PENN STATE UNIVERSITY
DECOMMISSIONING FUNDING PLAN
for
RADIATION RESEARCH FACILITIES

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INTRODUCTION

In 1988 the Nuclear Regulatory Commission (NRC) adopted regulations requiring that licensees provide assurance that funds will be available to decommission facilities when the licenses are terminated. For facilities with existing licenses the effective date for compliance was 27 July 1990. The amount of the funds that must be set aside is determined by the amount and type of radioactive material allowed by the license. There are 4 basic categories, as determined by formulas published in the regulations. The amount to be set aside in these categories is $0, $75,000, $150,000, or $750,000. If the license exceeds the $750,000 category, the licensee is required to submit a Decommissioning Funding Plan (DFP) to estimate the actual decommissioning costs and set aside that amount. The option to submit a DFP is also available for licenses in any of the other categories. The amounts to be set aside are separate and additive for each license. However, if a DFP, is prepared it can include all the licenses in one plan.

Penn State University has five NRC licenses at University Park plus two licenses at the Hershey Medical Center. At least two of these licenses require a DFP. Thus, it is more cost effective to include all the licenses under one plan, and the estimate should be more accurate than using the formula quantities from the regulations.

There are a variety of ways to provide assurance that funds for decommissioning will be available. These include the following.

> Prepaid deposits such as a trust fund, escrow account, certificate of deposit, government fund, or deposit of government securities.
>
> A surety method such as a surety bond (open ended or with automatic renewal), letter of credit, or line of credit. A parent company guarantee-in the case of Penn State University, the State of Pennsylvania could provide the guarantee.
>
> An external sinking fund coupled with a surety method, with the surety decreasing as the sinking fund increases.

The University has prepared estimates of the decommissioning costs associated with the NRC licenses issued for University Park and the Hershey Medical Center and has provided the assurance of the funds with a standby trust agreement and a letter of credit. Documentation for this was submitted to the NRC on 27 Mar 91. The estimated cost of decommissioning has increased with this revision of the plan, and the amount of the trust agreement and letter of credit will be revised on acceptance of the revised plan by the NRC.

Since the original plan was prepared in 1990, there have been a number of changes related to radioactive waste disposal facilities. Disposal sites in Nevada and Washington are closed or are no longer available to Pennsylvania licensees. The facility at Barnwell, SC was closed for a period of time, but it is currently available on a year-to-year basis to licensees outside the Southeast Compact. Some additional options for commercial incineration and super compaction are now available. The change with the most effect on the decommissioning cost estimate is the greatly increased unit cost for disposal. Increased labor costs and new requirements for stabilization or the use of high integrity containers (HICs) for waste with a high concentration of radioactive material have also increased the disposal cost. These changes have been incorporated into this revision of the plan to give an estimate for the cost of decommissioning as of October 1996.

DETERMINATION OF DECOMMISSIONING COSTS

Several assumptions are made to determine the cost of decommissioning the facilities under each license. One is that all activities are terminated at the same time. This is very unlikely, but results in the maximum cost estimate. It is much more probable that activities would be gradually terminated over a period of at least several years. Decommissioning would occur while the staff is also performing normal activities, and the costs would be largely supported by the normal operating budget. The second assumption is that the health physics staff at University Park and the Hershey Medical Center would continue at present strength and would be responsible for the decommissioning of the facilities under the material licenses. The staff of the reactor facility would be responsible for decommissioning the reactor and associated equipment with support from the health physics staff for surveys, assays, monitoring and waste disposal. Work requiring heavy equipment or tradesmen would be done by the University Physical Plant. This is the way that such work is currently done. Cost estimates can then be made by estimating the time required for a given task by the staff involved and using the annual operating budget as the basis for the cost. It is, therefore, not necessary to list separately each individual involved and the fraction of time spent on each task.

