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Cost Estimate for an Away-From-Reactor Generic Interim Storage Facility (GISF) for Spent Nuclear Fuel

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REPORT SUMMARY

As nuclear power plants began to run out of storage capacity in spent nuclear fuel (SNF) storage pools, many nuclear operating companies added higher density pool storage racks to increase pool capacity. Most nuclear power plant storage pools have been re-racked one or more times. As many spent fuel storage pools were re-racked to the maximum extent possible, nuclear operating companies began to employ interim dry storage technologies to store SNF in certified casks and canister-based systems outside of the storage pool in independent spent fuel storage installations (ISFSIs). Since there will be a need for additional SNF storage capacity for several decades into the future, an alternative to storing SNF at reactor sites would be to store SNF at away-from-reactor interim SNF storage facilities, referred to herein as a “generic interim storage facility” or “GISF.” This study provides an overview of the timing and projected costs associated with the design, licensing, construction, and operation of a GISF.

Background

As of December 2008, 45 nuclear power plant sites (with 74 nuclear power plants) have loaded spent fuel into dry storage facilities. More than 11,000 metric tons of uranium (MTU) of SNF has been loaded into dry storage in more than 1000 dry storage packages. In addition to the SNF storage requirements for the existing fleet of 104 operating nuclear power plants, U.S. companies have submitted or plan to submit applications to the NRC to license 34 new nuclear power plants. This cost estimate for an away-from-reactor GISF is particularly important in light of the issues raised by the lack of permanent storage capacity.

Objectives

To provide a cost estimate for the design, licensing, construction, and operation of a generic interim SNF storage facility, considering the primary variables of cask size and GISF capacity.

Approach

EPRI’s base case cost estimate in this report assumes that a 40,000 MTU capacity GISF would operate for a 40-year period. Alternative GISF capacities of 20,000 and 60,000 MTU were also considered. During the first 20 years, the GISF would receive SNF for storage at a rate of 2000 MTU per year, and during the second 20 years the GISF would ship the SNF offsite for subsequent waste management activities (including permanent disposal and recycling) In evaluating the costs for a 40,000 MTU GISF, EPRI assumed a capacity of 10 MTU per dual-purpose canister (DPC). EPRI also evaluated the impact of using canisters with a capacity of 13 MTU, which is more representative of the capacity of dry storage canisters currently in use at the reactor sites. In evaluating the number of canisters received at a GISF with a capacity of 20,000 MTU or 60,000 MTU and the resulting costs, EPRI utilized an assumed 10 MTU DPC capacity to estimate GISF system costs.

Results

EPRI estimated the costs associated with design, engineering, licensing, and startup professional services to be $67 million for all scenarios considered—no matter what GISF capacity is selected. For a 40,000 MTU facility with a capacity of 4000 storage systems, capital costs are estimated to be $490 million, and decommissioning costs for the fuel storage facility and concrete overpacks are estimated to be $230 million. For a 20,000 MTU facility with a capacity

of 2000 storage systems, capital costs are estimated to be $270 million, and decommissioning costs for the fuel storage facility and concrete overpacks are estimated to be $110 million. For a 60,000 MTU facility with a capacity of 6000 storage systems, capital costs are estimated to be $690 million, and decommissioning costs for the fuel storage facility and concrete overpacks are estimated to be $340 million. Cost elements associated with the difference in capital costs for the various facility capacities include transportation equipment (escort cars, locomotives, and buffer cars required); the number of fuel transfer cells in the canister transfer building; the capacity of the fuel storage facility; the number of rail casks and related equipment required; and site-specific geological conditions associated with the transfer of SNF by rail.

Staffing costs for the 40,000 MTU facility are estimated to be $8.0 million per year during periods of loading or unloading, with a staff of 85 full-time employees (FTE); $3.7 million per year during caretaker periods, with a staff of 40 FTE; and $8.5 million per year during periods of loading and unloading, with a staff of 91. Staffing costs for the 20,000 MTU facility are estimated to be $5.3 million per year during periods of loading or unloading, with a staff of 58 FTE; $3.7 million per year during caretaker periods, with a staff of 40 FTE; and $5.7 million per year during periods of loading and unloading, with a staff of 61 FTE. Staffing costs for the 60,000 MTU facility are estimated to be $9.9 million per year during periods of loading or unloading, with a staff of 106 FTE; $3.7 million per year during caretaker periods, with a staff of 40 FTE; and $11 million per year during periods of loading and unloading, with a staff of 120 FTE. The differences in staffing are primarily related to the cask throughput for the facility. This throughput will drive the number of maintenance and equipment operations staff as well as the number of staff needed to support at-reactor loading. The larger facilities also have somewhat greater requirements for administrative staff as well as additional health physics and quality assurance personnel.

EPRI Perspective

As interest in centralized ISFSIs increases, it is useful to perform a cost estimate that is relevant both to users of a centralized GISF (for example, nuclear utilities and DOE) as well as to potential host communities. Hence, the cost estimates EPRI provides in this report are as close to "best estimate" as possible. It should be noted that this study is a generic cost estimate and should be used accordingly.

