

DOE/EM--52368-Pt. 1.

**Life Cycle Cost Report
or
VHLW Cask**

**June 1995
Revision 0**

Prepared by:

**Chem Nuclear Systems, Inc.
Columbia, SC**

Prepared Under DOE Contract DE-AC04-89L5368

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GENERAL NUCLEAR SYSTEMS, INC.

A Chem-Nuclear Company

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July 5, 1995
611-0066-95

Mr. Roger Cartee
Energy & Technology Development Dept.
Department of Energy
PO Box 5400
Albuquerque, NM 87115

Dear Mr. Cartee:

**SUBJ: VHLW CASK LIFE CYCLE COST REPORT FOR CONTRACT DE-
AC04-53689**

Enclosed is the Life Cycle Cost Report for the VHLW Cask. The Life Cycle Costs developed in this report are based upon the VHLW Cask designed under the subject contract and described in the Draft Safety Analysis Report submitted to you on March 23, 1995. This submittal completes the requirements of Phase 1, Task 5 of the subject contract.

This Life Cycle Cost Report is being forwarded even though the VHLW Cask contract expired on June 30, 1995. All costs for developing the Report were incurred before the contract expired.

Sincerely,

Charles R. Witt
Sr. Project Engineer

Encl: Life Cycle Cost Report for VHLW Cask, Rev. 0, June 1995

A17:LTR2

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1. INTRODUCTION

This document, the Life Cycle Cost Report (LCCR) for the VHLW Cask, presents the life cycle costs for acquiring, using, and disposing of the VHLW casks. The VHLW cask consists of a ductile iron cask body, called the shielding insert, which is used for storage and transportation, and ultimately for disposal of Defense High Level Waste which has been vitrified and placed into VHLW canisters. Each ductile iron VHLW shielding insert holds one VHLW canister. For transportation, the shielding insert is placed into a containment overpack. The VHLW cask as configured for transportation is a legal weight truck cask which will be licensed by NRC. The cask was designed under DOE contract DE-AC04-89L53689 by Chem Nuclear Systems, Inc.

1.1 Purpose

The purpose of this LCCR is to present the development of the life cycle costs for using the VHLW cask to transport VHLW canisters from the generating sites to a disposal site. Life cycle costs include the cost of acquiring, operating, maintaining, and ultimately dispositioning the VHLW cask and its associated hardware.

1.2 Scope

This report summarizes costs associated with transportation of the VHLW casks. Costs are developed on the basis of expected usage, anticipated source and destination locations, and expected quantities of VHLW which must be transported. DOE overhead costs, such as the costs associated with source and destination facility handling of the VHLW, are not included. Also not included are costs exclusive to storage or disposal of the VHLW waste.

The costs in this report include estimates based on quotations for goods yet to be delivered. Also, costs are included for anticipated maintenance. Since the VHLW cask is a new design, maintenance costs must be estimated based on experience with similar equipment.

2. BASES FOR LIFE CYCLE COSTS

This section of the LCCR describes the bases for development of the life cycle costs for the VHLW cask.

2.1 Bases for Fixed Costs

Fixed costs include those costs which are independent of the number of VHLW shielding inserts required. These include one time fixed costs and fixed costs which occur on a scheduled recurring basis. For the VHLW shielding insert and associated hardware, fixed costs include the cost of designing the VHLW shielding insert and associated hardware, the costs of licensing the VHLW cask package, and the cost of renewing the package license. Each of these is discussed in more detail in the following sections. Note that all costs are developed in 1995 dollars. Adjustments for inflation are discussed in Section 3.3 of this report.

2.1.1 Design Cost

The design cost is based on actual costs incurred to date, and projected costs to complete, DOE contract DE-AC04-89L53689 for the VHLW cask. The present design for the VHLW cask was initiated with Modification 004 of this contract, so the incurred and projected costs are based on post-Modification 004. The tasks included in this cost are preliminary design, test planning, testing, preparation of the draft Safety Analysis Report (SAR), and preparation of the Life Cycle Cost Report. The design cost is a one time fixed cost.

2.1.2 Licensing Costs

This cost includes the preparation of the final SAR and the effort to obtain the Certificate of Compliance (C of C), which includes NRC review and Chem Nuclear support of the NRC review and licensing effort. Since this effort has yet to be completed, and since it is performed by NRC on a time and materials basis, it is a best estimate based on experience licensing other transportation packages. This is a one time fixed cost.

2.1.3 License Renewal Costs

Per NRC regulations, the C of C for a transportation packages is only valid for 5 years. Continued usage of a transportation package requires renewal of the C of C. Estimated costs for preparation of the renewal application and NRC review costs form the basis for this cost.

2.1.4 Shielding insert Set Up Charge

Competitive bids were obtained from three different vendors for the cast iron VHLW shielding insert body. (This component is referred to as the shielding insert in the VHLW transportation SAR.) The cost of the VHLW shielding insert is a variable cost, however the lowest bidder quoted a one time set up cost.

2.2 Bases for Variable Costs

Variable costs include costs which are not fixed with respect to time, but can vary as a function of time depending upon package usage. For the VHLW shielding insert and associated hardware, variable costs include the cost of procuring VHLW shielding inserts, VHLW cask overpacks and associated hardware required for transportation, and replacement parts such as seals, bolts, and test port plugs. Also included in variable costs are the costs of operation and maintenance of the VHLW cask transportation package and associated hardware required for transportation. Each of these is discussed in more detail in the following sections.

2.2.1 Hardware Acquisition Costs

Variable costs for hardware include the cost of procurement of the cast iron shielding inserts, cask overpacks, impact limiters, lifting yokes, and trailers, and procurement of replacement hardware. The bases for the hardware costs include vendor estimates and quotations, and the cost of similar hardware previously procured. Since the vendor quotations are for equipment yet to be delivered, these costs should also be treated as estimates. The bases for hardware acquisition costs are summarized in the following sections.

2.2.1.1 Shielding Insert

Competitive bids were obtained from three different vendors for the cast iron VHLW shielding insert body. The unit cost of the VHLW shielding insert provided by the lowest bidder is used as the basis for the VHLW shielding insert in this report. It is assumed that each shielding insert is shipped only once.

2.2.1.2 Overpack

Due to the simple design of the VHLW cask overpack, the cost per unit was estimated based on the overpack weight and an aggregate cost per pound for the fabricated product. The finished cost of the overpack body was estimated at \$6.00/pound, and the finished cost of the overpack base plate at \$7.00/pound. The assumed limiting number of uses for the overpack is shown in Table 2-1.

2.2.1.3 Trailer

The trailer cost is developed based upon the cost of the GA 4/9 truck cask trailer developed by General Atomics for the DOE under contract DE-AC01-88ID12698. The fabrication cost of the trailer was obtained in a meeting between Chem Nuclear and TRW Environmental Safety Systems (TESS). The assumed limiting number of uses for the trailer is shown in Table 2-1.

2.2.1.4 Impact Limiters

Impact limiter acquisition costs were developed based on similar units purchased in 1990, with an appropriate adjustment for inflation. The assumed limiting number of uses for the impact limiters is shown in Table 2-1.

Component	Limiting Unit	Limit
Overpack	Transportation round trips	100
Trailer	Transportation round trips	100
Impact Limiter (pair)	Transportation round trips	100
Yoke	Transportation round trips	500
Assembly Verification Test Apparatus	Transportation round trips	100
Annual Test Apparatus	Transportation round trips	100

Table 2-1 Life Expectancies of Transportation Hardware

2.2.1.5 Lifting Yoke

The lifting yoke acquisition cost was based on a vendor quotation for a similar unit. The assumed limiting number of uses for the lifting yoke is shown in Table 2-1.

2.2.1.6 Replacement Hardware

Replacement hardware includes the following components:

- Seals
- Closure bolts
- Base plates
- Test port plugs
- Impact limiter attachment bolts

Current vendor quotes for similar items are used as a basis for determining seal costs. Vendor estimates are used as the basis for the costs for the other replacement items. It is assumed that one set of replacement items is required per cask overpack per year. An additional set of seals will be required after the third use of each new cask overpack, i.e. in the first year.

2.2.1.7 Test Equipment

Another cost is the test equipment acquisition. The test equipment includes the annual test apparatus (halogen detector, calibration source, vacuum pump, instrumentation and piping) and the assembly verification test apparatus (piping and instrumentation). These cost are based on vendor quotations. It is assumed that one set of annual test apparatus will be required per 10 cask overpacks, and that one set of assembly verification

test apparatus will be required per cask overpack. The assumed limiting number of uses for the test equipment is shown in Table 2-1.

2.2.1.8 Test Consumables

Also included in this category are test consumables, specifically bottled sulfur hexafluoride gas for the annual containment verification test. The cost for this item is based on a vendor quotation. It is assumed one bottle of gas is required per annual inspection test performed.

2.2.2 Hardware Dispositioning Costs

Once the useful life of the components of the VHLW cask is over, each item must be dispositioned. The costs for dispositioning these components are included in the Life Cycle Cost calculations for the VHLW cask. The following assumptions have been made regarding disposal costs:

- Since the shielding insert is intended to be used as the overpack for the VHLW canister at the repository, no decommissioning or disposal costs are incurred.
- None of the components of the VHLW cask will require decontamination prior to disposal.
- The large metal components of the VHLW cask, such as the stainless steel overpack and overpack baseplate, the trailer, and the lifting yoke, can be dispositioned by selling as scrap metal, and therefore will be a positive contributor to the Life Cycle Cost. However, since the market prices for scrap metal are volatile, the disposal cost for these components is conservatively assumed to be zero.
- No inflation is applied to the remaining component disposal costs as these will be offset by the positive contribution of items sold for scrap metal which are being ignored in this evaluation.

The only components of the which will incur disposal costs are the impact limiters and the test hardware.

2.2.2.1 Impact Limiters

Chem Nuclear has received a verbal quotation for disposal of each pair of overpacks of \$3000. This price includes labor for preparation and shipment for disposal as well as actual disposal costs.

2.2.2.2 Test Hardware

It is conservatively assumed that a modest cost for disposal of miscellaneous test equipment components will be required. This cost is estimated at \$200 per unit.

2.2.3 Labor Costs

Labor costs in this report are based upon expected durations of activities to be performed in conjunction with the preparation, loading, testing, unloading, assembly, maintenance, and repair of the transportation package and associated hardware, such as the lifting yoke and trailer. The durations

used are based upon estimates provided by experienced cask handling and testing personnel. These costs do not include transportation costs, which are discussed separately below. Costs are based upon anticipated labor hours, frequency, and labor rates.

2.2.4 Transportation Costs

Transportation costs are developed based upon Chem Nuclear's extensive experience base in shipping radioactive waste in the U.S. Based on this experience, a typical cost per mile has been developed which is used in the life cycle cost calculations. This unit cost includes the cost for the driver, fuel, and other cost associated with transportation expense. The number of miles from each DHLW generation site to the anticipated repository site is used. The annual cost is a function of the cost per mile, the number of miles per trip, and the number of trips per year.

2.3 Costs Not Included

Costs which are not included in the life cycle cost estimate for the VHLW cask include the cost of a tractor for towing the VHLW cask transportation package, the costs associated with the VHLW canisters procurement and DHLW processing, and DOE overhead costs. In addition, all VHLW cask activities associated with storage or disposal functions of the cask are not included. This includes, for example, the welding of the secondary lid for storage and the welding of the primary and secondary lids for disposal.

3. UNIT COSTS FOR DEVELOPMENT OF LIFE CYCLE COSTS

Each of the following sections provides the unit cost for each of the identified costs for the VHLW cask. The life cycle cost summary utilizing each of these unit costs is provided in Section 4. Note that all costs are developed in 1995 dollars. Adjustments for inflation are discussed in Section 3.3 of this report.

3.1 Fixed Costs

Each of the fixed costs identified in Section 2.1 are provided in Table 3-1.

Component	Frequency	Cost (\$)
Design	one time	265,300.00
Initial Licensing	one time	175,000.00
Licensing Renewal	every 5 years	10,000.00
Shielding Insert Fabrication Set-Up Charge	one time	15,500.00

Table 3-1 VHLW Transportation Package Fixed Costs

3.2 Variable Costs

This section develops the variable costs associated with acquisition, disposal, operation and maintenance of the VHLW cask and associated hardware. Costs for each of these categories are summarized in the following sections.

3.2.1 Hardware Acquisition

The variable costs identified in Section 2.2.1 are provided on a per-unit basis in Table 3-2.

3.2.2 Hardware Disposition

The variable costs for dispositioning the hardware identified in Section 2.2.2 are provided on a per-unit basis in Section 2.2.2.

3.2.3 Operation and Maintenance

As discussed in Section 2.2.3, costs associated with operating, repairing, and maintaining the VHLW cask package components depend on the amount of labor required. A detailed summary of the operational and maintenance steps required for VHLW cask use, along with the resulting costs, is provided in Table 3-3. As can be seen in the table, each task

includes the time required to complete the task and the number of people required. This is used to develop the total labor required to perform the task. Next, the frequency of each activity on an annual basis is listed and utilized as the basis for developing the annual cost of each activity. The costs developed assume that each overpack is used to complete 12 shipments per year. The annual costs of each operation and maintenance activity are summed to obtain the total annual cost of operating a single VHLW cask overpack and its associated hardware for transportation of VHLW shielding inserts. The total annual cost for operation and maintenance is obtained by multiplying the single overpack cost by the number of overpacks required, which is a function of shipping campaign length as discussed in Section 4.