Decommissioning is treated in the same manner as routine operations under the various licenses. It is quite common to cease radioisotope operations in campus laboratories and return the lab to service, without restrictions, for some other use. Because radioisotope laboratories are kept at contamination levels that allow unrestricted access, there is usually very little decontamination required. In the past 30 years there have only been a few instances when material such as bench tops, floor tile, or hood ducting has had to be removed. It is expected that some portions of the reactor pool and the waste processing areas will require removal of concrete or piping, and the estimates include such work.

Facilities that have been decommissioned are to be released for unrestricted use. Residual contamination, if any is present, is not to exceed the limits specified in Table I of Regulatory Guide 1.86. Costs for remodeling and renovation are not included. Costs are based on the current inventory of material and the number of facilities under each license. Except for disposal

of the reactor core, no license amendments are required for decommissioning, as the activities are the same as for normal operation. It is assumed that a licensed disposal site will be available for disposal of all material except reactor fuel and transuranics. The decommissioning costs are estimated for each license in separate appendices to this plan.

The cost to continue the services of the health physics and reactor staffs is calculated by estimating the time required to perform each task in terms of total person-hours. No distinction is made as to the job titles or salaries involved. The number of person-hours is multiplied by the average cost per person-hour for the operation of the Health Physics Office. The average cost per person-hour is arrived at by taking the annual budget for salaries (including a 25% overhead for fringe benefits) plus the annual budget for supplies and materials (not including waste disposal) and dividing by the number of person-hours worked per year. The same value is used for tradespersons contracted from the University Physical Plant and for the reactor staff.

The waste disposal cost estimates are based on price lists and quotations from brokers through October 1996. The charge for solid waste disposal is based on the average weight per drum of waste in past shipments and assumes that 1% is biological material, 25% will be processed by supercompaction and 74% will be incinerated by the broker.
The unit costs used for standard items are listed below.

TABLE 1
UNIT COSTS FOR DECOMMISSIONING AND DISPOSAL

Solid waste	$375/ft^3
Waste disposed in high integrity containers	$950/ft^3
Liquid Scintillation Vials, deregulated	$51/ft^3
Liquid Scintillation Vials, regulated	$73/ft^3
Organic liquids	$73/ft^3
Hourly charge for health physics personnel and tradespersons	$24/hr

In order to account for significant changes in decommissioning costs because of inflation, changes in the amount or type of radioactive material, or contamination of facilities, the appendix dealing with a specific license is to be reviewed when the license is amended or renewed. The complete plan is to be reviewed at least once every 3 years. The financial assurance is to be increased if the review indicates an increase in the estimated cost of greater than 20%. An application to reduce the financial assurance can also be made, if a review indicates that the estimated cost has decreased.

SUMMARY

The estimated costs of decommissioning for each license are given in the appendices to this plan. The summary of all costs is given in Table 2.

TABLE 2
TOTAL DECOMMISSIONING COSTS

LICENSE		ESTIMATED COST
37-185-04	Appendix A	$477,000
37-185-05	Appendix B	$71,400
37-185-06	Appendix C	$61,000
SNM-95	Appendix D	$12,000
R-2	Appendix E	$224,800
37-13831-01	Appendix F	$418,800
37-13831-04	Appendix G	$54,700
TOTAL		**$1,319,700**

The total decommissioning cost in this revision represents an increase of 53% over the $862,000 value from the plan prepared in July 1990. Most the increase is because of increased costs for waste disposal.

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APPENDIX A
LICENSE 37-185-04

LICENSE DESCRIPTION

This license is the broad byproduct material license for the University Park campus. The number of individual rooms covered by this license is about 250, including the radioisotope laboratories at the nuclear reactor facility and 1 laboratory at a Commonwealth Campus. A number of sealed sources are also covered by this license, and it allows the use of up to 200 Ci of irradiated components in the hot cells. Each item is covered separately below

RADIOISOTOPE LABORATORIES

In order to simplify the estimate for decommissioning the radioisotope laboratories, a Reference Radioisotope Laboratory (RRL) is described. This laboratory is a single room, and the decommissioning estimate is based on past experience with such laboratories. The estimate may be slightly low for a few laboratories that are very heavily used, but this is more than offset by the large number of rooms that contain only a liquid scintillation counter, a gas chromatography source, or microcurie quantities of radioisotopes. It is a routine matter for new radioisotope laboratories to be opened and former radioisotope laboratories to be decommissioned and returned to unrestricted use. When a laboratory is decommissioned, all radioactive material is removed, the room is surveyed for fixed and removable contamination, and all radiation and radioactive material labels and signs are removed. Any contaminated items are removed, with the exception of minor fixed contamination of floors and benchtops with short half-life isotopes, such as ^{32}P. Hood ductwork and sink drains are not usually disassembled for checking, but are left labeled until the next time maintenance is required that involves access to these items.