Keywords

Independent Spent Fuel Storage
Centralized Spent Fuel Storage
Independent Spent Fuel Storage Installation (ISFSI)

CONTENTS

1 OVERVIEW OF AWAY-FROM-REACTOR SPENT FUEL STORAGE

1.1 Background

When commercial nuclear power plants were constructed in the U.S., spent nuclear fuel (SNF) storage pools were not designed with storage capacity for the lifetime of SNF that would ultimately be discharged from the plants over their original forty-year operating licenses. The original plan was for the SNF to cool for several years after being permanently discharged from nuclear power plants and then to ship the SNF to a SNF reprocessing facility for recycling. In 1977, the U.S. government decided that the U.S. would forego reprocessing and would instead directly dispose of SNF. The plan to directly dispose of SNF was codified into law with the passage of the Nuclear Waste Policy Act (NWPA) in 1982. The NWPA tasked the U.S. Department of Energy (DOE) with the development of a geologic repository for the direct disposal of SNF. However, this facility is behind schedule and is not expected to begin acceptance of SNF until 2020 or later. While recycling of SNF is currently being reconsidered in the U.S., it could be several decades before a recycling facility is built and begins to accept and process SNF.

As nuclear power plants began to run out of storage capacity in spent fuel storage pools, many nuclear operating companies added higher density pool storage racks to increase pool capacity. Most nuclear power plant storage pools have been reracked one or more times. As many spent fuel storage pools were reracked to the maximum extent possible, nuclear operating companies began to utilize dry storage technologies to store SNF in certified casks and canister based systems outside of the storage pool in Independent Spent Fuel Storage Installations (ISFSI).

The interim dry storage of SNF was first demonstrated at a nuclear power plant site in the U.S. with the licensing of Dominion Nuclear's Surry Station ISFSI in 1986. Over the past twenty years, as more reactors reached the limit of adding additional SNF storage capacity in SNF storage pools, the need for dry storage of spent fuel has increased. A significant need for additional SNF storage capacity now exists – 45 nuclear power plant sites (with 74 nuclear power plants) have loaded spent fuel into dry storage facilities as of December 2008. More than 11,000 metric tons of uranium (MTU) of SNF has been loaded into dry storage in more than 1,000 dry storage packages. In addition to these operating ISFSIs, several dozen nuclear power plants plan to implement dry storage in the near term. In addition to the SNF storage requirements for the existing fleet of 104 operating nuclear power plants, U.S. companies have submitted or plan to submit as many as 23 applications to the NRC to license 34 new nuclear power plants through 2010.[1]

Since there will be a need for additional storage capacity for SNF for several decades into the future, an alternative to storing SNF at reactor sites would be to store SNF at away-from-reactor

[1] U.S. NRC, Expected New Nuclear Power Plant Applications, Updated October 2, 2008. http://www.nrc.gov/reactors/new-reactors/new-licensing-files/expected-new-rx-applications.pdf

interim SNF storage facilities, referred to herein as a "generic interim storage facility" or "GISF". The study reported herein provided an overview of the timing and projected costs associated with the design, licensing, construction and operation of a GISF.

The costs presented in this study are based on estimates by the author or cited documents. It should be noted that this is a generic cost estimate and should be used accordingly. Site specific geological conditions, geographic location and specific site features may result in higher or lower costs for construction of facilities and transport of spent nuclear fuel by rail. Site proximity to rail transportation corridors and the need to build site access roads will be dependent upon the specific location under consideration for a GISF.

1.2 NRC Licensing Process for a GISF

A GISF would be designed, licensed, constructed and operated in accordance with the U.S. Nuclear Regulatory Commission's (NRC) site specific licensing provisions as provided in Title 10, Part 72, of the U.S. Code of Federal Regulations, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Great Than Class C Waste* (10CFR72).

Under current regulations, the initial license term for a GISF may not exceed 20 years from the date of issuance, and licenses may be renewed by the NRC at the expiration of the initial license term upon application by the licensee. In July 2008, NRC released preliminary draft language for public comment that would make changes to 10CFR72 to allow for longer initial and renewal terms for Part 72 licenses. That is, the NRC proposes to change the initial license term to 40 years from the date of issuance of a license. In addition, the NRC proposes to allow licenses to be renewed for a period up to 40 years.[2]

In order to obtain a site-specific license, the applicant must demonstrate to the NRC that issuance of the license, authorizing construction and operation of an ISFSI at a designated site, meets all of the technical, administrative, and environmental licensing requirements. A one-step licensing process is utilized in 10CFR72. The application for a site-specific license must contain general and financial information about the applicant, proposed technical specifications, a Safety Analysis Report (SAR), an emergency plan, an ISFSI decommissioning plan, a security plan, and an Environmental Report (ER).

The SAR presents a description and safety assessment of the proposed site and ISFSI structures; a plan for the conduct of operation; general design criteria; an emergency plan; a description of the quality assurance program; a description of a detailed physical protection plan; and a description of the decommissioning plan.

After the NRC receives and reviews a license for completeness, notice of the proposed action and opportunity for public hearing is published in the Federal Register to afford the public an opportunity to participate in the licensing process. Procedures associated with public hearings are specified in Title 10, Part 2, Subparts G and K.

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[2] U.S. NRC, 10 CFR Part 72, RIN: 3150-AI09, [NRC-2008-0361], License and Certificate of Compliance Terms AGENCY: Nuclear Regulatory Commission, Availability of preliminary draft rule language, MOL082381089.