Component	Unit	Unit Cost (\$)
Shielding Insert	each	69,000.00
Overpack	each	74,500.00
Trailer	each	50,000.00
Impact limiters	pair	19,200.00
Yoke	each	35,000.00
Replacement closure seals	pair	125.66
Replacement closure bolts	set	227.72
Replacement base plates	each	11,500.00
Replacement test port plug	each	20.00
Replacement impact limiter attachment bolts	set	10.55
Halogen leak detector and calibration source	each	4,700.00
Bottled halogen	each	100.00
Vacuum pump	each	625.00
Associated annual test apparatus	each	100.00
Assembly verification test apparatus	each	100.00

Table 3-2 Hardware and Consumables Acquisition Costs

Operation Description		Persons Req'd	Labor (MH)	Cost (\$)	Frequency of Operation (x per yr)	Annual Cost (\$)
Package Removal and Disassembly						
Remove impact limiters	2	3	6	210	24	5040
Disconnect cask to trailer tie down equipment	2	2	4	140	24	3360
Remove package from trailer	2	5	10	350	24	8400
Remove overpack barrel	2	3	6	210	24	5040
Install shield insert lifting trunnions	1	2	2	70	12	840
Package Assembly for Shipment						
Place loaded shield insert on overpack base plate	1	2	2	70	12	840
Remove shield insert trunnions and install plugs	1	2	2	70	12	840
Place and secure overpack barrel to base plate	2	3	6	210	24	5040
Install and torque closure bolts	2	3	6	210	24	5040
Perform Assembly Verification Leak Test (see below)						
Package Loading onto Trailer						
Lift package with yoke, place and downend on trailer	2	3	6	210	24	5040
Attach tie-down equipment and remove yoke	2	2	4	140	24	3360
Install impact limiters	2	3	6	210	24	5040
Perform pre-shipment radiological survey	2	2	4	140	24	3360
Install tamperproof seals	0.5	2	1	35	24	840
Assembly Verification Leak Test - Closure Seals						
Set up / attach test apparatus	1	2	2	70	12	840
Pressurize annulus	0.5	1	0.5	17.5	12	210
Perform test	1	2	2	70	12	840
Release pressure	0.1	1	0.1	3.5	12	42
Remove test apparatus	0.5	2	1	35	12	420
Install test port plug	0.5	2	1	35	12	420
Assembly Verification Leak Test - Test Port						
Attach test apparatus	1	2	2	70	12	840
Pressurize test port plug	0.5	1	0.5	17.5	12	210
Perform test	1	2	2	70	12	840
Release pressure	0.1	1	0.1	3.5	12	42
Remove test apparatus	0.5	1	0.5	17.5	12	210
Annual Containment Verification Leak Test						
Calibrate leak detector	2	2	4	140	1	140
Check test surfaces of overpack for residual halides	1	2	2	70	1	70
Clean test surfaces to remove residual halides	2	2	4	140	1	140
Examine O-rings and test port plug for damage	0.5	2	1	35	1	35
Place and secure overpack barrel to base plate	2	3	6	210	1	210
Set up / attach test apparatus	1	2	2	70	1	70
Pressurize annulus	0.1	2	0.2	7	1	7
Check for leakage around base plate with detector	0.5	2	1	35	1	35
Turn off and remove leak test equipment	0.5	1	0.5	17.5	1	17.5
Remove gas source and release pressure	0.1	1	0.1	3.5	1	3.5
Install test port plug	0.1	2	0.2	7	1	7
Attach test apparatus with vacuum source	0.5	2	1	35	1	35
Apply vacuum and check for leakage	0.2	2	0.4	14	1	14
Turn off and remove leak test equipment	0.5	1	0.5	17.5	1	17.5
Annual Yoke Compliance Verification Testing						
Set up test for yoke	2	3	6	210	1	210
Apply required load to yoke	0.2	3	0.6	21	1	21
Perform yoke visual defect and deformation inspection	2	2	4	140	1	140
Annual Overpack Trunnion NDE						
Set up for test	2	1	2	70	1	70
Perform PT of trunnions at corners and shoulder	2	2	4	140	1	140
Annual Overpack Maintenance						
Replace closure seals	2	2	4	140	1	140
Replace closure bolts	0.5	2	1	35	1	35
Replace impact limiter attachment bolts	0.5	2	1	35	1	35
Replace test port plug	0.5	2	1	35	1	35
Annual Trailer Maintenance						
Annual inspection	8	2	16	560	1	560
Routine maintenance and repair	40	2	80	2800	1	2800
TOTAL ANNUAL LABOR COST PER OVERPACK						61,981.50

Table 3-3 Operations and Maintenance Labor Costs

3.2.4 Transportation Costs

As discussed in Section 2.2.4, the annual cost for transportation is a function of the cost per mile, the number of miles per trip, and the number of trips per year. A unit cost per mile is used to determine the transportation costs. The unit cost used is \$ 2.00 per mile, which has been developed based on Chem Nuclear's extensive experience in transporting high level radioactive waste.

The number of miles per trip is based on the round trip distance from the waste producer's site to the assumed disposal site, Yucca Mountain. The one-way mileage from each VHLW production site to Yucca Mountain is provided in Table 3-4.

Site	Miles to Yucca Mtn.
Savannah River (SRS)	2000
West Valley (WVDP)	2250
Hanford	1000
Idaho (INEL)	700

Table 3-4 One-Way Mileage from VHLW Production Sites to Yucca Mountain

The cost per mile, the number of trips per year from each site, and the round trip mileage from each site is used to determine the total annual cost of transportation from each site, which are then summed to get the total annual transportation cost. The number of trips per year from each waste producer's site is a function of the shipping campaign length, as discussed in Section 4.

3.3 Inflation

As discussed above and shown in Tables 3-1 through 3-4, all costs have been developed in 1995 dollars. However, inflation will effect the total cost of using the VHLW cask. Since the transportation of VHLW shielding inserts to Yucca Mountain will not occur until the repository is open and available, it will be several years before the VHLW shielding inserts, overpacks, and associated hardware will be required. It is therefore likely, based on historical precedent, that costs for goods and services will continue to rise until then. Therefore the life cycle cost calculations provided in Section 4 of this report include total costs for assumed average inflation rates. Average annual inflation rates of 3%, 5% and 7% are included. In addition, assumed repository opening dates of 2010 and 2020 are used. The total cost in 1995 dollars, i.e. a zero inflation rate, is also included for comparison. Since zero inflation results in the same total regardless of the repository opening date, the zero inflation rate life cycle costs are only computed for the 2010 repository opening date.

4. SUMMARY OF LIFE CYCLE COSTS

This section of the VHLW Life Cycle Cost Report summarizes the total life cycle cost for transportation of VHLW waste to the repository. In addition, a cost per VHLW cask shipped is provided. The total life cycle cost is developed based upon the unit costs discussed in Section 3 of this report and the total quantity of waste canisters to be transported.

4.1 Quantity of Waste to Be Transported

As discussed in Section 1 of this report, the waste to be transported consists of DHLW which has been vitrified and placed into VHLW canisters. The projected number of VHLW canisters to be produced by production site is summarized in Table 4-1. Information in Table 4-1 is obtained from Reference 1.

4.2 Quantity of Hardware Required

Based on the number of canisters to be shipped, the duration of the shipping campaign, and the number of transportation trips which can be completed per year, the required number of transportation cask overpacks is developed. It is assumed that a set of impact limiters, a trailer, and a lifting yoke are required for each overpack. Also, as discussed in Section 2.2, it is assumed that the overpacks and associated hardware are suitable for 100 transportation cycles. It is assumed that each overpack can make 12 shipments per year. This information is summarized in Table 4-2.

4.3 Total Life Cycle Cost

Spreadsheets showing the life cycle cost calculations for shipping campaign durations of 10 years, 15 years, 20 years, and 25 years are provided in Appendices A through D, respectively. Within each Appendix, calculations are performed for assumed repository availability dates of 2010 and 2020. For each of these repository dates, calculation of the life cycle cost is performed for the inflation rates identified in Section 3.3.

For each combination of shipping campaign length, repository availability date, and inflation rate, a total life cycle cost for completion of the transportation of VHLW canisters from the four producing sites is determined. The total life cycle costs are summarized in Table 4-3.

In addition to the total life cycle cost, a unit life cycle cost is developed for each VHLW shielding insert. This unit cost is developed by dividing the total life cycle cost by the number of VHLW shielding inserts transported. As a result, the unit cost includes the cost of the VHLW shielding insert itself plus an equal portion of all other costs associated with the VHLW transportation package design, licensing, fabrication, shipment, and disposal. The unit cost represents an average over the length of the shipping campaign, as inflation increases costs over time. Unit life cycle costs are summarized in Table 4-4.

Calendar Year	WVDP	SRS	Hanford	INEL	Total
1992		136			136
1993	25	308			333
1994	200	376			576
1995	50	410			460
1996		410			410
1997		383			383
1998		369			369
1999		369			369
2000		342	240		582
2001		342	370		712
2002		342	345		687
2003		342	185		527
2004		302	370		672
2005		273	370		643
2006		273	80		353
2007		273			273
2008		32			32
2009					0
2010					0
2011					0
2012				500	500
2013				600	600
2014				700	700
2015				1000	1000
2016				1000	1000
2017				1000	1000
2018				1000	1000
2019				1000	1000
2020				1000	1000
TOTAL	275	5,282	1,960	7,800	15,317

Table 4-1 Quantity of VHLW Canisters to Be Shipped

Site	No. Canisters	Shipments per Year for Campaign Length of (yrs)			
		10	15	20	25
SRS	5,282	528	352	264	211
WVDP	275	28	18	14	11
Hanford	1,960	196	131	98	78
INEL	7,800	780	520	390	312
Total	15,317	1532	1021	766	613
No. of shield inserts per year		1532	1021	766	613
No of trips/overpack/year		12	12	12	12
No. of overpacks required		128	85	64	51
Req'd no. of trips/overpack		120	180	240	300

Table 4-2 Hardware Quantity Requirements

Inflation Rate (%)	Shipping Campaign Length (yrs)			
	10	15	20	25
Repository Availability Date = 2010				
0	1,231	1,218	1,220	1,214
3	2,262	2,416	2,626	2,833
5	3,374	3,808	4,392	5,037
7	5,011	5,990	7,360	9,015
Repository Availability Date = 2020				
3	3,040	3,247	3,529	3,808
5	5,496	6,203	7,154	8,205
7	9,857	11,783	14,478	17,734

Table 4-3 Total Life Cycle Costs (\$M)

Inflation Rate (%)	Shipping Campaign Length (yrs)			
	10	15	20	25
Repository Availability Date = 2010				
0	80,372	79,488	79,661	79,274
3	147,684	157,766	171,454	184,987
5	220,305	248,637	286,769	328,874
7	327,173	391,091	480,528	588,583
Repository Availability Date = 2020				
3	198,445	212,002	230,396	248,586
5	358,799	404,962	467,071	535,663
7	643,514	769,271	945,201	1,157,771

Table 4-4 Unit Life Cycle Costs (per VHLW Cask) (\$)

5. REFERENCES

1. Characteristics Database System, High Level Waste Database, DOE/RW-0184-R1, July 1992

Appendix A

Life Cycle Cost Calculations for 10 Year Shipping Campaign

**Appendix A.1 Life Cycle Cost Calculations for 10 Year Shipping
Campaign for Assumed Repository Availability Date of
2010**

Table A.1-1 Average Annual Inflation Rate = 0%

Table A.1-2 Average Annual Inflation Rate = 3%

Table A.1-3 Average Annual Inflation Rate = 5%

Table A.1-4 Average Annual Inflation Rate = 7%

Table A.1-1

Life Cycle Cost Summary - 10 Year Shipping Campaign

June 30, 1995

Repository open date: 2010		Inflation rate = 0										Total (\$k)
Cost (\$k)	Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Fixed Costs												
One time												
Design	265											265
NRG Licensing	175											175
Shielding Insert Set Up Charge		16										16
Recurring												
NRG License Renewal	20	10					10					40
Variable Costs												
Hardware Acquisition												
Shielding Inserts		105687	105687	105687	105687	105687	105687	105687	105687	105687	105687	1056873
Overpacks		9509								9509		19019
Trailers		6382								6382		12764
Impact Limiters		2451								2451		4901
Yokes		4467										4467
Replacement Seals		16	16	16	16	16	16	16	16	16	16	160
Replacement Bolts			29	29	29	29	29	29	29	29	29	262
Replacement Base Plates			1468	1468	1468	1468	1468	1468	1468	1468	1468	13211
Replacement test port plugs			3	3	3	3	3	3	3	3	3	23
Replacement I.L. attach bolts			1	1	1	1	1	1	1	1	1	12
Annual test apparatus		65							65	65		130
Assembly test apparatus		13							13	13		26
Annual test consumables			153	153	153	153	153	153	153	153	153	1379
Hardware Disposition												
Overpacks										0	0	0
Trailers										0	0	0
Impact Limiters										383	383	766
Yokes										0	0	0
Replacement Seals		0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0
Annual test apparatus		26								26	26	77
Assembly test apparatus		26								26	26	77
Labor												
Transportation			8014	7911	7911	7911	7911	7911	7911	7911	7911	79217
			3721	3721	3721	3721	3721	3721	3721	3721	3721	37206
Total:	460	140402	118989	118989	118989	118989	118999	118989	118989	137843	119423	1231064