For this plan it is assumed that the inside of the hood ductwork will be checked at the hood and exhaust ends. Likewise, sink drains will be checked with a sample from the sink trap. Contaminated plumbing or ductwork will be removed. The Health Physics Office routinely checks sink drains and exhaust hoods in radioisotope laboratories, when maintenance personnel are required to work on them. It is very rare that any contamination is found. In the past 30 years probably less than 5 laboratories have required the removal and disposal of sinks or fume hood components because of radioactive contamination. For the RRL it is assumed that one laboratory in 50 will require the removal and disposal of a sink basin and trap and the interior of a hood plus the ductwork and fan.

Small sealed sources, such as gas chromatography sources and calibration sources, from all labs will be packaged in one high integrity container for disposal. This container will also be used for small volumes of waste containing ^{3}H, ^{14}C, and other radioisotopes at a concentration that exceeds the limits for unstable waste forms. The average waste volume requiring a high integrity container for disposal is 7.5 ft^3/250 labs or 0.03 ft^3/RRL. The time for packaging the high integrity container is included in the time estimate for the RRL in Table A-1.

TABLE A-1
REFERENCE RADIOISOTOPE LABORATORY
HEALTH PHYSICS STAFF TIME ESTIMATE
FOR DECONTAMINATION AND SURVEYS

ITEM	PERSON-HOURS
Retrieve laboratory records	1
Physical radioisotope inventory	2
Prepare and package inventory for disposal	4
Initial survey and decontamination	4
Final survey	4
Records and filing	2
Travel time (2 persons, 2 trips)	2
Removal of plumbing and ductwork (Table A-2)	1.1
Supervision	2
TOTAL	22

TABLE A-2
REFERENCE RADIOISOTOPE LABORATORY
TIME ESTIMATE FOR
PLUMBING AND DUCTWORK REMOVAL
(Required for 1 lab in 50)

ITEM	PERSON-HOURS
Remove sink and drain (tradesperson)	4
Remove hood interior (tradesperson)	4
Remove hood ductwork and fan (tradesperson)	32
Final survey	4
Travel time (2 persons, 4 trips)	8
Records and filing	2
Supervision	2
TOTAL FOR 50 LABS	56
AVERAGE PER RRL (56 PERSON-HOURS/50 LABS)	1.1

The amount of radioactive waste that will require disposal includes the waste already in the laboratory, that generated during decontamination, and the plumbing and ductwork for the sink and hood removed from 1 in 50 labs. It is assumed that the amount of solid waste collected during the decommissioning is equal to that normally collected from the laboratories during a one year period. This value is about 1000 ft^3/250 labs or 4 ft^3/RRL. It is assumed that 50% of the solid waste contains ^{32}P and that this waste is allowed to decay for 10 half-lives before disposal as nonradioactive material. The remainder is compacted and shipped offsite for disposal. This is an overestimate of the volume that would have to be shipped offsite, because decommissioning will probably occur over a time period long enough to allow for decay in storage of ^{125}I, ^{35}S, ^{51}Cr

and other radioactive isotopes. An additional 0.4 ft^3 of solid waste is from hood ductwork and plumbing removal (20 ft^3 for 1 lab in 50).

