Inc.	Metals	\$133.47	\$7.00
	LSC Vials	\$116.10	\$7.25
2013	Dry Active Waste	\$34.22	\$5.61
Ecology Services, Inc.	LSC Vials	\$81.46	\$6.77
	Animal Carcasses	\$306.11	\$19.00
2014	Dry Active Waste	\$45.15	\$5.60
Ecology Services, Inc.	Metals	\$123.81	\$7.00
	LSC Vials	\$70.49	\$5.90
	Mixed Liquid Waste	\$1,935.85	\$161.98
	Lead	\$3,538.80	\$7.80
	Contaminated Asbestos		\$7.54
	LSC Standard	\$1080 / 3 LSCs	\$360 / LSC
2016	Dry Active Waste	\$48.48	\$7.50
Ecology Services, Inc.	Metals	\$268.03	\$7.35
	LSC Vials	\$368.67	\$7.35
	LSC Standard	\$500 / 1 LSC	\$500 / LSC

For easier analysis, the unit costs table above has been rearranged as follows:

Table 5 – Cost per Cubic Foot								
Year	DAW	Metals	LSC Vials	Animals	Mixed Waste	Lead	LSC Standards	Asbestos
2011	\$40.22	\$181.33	\$92.93					
2012	\$35.12	\$133.47	\$116.10					
2013	\$34.22		\$81.46	\$306.11				
2014	\$45.15	\$123.81	\$70.49		\$1,935.85	\$3,539		
2016	\$48.48	\$268.03	\$368.67					

Table 6 – Cost per Pound								
Year	DAW	Metals	LSC Vials	Animals	Mixed Waste	Lead	LSC Standards	Asbestos
2011	\$5.40	\$6.60	\$6.50					
2012	\$4.48	\$7.00	\$7.00					
2013	\$5.61		\$6.77	\$19.00				
2014	\$5.60	\$7.00	\$5.90		\$161.98	\$7.80	\$360/LSC	\$7.54
2016	\$7.50	\$7.35	\$7.35				\$500/LSC	

The projected cost of disposal for waste ‘On-hand’ will be based on the market rates currently in effect as quoted by our LLRW disposal contractor, Ecology Services, Inc. (November 2016):

Table 7 – Waste Costs per Pound for DFP			
	DAW	Metals	LSC
Cost per Pound	\$7.50	\$7.35	\$7.35

Volume of Contaminated Subsurface Materials

There are no known areas with subsurface contamination associated with this DFP.

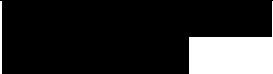


Section A.3.5 Number and Dimensions of Facility Components

Type of Space: Reference SNM radioactive material laboratory at Penn State University Park.

Average Size: 600 ft² (20 ft wide by 30 ft long by 10 ft high)

Level of Contamination: < 100 dpm/100 cm²

Table 8 – Reference Lab Components		
Component	Number of Components	Dimensions of Component
Fume Hood	1	5 W x 2 D x 5 H feet
Lab Rad Benches	3	10 x 3 x 0.25 feet
Sinks / Drains	1	2 W x 1.5 D x 1 H feet

Shelving	12	10 x 1.5 feet
Floors (net exposed ft ²)	1	450 ft ²
Walls	1	1000 ft ²
Ceiling Tiles	1	600 ft ²
Bulk Equipment:		
		
Waste Containers	3	1.5 x 1.5 x 2.5 feet
Benchtop Shielding (Plastic)	2	1.5 x 2 x 2.5 feet
Hand Items (Misc. lab ware)	10	

Section A.3.6 Planning and Preparation (Work Days)

Current Conditions

A third party contractor will be utilized for the decommissioning effort. It is assumed that normal operations continue up until the date the contractor comes on site. The contractor will need to first familiarize themselves with the facility and define the scope of work.