Cost per shielding insert unit = 80372

Table A.1-2

Life Cycle Cost Summary - 10 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Repository open date: 2010										Inflation rate = 3%		Total (\$k)
	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020		
Fixed Costs													
One time	265											265	
Design	175											175	
NRC Licensing		25										25	
Shielding Insert Set Up Charge													
Recurring	22	16					19					56	
NRC License Renewal													
Variable Costs													
Hardware Acquisition													
Shielding Inserts		169597	174685	179926	185323	190883	196610	202508	208583	214841	221286	1944241	
Overpacks		15260								19330		34590	
Trailers		10241								12973		23215	
Impact Limiters		3933								4982		8914	
Yokes		7169										7169	
Replacement Seals		26	27	27	28	29	30	31	32	33	34	295	
Replacement Bolts			48	49	51	52	54	56	57	59	61	488	
Replacement Base Plates			2426	2499	2574	2651	2731	2813	2897	2984	3073	24648	
Replacement test port plugs			4	4	4	5	5	5	5	5	5	43	
Replacement I.L. attach bolts			2	2	2	2	3	3	3	3	3	23	
Annual test apparatus		104								132		237	
Assembly test apparatus		20	253	261	269	277	285	293	302	311	321	46	
Annual test consumables												2572	
Hardware Disposition													
Overpacks										0	0	0	
Trailers										0	0	0	
Impact Limiters										383	383	766	
Yokes										0	0	0	
Replacement Seals		0	0	0	0	0	0	0	0	0	0	0	
Replacement Bolts			0	0	0	0	0	0	0	0	0	0	
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0	
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0	
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0	
Annual test apparatus		26								26	26	77	
Assembly test apparatus		26								26	26	77	
Labor													
		12860	13076	13469	13873	14289	14718	15159	15614	16082	16565	145704	
Transportation													
		5970	6150	6334	6524	6720	6921	7129	7343	7563	7790	68444	
Total:	462	225,272	196,671	202,571	208,649	214,908	221,374	227,996	234,836	279,759	249,571	2,262,069	

Cost per shielding insert unit = \$ 147,684

Table A.1-3

Life Cycle Cost Summary - 10 Year Shipping Campaign

June 30, 1995

Repository open date: 2010													Inflation rate = 5%				Total (\$k)
Cost (\$k)	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020						
Fixed Costs	265 175												265 175				
One time																	
Design																	
NRC Licensing		34											34				
Shielding Insert Set Up Charge																	
Recurring	23						28						72				
NRC License Renewal																	
Variable Costs																	
Hardware Acquisition																	
Shielding Inserts		230702	242237	254349	267067	280420	294441	309163	324621	340852	357895		2901746				
Overpacks		20758								30668			51426				
Trailers		13931								20583			34514				
Impact Limiters		5350								7904			13253				
Yokes		9752											9752				
Replacement Seals		35	37	39	41	43	45	47	49	52	54		440				
Replacement Bolts			67	70	73	77	81	85	89	94	98		735				
Replacement Base Plates			3364	3533	3709	3895	4089	4294	4509	4734	4971		37098				
Replacement test port plugs			6	6	6	7	7	7	8	8	9		65				
Replacement I.L. attach bolts			3	3	3	4	4	4	4	4	5		34				
Annual test apparatus		142								210			352				
Assembly test apparatus		28								41			69				
Annual test consumables			351	369	387	406	427	448	470	494	519		3871				
Hardware Disposition																	
Overpacks										0	0		0				
Trailers										0	0		0				
Impact Limiters										383	383		766				
Yokes											0		0				
Replacement Seals		0	0	0	0	0	0	0	0	0	0		0				
Replacement Bolts			0	0	0	0	0	0	0	0	0		0				
Replacement Base Plates			0	0	0	0	0	0	0	0	0		0				
Replacement test port plugs			0	0	0	0	0	0	0	0	0		0				
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0		0				
Annual test apparatus		26								26	26		77				
Assembly test apparatus		26								26	26		77				
Labor		17493	18133	19040	19992	20991	22041	23143	24300	25515	26791		217439				
Transportation		8121	8528	8954	9402	9872	10365	10884	11428	11999	12599		102151				
Total:	463	306,419	272,726	286,362	300,680	315,714	331,528	348,075	365,479	443,593	403,374		3,374,411				

Cost per shielding insert unit = \$ 220,305

Table A.1-4

Life Cycle Cost Summary - 10 Year Shipping Campaign

June 30, 1995

Repository open date: 2010 Inflation rate = 7%

Cost (\$k)	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total (\$k)
Fixed Costs												
One time	265											265
Design	175											175
NRC Licensing		46										46
Shielding Insert Set Up Charge												
Recurring	24	30					41					95
NRC License Renewal												
Variable Costs												
Hardware Acquisition												
Shielding Inserts		312006	333847	357216	382221	408977	437605	468237	501014	536085	573611	4310818
Overpacks		28073								48235		76308
Trailers		18841								32372		51213
Impact Limiters		7235								12431		19666
Yokes		13189										13189
Replacement Seals		47	51	54	58	62	66	71	76	81	87	654
Replacement Bolts			92	98	105	112	120	129	138	147	158	1100
Replacement Base Plates			4637	4961	5309	5680	6078	6503	6959	7446	7967	55539
Replacement test port plugs			8	9	9	10	11	11	12	13	14	97
Replacement I.L. attach bolts			4	5	5	5	6	6	6	7	7	51
Annual test apparatus		192								330		522
Assembly test apparatus		38	484	518	554	593	634	679	726	65		102
Annual test consumables										777	831	5795
Hardware Disposition												
Overpacks										0	0	0
Trailers										0	0	0
Impact Limiters										383	383	766
Yokes										0	0	0
Replacement Seals		0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0
Annual test apparatus		26								26	26	77
Assembly test apparatus		26								26	26	77
Labor		23658	24991	26740	28612	30615	32758	35051	37504	40130	42939	322996
Transportation		10984	11753	12575	13455	14397	15405	16484	17637	18872	20193	151755
Total:	464	414,389	375,865	402,176	430,328	460,451	492,724	527,171	564,072	697,424	646,241	5,011,306

Cost per shielding insert unit = \$ 327,173

**Appendix A.2 Life Cycle Cost Calculations for 10 Year Shipping
Campaign for Assumed Repository Availability Date of
2020**

Table A.2-1 Average Annual Inflation Rate = 3%

Table A.2-2 Average Annual Inflation Rate = 5%

Table A.2-3 Average Annual Inflation Rate = 7%

Table A.2-1

Life Cycle Cost Summary - 10 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Repository open date: 2020											Total (\$k)
	Inflation rate = 3%											
	1995	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Fixed Costs												
One time												
Design	265											265
NRC Licensing	175											175
Shielding Insert Set Up Charge		33										33
Recurring												
NRC License Renewal	51	22					25					97
Variable Costs												
Hardware Acquisition												
Shielding Inserts		227924	234762	241805	249059	256531	264227	272154	280318	288728	297390	2612897
Overpacks		20508								25979		46486
Trailers		13764								17435		31199
Impact Limiters		5285								6695		11980
Yokes		9634										9634
Replacement Seals		35	36	37	38	39	40	41	43	44	45	397
Replacement Bolts			65	67	68	71	73	75	77	79	82	656
Replacement Base Plates			3261	3358	3459	3563	3670	3780	3893	4010	4130	33125
Replacement test port plugs			6	6	6	6	6	7	7	7	7	58
Replacement I.L. attach bolts			3	3	3	3	3	3	4	4	4	30
Annual test apparatus		140								178		318
Assembly test apparatus		28								35		62
Annual test consumables			340	350	361	372	383	394	406	418	431	3456
Hardware Disposition												
Overpacks										0	0	0
Trailers										0	0	0
Impact Limiters										383	383	766
Yokes										0	0	0
Replacement Seals		0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0
Annual test apparatus		26								26	26	77
Assembly test apparatus		26								26	26	77
Labor												
		17282	17574	18101	18644	19203	19779	20373	20984	21613	22262	195814
Transportation												
		8024	8264	8512	8768	9031	9302	9581	9868	10164	10469	91983
Total:	491	302730	264310	272239	280406	288818	297508	306407	315600	375823	335254	3039585

Cost per shielding insert unit = \$ 198,445

Table A.2-2

Life Cycle Cost Summary - 10 Year Shipping Campaign

June 30, 1995

Repository open date: 2020 Inflation rate = 5%

Cost (\$k)	Year											Total (\$k)
	1995	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Fixed Costs												
One time	265											265
Design	175											175
NRC Licensing		55										55
Shielding Insert Set Up Charge												
Recurring	60	36					45					141
NRC License Renewal												
Variable Costs												
Hardware Acquisition		375789	394579	414308	435023	456774	479613	503594	528773	555212	582973	4726639
Shielding Inserts		33812								49956		83768
Overpacks		22693								33527		56220
Trailers		8714								12874		21588
Impact Limiters		15885										15885
Yokes		57	60	63	66	69	73	76	80	84	88	717
Replacement Seals			109	114	120	126	132	139	145	153	160	1197
Replacement Bolts			5480	5754	6042	6344	6661	6994	7344	7711	8097	60428
Replacement Base Plates			10	10	11	11	12	12	13	13	14	105
Replacement test port plugs			5	5	6	6	6	6	7	7	7	55
Replacement I.L. attach bolts		231								342		573
Annual test apparatus		45	572	600	630	662	695	730	766	805	845	6306
Assembly test apparatus												
Annual test consumables												
Hardware Disposition												
Overpacks										0	0	0
Trailers										0	0	0
Impact Limiters										383	383	766
Yokes										0	0	0
Replacement Seals		0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0
Annual test apparatus		26								26	26	77
Assembly test apparatus		26								26	26	77
Labor		28494	29537	31014	32564	34193	35902	37697	39582	41561	43640	354185
Transportation		13229	13891	14585	15314	16080	16884	17728	18615	19545	20523	166394
Total:	500	499,092	444,241	466,454	489,776	514,265	540,024	566,977	595,326	722,293	656,781	5,495,729

Cost per shielding insert unit =\$ 358,799

Table A.2-3

Life Cycle Cost Summary - 10 Year Shipping Campaign

June 30, 1995

Repository open date: 2020 Inflation rate = 7%

Cost (\$k)	Year											Total (\$k)
	1995	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Fixed Costs												
One time												
Design	265											265
NRC Licensing	175											175
Shielding Insert Set Up Charge		90										90
Recurring												
NRC License Renewal	71	58					81					211
Variable Costs												
Hardware Acquisition												
Shielding Inserts		613763	656727	702698	751887	804519	860835	921093	985570	1054560	1128379	8480031
Overpacks		55224								94885		150109
Trailers		37063								63681		100744
Impact Limiters		14232								24454		38686
Yokes		25944										25944
Replacement Seals		93	100	107	114	122	131	140	150	160	171	1287
Replacement Bolts			181	193	207	221	237	253	271	290	310	2163
Replacement Base Plates			9121	9760	10443	11174	11956	12793	13688	14647	15672	109254
Replacement test port plugs			16	17	18	19	21	22	24	25	27	190
Replacement I.L. attach bolts			8	9	10	10	11	12	13	13	14	100
Annual test apparatus		378								650		1028
Assembly test apparatus		74								127		201
Annual test consumables			952	1018	1090	1166	1248	1335	1428	1528	1635	11400
Hardware Disposition												
Overpacks										0	0	0
Trailers										0	0	0
Impact Limiters										383	383	766
Yokes										0	0	0
Replacement Seals		0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0
Annual test apparatus		26								26	26	77
Assembly test apparatus		26								26	26	77
Labor		46539	49161	52602	56284	60224	64439	68950	73777	78941	84467	635383
Transportation		21607	23119	24737	26469	28322	30304	32426	34695	37124	39723	298526
Total:	512	815,116	739,384	791,141	846,521	905,777	969,263	1,037,024	1,109,616	1,371,520	1,270,833	9,856,706

Cost per shielding insert unit = \$ 643,514

Appendix B

Life Cycle Cost Calculations for 15 Year Shipping Campaign

**Appendix B.1 Life Cycle Cost Calculations for 15 Year Shipping
Campaign for Assumed Repository Availability Date of
2010**

Table B.1-1 Average Annual Inflation Rate = 0%

Table B.1-2 Average Annual Inflation Rate = 3%

Table B.1-3 Average Annual Inflation Rate = 5%

Table B.1-4 Average Annual Inflation Rate = 7%

Table B.1-1

Life Cycle Cost Summary - 15 Year Shipping Campaign

June 30, 1995

Repository open date: 2010 Inflation rate = 0

Cost (\$k)	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total (\$k)
Fixed Costs																	
One time	265																265
Design	175																175
NRC Licensing		16															16
Shielding Insert Set Up Charge																	
Recurring	20	10					10										50
NRC License Renewal																	
Variable Costs																	
Hardware Acquisition																	
Shielding Inserts		70458	70458	70458	70458	70458	70458	70458	70458	70458	70458	70458	70458	70458	70458	70458	1056873
Overpacks		6340															12679
Trailers		4255															8509
Impact Limiters		1634															3268
Yokes		2978															2978
Replacement Seals		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	160
Replacement Bolts			19	19	19	19	19	19	19	19	19	19	19	19	19	19	271
Replacement Base Plates			979	979	979	979	979	979	979	979	979	979	979	979	979	979	13700
Replacement test port plugs			2	2	2	2	2	2	2	2	2	2	2	2	2	2	24
Replacement I.L. attach bolts			1	1	1	1	1	1	1	1	1	1	1	1	1	1	13
Annual test apparatus		43															87
Assembly test apparatus		9															17
Annual test consumables			102	102	102	102	102	102	102	102	102	102	102	102	102	102	1430
Hardware Disposition																	
Overpacks																	0
Trailers																	0
Impact Limiters																	511
Yokes																	0
Replacement Seals		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus		17															51
Assembly test apparatus		17															51
Labor																	
		5342	5274	5274	5274	5274	5274	5274	5274	5274	5274	5274	5274	5274	5274	5274	79182
Transportation																	
		2480	2480	2480	2480	2480	2480	2480	2480	2480	2480	2480	2480	2480	2480	2480	37206
Total:	460	93610	79326	79326	79326	79326	79336	79326	79326	91896	79326	79336	79326	79326	79326	79616	1217516