The amount of liquid waste for disposal on decommissioning is also assumed to be about the same as that normally collected from the labs in a one year period. As with the solid waste, 50% is assumed to contain ^{32}P, which is held for decay. Our experience is that almost all aqueous liquid waste can be released to the sanitary sewer in conformance with 20 CFR 20.2003. This amounts to about 1500 gallons/250 labs in one year or 0.8 ft^3/RRL. The amount of organic liquid waste collected in one year is about 100 gallons/250 labs (0.05 ft^3/RRL). Of this amount, 50% is assumed to contain ^{32}P, which is held for decay and then disposed as nonradioactive waste (as hazardous material, if necessary). The remaining organic liquid waste is shipped offsite for incineration.

Liquid scintillation fluid is assumed to be collected and shipped for disposal in the vials (3000 vials/55-gallon drum) as deregulated material. Table A-3 lists the summary of the amount of waste disposed per RRL.

TABLE A-3
REFERENCE RADIOISOTOPE LABORATORY
RADIOACTIVE WASTE FOR DISPOSAL

ITEM	FT^3
FOR SHIPMENT OFFSITE	
Solid, 2 ft^3, compact 3:1	0.67
Solid, sink and hood	0.40
Liquid, organic	0.025
High integrity container waste	0.03
Total for offsite shipment	1.1
FOR DECAY AND ONSITE DISPOSAL	
Solid, 2 ft^3	2.0
Liquid, aqueous	0.8
Liquid, organic	0.025
Total for onsite disposal	2.8
LIQUID SCINTILLATION FLUID	
500 vials	1.2

HOT CELL FACILITY

To date, the 2 hot cells at the reactor facility have only been used for sealed sources or irradiated components and no decontamination would be required to return the facilities to unrestricted use. Over the next few years some testing of irradiated components is planned that will generate some waste and might produce minor contamination of the cells and the ventilation system. The estimate assumes that the roughing and absolute filters will require disposal and that the cell and ductwork will require cleaning. Some waste may require disposal in high integrity containers, but all items should be within the limits for Type A shipping containers. The estimated time and waste volume for decommissioning the hot cells is given in Table A-4.

TABLE A-4
HOT CELL FACILITY

ITEM	PERSON-HOURS	WASTE FT^3
Initial survey	16	
Filter removal and packaging	8	15
Package specimens and other waste	240	30
Waste requiring HIC		7
Decontamination	100	
Sample identification and assay	30	
Records and filing	8	
Supervision	40	
Total	442	52

SEALED SOURCES

Small sealed sources are included in the time and waste estimates for the RRL. The sealed sources that require special attention are a ^{244}Cm source and several ^{241}Am sources. A 3 Ci ^{241}Am source is stored in a neutron howitzer that is also a 7A shipping container and would require no additional packaging. The other ^{241}Am sources are mostly in moisture gauges, and the sources would be removed and shipped for disposal in a shielded 7A container or in the 7A package for the gauge. This assumes that a disposal site will be available for transuranics, which is presently not the case. Those sources that the manufacturer will accept will be returned for disposal. Otherwise, the sources will be packaged and stored until a disposal site is available. The estimated time and waste volume are given in Table A-5. No disposal cost is available for transuranics, because there is no disposal site available, so the disposal cost for high integrity containers is used for sealed sources.

TABLE A-5
SEALED SOURCES

ITEM	PERSON-HOURS	WASTE FT^3
Am-241, 3 Ci	4	3.
Am-241, other sealed sources	160	22.
^{244}Cm	10	
Records and filing	10	
Supervision	20	
TOTAL	204	25.

WASTE DISPOSAL

The waste that is to be processed and disposed includes the waste discussed above, which is collected at the time of decommissioning, plus the waste that is in storage at the termination of activities. Most of the waste that is in storage is short half-life material that is being held for decay and would be disposed as nonradioactive material. For this plan, only the ^{32}P waste is considered in this category, all other waste would be shipped offsite for disposal. Disposal costs are listed in Table 1 of the plan. Table A-6 shows the estimates for processing time and the volume of waste.