The Radiation Protection Office and Breazeale Nuclear Reactor Facility maintain all records pertinent to the use of radioactive materials under the licenses. These include receipts, inventory, locations of use or storage, waste inventory, personnel, and sealed sources. The records are kept electronically in a database and updated as the record is generated (i.e. inventory is updated as stocks are received; lab survey data is updated soon after the survey is completed, etc.) Laboratory surveys are performed on at least a quarterly basis and paper records kept for at least three years; therefore, a review of these documents will demonstrate the recent levels of contamination which may be expected. Locations of all licensable and generally licensed sealed sources are kept.

Historical Site Assessment

The following records are available in the Radiation Protection Office (RPO) with regard to historical use of radioactive materials:

A) Paper survey reports of laboratories where radioactive material has been used for the past three years. Survey reports are not to scale, but represent the pertinent fixtures and equipment used for radioactive materials work. Surveys may extend to non-use areas and equipment that may be in a particular location. Survey reports typically record the radionuclides recently used and may not reflect all historical uses in a particular location; however, historical purchase records are available.

B) Paper final survey reports of laboratories that have been decommissioned and released for unrestricted use after cessation of radioactive materials use. Survey reports are not to scale, but represent the pertinent fixtures and equipment used for radioactive materials work. Portable equipment released in a final survey report is not identified with specific information such as manufacturer, model or serial

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number. Once an item of equipment is determined to be free of radioactive contamination, the Caution Radioactive Materials label is removed and it is released to unrestricted use.

C) A listing of all locations by user, nuclides, building and room number where radioactive materials were ever authorized under license.

D) A listing of locations where radioactive materials are currently authorized.

E) A database of all licensable, generally licensed, and sealed sources currently in possession. Sealed sources are inventoried at least semi-annually by the RPO and all disposals of sealed sources are by the RPO. A concerted effort has been made to dispose of sources no longer needed; therefore there should not be any surprise discoveries of sealed sources.

F) Leak test records for all sealed sources.

G) A database of all radioactive waste currently being held in storage, whether for decay-in-storage, or ship-out.

H) Scale floor plans of buildings are maintained by Facilities Management but survey maps used by the RPO show major room components.

Other Activities

In addition to a records review, a visit to a representative sampling of locations will be made to confirm the starting radiological conditions. Based upon the current level of use, Penn State's "*no contamination*" policy, and a review of past surveys showing no contamination in labs, it can be concluded that radiological conditions are already within the release criteria.

The contractor will prepare the actual decommissioning plan for regulatory review. This will define the scope of work, the radiological conditions of the site, and provide a plan for action. Upon approval by the regulator, a working plan will be developed to include a strategy for systematic decommissioning surveys along with manpower and equipment requirements.

The following table summarizes the work days associated with these activities. The estimates are from Ecology Services, Inc. and Chase Environmental, Inc. and are the worst case values for a particular activity. Other than the characterization activity in Table 9, all others are independent of the number of laboratories. In addition, the final work days for this step are divided by the number of labs currently in use to obtain the work days per lab, which is the basis for all following tables.

Table 9 – Planning and Preparation Work Days					
Activity	Health Physicist	HP Technician	Clerical	Laborer	Job Supervisor
Prepare documentation for regulatory agencies	2	1	5		5

Submittal of decommissioning plan	2	5	3		2
Development of work plans	2	5	3		1
Procurement of equipment and supplies	1		1		4
Staff training	1	2	1	2	1
Characterization of radiological conditions	0.2	3	1		1
Other (mobilization)	1	1	1	1	1
Total Days	9.2	17	15	3	15
Total Days per Lab	1.8	3.4	3	0.6	3

Section A.3.7 Decontamination or Dismantling of Components (Work Days)

Based upon the continuous survey and decontamination efforts conducted during the normal radiation safety surveillance program, there are few components which might need to be addressed in this category.

Fume hoods - A very small number, less than three (3), of chemical fume hoods are used with SNM radioactive materials. For these hoods, removal of interior air baffles will be done to reveal hidden surface areas and the connection to the exhaust duct. These areas will be checked for contamination.