Cost per shielding insert unit = 79488

Table B.1-2

Life Cycle Cost Summary - 15 Year Shipping Campaign

June 30, 1995

Repository open date: 2010 Inflation rate = 3%

Cost (\$k)	Year																Total (\$k)
	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Fixed Costs																	
One time	265																265
Design	175																175
NRC Licensing		25															25
Shielding Insert Set Up Charge																	
Recurring	22	16					19					22					78
NRC License Renewal																	
Variable Costs																	
Hardware Acquisition		113065	116457	119950	123549	127255	131073	135005	139055	143227	147524	151950	156508	161203	166039	171021	2102881
Shielding Inserts		10173								12887							23060
Overpacks		6828								8649							15477
Trailers		2622								3321							5943
Impact Limiters		4779															4779
Yokes		17	18	18	19	19	20	20	21	22	22	23	24	24	25	26	319
Replacement Seals			32	33	34	35	36	37	38	39	41	42	43	44	46	47	547
Replacement Bolts			1617	1666	1716	1767	1820	1875	1931	1989	2049	2110	2174	2239	2306	2375	27636
Replacement Base Plates			3	3	3	3	3	3	3	3	4	4	4	4	4	4	48
Replacement test port plugs			1	2	2	2	2	2	2	2	2	2	2	2	2	2	25
Replacement I.L. attach bolts		70								88							158
Annual test apparatus		14	169	174	179	184	190	196	202	208	214	220	227	234	241	248	31
Assembly test apparatus										17							2884
Annual test consumables																	
Hardware Disposition																	
Overpacks										0						0	0
Trailers										0						0	0
Impact Limiters										255						255	511
Yokes																0	0
Replacement Seals	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus	17									17						17	51
Assembly test apparatus	17									17						17	51
Labor	8573		8718	8979	9248	9526	9812	10106	10409	10722	11043	11374	11716	12067	12429	12802	157525
Transportation	3980		4100	4223	4349	4480	4614	4753	4895	5042	5193	5349	5510	5675	5845	6021	74029
Total:	462	150,195	131,114	135,048	139,099	143,272	147,589	151,997	156,557	166,506	166,091	171,096	176,206	181,493	186,937	192,835	2,416,498

Cost per shielding insert unit = \$

157,766

Table B.1-3

Life Cycle Cost Summary - 15 Year Shipping Campaign

June 30, 1995

Repository open date: 2010 Inflation rate = 5% Year

Cost (\$k)	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total (\$k)
Fixed Costs																	
One time	265																265
Design	175																175
NRC Licensing		34															34
Shielding Insert Set Up Charge																	
Recurring																	
NRC License Renewal	23						28						36				108
Variable Costs																	
Hardware Acquisition		153801	161491	169566	178044	186947	196294	206109	216414	227235	238596	250526	263053	276205	290016	304516	3318814
Shielding Inserts		13838								20446							34284
Overpacks		9288								13722							23009
Trailers		3566								5269							8836
Impact Limiters		6501															6501
Yokes		23															504
Replacement Seals			25	26	27	28	30	31	33	34	36	38	40	42	44	46	504
Replacement Bolts			44	47	49	51	54	57	60	62	66	69	72	76	80	84	870
Replacement Base Plates			2243	2355	2473	2596	2726	2863	3006	3156	3314	3480	3654	3836	4028	4229	43959
Replacement test port plugs			4	4	4	5	5	5	5	5	6	6	6	7	7	7	76
Replacement I.L. attach bolts			2	2	2	2	3	3	3	3	3	3	3	4	4	4	40
Annual test apparatus		95								140							235
Assembly test apparatus		19								27							46
Annual test consumables			234	246	258	271	284	299	314	329	346	363	381	400	420	441	4587
Hardware Disposition																	
Overpacks										0							0
Trailers										0							0
Impact Limiters										255							511
Yokes																	0
Replacement Seals	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus	17									17							51
Assembly test apparatus	17									17							51
Labor		11662	12089	12693	13328	13994	14694	15429	16200	17010	17861	18754	19691	20676	21710	22795	248585
Transportation		5414	5685	5969	6268	6581	6910	7256	7619	7999	8399	8819	9260	9723	10210	10720	116833
Total:	463	204,298	181,817	190,908	200,453	210,476	221,028	232,050	243,652	255,728	268,627	282,094	296,161	310,969	326,517	343,133	3,808,374

Cost per shielding insert unit = \$ 248,637

Table B.1-4

Life Cycle Cost Summary - 15 Year Shipping Campaign

June 30, 1995

Repository open date: 2010																			Inflation rate = 7%									
Cost (\$k)		Year																	Total (\$k)									
		1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025											
Fixed Costs	One time	265																	265									
	Design	175																	175									
	NRC Licensing																											
	Shielding Insert Set Up Charge		46																46									
	Recurring	24																										
	NRC License Renewal		30					41						58					153									
	Variable Costs																											
	Hardware Acquisition																											
	Shielding Inserts	208004		222564	238144	254814	272651	291737	312158	334009	357390	382407	409176	437818	468465	501258	536346	5226941										
	Overpacks	18715										32156							50872									
Variable Costs	Trailers	12561									21582								34142									
	Impact Limiters	4823									8287								13111									
	Yokes	8792																8792										
	Replacement Seals	32		34	36	39	41	44	47	51	54	58	62	66	71	76	81	793										
	Replacement Bolts			61	65	70	75	80	86	92	98	105	113	120	129	138	148	1380										
	Replacement Base Plates			3091	3308	3539	3787	4052	4336	4639	4964	5311	5683	6081	6506	6962	7449	69707										
	Replacement test port plugs			5	6	6	7	7	8	8	9	9	10	11	11	12	13	121										
	Replacement I.L. attach bolts			3	3	3	3	4	4	4	5	5	5	6	6	6	7	64										
	Annual test apparatus	128									220							348										
	Assembly test apparatus	25									43							68										
Hardware Disposition	Annual test consumables			323	345	369	395	423	452	484	518	554	593	635	679	726	777	7274										
	Overpacks																											
	Trailers																											
	Impact Limiters																											
	Yokes																											
	Replacement Seals	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
	Replacement Bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
	Replacement Base Plates			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
	Replacement test port plugs			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
	Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
Labor	Annual test apparatus		17								17						17	51										
	Assembly test apparatus		17								17						17	51										
Transportation		15772		16660	17827	19075	20410	21838	23367	25003	26753	28626	30630	32774	35068	37523	40149	391474										
		7322		7835	8383	8970	9598	10270	10989	11758	12581	13462	14404	15413	16492	17646	18881	184006										
Total:		464	276,284	250,577	268,117	286,885	306,967	328,497	351,447	376,048	464,950	430,538	460,733	492,923	527,427	564,347	604,141	5,990,346										

Cost per shielding insert unit = \$ 391,091

**Appendix B.2 Life Cycle Cost Calculations for 15 Year Shipping
Campaign for Assumed Repository Availability Date of
2020**

Table B.2-1 Average Annual Inflation Rate = 3%

Table B.2-2 Average Annual Inflation Rate = 5%

Table B.2-3 Average Annual Inflation Rate = 7%

Table B.2-1

Life Cycle Cost Summary - 15 Year Shipping Campaign

June 30, 1995

Repository open date: 2020 Inflation rate = 3%

Cost (\$k)	1985	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total (\$k)
Fixed Costs																	
One time	265																265
Design	175																175
NRC Licensing		33															33
Shielding Insert Set Up Charge																	
Recurring	51																51
NRC License Renewal		22					25					29					126
Variable Costs																	
Hardware Acquisition		151950	156508	161203	166039	171021	176151	181436	186879	192485	198260	204207	210334	216644	223143	229837	2826096
Shielding Inserts		13672								17319							30991
Overpacks		9176								11623							20799
Trailers		3523								4463							7987
Impact Limiters		6423															6423
Yokes		23															23
Replacement Seals			24	24	25	26	27	28	28	29	30	31	32	33	34	35	429
Replacement Bolts			43	44	46	47	48	50	51	53	55	56	58	60	61	63	735
Replacement Base Plates			2174	2239	2306	2375	2447	2520	2596	2673	2754	2836	2921	3009	3099	3192	37141
Replacement test port plugs			4	4	4	4	4	4	5	5	5	5	5	5	5	6	65
Replacement I.L. attach bolts			2	2	2	2	2	2	2	2	3	3	3	3	3	3	34
Annual test apparatus		94								119							212
Assembly test apparatus		16								23							42
Annual test consumables			227	234	241	248	255	263	271	279	287	296	305	314	323	333	3876
Hardware Disposition																	
Overpacks										0							0
Trailers										0							0
Impact Limiters										0							0
Yokes		0								255							511
Replacement Seals																	0
Replacement Bolts																	0
Replacement Base Plates																	0
Replacement test port plugs																	0
Replacement test apparatus																	0
Annual test apparatus		17								17							51
Assembly test apparatus		17								17							51
Labor		11522	11716	12067	12429	12802	13186	13582	13989	14409	14841	15286	15745	16217	16704	17205	211700
Transportation		5349	5510	5675	5845	6021	6201	6387	6579	6776	6979	7189	7404	7627	7855	8091	99488
Total:	491	201,838	176,206	181,493	186,937	192,546	198,347	204,272	210,400	210,400	223,213	229,938	236,807	243,911	251,228	259,054	3,247,230

Cost per shielding insert unit = \$ 212,002

Table B.2-2

Life Cycle Cost Summary - 15 Year Shipping Campaign

June 30, 1995

Repository open date: 2020										Inflation rate = 5%							Total (\$k)	
Year																		
Cost (\$k)		1995	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	
Fixed Costs	One time	265																265
	Design	175																175
	NRC Licensing		55															55
	Shielding Insert Set Up Charge																	
	Recurring	60	36															199
	NRC License Renewal							45						58				
	Variable Costs																	
	Hardware Acquisition		250526	263053	276205	290016	304516	319742	335729	352516	370141	388649	408081	428485	449909	472405	496025	5405998
	Shielding Inserts		22541								33304							55845
	Overpacks		15128								22352							37480
Trailers		5809								8583							14392	
Impact Limiters		10590															10590	
Yokes																		
Replacement Seals			38	40	42	44	46	49	51	54	56	59	62	65	68	72	75	820
Replacement Bolts				72	76	80	84	88	92	97	102	107	112	118	124	130	136	1418
Replacement Base Plates				3654	3836	4028	4229	4441	4663	4896	5141	5398	5668	5951	6249	6561	6889	71604
Replacement test port plugs				6	7	7	7	8	8	9	9	9	10	10	11	11	12	125
Replacement I.L. attach bolts				3	4	4	4	4	4	4	5	5	5	5	6	6	6	66
Annual test apparatus		154									228							382
Assembly test apparatus		30									45							75
Annual test consumables				381	400	420	441	463	487	511	536	563	591	621	652	685	719	7472
Hardware Disposition	Overpacks																	
	Trailers																	
	Impact Limiters																	
	Yokes																	
	Replacement Seals		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Replacement Bolts			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Replacement Base Plates				0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Replacement test port plugs				0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Replacement I.L. attach bolts																	
	Annual test apparatus		17															51
Assembly test apparatus		17									17						17	51
Labor		18996	19691	20676	21710	22795	23935	25132	26388	27708	29093	30548	32075	33679	35363	37131	404919	
Transportation		8819	9260	9723	10210	10720	11256	11819	12410	13030	13682	14366	15084	15838	16630	17462	190309	
Total:		500	332758	296161	310969	326517	342843	360031	377985	396884	481529	437565	459501	482415	506536	531863	558745	6202801

Cost per shielding insert unit = \$ 404.962

Cost per shielding insert unit = \$ 769,271

Appendix C

Life Cycle Cost Calculations for 20 Year Shipping Campaign

Appendix C.1 Life Cycle Cost Calculations for 20 Year Shipping
Campaign for Assumed Repository Availability Date of
2010

Table C.1-1 Average Annual Inflation Rate = 0%

Table C.1-2 Average Annual Inflation Rate = 3%

Table C.1-3 Average Annual Inflation Rate = 5%

Table C.1-4 Average Annual Inflation Rate = 7%

Table C.1-1

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Repository open date: 2010		Inflation rate = 0									
Cost (\$k)	1995	Year									
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fixed Costs											
One time											
Design	265										
NRC Licensing	175										
Shielding Insert Set Up Charge		16									
Recurring											
NRC License Renewal	20	10					10				
Variable Costs											
Hardware Acquisition											
Shielding Inserts		52844	52844	52844	52844	52844	52844	52844	52844	52844	52844
Overpacks	4755	4755								4755	
Trailers	3191	3191								3191	
Impact Limiters	1225	1225								1225	
Yokes	2234	2234									
Replacement Seals	8	8	8	8	8	8	8	8	8	8	8
Replacement Bolts			15	15	15	15	15	15	15	15	15
Replacement Base Plates			734	734	734	734	734	734	734	734	734
Replacement test port plugs			1	1	1	1	1	1	1	1	1
Replacement I.L. attach bolts			1	1	1	1	1	1	1	1	1
Annual test apparatus	33	33								33	
Assembly test apparatus	6	6	77	77	77	77	77	77	77	77	77
Annual test consumables											
Hardware Disposition											
Overpacks										0	
Trailers										0	
Impact Limiters										191	
Yokes											
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0
Annual test apparatus	13	13								13	
Assembly test apparatus	13	13								13	
Labor		4007	3956	3956	3956	3956	3956	3956	3956	3956	3956
Transportation		1860	1860	1860	1860	1860	1860	1860	1860	1860	1860
Total:	460	70214	59495	59495	59495	59495	59505	59495	59495	68922	59495