1.3 Schedule for Development of a GISF

Based on recent license applications to the NRC for other fuel cycle facilities (such as enrichment facilities), EPRI has developed an estimated schedule for the siting, design, licensing and construction of a GISF. As shown in Figure 1-1, three phases are associated with the development of a GISF including: a Pre-License Application Phase, a License Application Review Phase, and an Initial Construction/Pre-Operations Phase.

During the Pre-License Application Phase, the GISF applicant would develop a program management infrastructure, perform siting studies and geotechnical investigations associated with sites under consideration, and would begin interactions with stakeholders in the areas of the potential sites. Once a site has been selected, the GISF applicant would complete preliminary designs for the GISF, balance of plant facilities, and transportation infrastructure to support completion of the ER and SAR that accompany the facility License Application (LA). For the purposes of cost estimation, EPRI assumed the Pre-License Application Phase would take eighteen months to complete.

During the License Application Review Phase, the NRC would review the application for the GISF and would prepare a Safety Evaluation Report (SER) and an Environmental Impact Statement (EIS) to support the licensing decision. The applicant would continue its project management functions and stakeholder interactions. In addition, this phase would include technical and legal support to answer NRC Requests for Additional Information (RAI) regarding the application and to participate in the hearing process. Detailed designs would be completed for the facility, balance of plant facilities, and transportation infrastructure. This phase would also include any state or local review required, such as reviews associated with obtaining building permits. At the end of this phase, the NRC would issue a license under 10CFR72 for the construction and operation of a GISF.

It should be noted that the time required for the NRC to reach a final decision on a LA for an away-from-reactor GISF will depend on the extent to which the spent fuel storage technology to be referenced in the license has already been certified by NRC. Based on review times associated with other recent fuel cycle facility licensing actions, EPRI assumes an NRC review time of three years. This assumes that the dry storage technology referenced in the facility license has already been certified by the NRC under 10CFR72.

During the Initial Construction/Pre-Operations Phase, the applicant would continue its project management functions to oversee construction operations and would begin building its staff to operate the facility. Interactions with stakeholder would continue. In addition, this phase would include any engineering or legal support required during construction. This phase would conclude with system start up and dry-run testing which would precede facility operations. EPRI estimates that this phase would take approximately eighteen months.

As presented in Figure 1-1, EPRI assumes that it could take a total of six years to develop a GISF from the time that siting studies begin until the facility is ready to begin operation. It should be noted that the schedule for siting, design, construction and licensing for a GISF could take longer than six years. The schedule will be dependent upon the quality of the LA submitted, the extent to which certified dry storage technologies are referenced in the facility design, and whether or not there is intervention in the NRC hearing process.

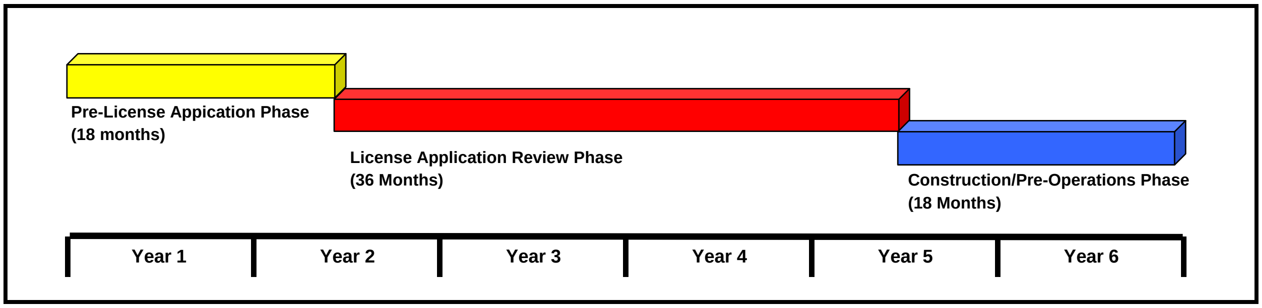

Figure 1-1
Estimated Schedule for Siting, Design, Licensing and Construction of a GISF

1.4 Basic Site Description for a GISF

A generic site plan for a GISF is presented in Figure 1-2. For the purposes of this analysis, EPRI relied upon the site plan, types of facilities, and facility sizes assumed in the Private Fuel Storage LLC Final Environmental Impact Statement (NUREG-1714).[3] NUREG-1714 was utilized as it provides a recent example of the types of facilities that would be required for an away-from-reactor SNF storage facility.

The Owner Controlled Area (OCA) would be bounded by a fence. Within the OCA, there would be a Restricted Area that would contain the Fuel Storage Facility including the storage pads, the Canister Transfer Facility, and a Security/Health Physics building. Fencing around the Restricted Area would consist of two 8-foot security fences. The inner fence would be separated from the outer nuisance fence by a 20 foot isolation area, as required by NRC regulations. Other buildings on the GISF site, such as an Administration Building, Concrete Batch Plant, and Operations and Maintenance Building would be located within the OCA, but outside of the Restricted Area security fences.

EPRI utilized the description of the various buildings and building specifications assumed in NUREG-1714 as proxies for the buildings for a GISF.