TABLE A-6
RADIOACTIVE WASTE DISPOSAL

ITEM	PROCESSING PERSON-HOURS	SHIPPED WASTE FT^3
Disposal as nonradioactive waste		
Solid, in storage, 1300 ft^3	400	
Liquid, in storage, aqueous, 80 ft^3	50	
Liquid, in storage, organic, 7.5 ft^3	20	
Solid, 2 ft^3/RRL	250	
Liquid, aqueous, 0.8 ft^3/RRL	250	
Liquid, organic, 0.025 ft^3/RRL	20	
Shipment for disposal		
Solid, in storage, 700 ft^3, compact 3:1	200	230
Liquid, in storage, organic	20	7.5
Solid, 0.67 ft^3/RRL	180	170
Solid, plumbing and duct, 0.4 ft^3/RRL	80	100
Liquid, 0.025 ft^3/RRL, organic	20	6.3
Solid, HIC, 0.03 ft^3/RRL	20	7.5
Solid, hot cell	30	52
Solid, hot cell, HIC	5	7
Sealed sources, HIC	20	25
Liquid scintillation fluid, in storage	100	100
Liquid scintillation fluid, 1.2 ft^3/RRL	300	300
Shipment preparation	400	
Records and filing	60	
Supervision	240	
TOTAL	2665	1005
Subtotals for shipped waste		
Solid		552
HIC		39
Liquid, organic		14
Liquid scintillation fluid		400

TOTAL COST

The total decommissioning cost for license 37-185-04 is summarized in Table A-7. Unit costs used in the estimates are listed in Table 1 of the plan.

TABLE A-7
COST ESTIMATE FOR LICENSE 37-185-04

ITEM	PERSON-HOURS	COST $ x1000
RRL, 250 labs @22 hr/RRL, Table A-1	5500	132.0
Hot cells, Table A-4	442	10.6
Sealed sources, Table A-5	204	4.9
Waste disposal, Table A-6	2665	64.0
Subtotal person-hours	8811	$211.5
	FT^3	
Solid waste	552	$207.0
Solid, HIC	39	$37.1
Liquid, organic	14	$1.0
Liquid scintillation fluid	400	$20.4
Subtotal waste shipped	1005	$265.5
	TOTAL	**$477.0**

APPENDIX B
LICENSE 37-185-05

LICENSE DESCRIPTION

This license covers the Co-60 facility. It consists of a pool-type irradiation facility with rod sources with a current total activity of 2900 Ci. Lead-shielded steel casks are available for emergency storage of the sources, if the pool must be drained. The sources would probably be shipped for disposal in one or more of these containers inside an overpack. It would probably require 2 shipments at an estimated cost of $26,000/shipment.

Other than the removal of the sources, very little decontamination is anticipated. The pool water contamination levels (<5 pCi/l) are well below the release levels for ^{60}Co in water in 10CFR20 Appendix B, Table 3. Disposal of the resin in the demineralizer is included, even though the activity is insignificant. No disposal is planned for the pool liner or any plumbing. Table B-1 gives the summary of the decommissioning costs.

TABLE B-1
COBALT-60 FACILITY

ITEM		PERSON-HOURS	WASTE FT^3
Initial surveys and assays		24	
Resin packaging		40	22
Load and ship sources		120	
Drain and clean pool		24	
Final survey		30	
Records and filing		20	
Supervision		40	
	Total	298	22

	COST
Person-hours	$7,152
Waste disposal	$8,250
Source disposal, 2 trips	$56,000
Total	**$71,402**

APPENDIX C
LICENSE 37-185-06

LICENSE DESCRIPTION

This license covers 2 Co-60 irradiators and 1 Cs-137 instrument calibration facility, as listed below.

	PRESENT ACTIVITY Ci
AECL Gammacell Model 200, ^{60}Co	570
AECL Gammacell Model 220, ^{60}Co	5200
J. L. Shepherd Model 78, ^{137}Cs	48

The irradiators would be disposed of by return to the manufacturer or by shipment of the irradiator shield and source unit to another licensee or to a disposal site. The cost estimate is based on the transfer of a Gammacell 220 and a Gammacell 100 irradiator to another licensee a few years ago, with an increase for inflation. The ^{137}Cs irradiator is small enough to be shipped in a 55-gallon drum overpack. The time estimates include the time to arrange the shipments, prepare the shields, and package the irradiators in the overpacks. Preparation of the shields requires removing the sheet metal shrouds and electrical controls and securing the sample drawer in place. Table C-1 gives the costs for disposal of these sources. No decontamination is necessary.