Table C.1-1

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year										Total (\$k)
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Fixed Costs											
One time											265
Design											175
NRC Licensing											16
Shielding Insert Set Up Charge											60
Recurring	10					10					
NRC License Renewal											
Variable Costs											
Hardware Acquisition											1056873
Shielding Inserts	52844	52844	52844	52844	52844	52844	52844	52844	52844	52844	14264
Overpacks							4755				9573
Trailers							3191				3676
Impact Limiters							1225				2234
Yokes											160
Replacement Seals	8	8	8	8	8	8	8	8	8	8	8
Replacement Bolts	15	15	15	15	15	15	15	15	15	15	15
Replacement Base Plates	734	734	734	734	734	734	734	734	734	734	734
Replacement test port plugs	1	1	1	1	1	1	1	1	1	1	1
Replacement I.L. attach bolts	1	1	1	1	1	1	1	1	1	1	1
Annual test apparatus							33				98
Assembly test apparatus							6				19
Annual test consumables	77	77	77	77	77	77	77	77	77	77	1455
Hardware Disposition											
Overpacks							0			0	0
Trailers							0			0	0
Impact Limiters							191			191	574
Yokes										0	0
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus							13			13	51
Assembly test apparatus							13			13	51
Labor	3956	3956	3956	3956	3956	3956	3956	3956	3956	3956	79165
Transportation	1860	1860	1860	1860	1860	1860	1860	1860	1860	1860	37206
Total:	59505	59495	59495	59495	59495	59505	68922	59495	59495	59712	1220173

Cost per shielding insert unit = 79661

Table C.1-2

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Repository open date: 2010												Inflation rate = 3%			
Cost (\$k)	Year														
	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020				
Fixed Costs															
One time															
Design	265														
NRC Licensing	175														
Shielding Insert Set Up Charge		25													
Recurring															
NRC License Renewal	22	16					19								
Variable Costs															
Hardware Acquisition															
Shielding Inserts	84799		87343	89963	92662	95442	98305	101254	104292	107420	110643				
Overpacks	7630									9665					
Trailers	5121									6487					
Impact Limiters	1966									2491					
Yokes	3584														
Replacement Seals	13		13	14	14	14	15	15	16	16	17				
Replacement Bolts			24	25	25	26	27	28	29	30	30				
Replacement Base Plates			1213	1249	1287	1326	1365	1406	1448	1492	1537				
Replacement test port plugs			2	2	2	2	2	2	3	3	3				
Replacement I.L. attach bolts			1	1	1	1	1	1	1	1	1				
Annual test apparatus	52									66					
Assembly test apparatus	10		127	130	134	138	142	147	151	156	160				
Annual test consumables															
Hardware Disposition															
Overpacks										0					
Trailers										0					
Impact Limiters										191					
Yokes															
Replacement Seals	0		0	0	0	0	0	0	0	0	0				
Replacement Bolts			0	0	0	0	0	0	0	0	0				
Replacement Base Plates			0	0	0	0	0	0	0	0	0				
Replacement test port plugs			0	0	0	0	0	0	0	0	0				
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0				
Annual test apparatus	13		0	0	0	0	0	0	0	13					
Assembly test apparatus	13									13					
Labor		6430	6538	6734	6936	7144	7359	7580	7807	8041	8282				
Transportation		2985	3075	3167	3262	3360	3461	3564	3671	3762	3895				
Total:	462	112,657	98,336	101,286	104,324	107,454	110,696	113,998	117,418	139,879	124,569				

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year										Total (\$k)
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Fixed Costs											
One time											265
Design											175
NRC Licensing											25
Shielding Insert Set Up Charge											103
Recurring											
NRC License Renewal	22					25					
Variable Costs											
Hardware Acquisition											
Shielding Inserts	113962	117381	120902	124530	128265	132113	136077	140159	144364	148695	2278569
Overpacks							12244				29539
Trailers							8217				19825
Impact Limiters							3155				7613
Yokes	17	18	18	19	19	20	21	21	22	23	3584
Replacement Seals	31	32	33	34	35	36	37	39	40	41	346
Replacement Bolts	1583	1630	1679	1730	1781	1835	1890	1947	2005	2065	603
Replacement Base Plates	3	3	3	3	3	3	3	3	3	4	30469
Replacement test port plugs	1	1	2	2	2	2	2	2	2	2	53
Replacement I.L. attach bolts											28
Annual test apparatus							84				202
Assembly test apparatus							16				40
Annual test consumables	165	170	175	180	186	191	197	203	209	215	3179
Hardware Disposition											
Overpacks							0			0	0
Trailers							0			0	0
Impact Limiters							191			191	574
Yokes										0	0
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus							13			13	51
Assembly test apparatus							13			13	51
Labor	8531	8787	9050	9322	9602	9890	10186	10492	10807	11131	170649
Transportation	4012	4132	4256	4384	4515	4651	4790	4934	5082	5235	80213
Total:	128,327	132,155	136,119	140,203	144,409	148,766	177,137	157,800	162,534	167,627	2,626,156

Cost per shielding insert unit =\$ 171,454

Table C.1-3

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Repository open date: 2010 Inflation rate = 5%

Cost (\$k)	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fixed Costs											
One time											
Design	265										
NRC Licensing	175	34									
Shielding Insert Set Up Charge											
Recurring	23	22					28				
NRC License Renewal											
Variable Costs											
Hardware Acquisition		115351	121119	127175	133533	140210	147220	154581	162311	170426	178947
Shielding Inserts		10379								15334	
Overpacks		6966								10291	
Trailers		2675								3952	
Impact Limiters		4876									
Yokes		18	18	19	20	21	22	23	25	26	27
Replacement Seals			33	35	37	39	40	43	45	47	49
Replacement Bolts			1682	1766	1855	1947	2045	2147	2254	2367	2485
Replacement Base Plates			3	3	3	3	4	4	4	4	4
Replacement test port plugs			2	2	2	2	2	2	2	2	2
Replacement I.L. attach bolts		71								105	
Annual test apparatus		14	176	184	194	203	213	224	235	247	259
Assembly test apparatus										21	
Annual test consumables											
Hardware Disposition											
Overpacks										0	
Trailers										0	
Impact Limiters										191	
Yokes											
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts		0	0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0
Annual test apparatus	13	13								13	
Assembly test apparatus										13	
Labor		8746	9067	9520	9996	10496	11020	11571	12150	12758	13395
Transportation		4081	4264	4477	4701	4936	5183	5442	5714	6000	6300
Total:	463	153,237	136,363	143,181	150,340	157,857	165,778	174,037	182,739	221,796	201,470

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year										Total (\$k)
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Fixed Costs											
One time											265
Design											175
NRC Licensing											34
Shielding Insert Set Up Charge											
Recurring											153
NRC License Renewal	36					45					
Variable Costs											
Hardware Acquisition											
Shielding Inserts	187895	197289	207154	217512	228387	239807	251797	264387	277606	291486	3814193
Overpacks							22656				48369
Trailers							15205				32462
Impact Limiters							5839				12465
Yokes											4876
Replacement Seals	29	30	31	33	35	36	38	40	42	44	579
Replacement Bolts	52	54	57	60	63	66	69	73	76	80	1017
Replacement Base Plates	2610	2740	2877	3021	3172	3331	3497	3672	3856	4048	51373
Replacement test port plugs	5	5	5	5	6	6	6	6	7	7	89
Replacement I.L. attach bolts	2	3	3	3	3	3	3	3	4	4	47
Annual test apparatus							155				331
Assembly test apparatus							30				65
Annual test consumables	272	286	300	315	331	348	365	383	402	422	5361
Hardware Disposition											
Overpacks							0			0	0
Trailers							0			0	0
Impact Limiters							191			191	574
Yokes							0			0	0
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus							13			13	51
Assembly test apparatus							13			13	51
Labor	14065	14768	15507	16282	17096	17951	18849	19791	20781	21820	285630
Transportation	6615	6945	7293	7657	8040	8442	8864	9307	9773	10261	134272
Total:	211,579	222,121	233,227	244,888	257,133	270,035	327,591	297,663	312,546	328,390	4,392,434

Cost per shielding insert unit =\$ 286,769

Table C.1-4

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Repository open date: 2010										Inflation rate = 7%			
	1995	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020			
Fixed Costs														
One time	265													
Design	175													
NRC Licensing		46												
Shielding Insert Set Up Charge														
Recurring	24	30					41							
NRC License Renewal														
Variable Costs														
Hardware Acquisition		156003	166923	178608	191111	204488	218802	234119	250507	268042	286805			
Shielding Inserts		14037								24117				
Overpacks		9420								16186				
Trailers		3617								6215				
Impact Limiters		6594												
Yokes		24	25	27	29	31	33	36	38	41	44			
Replacement Seals			46	49	53	56	60	64	69	74	79			
Replacement Bolts			2318	2481	2654	2840	3039	3252	3479	3723	3983			
Replacement Base Plates			4	4	5	5	5	6	6	6	7			
Replacement test port plugs			2	2	2	3	3	3	3	3	4			
Replacement I.L. attach bolts		96								165				
Annual test apparatus		19	242	259	277	296	317	339	363	388	416			
Assembly test apparatus										32				
Annual test consumables														
Hardware Disposition														
Overpacks										0				
Trailers										0				
Impact Limiters										191				
Yokes														
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0			
Replacement Bolts		0	0	0	0	0	0	0	0	0	0			
Replacement Base Plates		0	0	0	0	0	0	0	0	0	0			
Replacement test port plugs		0	0	0	0	0	0	0	0	0	0			
Replacement I.L. attach bolts		0	0	0	0	0	0	0	0	0	0			
Annual test apparatus	13									13				
Assembly test apparatus	13									13				
Labor		11829	12495	13370	14306	15307	16379	17525	18752	20065	21469			
Transportation		5492	5876	6288	6728	7199	7703	8242	8819	9436	10097			
Total:	464	207,232	187,933	201,088	215,164	230,226	246,383	263,585	282,036	348,712	322,903			

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$K)	Year										Total (\$K)
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Fixed Costs											
One time											265
Design											175
NRC Licensing											46
Shielding Insert Set Up Charge											
Recurring											234
NRC License Renewal	58					81					
Variable Costs											
Hardware Acquisition											639,542
Shielding Inserts	306,882	328,363	351,349	375,943	402,259	430,417	460,547	492,785	527,280	564,190	79,592
Overpacks							41,438				53,417
Trailers							27,811				20,512
Impact Limiters							106,79				6,594
Yokes											
Replacement Seals	47	50	53	57	61	65	70	75	80	86	971
Replacement Bolts	84	90	97	103	111	118	127	136	145	155	1,716
Replacement Base Plates	42,621	45,611	48,801	52,211	55,871	59,781	63,961	68,441	73,231	78,361	86,559
Replacement test port plugs	7	8	8	9	10	10	11	12	13	14	151
Replacement I.L. attach bolts	4	4	4	5	5	5	6	6	7	7	79
Annual test apparatus							284				545
Assembly test apparatus							56				107
Annual test consumables	445	476	509	545	583	624	667	714	764	818	9,043
Hardware Disposition											
Overpacks							0			0	0
Trailers							0			0	0
Impact Limiters							191			191	574
Yokes										0	0
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus							13			13	51
Assembly test apparatus							13			13	51
Labor	22,972	24,580	26,301	28,142	30,112	32,220	34,475	36,888	39,471	42,233	478,993
Transportation	10,803	11,560	12,369	13,234	14,161	15,152	16,213	17,348	18,562	19,861	225,141
Total:	345,565	369,692	395,570	423,260	452,889	484,672	598,997	554,808	593,645	635,417	7,360,240

Cost per shielding insert unit = \$ 480.528

**Appendix C.2 Life Cycle Cost Calculations for 20 Year Shipping
Campaign for Assumed Repository Availability Date of
2020**

Table C.2-1 Average Annual Inflation Rate = 3%

Table C.2-2 Average Annual Inflation Rate = 5%

Table C.2-3 Average Annual Inflation Rate = 7%

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$)	Repository open date: 2020						Inflation rate = 3%				
	1995	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fixed Costs											
One time											
Design	265										
NRC Licensing	175										
Shielding Insert Set Up Charge		33									
Recurring											
NRC License Renewal	51	22					25				
Variable Costs											
Hardware Acquisition											
Shielding Inserts	113962		117381	120902	124530	128265	132113	136077	140159	144364	148695
Overpacks	10254									12989	
Trailers	6882									8718	
Impact Limiters	2643									3348	
Yokes	4817										
Replacement Seals	17		18	18	19	19	20	21	21	22	23
Replacement Bolts			32	33	34	35	36	37	39	40	41
Replacement Base Plates			1630	1679	1730	1781	1835	1890	1947	2005	2065
Replacement test port plugs			3	3	3	3	3	3	3	3	4
Replacement I.L. attach bolts			1	2	2	2	2	2	2	2	2
Annual test apparatus		70								89	
Assembly test apparatus		14	170	175	180	186	191	197	203	209	215
Annual test consumables											
Hardware Disposition											
Overpacks										0	
Trailers										0	
Impact Limiters										191	
Yokes											
Replacement Seals	0		0	0	0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0
Annual test apparatus	13									13	
Assembly test apparatus	13									13	
Labor											
	8641		8787	9050	9322	9602	9890	10186	10492	10807	11131
Transportation											
	4012		4132	4256	4384	4515	4651	4790	4934	5082	5235
Total:	491	151,392	132,155	136,119	140,203	144,409	148,766	153,204	157,800	167,912	167,410