Sinks – Although liquids are collected by the RPO, within a posted laboratory one sink per lab is assumed to possibly be contaminated from accidental spillage in the sink or for personal decontamination. To insure contamination has not lodged in the drain system, the sink traps will be disconnected to survey interior of drain piping.

Type of Space: Reference SNM radioactive material laboratory at Penn State University Park.


Average Size: 600 ft² (20 ft wide by 30 ft long by 10 ft high)

Level of Contamination: < 100 dpm/100 cm²

Table 10 – Decontamination or Dismantling of Components Work Days per Lab

Component	Decon Method	Health Physicist	HP Technician	Clerical	Laborer	Job Supervisor
Fume Hood	Wipe Down		1		1	
Lab Rad Benches	Wipe Down		0.5		0.5	
Sinks / Drains	Wipe Down		0.5		0.5	
Shelving	Wipe Down		0.1		0.1	

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Floors (net exposed ft ²)	Wipe Down		0.5		0.5	
Walls	Wipe down		1		1	
Ceiling Tiles	Test and Dispose		1		1	
Bulk Equipment:						
	Wipe Down		0.1		0.1	
Waste Containers	Wipe Down		0.1		0.1	
Benchtop Shielding (Plastic)	Wipe Down		0.1		0.1	
Hand Items (Misc labware)	Wipe Down		0.5		0.5	
Other (Supervision, analysis, record keeping, etc.)		1		1		1
Total Days		1	5.4	1	5.4	1

Section A.3.8 Restoration of Contaminated Areas (Work Days)

There are no known areas external to buildings where contamination has occurred for this DFP.

Section A.3.9 Final Radiation Survey (Work Days)

HP Technician activities during the final survey include removal of SNM materials and waste in laboratory, preparing survey documents, taking wipes and performing a meter survey, analyzing wipes, recording wipe and survey results, returning to lab to decontaminate, if needed, and removing radiation labels. HP activities include review of survey results, inspection of laboratory, and signing off on report. Clerical activities include preparation of documents for submission to regulatory authority.

Table 11 – Final Radiation Surveys Work Days per Lab

Task	Health Physicist	HP Technician	Clerical	Laborer	Job Supervisor
Final Characterization Surveys	0.1	1	0.1		0.1
Final Report	0.5	0.5	0.1		0.1
Total Days	0.6	1.5	0.2		0.2

Section A.3.10 Site Stabilization Long Term Surveillance (Work Days)

There are no known areas requiring stabilization or long term surveillance for this DFP.

Section A.3.11 Total Work Days By Labor Category

Table 12 – Total Work Days By Labor Category per Lab					
Task	Health Physicist	HP Technician	Clerical	Laborer	Job Supervisor
Planning and Prep (Table 9)	1.8	3.4	3	0.6	3
Decontamination (Table 10)	1	5.4	1	5.4	1
Restoration of Contam Areas	0	0	0	0	0
Final Rad Survey (Table 11)	0.6	1.5	0.2	0	0.2
Site Stabilization	0	0	0	0	0
Total Days	3.4	10.3	4.2	6	4.2

Section A.3.12 Worker Unit Cost Schedule

Salary data for Certified Health Physicists was obtained from the article “The 2015 CHP Salary Survey” published in the Health Physics Newsletter; Volume 25, Number 2, December 2015. (Latest data accessed on September 6, 2016): https://hps.org/documents/2015_chp_salary_survey.pdf

- Median CHP salary for the Northeast = \$128,750

Salary and labor rate data for Pennsylvania May 2015 (latest data accessed on Sept 6, 2016) was obtained from: http://www.bls.gov/oes/current/oes_pa.htm#19-0000

- Life, Physical Social Science – nuclear technician (code 19-4051) = \$77,660
- Office admin support – info and records clerk (code 43-4199) = \$40,820
- Construction laborer (code 47-2061) = \$37,740
- Management – construction manager (code 11-9021) = \$115,520