[3] U.S. Nuclear Regulatory Commission, Final Environmental Impact Statement for the Construction and Operation of an Independent Spent Fuel Storage Installation on the Reservation of the Skull Valley Band of Goshute Indians and the Related Transportation Facility in Tooele County, Utah, NUREG-1714, December 2001. (NRC 2001)

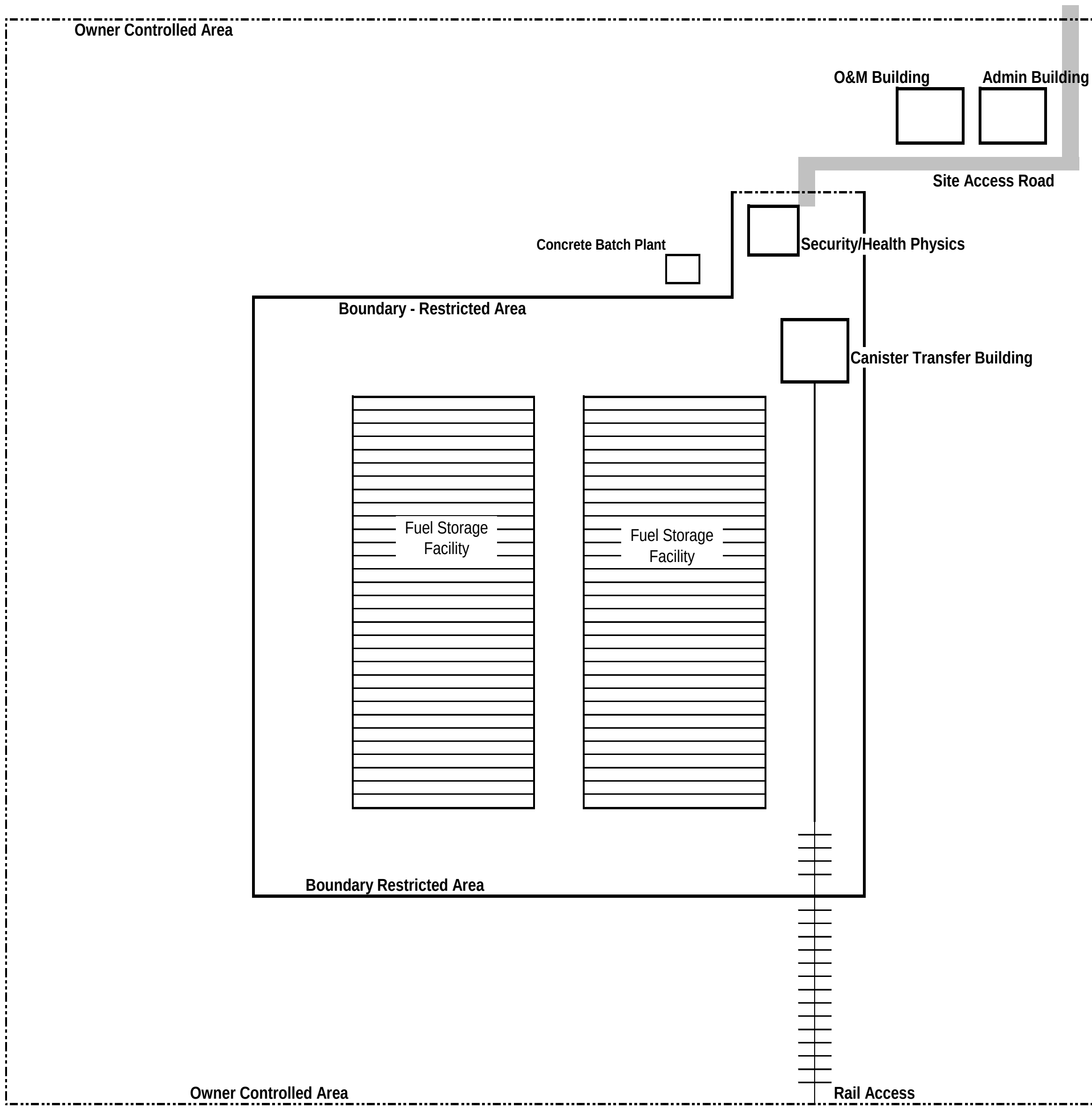

Figure 1-2
Basic Site Plan For a Generic Interim SNF Storage Facility

1.5 Logistical Assumptions Used to Estimate Capital and Operating Costs

EPRI's base case cost estimate in this report assumes that a 40,000 MTU capacity GISF would operate for a 40 year period. Alternative GISF capacities of 20,000 and 60,000 MTU were also considered. During the first 20 years, the GISF would receive SNF for storage at a rate of 2,000 MTU per year, and during the second 20 years the GISF would ship SNF offsite for subsequent waste management activities (permanent disposal, recycling, etc.) For a given facility capacity (e.g., 40,000 MTU), the number of dual-purpose canisters (DPC) received for storage on an annual basis will depend upon the capacity of the DPCs. While EPRI refers to the GISF as accepting and storing DPCs, the GISF could also accept and store transport, aging and disposal (TAD) canisters that are currently under development by the DOE. A DPC (or TAD) package with a 10 MTU capacity would store approximately 21 PWR assemblies or 44 BWR assemblies. A higher-capacity DPC, such as those currently used for onsite storage at nuclear power plants, has a capacity of approximately 13 MTU and would store approximately 32 PWR assemblies or 68 BWR assemblies.[4]

In evaluating the costs for a 40,000 MTU GISF, EPRI assumed a capacity of 10 MTU per canister. EPRI also evaluated the impact of using canisters with a capacity of 13 MTU, which is more representative of the capacity of the dry storage canisters currently being used at the reactor sites. In evaluating the number of canisters received at a GISF with a capacity of 20,000 MTU or 60,000 MTU and the resulting costs, EPRI utilized an assumed 10 MTU DPC capacity to estimate GISF system costs.