Table C.2-1

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year										Total (\$k)
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	
Fixed Costs											
One time											
Design											265
NRC Licensing											175
Shielding Insert Set Up Charge											33
Recurring											
NRC License Renewal	29					34					160
Variable Costs											
Hardware Acquisition											
Shielding Inserts	153156	157750	162483	167357	172378	177549	182876	188362	194013	199833	3062206
Overpacks							16454				39698
Trailers							11043				26643
Impact Limiters							4241				10231
Yokes											4817
Replacement Seals	23	24	25	25	26	27	28	29	29	30	465
Replacement Bolts	42	43	45	46	47	49	50	52	53	55	811
Replacement Base Plates	2127	2191	2257	2324	2394	2466	2540	2616	2695	2775	40948
Replacement test port plugs	4	4	4	4	4	4	4	5	5	5	71
Replacement I.L. attach bolts	2	2	2	2	2	2	2	2	2	3	38
Annual test apparatus							113				272
Assembly test apparatus							22				53
Annual test consumables	222	229	235	243	250	257	265	273	281	290	4273
Hardware Disposition											
Overpacks							0			0	0
Trailers							0			0	0
Impact Limiters							191			191	574
Yokes										0	0
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus							13			13	51
Assembly test apparatus							13			13	51
Labor	11465	11809	12163	12528	12904	13291	13690	14100	14523	14959	229337
Transportation	5392	5553	5720	5892	6068	6250	6438	6631	6830	7035	107800
Total:	172,461	177,605	182,933	188,421	194,074	199,930	207,983	212,070	218,432	225,202	3,528,971

Cost per shielding insert unit = \$ 230,396

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$)		Repository open date: 2020										Inflation rate = 5%	
		Year											
		1995	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Fixed Costs													
One time													
Design	265												
NRC Licensing	175												
Shielding Insert Set Up Charge		55											
Recurring								45					
NRC License Renewal	60												
Variable Costs													
Hardware Acquisition													
Shielding Inserts		187895	197289		207154	217512	228387	239807	251797	264387	277606	291486	
Overpacks		16906									24978		
Trailers		11346									16764		
Impact Limiters		4357									6437		
Yokes		7942											
Replacement Seals		29	30	30	31	33	35	36	38	40	42	44	
Replacement Bolts			54	54	57	60	63	66	69	73	76	80	
Replacement Base Plates			2740	2740	2877	3021	3172	3331	3497	3672	3856	4048	
Replacement test port plugs			5	5	5	5	6	6	6	6	7	7	
Replacement I.L. attach bolts			3	3	3	3	3	3	3	3	4	4	
Annual test apparatus		116									171		
Assembly test apparatus		23									34		
Annual test consumables			286	286	300	315	331	348	365	383	402	422	
Hardware Disposition													
Overpacks											0		
Trailers											0		
Impact Limiters											191		
Yokes													
Replacement Seals		0	0	0	0	0	0	0	0	0	0	0	
Replacement Bolts			0	0	0	0	0	0	0	0	0	0	
Replacement Base Plates			0	0	0	0	0	0	0	0	0	0	
Replacement test port plugs			0	0	0	0	0	0	0	0	0	0	
Replacement I.L. attach bolts			0	0	0	0	0	0	0	0	0	0	
Annual test apparatus		13									13		
Assembly test apparatus		13									13		
Labor													
Transportation			14247	14768	15507	16282	17096	17951	18849	19791	20781	21820	
		6615	6945	7293	7293	7657	8040	8442	8854	9307	9773	10261	
Total:		500	249,591	222,121	233,227	244,888	257,133	270,035	283,489	297,663	361,146	328,173	

Table C.2-2

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year										Total (\$k)
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	
Fixed Costs											
One time											265
Design											175
NRC Licensing											55
Shielding Insert Set Up Charge											
Recurring											273
NRC License Renewal	58					74					
Variable Costs											
Hardware Acquisition											
Shielding Inserts	306061	321364	337432	354304	372019	390620	410151	430658	452191	474801	6212918
Overpacks							36904				78787
Trailers							24768				52878
Impact Limiters							9511				20305
Yokes											7942
Replacement Seals	46	49	51	54	56	59	62	65	69	72	943
Replacement Bolts	84	88	93	97	102	107	113	118	124	131	1657
Replacement Base Plates	4251	4463	4687	4921	5167	5425	5697	5981	6280	6594	83681
Replacement test port plugs	7	8	8	9	9	9	10	10	11	11	146
Replacement I.L. attach bolts	4	4	4	5	5	5	5	5	6	6	77
Annual test apparatus							253				539
Assembly test apparatus							50				106
Annual test consumables	444	466	489	513	539	566	594	624	655	688	8732
Hardware Disposition											
Overpacks							0			0	0
Trailers							0			0	0
Impact Limiters							191			191	574
Yokes										0	0
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus							13			13	51
Assembly test apparatus							13			13	51
Labor	22911	24056	25259	26522	27848	29241	30703	32238	33850	35542	465262
Transportation	10774	11313	11879	12473	13096	13751	14439	15161	15919	16715	218716
Total:	344,640	361,811	379,902	398,897	418,842	439,858	533,474	484,862	509,105	534,777	7,154,133

Cost per shielding insert unit =\$ 467,071

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$k)		Repository open date: 2020											Inflation rate = 7%			
		Year														
		1995	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030				
Fixed Costs	One time															
	Design	265														
	NRC Licensing	175	90													
	Shielding Insert Set Up Charge															
	Recurring	71	58				81									
	NRC License Renewal															
	Variable Costs															
	Hardware Acquisition															
	Shielding Inserts	306882		328363	351349	375943	402259	430417	460547	492785	527280	564190				
	Overpacks	27612									47442					
	Trailers	18532									31841					
	Impact Limiters	7116									12227					
	Yokes	12972														
Replacement Seals	47	50	53	57	61	65	70	75	80	86						
Replacement Bolts		90	97	103	111	118	127	136	145	155						
Replacement Base Plates		4561	4880	5221	5587	5978	6396	6844	7323	7836						
Replacement test port plugs		8	8	9	10	10	11	12	13	14						
Replacement I.L. attach bolts		4	4	5	5	5	6	6	7	7						
Annual test apparatus	189									325						
Assembly test apparatus	37									64						
Annual test consumables		476	509	545	583	624	667	714	764	818						
Hardware Disposition																
Overpacks										0						
Trailers										0						
Impact Limiters										191						
Yokes																
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0					
Replacement Bolts		0	0	0	0	0	0	0	0	0	0					
Replacement Base Plates		0	0	0	0	0	0	0	0	0	0					
Replacement test port plugs		0	0	0	0	0	0	0	0	0	0					
Replacement I.L. attach bolts		0	0	0	0	0	0	0	0	0	0					
Annual test apparatus	13									13						
Assembly test apparatus	13									13						
Labor		23269	24580	26301	28142	30112	32220	34475	36888	39471	42233					
Transportation		10803	11560	12369	13234	14161	15152	16213	17348	18562	19861					
Total:		512	407,632	369,692	395,570	423,260	452,889	484,672	518,512	554,808	585,760	635,200				

Table C.2-3

Life Cycle Cost Summary - 20 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year										Total (\$k)
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	
Fixed Costs											
One time											
Design											265
NRC Licensing											175
Shielding Insert Set Up Charge											90
Recurring											
NRC License Renewal	114					160					485
Variable Costs											
Hardware Acquisition											
Shielding Inserts	603683	645941	691156	739537	791305	846696	905965	969383	1037239	1109846	12580767
Overpacks							81515				155569
Trailers							54708				105080
Impact Limiters							21008				40351
Yokes	92	98	105	112	120	129	137	147	157	168	12972
Replacement Seals	166	178	190	203	218	233	249	267	285	305	1909
Replacement Bolts	8384	8971	9599	10271	10990	11760	12583	13464	14406	15415	3376
Replacement Base Plates	15	16	17	18	19	20	22	23	25	27	170471
Replacement test port plugs	8	8	9	9	10	11	12	12	13	14	296
Replacement I.L. attach bolts											156
Annual test apparatus	875	936	1002	1072	1147	1227	1313	1405	1503	1608	1072
Assembly test apparatus							558				210
Annual test consumables							109				17788
Hardware Disposition											
Overpacks							0			0	0
Trailers							0			0	0
Impact Limiters							191			191	574
Yokes	0	0	0	0	0	0	0	0	0	0	0
Replacement Seals	0	0	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	0	0
Annual test apparatus							13			13	51
Assembly test apparatus							13			13	51
Labor	45190	48353	51738	55359	59235	63381	67818	72565	77645	83080	942054
Transportation	21252	22739	24331	26034	27857	29807	31893	34126	36514	39070	442886
Total:	679,778	727,240	778,147	832,617	890,900	953,424	1,178,107	1,091,391	1,167,789	1,249,751	14,477,650

Cost per shielding insert unit = \$ 945,201

Appendix D

Life Cycle Cost Calculations for 25 Year Shipping Campaign

**Appendix D.1 Life Cycle Cost Calculations for 25 Year Shipping
Campaign for Assumed Repository Availability Date of
2010**

Table D.1-1 Average Annual Inflation Rate = 0%

Table D.1-2 Average Annual Inflation Rate = 3%

Table D.1-3 Average Annual Inflation Rate = 5%

Table D.1-4 Average Annual Inflation Rate = 7%

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Repository open date: 2010			Inflation rate = 0							
Cost (\$k)	Year									
	1995	2011	2012	2013	2014	2015	2016	2017	2018	
Fixed Costs										
One time										
Design	265									
NRC Licensing	175									
Shielding Insert Set Up Charge		16								
Recurring										
NRC License Renewal	20	10					10			
Variable Costs										
Hardware Acquisition		42275	42275	42275	42275	42275	42275	42275	42275	
Shielding Inserts		3804								
Overpacks		2553								
Trailers		980								
Impact Limiters		1787								
Yokes		6	6	6	6	6	6	6	6	
Replacement Seals			12	12	12	12	12	12	12	
Replacement Bolts			587	587	587	587	587	587	587	
Replacement Base Plates			1	1	1	1	1	1	1	
Replacement test port plugs			1	1	1	1	1	1	1	
Replacement i.L. attach bolts			1	1	1	1	1	1	1	
Annual test apparatus		27								
Assembly test apparatus		5	61	61	61	61	61	61	61	
Annual test consumables										
Hardware Disposition										
Overpacks										
Trailers										
Impact Limiters										
Yokes		0	0	0	0	0	0	0	0	
Replacement Seals			0	0	0	0	0	0	0	
Replacement Bolts			0	0	0	0	0	0	0	
Replacement Base Plates			0	0	0	0	0	0	0	
Replacement test port plugs			0	0	0	0	0	0	0	
Replacement i.L. attach bolts			0	0	0	0	0	0	0	
Annual test apparatus		10								
Assembly test apparatus		10								
Labor		3205	3165	3165	3165	3165	3165	3165	3165	
Transportation		1488	1488	1488	1488	1488	1488	1488	1488	
Total:	460	56177	47596	47596	47596	47596	47606	47596	47596	

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year								
	2019	2020	2021	2022	2023	2024	2025	2026	2027
Fixed Costs									
One time									
Design									
NRC Licensing									
Shielding Insert Set Up Charge									
Recurring									
NRC License Renewal			10					10	
Variable Costs									
Hardware Acquisition									
Shielding Inserts	42275	42275	42275	42275	42275	42275	42275	42275	42275
Overpacks	3804								3804
Trailers	2553								2553
Impact Limiters	980								980
Yokes									
Replacement Seals	6	6	6	6	6	6	6	6	6
Replacement Bolts	12	12	12	12	12	12	12	12	12
Replacement Base Plates	587	587	587	587	587	587	587	587	587
Replacement test port plugs	1	1	1	1	1	1	1	1	1
Replacement I.L. attach bolts	1	1	1	1	1	1	1	1	1
Annual test apparatus	27								27
Assembly test apparatus	5								5
Annual test consumables	61	61	61	61	61	61	61	61	61
Hardware Disposition									
Overpacks	0								0
Trailers	0								0
Impact Limiters	153								153
Yokes									
Replacement Seals	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0
Annual test apparatus	10								10
Assembly test apparatus	10								10
Labor	3165	3165	3165	3165	3165	3165	3165	3165	3165
Transportation	1488	1488	1488	1488	1488	1488	1488	1488	1488
Total:	55138	47596	47606	47596	47596	47596	47596	47606	55138