Table 13 – Worker Unit Cost Schedule					
Labor Cost Component	Health Physicist	HP Technician	Clerical	Laborer	Job Supervisor
Salary (\$/yr)	\$128,750	\$77,660	\$40,820	\$37,740	\$115,520
Fringe Benefits (%)	22%	22%	22%	22%	22%
Overhead & Profit Rate (%)	30%	30%	30%	30%	30%
Total cost per Year (\$)	\$195,700	\$118,043	\$62,046	\$57,365	\$175,590
Travel and Per-Diem per Day	\$210	\$210	\$210	\$210	\$210
Total Cost per Work Day *	\$963	\$664	\$449	\$431	\$885
* Based on 260 work days per year					

Section A.3.13 Total labor Costs by Major Decommissioning Task

Table 14 – Total Labor Costs per Lab						
Task	Health Physicist	HP Tech	Clerical	Laborer	Job Supervisor	Total
Planning and Prep	\$1,733	\$2,258	\$1,347	\$259	\$2,655	\$8,252
Decontamination	\$963	\$3,586	\$449	\$2,327	\$885	\$8,210
Restoration of Contam Areas	0	0	0	0	0	0
Final Rad Survey	\$578	\$996	\$90	0	\$177	\$1,841
Site Stabilization	0	0	0	0	0	0
Total Cost	\$3,274	\$6,840	\$1,886	\$2,586	\$3,717	\$18,303

To obtain the complete costs, the number of labs (5) is then multiplied by the per lab costs from above.

Table 15 – Total Labor Costs ALL Labs						
Task	Health Physicist	HP Tech	Clerical	Laborer	Job Supervisor	Total
Planning and Prep	\$8,665	\$11,290	\$6,735	\$1,295	\$13,275	\$41,260
Decontamination	\$4,815	\$17,930	\$2,245	\$11,635	\$4,225	\$41,050
Restoration of Contam Areas	0	0	0	0	0	0
Final Rad Survey	\$2,890	\$4,980	\$450	0	\$885	\$9,205
Site Stabilization	0	0	0	0	0	0
Total Cost	\$16,370	\$34,200	\$9,430	\$12,930	\$18,585	\$91,515

Section A.3.14 Packing, Shipping, and Disposal of Wastes

Note: Labor costs for waste processing is included in this section and not in the above analysis.

Packaging Material Costs

Because of our “no contamination” policy, there would be a minimal amount of waste generated from decommissioning. There are no areas in which protective clothing, other than gloves, need to be worn. Penn State owns enough dry and liquid waste containers to handle all waste on-hand and residual liquid and dry collection beyond the normal waste generation volume. The only waste stream anticipated will be dry waste consisting of wipe down towels, gloves, and miscellaneous paper and/or solid items. Note that no labor costs are associated with packing materials needed. Using the Reference Laboratory, the following packing materials will be needed:

Table 16 – Packing Material Costs per Lab					
Waste Type	Volume	Number of Containers	Type of Container	Container Unit Cost	Total Packaging Costs
DAW	15.6 ft ³	1	Fiber Box	\$35	\$35

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Liquid	1 gal	1	Plastic ¹	\$2.50	\$2.50
Total					\$37.50

1 - <https://www.uline.com/Product/Detail/S-10748/Jugs/F-Style-Jugs-1-Gallon-White>

For the total number of labs, the per lab packing material costs are multiplied by 5

Table 17 – Packing Material Costs ALL Labs					
Waste Type	Volume	Number of Containers	Type of Container	Container Unit Cost	Total Packaging Costs
Dry	15.6 ft ³	5	Fiber Box	\$35	\$175
Liquid	1 gal	5	Plastic	\$2.50	\$12.50
Liquid Overpack	30 gal	1	Plastic Drum ¹	\$64	\$64
Drum	55 gal	10	Metal Drum ²	\$99	\$990
Total					\$1,242

1 – https://www.uline.com/BL_8154/Plastic-Drums

2 – https://www.uline.com/BL_8156/Steel-Drums

Shipping Costs

Once a laboratory has been decommissioned, there is labor cost associated with the collection of the waste containers from the lab, documenting the shipment, and packing the truck. These costs are addressed below. Note that since all lab wastes will be shipped at one time, the costs shown are for ALL labs.