Table 1-1 summarizes the logistical assumptions for a GISF with a 40,000 MTU capacity receiving SNF in DPCs with capacities of either 10 MTU or 13 MTU. Table 1-1 also includes the logistics associated with a GISF with a capacity of 20,000 MTU and 60,000 MTU. Thus, a GISF with a 40,000 MTU capacity, receiving SNF in DPCs with a capacity of 10 MTU over a 20-year period, would have an annual receipt rate of 2,000 MTU per year or 200 DPCs per year. This would be a mix of DPCs containing either pressurized water reactor (PWR) or boiling water reactor (BWR) SNF. A 40,000 MTU capacity GISF, receiving 2,000 MTU of SNF in 13-MTU capacity DPCs, would have annual receipts of 154 DPCs per year. Similarly, a 20,000 MTU capacity GISF would receive 100 DPCs per year over a 20 year period, and a 60,000 MTU capacity GISF would receive 300 DPCs per year over a 20-year period.

Table 1-1
GISF Capacity and Annual Throughput Assumptions

GISF Capacity (MTU)	Annual Receipt Rate (MTU/Year)	DPC Capacity (MTU)	DPC Receipt Rate (DPC/Year)
40,000	2,000	10	200
40,000	2,000	13	154
20,000	1,000	10	100
60,000	3,000	10	300

These capacity and throughput assumptions are utilized by EPRI to determine the number of transportation casks needed in a GISF cask fleet, along with the amount of rail car equipment and to calculate costs for the GISF storage-related infrastructure.

A detailed cost estimate for a 40,000 MTU GISF accepting 10 MTU capacity DPCs is summarized in Section 2. In Section 3, EPRI summarizes the capital and operating costs associated with a 40,000 MTU GISF accepting 13 MTU capacity DPCs. For comparison purposes, Section 3 also summarizes the capital and operating costs for a 20,000 MTU and 60,000 MTU capacity GISF as described in Table 1-1, above. Even though some of the numbers report in the following tables contain more than two significant digits to aid in traceability back to the spreadsheet calculations, the cost estimates are accurate to no more than two significant digits.

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[4] Even higher capacity dual-purpose systems now exist. However, the 32P/68B size was used as representative of the average dual-purpose cask size currently in use.

2
ESTIMATED CAPITAL AND OPERATING COSTS FOR A GISF

As discussed in Section 1, there will be a need for additional interim storage capacity for SNF for several decades into the future. The nuclear industry is exploring whether the development of a GISF for interim dry storage of SNF may provide another alternative to storing SNF at reactor sites in dry storage. This section provides an overview of the capital and operating cost elements for a GISF. This includes costs associated with the design, engineering and licensing for the facility, GISF capital costs, GISF annual operating costs, and estimates for annual labor costs. Each of these cost elements is discussed in more detail below along with a summary of estimated costs. All cost provided are in constant 2009 dollars, and are not escalated or discounted. Since this cost estimate is not based on a specific site or a detailed design, EPRI applied a contingency factor of 30% to all cost elements. Labor costs include a 40% adder for benefits and contingency.

EPRI estimated costs for a base case facility capacity of 40,000 MTU, but also examined the costs associated with a 20,000 and 60,000 MTU capacity. EPRI's base case cost estimate, presented in this section, assumes that the SNF storage systems that would be used at the site have a capacity of approximately 10 MTU per storage container. However, EPRI has also evaluated the impact on the various cost elements associated with use of a higher capacity storage system that can store approximately 13 MTU per container. These results are summarized in Section 3.

As noted previously, the costs presented in this study are based on estimates by the author or cited documents. It should be noted that this is a generic cost estimate and should be used accordingly. For some cost elements, EPRI has included what it refers to as "placeholder" costs. That is, the cost element is site specific and more knowledge would be needed about a specific GISF site location in order to determine, for example, how much it would cost to construct a rail line to the site.

2.1 GISF Design, Engineering, Licensing and Startup Professional Services

GISF design, engineering, licensing and startup professional services costs include activities associated with the three pre-operational phases described in Section 1.3 and shown in Figure 1-1: a Pre-License Application Phase, a License Application Review Phase, and an Initial Construction/Pre-Operations Phase. The costs are meant to be representative of costs associated with design, engineering and licensing for a GISF. However, as noted previously, site specific geological conditions, geographic location and specific site features may result in higher or lower costs for facility design and engineering. Site proximity to rail transportation corridors and the need to develop site access roads will impact the costs for design and engineering for transportation infrastructure. EPRI estimates that representative costs associated with GISF design, engineering, licensing and startup total approximately $67.4 million, including a 30% contingency factor.

2.1.1 Pre-License Application Phase

During the Pre-License Application Phase, the GISF applicant would develop a program management infrastructure, perform siting studies and geotechnical investigations associated with sites under consideration, and would begin interactions with stakeholders in the areas of the potential sites. Once a site has been selected, the GISF applicant would complete preliminary designs for the GISF, balance of plant facilities, and transportation infrastructure to support completion of the ER and SAR that accompany the facility License Application (LA). EPRI assumes the Pre-License Application Phase would take eighteen months to complete.