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year							Total (\$k)	
	2028	2029	2030	2031	2032	2033	2034		2035
Fixed Costs									
One time									265
Design									175
NRC Licensing									16
Shielding Insert Set Up Charge									
Recurring									
NRC License Renewal				10					70
Variable Costs									
Hardware Acquisition									1056873
Shielding Inserts	42275	42275	42275	42275	42275	42275	42275	42275	11411
Overpacks									7659
Trailers									2941
Impact Limiters									1787
Yokes	6	6	6	6	6	6	6	6	160
Replacement Seals	12	12	12	12	12	12	12	12	279
Replacement Bolts	587	587	587	587	587	587	587	587	14092
Replacement Base Plates									
Replacement test port plugs	1	1	1	1	1	1	1	1	25
Replacement I.L. attach bolts	1	1	1	1	1	1	1	1	13
Annual test apparatus									81
Assembly test apparatus									15
Annual test consumables	61	61	61	61	61	61	61	61	1470
Hardware Disposition									
Overpacks									0
Trailers									0
Impact Limiters									0
Yokes								153	460
Replacement Seals	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0
Annual test apparatus									41
Assembly test apparatus									41
Labor	3165	3165	3165	3165	3165	3165	3165	3165	79155
Transportation	1488	1488	1488	1488	1488	1488	1488	1488	37206
Total:	47596	47596	47596	47606	47596	47596	47596	47769	1214234

Cost per shielding insert unit = 79274

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$K)	Repository open date: 2010						Inflation rate = 3%		
	1995	2011	2012	2013	2014	2015	2016	2017	2018
Fixed Costs									
One time									
Design	265								
NRC Licensing	175								
Shielding Insert Set Up Charge		25							
Recurring									
NRC License Renewal	22	16					19		
Variable Costs									
Hardware Acquisition									
Shielding Inserts		67839	69874	71970	74129	76353	78644	81003	83433
Overpacks		6104							
Trailers		4097							
Impact Limiters		1573							
Yokes		2868							
Replacement Seals		10	11	11	11	12	12	12	13
Replacement Bolts			19	20	20	21	22	22	23
Replacement Base Plates			970	1000	1030	1060	1092	1125	1159
Replacement test port plugs			2	2	2	2	2	2	2
Replacement I.L. attach bolts			1	1	1	1	1	1	1
Annual test apparatus		44							
Assembly test apparatus		8							
Annual test consumables			101	104	107	111	114	117	121
Hardware Disposition									
Overpacks									
Trailers									
Impact Limiters									
Yokes		0	0	0	0	0	0	0	0
Replacement Seals			0	0	0	0	0	0	0
Replacement Bolts			0	0	0	0	0	0	0
Replacement Base Plates			0	0	0	0	0	0	0
Replacement test port plugs			0	0	0	0	0	0	0
Replacement I.L. attach bolts			0	0	0	0	0	0	0
Annual test apparatus		10							
Assembly test apparatus		10							
Labor		5144	5231	5387	5549	5716	5887	6064	6246
Transportation		2388	2460	2534	2610	2688	2769	2852	2937
Total:	462	90,135	78,668	81,029	83,459	85,963	88,561	91,198	93,934

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Table D.1-2

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year							Total (\$k)
	2028	2029	2030	2031	2032	2033	2034	2035
Fixed Costs								
One time								
Design								265
NRC Licensing								175
Shielding Insert Set Up Charge								25
Recurring								
NRC License Renewal				29				132
Variable Costs								
Hardware Acquisition								
Shielding Inserts	112127	115491	118956	122524	126200	129986	133886	137902
Overpacks								
Trailers								
Impact Limiters								
Yokes								
Replacement Seals	17	18	18	19	19	20	20	21
Replacement Bolts	31	32	33	34	35	36	37	38
Replacement Base Plates	1557	1604	1652	1702	1753	1805	1860	1915
Replacement test port plugs	3	3	3	3	3	3	3	3
Replacement I.L. attach bolts	1	1	2	2	2	2	2	2
Annual test apparatus								
Assembly test apparatus	163	167	172	178	183	188	194	200
Annual test consumables								
Hardware Disposition								
Overpacks								0
Trailers								0
Impact Limiters								0
Yokes								153
Replacement Seals	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0
Annual test apparatus								10
Assembly test apparatus								10
Labor	8393	8645	8905	9172	9447	9730	10022	10323
Transportation	3947	4066	4188	4313	4443	4576	4713	4855
Total:	126,240	130,027	133,928	137,975	142,084	146,347	150,737	155,433
								2,833,446

Cost per shielding insert unit = \$ 184,987

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Repository open date: 2010											Inflation rate = 5%				
Cost (\$k)		Year													
		1995	2011	2012	2013	2014	2015	2016	2017	2018					
Fixed Costs	One time														
	Design	265													
	NRC Licensing	175	34												
	Shielding Insert Set Up Charge														
	Recurring														
	NRC License Renewal	23	22					28							
	Variable Costs														
	Hardware Acquisition														
	Shielding Inserts		92281	96895	101740	106827	112168	117776	123665	129848					
	Overpacks		8303												
	Trailers		5573												
	Impact Limiters		2140												
	Yokes		3901												
	Replacement Seals		14	15	15	16	17	18	19	20					
	Replacement Bolts			27	28	29	31	32	34	36					
Replacement Base Plates			1346	1413	1484	1558	1636	1718	1803						
Replacement test port plugs			2	2	3	3	3	3	3						
Replacement I.L. attach bolts			1	1	1	1	2	2	2						
Annual test apparatus		59													
Assembly test apparatus		11		140	147	155	163	171	179	188					
Annual test consumables															
Hardware Disposition															
Overpacks															
Trailers															
Impact Limiters															
Yokes		0	0	0	0	0	0	0	0	0					
Replacement Seals															
Replacement Bolts															
Replacement Base Plates															
Replacement test port plugs															
Replacement I.L. attach bolts															
Annual test apparatus		10													
Assembly test apparatus		10													
Labor			6997	7253	7616	7997	8397	8816	9257	9720					
Transportation			3249	3411	3582	3761	3949	4146	4353	4571					
Total:		463	122,603	109,090	114,545	120,272	126,286	132,628	139,230	146,191					

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year							Total (\$k)
	2028	2029	2030	2031	2032	2033	2034	2035
Fixed Costs								
One time								
Design								265
NRC Licensing								175
Shielding Insert Set Up Charge								34
Recurring								
NRC License Renewal				58				211
Variable Costs								
Hardware Acquisition								
Shielding Inserts	211509	222085	233189	244849	257091	269946	283443	297615
Overpacks								
Trailers								
Impact Limiters								
Yokes	32	34	35	37	39	41	43	45
Replacement Seals	58	61	64	67	71	74	78	82
Replacement Bolts	2938	3085	3239	3401	3571	3749	3937	4134
Replacement Base Plates								
Replacement test port plugs	5	5	6	6	6	7	7	7
Replacement I.L. attach bolts	3	3	3	3	3	3	4	4
Annual test apparatus								
Assembly test apparatus								
Annual test consumables	307	322	338	355	373	391	411	431
Hardware Disposition								
Overpacks								0
Trailers								0
Impact Limiters								153
Yokes								0
Replacement Seals	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0
Annual test apparatus								10
Assembly test apparatus								10
Labor	15833	16625	17456	18329	19245	20207	21218	22279
Transportation	7446	7818	8209	8619	9050	9503	9978	10477
Total:	238,130	250,037	262,539	275,724	289,449	303,921	319,118	335,247
								5,037,369

Cost per shielding insert unit = \$ 328,874

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Repository open date: 2010										Inflation rate = 7%			
Cost (\$k)	Year												
	1995	2011	2012	2013	2014	2015	2016	2017	2018				
Fixed Costs													
One time													
Design	265												
NRC Licensing	175												
Shielding Insert Set Up Charge		46											
Recurring													
NRC License Renewal	24	30					41						
Variable Costs													
Hardware Acquisition													
Shielding Inserts		124802	133539	142886	152888	163591	175042	187295	200406				
Overpacks		11229											
Trailers		7536											
Impact Limiters		2894											
Yokes		5275											
Replacement Seals		19	20	22	23	25	27	28	30				
Replacement Bolts			37	39	42	45	48	52	55				
Replacement Base Plates			1855	1985	2123	2272	2431	2601	2783				
Replacement test port plugs			3	3	4	4	4	5	5				
Replacement I.L. attach bolts			2	2	2	2	2	2	3				
Annual test apparatus		80											
Assembly test apparatus		15	194	207	222	237	254	271	290				
Annual test consumables													
Hardware Disposition													
Overpacks													
Trailers													
Impact Limiters													
Yokes		0	0	0	0	0	0	0	0				
Replacement Seals			0	0	0	0	0	0	0				
Replacement Bolts			0	0	0	0	0	0	0				
Replacement Base Plates			0	0	0	0	0	0	0				
Replacement test port plugs			0	0	0	0	0	0	0				
Replacement I.L. attach bolts			0	0	0	0	0	0	0				
Annual test apparatus		10											
Assembly test apparatus		10											
Labor													
		9463	9996	10696	11445	12246	13103	14020	15002				
Transportation		4393	4701	5030	5382	5759	6162	6593	7055				
Total:	464	165,804	150,346	160,870	172,131	184,180	197,114	210,868	225,629				

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year								
	2019	2020	2021	2022	2023	2024	2025	2026	2027
Fixed Costs									
One time									
Design									
NRC Licensing									
Shielding Insert Set Up Charge									
Recurring									
NRC License Renewal			58					81	
Variable Costs									
Hardware Acquisition									
Shielding Inserts	214434	229444	245505	262691	281079	300755	321807	344334	368437
Overpacks	19294								33150
Trailers	12949								22249
Impact Limiters	4972								8543
Yokes									
Replacement Seals	33	35	37	40	43	46	49	52	56
Replacement Bolts	59	63	68	72	77	83	89	95	101
Replacement Base Plates	2978	3187	3410	3648	3904	4177	4470	4782	5117
Replacement test port plugs	5	6	6	6	7	7	8	8	9
Replacement I.L. attach bolts	3	3	3	3	4	4	4	4	5
Annual test apparatus	138								236
Assembly test apparatus	26								44
Annual test consumables	311	333	356	381	407	436	466	499	534
Hardware Disposition									
Overpacks	0								0
Trailers	0								0
Impact Limiters	153								153
Yokes									
Replacement Seals	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0
Annual test apparatus	10								10
Assembly test apparatus	10								10
Labor	16052	17175	18378	19664	21041	22514	24090	25776	27580
Transportation	7549	8077	8643	9248	9895	10588	11329	12122	12970
Total:	278,975	258,323	276,463	295,754	316,456	338,608	362,311	387,754	479,207

Table D.1-4

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year							Total (\$k)
	2028	2029	2030	2031	2032	2033	2034	2035
Fixed Costs								
One time								
Design								265
NRC Licensing								175
Shielding Insert Set Up Charge								46
Recurring								
NRC License Renewal				114				349
Variable Costs								
Hardware Acquisition								
Shielding Inserts	394228	421824	451352	482946	516752	552925	591630	633044
Overpacks								
Trailers								
Impact Limiters								
Yokes								
Replacement Seals	60	64	69	73	78	84	90	96
Replacement Bolts	108	116	124	133	142	152	163	174
Replacement Base Plates	5475	5859	6269	6708	7177	7680	8217	8792
Replacement test port plugs	10	10	11	12	12	13	14	15
Replacement I.L. attach bolts	5	5	6	6	7	7	8	8
Annual test apparatus								
Assembly test apparatus								
Annual test consumables	571	611	654	700	749	801	857	917
Hardware Disposition								
Overpacks								
Trailers								
Impact Limiters								
Yokes								
Replacement Seals	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0
Annual test apparatus								
Assembly test apparatus								
Labor	29511	31576	33787	36152	38682	41390	44288	47388
Transportation	13878	14850	15889	17001	18191	19465	20827	22285
Total:	443,846	474,916	508,160	543,845	581,792	622,517	666,094	712,894
								9,015,323

Cost per shielding insert unit = \$ 588,583

**Appendix D.2 Life Cycle Cost Calculations for 25 Year Shipping
Campaign for Assumed Repository Availability Date of
2020**

Table D.2-1 Average Annual Inflation Rate = 3%

Table D.2-2 Average Annual Inflation Rate = 5%

Table D.2-3 Average Annual Inflation Rate = 7%

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Repository open date: 2020										Inflation rate = 3%			
Cost (\$k)	Year												
	1995	2021	2022	2023	2024	2025	2026	2027	2028				
Fixed Costs													
One time													
Design	265												
NRC Licensing	175												
Shielding Insert Set Up Charge		33											
Recurring													
NRC License Renewal	51	22					25						
Variable Costs													
Hardware Acquisition													
Shielding Inserts		91170	93905	96722	99624	102612	105691	108861	112127				
Overpacks		8203											
Trailers		5505											
Impact Limiters		2114											
Yokes		3854											
Replacement Seals		14	14	15	15	16	16	17	17				
Replacement Bolts			26	27	27	28	29	30	31				
Replacement Base Plates			1304	1343	1384	1425	1468	1512	1557				
Replacement test port plugs													
Replacement I.L. attach bolts			2	2	2	2	3	3	3				
Annual test apparatus		58	1	1	1	1	1	1	1				
Assembly test apparatus		11											
Annual test consumables			136	140	144	149	153	158	163				
Hardware Disposition													
Overpacks													
Trailers													
Impact Limiters													
Yokes		0	0	0	0	0	0	0	0				
Replacement Seals			0	0	0	0	0	0	0				
Replacement Bolts			0	0	0	0	0	0	0				
Replacement Base Plates			0	0	0	0	0	0	0				
Replacement test port plugs			0	0	0	0	0	0	0				
Replacement I.L. attach bolts			0	0	0	0	0	0	0				
Annual test apparatus		10											
Assembly test apparatus		10											
Labor		6913	7029	7240	7458	7681	7912	8149	8393				
Transportation		3209	3306	3405	3507	3612	3721	3832	3947				
Total:	491	121,127	105,724	108,896	112,162	115,527	119,018	122,563	126,240				