To calculate the number of standard 40 foot semi-truck loads needed, the volume of a 40 foot trailer (<http://www.yrc.com/shippers/semi-trailer-dimensions.html>) is 3083 ft³. The total volume to be shipped is:

Table 18 – Shipping Volume of Wastes ALL Labs			
Waste Type	Unit Volume	Number of Containers	Total Volume (ft³)
Dry	15.6 ft ³ (Box)	5	780
Liquids	4 ft ³ (30 gal)	1	4
Metals	7.4 ft ³ (55 gal)	10	74
Total			858

Therefore only one 40 foot truck, or less, will be needed to ship all wastes. The labor costs for handling containers and packing the truck are:

Table 19 – Shipping Labor Costs ALL Labs						
Task	Health Physicist	HP Tech	Clerical	Laborer	Job Supervisor	Total
Collect Containers From Lab (Work Days per Lab)	0	0.1	0	0.1	0.1	0.3
Load Truck (Work Days per Lab)	0	0	0	0.1	0.1	0.2
Documentation (Work Days per Lab)	0.1	0.1	0.1	0	0	0.3
Subtotal Work Days per Lab	0.1	0.2	0.1	0.2	0.2	0.8
Total for 5 Labs (Work Days)	0.5	1	0.5	1	1	4
Cost / Work Day	\$963	\$664	\$449	\$431	\$885	
Total Cost	\$482	\$664	\$225	\$431	\$885	\$2,687

Shipping costs were provided by Ecology Services, Inc. Note that normally rad waste would ship to Energy Solutions in Oak Ridge, TN (705 miles to TN).

Table 20 – Shipping Costs ALL Labs							
Waste Type	Number of Truckloads	Unit Cost (\$/mile/load)	Surcharges (\$/mile)	Overweight Charges (\$/mile)	Distance Shipped (miles)	Labor Cost from Table 19	Total Shipping Costs
All	1	\$3.90	\$0.50	\$0	705		\$3,102
Labor						\$2,687	\$2,687
Truck Rental	1						\$2,500
Total							\$8,289

Waste Disposal Costs

For the Reference Lab, one dry box and one gallon of liquid per lab is assumed to be generated. Historically, the cost per pound is more consistent year to year so this DFP will estimate disposal cost by weight rather than volume. The following assumptions apply to this estimate:

- Each box of Dry Active Waste is assumed to weigh 100 pounds, 5 boxes generated
- Each 30 gallon drum of liquid waste is assumed to weigh 175 pounds, 1 drum generated
- Each 55 gallon drum of metals is assumed to weigh 175 pounds, 1 drum generated

Table 21 – Waste Disposal Costs ALL Labs				
Waste Type	Total Weight ALL Labs (lb)	Unit Cost (\$/lb)	Surcharges (\$/lb)	Total Disposal Cost
Dry	500	\$7.50	\$0	\$3,750
Liquids	175	\$7.35	\$0	\$1,287

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Metals	175	\$7.35	\$0	\$1,287
Total				\$6,324

Sealed Sources

For the discrete sources, some are owned by the Department of Energy and it is expected that the DOE will accept these sources back. However, for this DFP disposal costs are included to be conservative.