TABLE C-1
GAMMA IRRADIATORS

ITEM	PERSON-HOURS	DISPOSAL COST
Gammacell 200		
Packaging and disposal	80	$25,000
Gammacell 220		
Packaging and disposal	80	$25,000
Cs-137 irradiator		
Packaging and disposal	40	$ 5,000
Surveys	10	
Records and filing	10	
Supervision	30	
TOTAL	250	$55,000
	$6,000	

TOTAL COST $61,000

APPENDIX D
LICENSE SNM-95

LICENSE DESCRIPTION

This license covers all the special nuclear material not included in the reactor license R-2. Among the major items are 417 unused fuel elements from the Pathfinder power reactor. These are the property of the U.S. Department of Energy and will be returned to DOE as soon as DOE can arrange for the loan of certified shipping containers for the transfer. DOE will provide the containers and pay shipping charges. This license also includes 2500 kg of natural uranium in canned slugs for a subcritical reactor. This material would also be returned to DOE with the only charges for arranging shipping and packaging the material. No decontamination is required.

This license includes six 1 Ci and one 5 Ci ^{239}Pu-Be neutron sources. These would also be returned to DOE. The University has a shipping container that could be used for the transfer of the 5 Ci source and the time estimate includes time to make a second, should that be required.

The other items on the license are various fission counters plus unsealed material containing about 0.182 mCi of ^{235}U, 19 mCi of ^{233}U, and several μCi of ^{239}Pu as alpha sources. This material would be disposed at a licensed disposal site or returned to DOE, depending on ownership. Although all the material would easily fit inside one 55-gallon drum, multiple containers will probably be required to meet transportation requirements. Only minimal decontamination of storage containers for the unsealed material will be required.

The estimated cost for transfer to the DOE is given in Table D-1. No estimate is made for disposal cost, because no disposal site is available for this material.

TABLE D-1
SPECIAL NUCLEAR MATERIAL LICENSE

ITEM	PERSON-HOURS
Pathfinder fuel packaging	120
Natural uranium, 2500 kg, packaging	80
Pu-239-Be neutron sources, packaging	100
Other ^{233}U, ^{235}U, ^{239}Pu, packaging	20
Surveys	40
Shipping	80
Records and filing	20
Supervision	40
Total	500

Total cost $12,000

APPENDIX E
LICENSE R-2

LICENSE DESCRIPTION

This license covers the Penn State Breazeale Reactor. Included in this section of the DFP are the reactor bay, the demineralizer room and the liquid waste evaporator. The decontamination option is used for the reactor facility, as opposed to entombment. It is assumed that any license amendments required for decommissioning have been obtained before decommissioning begins. The decommissioning costs for radioisotope laboratories in the reactor facility are included in Appendix A.

REACTOR BAY

The first step in decommissioning will be to remove all fuel and return it to the DOE. The cask for this and the transportation will be paid for by the DOE. It is assumed that the University will be responsible for costs involved in loading the fuel, such as crane rental, surveys, and personnel costs for arranging the transfer. The water in the pool can be released to the sanitary sewer as the concentration of radionuclides is normally less than 1% of the limits in 10CFR20 Appendix B for such release, after a decay time of 1 week. With the additional decay time and continued operation of the demineralizer system until the fuel is removed, concentrations would be even lower.

During this period experimental apparatus with contamination or activation could be removed and packaged for disposal. Items without contamination or activation could be surveyed and released. After the fuel is removed from the reactor core and stored in the fuel storage racks, the south side of the pool can be drained, and cleaning of the pool and disassembly of the reactor bridge started. The lower part of the tower will have to be packaged in drums with concrete shielding. The grid plate will probably have to be cut into two or more pieces to fit the shipping containers. This will require portable shielding and remote tools to reduce personnel exposure. Additional items that will require cutting for disposal are the lead shield on the pool floor below the reactor core and the D_2O tank.