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year									
	2029	2030	2031	2032	2033	2034	2035	2036	2037	
Fixed Costs										
One time										
Design										
NRC Licensing										
Shielding Insert Set Up Charge										
Recurring										
NRC License Renewal			29					34		
Variable Costs										
Hardware Acquisition										
Shielding Inserts	115491	118956	122524	126200	129986	133886	137902	142039	146301	
Overpacks	10391								13164	
Trailers	6974								8835	
Impact Limiters	2678								3392	
Yokes										
Replacement Seals	18	18	19	19	20	20	21	22	22	
Replacement Bolts	32	33	34	35	36	37	38	39	40	
Replacement Base Plates	1604	1652	1702	1753	1805	1860	1915	1973	2032	
Replacement test port plugs	3	3	3	3	3	3	3	3	4	
Replacement I.L. attach bolts	1	2	2	2	2	2	2	2	2	
Annual test apparatus	74								94	
Assembly test apparatus	14								18	
Annual test consumables	167	172	178	183	188	194	200	206	212	
Hardware Disposition										
Overpacks	0								0	
Trailers	0								0	
Impact Limiters	153								153	
Yokes										
Replacement Seals	0	0	0	0	0	0	0	0	0	
Replacement Bolts	0	0	0	0	0	0	0	0	0	
Replacement Base Plates	0	0	0	0	0	0	0	0	0	
Replacement test port plugs	0	0	0	0	0	0	0	0	0	
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	
Annual test apparatus	10								10	
Assembly test apparatus	10								10	
Labor	8645	8905	9172	9447	9730	10022	10323	10633	10952	
Transportation	4066	4188	4313	4443	4576	4713	4855	5000	5150	
Total:	150,332	133,928	137,975	142,084	146,347	150,737	155,259	159,950	190,390	

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year							Total (\$k)
	2038	2039	2040	2041	2042	2043	2044	2045
Fixed Costs								
One time								
Design								265
NRC Licensing								175
Shielding Insert Set Up Charge								33
Recurring								
NRC License Renewal				39				199
Variable Costs								
Hardware Acquisition								
Shielding Inserts	150690	155210	159867	164663	169603	174691	179931	185329
Overpacks								
Trailers								
Impact Limiters								
Yokes								
Replacement Seals	23	24	24	25	26	27	27	28
Replacement Bolts	41	43	44	45	47	48	49	51
Replacement Base Plates								
Replacement test port plugs	2093	2156	2220	2287	2356	2426	2499	2574
Replacement I.L. attach bolts	4	4	4	4	4	4	4	4
Annual test apparatus	2	2	2	2	2	2	2	2
Assembly test apparatus								
Annual test consumables								
Hardware Disposition	218	225	232	239	246	253	261	269
Overpacks								
Trailers								
Impact Limiters								
Yokes								
Replacement Seals	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0
Annual test apparatus								
Assembly test apparatus								
Labor	11280	11619	11967	12326	12696	13077	13469	13873
Transportation	5305	5464	5628	5797	5971	6150	6334	6524
Total:	169,656	174,745	179,988	185,426	190,949	196,678	202,578	208,829
								3,807,599

Cost per shielding insert unit = \$ 248,586

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Repository open date: 2020										Inflation rate = 5%			
Cost (\$k)	Year												
	1995	2021	2022	2023	2024	2025	2026	2027	2028				
Fixed Costs													
One time													
Design	265												
NRC Licensing	175												
Shielding Insert Set Up Charge		55											
Recurring													
NRC License Renewal	60	36					45						
Variable Costs													
Hardware Acquisition													
Shielding Inserts		150316	157832	165723	174009	182710	191845	201438	211509				
Overpacks		13525											
Trailers		9077											
Impact Limiters		3486											
Yokes		6354											
Replacement Seals		23	24	25	26	28	29	31	32				
Replacement Bolts			43	46	48	50	53	55	58				
Replacement Base Plates			2192	2302	2417	2538	2665	2798	2938				
Replacement test port plugs			4	4	4	4	5	5	5				
Replacement I.L. attach bolts			2	2	2	2	2	3	3				
Annual test apparatus		96											
Assembly test apparatus		18	229	240	252	265	278	292	307				
Annual test consumables													
Hardware Disposition													
Overpacks													
Trailers													
Impact Limiters													
Yokes		0	0	0	0	0	0	0	0				
Replacement Seals			0	0	0	0	0	0	0				
Replacement Bolts			0	0	0	0	0	0	0				
Replacement Base Plates			0	0	0	0	0	0	0				
Replacement test port plugs			0	0	0	0	0	0	0				
Replacement I.L. attach bolts			0	0	0	0	0	0	0				
Annual test apparatus		10											
Assembly test apparatus		10											
Labor		11398	11815	12406	13026	13677	14361	15079	15833				
Transportation		5292	5556	5834	6126	6432	6754	7091	7446				
Total:	500	199,695	177,697	186,581	195,910	205,706	216,037	226,791	238,130				

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year									
	2029	2030	2031	2032	2033	2034	2035	2036	2037	
Fixed Costs										
One time										
Design										
NRC Licensing										
Shielding Insert Set Up Charge										
Recurring										
NRC License Renewal			58					74		
Variable Costs										
Hardware Acquisition										
Shielding Inserts	222085	233189	244849	257091	269946	283443	297615	312496	328120	
Overpacks	19982								29523	
Trailers	13411								19814	
Impact Limiters	5150								7609	
Yokes										
Replacement Seals	34	35	37	39	41	43	45	47	50	
Replacement Bolts	61	64	67	71	74	78	82	86	90	
Replacement Base Plates	3085	3239	3401	3571	3749	3937	4134	4340	4557	
Replacement test port plugs	5	6	6	6	7	7	7	8	8	
Replacement I.L. attach bolts	3	3	3	3	3	4	4	4	4	
Annual test apparatus	142								211	
Assembly test apparatus	27								40	
Annual test consumables	322	338	355	373	391	411	431	453	476	
Hardware Disposition										
Overpacks	0								0	
Trailers	0								0	
Impact Limiters	153								153	
Yokes										
Replacement Seals	0	0	0	0	0	0	0	0	0	
Replacement Bolts	0	0	0	0	0	0	0	0	0	
Replacement Base Plates	0	0	0	0	0	0	0	0	0	
Replacement test port plugs	0	0	0	0	0	0	0	0	0	
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0	
Annual test apparatus	10								10	
Assembly test apparatus	10								10	
Labor	16625	17456	18329	19245	20207	21218	22279	23392	24562	
Transportation	7818	8209	8619	9050	9503	9978	10477	11001	11551	
Total:	288,923	262,539	275,724	289,449	303,921	319,118	335,073	351,901	426,788	

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year								Total (\$k)
	2038	2039	2040	2041	2042	2043	2044	2045	
Fixed Costs									
One time									265
Design									175
NRC Licensing									55
Shielding Insert Set Up Charge									367
Recurring				94					
NRC License Renewal									
Variable Costs									
Hardware Acquisition									7174136
Shielding Inserts	344527	361753	379840	398833	418774	439713	461698	484783	63030
Overpacks									42302
Trailers									16244
Impact Limiters									6354
Yokes									1089
Replacement Seals	52	55	58	61	64	67	70	74	1932
Replacement Bolts	95	99	104	110	115	121	127	133	97553
Replacement Base Plates	4785	5024	5276	5539	5816	6107	6412	6733	170
Replacement test port plugs	8	9	9	10	10	11	11	12	89
Replacement I.L. attach bolts	4	5	5	5	5	6	6	6	449
Annual test apparatus									85
Assembly test apparatus									10179
Annual test consumables	499	524	550	578	607	637	669	703	
Hardware Disposition									0
Overpacks									0
Trailers									0
Impact Limiters								153	460
Yokes								0	0
Replacement Seals	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0
Annual test apparatus								10	41
Assembly test apparatus								10	41
Labor	25790	27080	28434	29855	31348	32916	34561	36289	537179
Transportation	12128	12735	13372	14040	14742	15479	16253	17066	252554
Total:	387,889	407,284	427,648	449,125	471,482	495,056	519,809	545,973	8,204,749

Cost per shielding insert unit = \$ 535,663

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Repository open date: 2020										Inflation rate = 7%			
Cost (\$k)	Year												
	1995	2021	2022	2023	2024	2025	2026	2027	2028				
Fixed Costs													
One time													
Design	265												
NRC Licensing	175												
Shielding Insert Set Up Charge		90											
Recurring													
NRC License Renewal	71	58					81						
Variable Costs													
Hardware Acquisition													
Shielding Inserts		245505	262691	281079	300755	321807	344334	368437	394228				
Overpacks		22090											
Trailers		14825											
Impact Limiters		5693											
Yokes		10378											
Replacement Seals		37	40	43	46	49	52	56	60				
Replacement Bolts			72	77	83	89	95	101	108				
Replacement Base Plates			3648	3904	4177	4470	4782	5117	5475				
Replacement test port plugs			6	7	7	8	8	9	10				
Replacement I.L. attach bolts			3	4	4	4	4	5	5				
Annual test apparatus	158												
Assembly test apparatus	30												
Annual test consumables			381	407	436	466	499	534	571				
Hardware Disposition													
Overpacks													
Trailers													
Impact Limiters													
Yokes		0	0	0	0	0	0	0	0				
Replacement Seals			0	0	0	0	0	0	0				
Replacement Bolts			0	0	0	0	0	0	0				
Replacement Base Plates			0	0	0	0	0	0	0				
Replacement test port plugs			0	0	0	0	0	0	0				
Replacement I.L. attach bolts			0	0	0	0	0	0	0				
Annual test apparatus	10		0	0	0	0	0	0	0				
Assembly test apparatus	10												
Labor		18615	19664	21041	22514	24090	25776	27580	29511				
Transportation		8643	9248	9895	10588	11329	12122	12970	13878				
Total:	512	326,142	295,754	316,456	338,608	362,311	387,754	414,810	443,846				

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$k)	Year								
	2029	2030	2031	2032	2033	2034	2035	2036	2037
Fixed Costs									
One time									
Design									
NRC Licensing									
Shielding Insert Set Up Charge									
Recurring			114					160	
NRC License Renewal									
Variable Costs									
Hardware Acquisition									
Shielding Inserts	421824	451352	482946	516752	552925	591630	633044	677357	724772
Overpacks	37954								65212
Trailers	25472								43766
Impact Limiters	9781								16806
Yokes									
Replacement Seals	64	69	73	78	84	90	96	103	110
Replacement Bolts	116	124	133	142	152	163	174	186	199
Replacement Base Plates	5859	6269	6708	7177	7680	8217	8792	9408	10066
Replacement test port plugs	10	11	12	12	13	14	15	16	18
Replacement I.L. attach bolts	5	6	6	7	7	8	8	9	9
Annual test apparatus	271								465
Assembly test apparatus	51								88
Annual test consumables	611	654	700	749	801	857	917	982	1050
Hardware Disposition									
Overpacks	0								0
Trailers	0								0
Impact Limiters	153								153
Yokes									
Replacement Seals	0	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0	0
Annual test apparatus	10								10
Assembly test apparatus	10								10
Labor	31576	33787	36152	38682	41390	44288	47388	50705	54254
Transportation	14850	15889	17001	18191	19465	20827	22285	23845	25514
Total:	548,619	508,160	543,845	581,792	622,517	666,094	712,720	762,771	942,504

Life Cycle Cost Summary - 25 Year Shipping Campaign

June 30, 1995

Cost (\$)	Year							Total (\$)
	2038	2039	2040	2041	2042	2043	2044	2045
Fixed Costs								
One time								
Design								265
NRC Licensing								175
Shielding Insert Set Up Charge								90
Recurring								
NRC License Renewal				225				710
Variable Costs								
Hardware Acquisition	775506	829792	887877	950028	1016530	1087687	1163826	1245293
Shielding Inserts								15527979
Overpacks								125256
Trailers								84064
Impact Limiters								32281
Yokes								10378
Replacement Seals	118	126	135	144	154	165	177	189
Replacement Bolts	213	228	244	261	280	299	320	342
Replacement Base Plates	10771	11525	12332	13195	14118	15107	16164	17296
Replacement test port plugs	19	20	21	23	25	26	28	30
Replacement I.L. attach bolts	10	11	11	12	13	14	15	16
Annual test apparatus								
Assembly test apparatus								
Annual test consumables	1124	1203	1287	1377	1473	1576	1687	1805
Hardware Disposition								
Overpacks								
Trailers								
Impact Limiters								
Yokes								
Replacement Seals	0	0	0	0	0	0	0	0
Replacement Bolts	0	0	0	0	0	0	0	0
Replacement Base Plates	0	0	0	0	0	0	0	0
Replacement test port plugs	0	0	0	0	0	0	0	0
Replacement I.L. attach bolts	0	0	0	0	0	0	0	0
Annual test apparatus								
Assembly test apparatus								
Labor	58052	62116	66464	71116	76094	81421	87120	93219
Transportation	27300	29211	31256	33444	35785	38290	40971	43839
Total:	873,113	934,231	999,627	1,069,826	1,144,473	1,224,586	1,310,307	1,402,202
								17,733,580

Cost per shielding insert unit = \$ 1,157,771