Table 22 – Discrete Source Disposal				
Discrete Sources	Description	Number of Sources	Contractor Hours ¹	2016 External Vendor Total Charge ¹
[REDACTED]	[REDACTED]	1	0	\$0
[REDACTED]	[REDACTED]	1	40	\$7,000
[REDACTED]	[REDACTED]	1	40	\$21,000
		Total Hours	80	
		Total Contractor Charges (\$225/hr)	\$18,000	
		Total Other Vendor Charges		\$28,000
Total				\$46,000

1 – Cost estimate from Ecology Services, Inc. (November 2016)

Section A.3.15 Equipment and Supply Costs

Smears and related supplies (gloves, vials, and scintillation fluid) are based on MARSSIM criteria for

final surveys. Estimating an average of 20 smears per lab, and 5 labs to be surveyed, indicates a need for approximately 100 smears, to be analyzed via liquid scintillation counting. Purchase costs for anticipated packaging supplies are noted in Table 17.

Instrumentation needs would include pancake GM survey meters, low energy sodium iodide detectors, and an alpha probe survey meter.

Table 23 – Equipment and Supply Costs			
Equip / Supplies	Quantity	Unit Cost	Total
Survey Meters (GM)	2	\$1,062	\$2,124
Survey Meter (LE NaI)	1	\$1,392	\$1,392
Survey Meter (Alpha)	1	\$1,751	\$1,751
Smears	1 boxes @ 100/box	\$1	\$1
Gloves	1 boxes @ 150 gloves/box	\$7	\$7
Scintillation vials	1 case @ 500/case	\$108	\$108
Scintillation cocktail	1 case	\$121	\$121
Total			\$5,504

Section A.3.16 Laboratory Costs

It is not anticipated that any analyses will need to be performed by an independent third party laboratory; however, to be conservative, this DFP includes outside laboratory services to analyze laboratory smear surveys for these 5 labs being decommissioned.

Third-party laboratory estimates that smear analysis cost is \$5/sample. Each laboratory would need 20 smear samples per lab, for a unit cost of \$100 per lab. With 5 active labs being decommissioned, the Laboratory Cost estimate can be determined.

Table 24 – Laboratory Cost			
Equip / Supplies	Quantity	Unit Cost	Total
Sample Analysis (LSC)	5 labs	\$100 per lab	\$500
Total			\$500

Section A.3.17 Miscellaneous Costs

Present methods of waste disposal are through a waste broker and no special licenses or site permits are necessary. Contractors provide proof of insurance before being awarded contracts. The work associated with decommissioning is not taxable by Pennsylvania.

The Nuclear regulatory Commission may bill for regulatory oversight efforts to include final status survey reports, confirmatory survey efforts, department lab, or contractor fees and oversight of license

termination activities. An estimate of these costs is included in the following table.

Table 25 – Miscellaneous Costs	
Cost Item	Total
License fees, insurance, taxes, other	\$0
NRC oversight	\$50,000
Total	\$50,000

Section A.3.18 Total Decommissioning Costs

This estimate does not take credit for any salvage value that might be realized from the sale of potential assets.

Table 26 – Total Decommissioning Costs		
Task/Component	Cost	Percentage
Planning and Preparation (Table 15)	\$41,260	19.7 %
Decontamination/Dismantling (Table 15)	\$41,050	19.6 %
Restoration (Table 15)	\$0	0 %
Final Rad Survey (Table 15)	\$9,205	4.4 %
Site Stabilization (Table 15)	\$0	0 %
Packing Material Costs (Table 17)	\$1,242	0.6 %
Shipping Costs (Labor and Transport) (Table 20)	\$8,289	4.0 %
Waste Disposal Costs (Table 21)	\$6,324	3.0 %
Discrete Source Disposal (Table 22)	\$46,000	22.0 %
Equipment Costs (Table 23)	\$5,504	2.6 %
Laboratory Costs (Table 24)	\$500	0.2 %
Miscellaneous Costs (Table 25)	\$50,000	23.9 %
Subtotal	\$209,374	100 %
25% Contingency	\$52,344	
Total Decommissioning Cost Estimate	\$261,718	