As shown in Table 2-1, EPRI estimates that the project management activities during this time period would cost approximately $3.0 million. Public information and stakeholder outreach activities are estimated to be $1.5 million. This value will be dependent upon the number of sites initially being investigated prior to site selection. Geotechnical investigations needed to support development of the ER and SAR, and development of the ER to support the License Application are estimated at a cost of $2.0 million. EPRI estimates that the cost to perform preliminary design work for the GISF, balance of plant facilities, and transportation infrastructure; and development of the SAR and License Application will cost $7.4. These costs can vary based on site geologic conditions, site topography, the proximity of the site to transportation infrastructure, etc. Total costs during this phase are estimated to be approximately $18.1 million, with a 30% contingency added.

Table 2-1
GISF Pre-License Submittal Phase: Estimated Costs for Siting, Design and Engineering Services

Description of Service	Cost Estimate (Millions 2009$)
Project Management	$3.0
Public Information and Stakeholder Involvement	$1.5
Geotechnical Investigations and Environment Report Development	$2.0
Preliminary Design, Safety Analysis, and Preparation of License Application	$7.4
Subtotal GISF Pre-License Submittal Phase	**$13.9**
Contingency: 30%	**$ 4.2**
Total GISF Pre-License Submittal Phase:	**$18.1**

2.1.2 License Application Review Phase

EPRI assumes that activities completed during the License Application Review Phase will take approximately 36-months. During this phase, the NRC would review the application for the GISF and would prepare an Environmental Impact Statement (EIS) to support the licensing decision. The applicant would continue its project management functions and stakeholder interactions. Project management during the License Application Review Phase is estimated to cost $2.5 million. Public outreach and stakeholder interaction activities are estimated to cost $1.5 million.

Costs for NRC fees for review and approval of the License Application are estimated to be $16.0 million.[5] The applicant would also incur costs associated with technical and legal support during this phase, estimated to cost $6.0 million. It should be noted that these costs could be significantly higher if the NRC staff has significant questions regarding the analyses in the ER or SAR or if there is contentious intervention in the licensing proceeding. Costs associated with completion of detailed designs for GISF facilities and transportation infrastructure are estimated to be $4.5 million. As noted above, the costs for design of the GISF and transportation infrastructure will be highly site specific and will depend upon site specific geological conditions, geographic location, specific site features, and site proximity to existing transportation infrastructure.

This phase would also include technical and legal support and fees associated with any state or local review required, such as reviews associated with obtaining building permits. EPRI estimates these costs to be $0.5 million. EPRI estimates that total costs during the License Application Review Phase would be approximately $40.3 million with a 30% contingency added.

Table 2-2
GISF License Application Review Phase: Estimated Costs for Siting, Design and Engineering Services

Description of Service	Cost Estimate (Millions 2009$)
Project Management	$ 2.5
Public Information and Stakeholder Involvement	$ 1.5
NRC Fees for LA Review, EIS, and Hearing Process	$16.0
Technical and Legal Support During LA Review and Hearing Process	$ 6.0
Detailed design for GISF Facilities and Transportation Infrastructure	$ 4.5
State and Local Authority Review	$ 0.5
Subtotal: GISF License Application Review Phase	**$31.0**
Contingency: 30%	**$ 9.3**
Total GISF License Application Review Phase	**$40.3**

2.1.3 Initial Construction/Pre-Operations Phase

EPRI assumes that activities completed during the Initial Construction/Pre-Operations Phase will take approximately 18-months. During this phase, the applicant would continue its project management functions to oversee construction operations and would begin building its staff to

[5] This estimate assumes that NRC will utilize a total of five full-time equivalent (FTE) staff and five FTE contractors over a three-year period to review the application, develop an EIS, and a Safety Evaluation Report and support the hearing process before an Atomic Safety and Licensing Board. EPRI assumed an NRC review cost of $260/hour which is the same order of magnitude as NRC review costs described in 10CFR170.2.

operate the facility. Project management costs are estimated to be $1.4 million. Interactions with stakeholder would continue at an estimated cost of $1.5 million. In addition, this phase would include any engineering or legal support required during construction, assumed to cost $2.3 million. This phase would conclude with system start up and dry-run testing for the facility and the transportation system, at an estimated cost of $1.7 million. Total costs during this phase are estimated to be $9.0 million, with a 30% contingency added.

Table 2-3
GISF Initial Construction/Pre-Operations Phase: Estimated Costs for Siting, Design and Engineering Services

Description of Service	Cost Estimate (Millions 2009$)
Project Management	$1.4
Public Information and Stakeholder Involvement	$1.5
Engineering and Legal Support During Construction	$2.3
System startup, dry-run testing	$1.7
Subtotal GISF Initial Construction/Pre-Operations Phase	**$6.9**
Contingency: 30%	**$2.1**
Total GISF Initial Construction/Pre-Operations Phase	**$9.0**

2.2 GISF Capital Costs

Capital costs associated with a GISF include the costs for construction of GISF facilities including: transportation infrastructure; GISF buildings, equipment, and infrastructure; and equipment needed to load and transport SNF from nuclear power plants to the GISF. The costs presented are meant to be representative of capital costs for a GISF and associated infrastructure costs associated with design, engineering and licensing for a GISF. However, as noted previously, site specific geological conditions, geographic location and specific site features may result in higher or lower costs for facility design and engineering. Site proximity to rail transportation corridors and the need to develop site access roads will impact the costs for design and engineering for transportation infrastructure. EPRI estimates that representative capital costs associated with construction of the GISF and transportation infrastructure are $493.7 million. The major capital cost drivers are rail transport equipment, Fuel Storage Facility storage pads, concrete storage overpacks, and transport cask equipment, as described in more detail below.