Because the low concentration of contaminates in the pool water, decontamination should not be difficult. Activation of the concrete directly below the normal operating position of the reactor core and around the central beam tube may make removal of some concrete necessary. The cost estimate includes removal of 100 ft^3 of concrete. Only the central beam port has been used in recent years, and removal of the other ports should not be necessary. Table E-1 lists the estimates for the tasks in the reactor bay.

TABLE E-1
REACTOR BAY

ITEM	PERSON-HOURS	EQUIPMENT	WASTE FT^3
FUEL SHIPMENTS (5)			
Cask arrangements & QA	400		
Cask transfers to pool	400	$10,000	
Cask loading	200		
Surveys and assays	200		
Records and filing	40		
Supervision	200		
SUBTOTAL	1440	$10,000	
CONCRETE REMOVAL			
Tradespersons	400	$5,000	120
Surveys and assays	100		
Cleaning	100	$1,000	15
Records and filing	20		
Supervision	100		
SUBTOTAL	720	$6,000	135
D_2O TANK			
Package D_2O	20		
Shipping & QA	100		
Assays	20		
Records and filing	20		
Supervision	20		
SUBTOTAL	180		
COMPONENT REMOVAL			
Packaging	100		22
Surveys and assays	100		
Records and filing	20		
Supervision	20		
SUBTOTAL	240		22
OTHER BUILDING SURVEYS AND DECONTAMINATION			
Surveys and assays	200		
Cleaning	100		
SUBTOTAL	300		
REACTOR BAY TOTALS	2880	$16000	157

DEMINERALIZER ROOM

This room contains the water handling system for the reactor, including the demineralizer, filter, heat exchanger and associated pumps. The demineralizer resin and the filter will require disposal. It may be possible to decontaminate the filter holder and demineralizer tank, but the cost estimate assumes that these items will be cut up and packaged for disposal. The heat exchanger and other plumbing should require only minimal cleaning for unrestricted release. Table E-2 lists the items in the cost estimate.

TABLE E-2
DEMINERALIZER ROOM

ITEM	PERSON-HOURS	WASTE FT^3
Initial surveys and assays	40	
Package resins	100	22
Package filter	20	7
Package demineralizer	100	22
Final surveys	30	
Records and filing	10	
Supervision	20	
DEMINERALIZER ROOM TOTALS	320	51

WASTE WATER EVAPORATOR

This facility consists of a steel shed housing an evaporator, a stainless steel lined holdup tank, and a small tank used for the final evaporation of concentrate from the evaporator. A 1000 gallon underground suspect tank is located beside the shed. These tanks have contained relatively low concentration waste water in recent years and they might meet release criteria without decontamination. However, the estimate includes disposal of the tanks and the evaporator as radioactive waste. A 6000 gallon fiberglass distillate tank is also buried near the shed. This tank is used to store the distillate from the evaporator for use as reactor makeup water. It has not been exposed to contaminated water and decontamination should not be necessary. There may be minor contamination in the underground piping for the waste tanks. The piping will be checked for contamination at the accessible ends and, where possible, with small radiation detectors inside the piping. Table E-3 gives the estimates for the waste water evaporator.

TABLE E-3
WASTE WATER EVAPORATOR

ITEM	PERSON-HOURS	EQUIPMENT	WASTE FT^3
Initial surveys and assay	50		
Package suspect tank	100	$500	22
Package holdup tank	50	$500	22
Package evaporator	100		15
Package plumbing	50		22
Package concentrate tanks	100		22
Final surveys	30		
Reports and filing	20		
Supervision	100		
TOTAL	600	$1000	103

REACTOR FACILITY TOTAL

Table E-4 lists the total decommissioning cost estimate for the reactor.