2.2.1 Transportation Infrastructure

The costs associated with development of the transportation infrastructure for a GISF will be highly dependent upon the site chosen for the facility. Costs will depend upon the site's proximity to rail transportation corridors and the resulting length of a rail spur or heavy haul route to the site. The costs associated with the design and construction of site access roads will depend upon the existing transportation infrastructure, site topography, etc. The costs for access road improvements and rail spur and rail siding construction are included for illustrative purposes but should not be construed as bounding costs for construction of these types of facilities. In addition to construction of transportation access roads and rail infrastructure, this cost element also includes the costs associated with purchase of rail equipment needed to transport loaded SNF transportation casks from reactor sites to the GISF site for interim storage. In addition, this cost category includes the capital costs associated with land improvements for the transportation infrastructure – another cost element that will be highly dependent upon the conditions of the site ultimately selected for a GISF. Transfer and transportation equipment costs are considered in Section 2.2.4.

The equipment needed to transport loaded SNF casks from reactor sites to the GISF includes: rail locomotives (these could also be leased), rail escort cars, and rail buffer cars (flatbed rail cars that are required by regulation to separate SNF cask cars from the locomotive and escort car). Each shipment is assumed to include one locomotive, one escort car, two buffer cars, and two cask cars. In order to calculate the cost of the rail equipment, EPRI estimated the cask fleet size based upon an assumed GISF capacity of 40,000 MTU, annual receipt rate of 2,000 MTU, and annual DPC receipt of 200 DPCs. EPRI assumed a transport cask turnaround time of 7 weeks per rail cask. This is the time assumed for a round-trip shipment of the empty rail cask from the GISF to the reactor site, factoring time to load two casks, return shipment of the loaded rail cask to the GISF, and any time needed to unload the casks and ready the empty casks for shipment to the next user. Multiplying the cask capacity (10 MTU) by 52 weeks in a year and dividing by the cask turn-around time results in each transport cask being able to ship 74 MTU of SNF annually. If the GISF receives 2000 MTU of SNF annually using casks that can each transport 74 MTU of SNF annually, a fleet of 28 casks would be needed, as shown in Table 2-4. Note that EPRI rounded up to an even number of casks so that they are loaded and transported in pairs. The cask fleet requirements for the various facility capacities considered are shown in Table 2-4.

Table 2-4
Transportation Cask Fleet Assumptions

GISF Capacity (MTU)	Cask Capacity (MTU)	DPC Receipt Rate (DPC/Year)	Transport Cask Turn-Around Time (Weeks)	MTU Shipped Per Year by Cask (MTU/year/Cask)	Cask Fleet Size (# Casks)
	(a)	(b)	(c)	(d) = [(a)*52 weeks]/(c)	[Annual MTU/(d)]
40,000	10	200	7	74	28
40,000	13	154	7	97	22
20,000	10	100	7	74	14
60,000	10	300	7	74	40

Table 2-5 presents the number of escort cars, buffer cars and locomotives needed to transport SNF to the GISF for the various facility capacities considered. EPRI assumed that each train will include: one locomotive, the first buffer car, two SNF rail cars, a second buffer car, and an escort car. This means that there will be 2 buffer cars for every two rail cask cars, and one locomotive and one escort car for every two rail cask cars. For a 40,000 MTU GISF, a cask fleet of 28 rail casks would be needed along with 28 buffer cars, 14 locomotives, and 14 rail cars, as shown in Table 2-4 and 2-5.

Table 2-5
Transportation Rail Equipment Assumptions

GISF Capacity (MTU)	Cask Capacity (MTU)	DPC Receipt Rate (DPC/Year)	Rail Cask Fleet Size	Buffer Cars	Locomotives	Escort Cars
40,000	10	200	28	28	14	14
40,000	13	154	22	22	11	11
20,000	10	100	14	14	7	7
60,000	10	300	40	40	20	20

Table 2-6 presents the costs for transportation infrastructure for a GISF. EPRI's analysis assumed placeholder costs for access road improvements of $3 million, rail spur and rail siding construction costs of $6 million, and transportation infrastructure land improvements of $5 million. These costs will be dependent upon the site selected, hence EPRI's characterization of the assumed costs as "placeholder" costs.

EPRI assumed that the costs for escort cars would be $3.7 million per car and that buffer cars would be $0.5 million per car.[6] This estimate is based on recently published estimates for escort and buffer cars for a DOE life cycle cost estimate for the Yucca Mountain repository. EPRI assumed that locomotives would cost $4 million per locomotive. The American Public Transport Association lists cost for a commuter rail locomotive of $2.4 million.[7] The EPRI estimate of $4 million per locomotive assumed that freight locomotives would be more costly than a commuter rail locomotive. EPRI estimated a cost of $56 million for 14 locomotives, $51.8 million for 14 escort cars, and $14.0 million for 28 buffer cars. Total costs for Transportation Infrastructure are estimated to be $176.5 million, when a 30% contingency applied.