TABLE E-4
REACTOR TOTAL COST

ITEM	PERSON HOURS	EQUIPMENT	WASTE FT^3
Reactor bay	2880	$16,000	157
Demineralizer room	320		51
Waste water evaporator	600	$ 1,000	103
TOTALS	3800		311
	$91,200	$17,000	$116,625

TOTAL COST $224,825

APPENDIX F
LICENSE 37-13831-01

LICENSE DESCRIPTION

This license is the broad byproduct material license for the Hershey Medical Center at Hershey, PA. Excluding nuclear medicine, there are almost the same number of radioisotope laboratories (rooms) under this license as are under the broad byproduct material license for the University Park Campus (Appendix A). The waste disposal program and the operation of the laboratories are also very similar at both campuses. Therefore, the same estimates for decommissioning and disposal are used for the Hershey Medical Center as for the University Park Campus. The hot cell items are deleted, because there are no hot cells at the Hershey Medical Center. The data for sealed sources was also adjusted to account for the smaller number of ^{241}Am sources (one 100 mCi and one 12 mCi) at the Hershey Medical Center.

TABLE F-1
RADIOACTIVE WASTE DISPOSAL
HERSHEY MEDICAL CENTER

ITEM	PROCESSING PERSON-HOURS	SHIPPED WASTE FT^3
Disposal as nonradioactive waste		
Solid, in storage, 1300 ft^3	400	
Liquid, in storage, aqueous, 80 ft^3	50	
Liquid, in storage, organic, 7.5 ft^3	20	
Solid, 2 ft^3/RRL	250	
Liquid, aqueous, 0.8 ft^3/RRL	250	
Liquid, organic, 0.025 ft^3/RRL	20	
Shipment for disposal		
Solid, in storage, 700 ft^3, compact 3:1	200	230
Liquid, in storage, organic	20	7.5
Solid, 0.67 ft^3/RRL	180	170
Solid, sink and hood, 0.4 ft^3/RRL	80	100
Liquid, 0.025 ft^3/RRL	20	6.3
Solid, HIC, 0.03 ft^3/RRL	20	7.5
Sealed sources, HIC	20	7.5
Liquid scintillation fluid, in storage	100	100
Liquid scintillation fluid, 1.2 ft^3/RRL	300	300
Shipment preparation	400	
Records and filing	60	
Supervision	240	
TOTAL	2630	929

Subtotal for shipped waste	FT^3
Solid	500
HIC	15
Liquid, organic	14
Liquid scintillation fluid	400

TOTAL COST

The total decommissioning cost for license 37-13831-01 is summarized in Table F-2. Unit costs used in the estimates are listed in Table 1 of the plan.

TABLE F-2
COST ESTIMATE FOR LICENSE 37-13831-01

ITEM	PERSON-HOURS	COST $ x1000
RRL, 250 labs @22 hr/RRL, Table A-1	5500	$132.0
Sealed sources	20	$ 0.5
Waste disposal, Table A-6	2630	$63.1
Subtotal person-hours	8150	$195.6
	FT^3	
Solid waste	500	$187.5
Solid, HIC	15	$14.3
Liquid, organic	14	$1.0
Liquid scintillation fluid	400	$20.4
Subtotal waste shipped	1005	$223.2
	TOTAL	**$418.8**

APPENDIX G
LICENSE 37-13831-04

LICENSE DESCRIPTION

This license covers one AECL Model 220 Gammacell irradiator at the Hershey Medical Center with a present activity of about 300 Ci of ^{60}Co. This unit is scheduled to be replaced with a new Gammacell 220 irradiator. The old irradiator will be returned to the manufacturer. An additional self-shielded ^{137}Cs irradiator is expected to be added to this license within a few months and is included in the estimate. Decommissioning costs are assumed to be the same as for the Gammacell irradiators at the University Park campus, as shown in Appendix C. The estimated cost is shown below in Table G-1.

TABLE G-1
GAMMACELL 220 IRRADIATOR

ITEM	PERSON-HOURS	DISPOSAL COST
Gammacell 220		
Packaging and disposal	80	$25,000
^{137}Cs irradiator		
Packaging and disposal	80	$25,000
Surveys	8	
Records and filing	8	
Supervision	20	
TOTAL	196	$50,000
	$4,704	

TOTAL COST $54,704