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[6] These are the same unit costs assumed by the U.S. Department of Energy in its "*Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program, Fiscal Year 2007*, July 2008, DOE/RW-0591, Table 3-8. (2008 TSLCC)

[7] American Public Transport Association, U.S. Average New Vehicle Costs for 2007 and 2008 Vehicles by Type, Table 22, http://www.apta.com/research/stats/documents/table22_vehvosttransitlength.pdf; http://www.co.dane.wi.us/rail/report/systemop.htm

Table 2-6
GISF Capital Costs: Transportation Infrastructure for a 40,000 MTU GISF

Description of Service	Cost Estimate (Millions 2009$)
Access road improvements	$ 3.0
Rail spur / rail siding construction	$ 6.0
Land improvements	$ 5.0
Rail locomotive: 14	$56.0
Rail escort cars: 14	$51.8
Rail buffer cars: 28	$14.0
Subtotal Transportation Infrastructure	**$135.8**
Contingency: 30%	**$ 40.7**
Total Transportation Infrastructure	**$176.5**

2.2.2 GISF Infrastructure

The GISF Infrastructure costs include the cost of the support buildings, equipment, Fuel Storage Facility, cask and canister handling equipment, and cask transportation equipment. EPRI assumed that a GISF would have the same types and sizes of buildings assumed for the PFS facility as summarized in NUREG-1714. GISF Infrastructure includes: Administration Building, Security and Health Physics Building, and an Operations and Maintenance Building. EPRI assumed that the facility footprints and therefore the costs for these facilities would be the same for the three GISF capacities evaluated. In addition, GISF Infrastructure includes the Canister Transfer Building, Fuel Storage Facility, and Equipment for DPC loading, handling and transportation, all of which are capacity dependent.

The Administration Building was assumed to have a footprint of 12,000 square feet (ft^2).(NRC 2001) This facility would include functions for administrative offices, document control and records management, communications and emergency response center, training center, and a lunch room. In order to determine an approximate cost for construction of the support facilities, EPRI located an estimate for a warehouse facility that assumed a cost of $104/$ft^2$ for a facility to be built in the State of Maryland.[8] Since the Administration Building would require more finishing than a warehouse, EPRI assumed that the cost to construct this facility would be $120/$ft^2$. As shown in Table 2-7, the estimated cost for construction of the Administration Building is $1.4 million. An additional $2.3 million was assumed for furnishing and office equipment, and site improvements and utilities. Total estimated costs for construction of the Administration Building is $3.7 million.

[8] Western Correctional Institution , Department of Public Safety and Correctional Services, New Warehouse, http://mlis.state.md.us/2005rs/budget_docs/All/Capital/QB0801A_-_DPSCS_Western_Corr_Inst_New_Warehouse.pdf

The Security and Health Physics Building was assumed to have a footprint of 10,000 ft^2. (NRC 2001) This facility would include functions for facility access portals, badging, security monitoring center, dosimetry center, locker and shower facilities, and fire and emergency management (EMT) center. EPRI assumed that the cost to construct this facility would be \$105/ft^2. This unit cost is similar to the cost for the warehouse facility noted above. As shown in Table 2-7, the estimated cost for construction of the Security and Health Physics Building is \$1.0 million. An additional \$1.8 million was assumed for furnishing and equipment, an emergency diesel generator, and a vehicle motor pool. Total estimated costs for construction of the Security and Health Physics Building is \$2.8 million.

The Operations and Maintenance Building was assumed to have a footprint of 16,000 ft^2. (NRC 2001) This facility would include functions for maintenance shops, storage areas for spare parts and equipment, and heavy lifting equipment such as a bridge crane and fork lift. EPRI assumed that the cost to construct this facility would be \$105/ft^2. As shown in Table 2-7, the estimated cost for construction of the Operations and Maintenance Building is \$1.7 million. An additional \$1.3 million was assumed for furnishing and equipment, and the heavy lifting equipment was estimated to cost \$3.0 million. Total estimated costs for construction of the Operations and Maintenance Building is \$6.0 million.

The Canister Transfer Building was assumed to have a footprint of 52,000 ft^2 (NRC 2001). This facility would include functions for transport cask receipt, transport cask decontamination, and transfer of DPCs from transport casks to storage overpacks. The facility would include canister transfer cells, heavy lifting equipment (such as bridge and gantry cranes), and heavy haul equipment to transfer loaded storage casks to the Fuel Storage Facility. EPRI assumed that the cost to construct this facility would be \$105/ft^2. As shown in Table 2-7, the estimated cost for construction of the Canister Transfer Building is \$5.4 million. EPRI assumed that canister transfer cells and associated equipment would cost \$2.5 million per transfer cell. For a facility throughput of 200 canisters per year, there would be an average of 18 DPCs transferred per month. EPRI assumed that each canister transfer station could transfer up to 8 DPCs per month (2 per week), resulting in a need to have three canister transfer facilities for the 40,000 MTU facility receiving DPCs with a 10 MTU capacity. Thus, the total cost of the canister transfer stations is \$7.5 million. EPRI assumed a cost of \$6.0 million for the heavy lifting equipment and heavy haul equipment. Total estimated costs for construction of the Canister Transfer Building is \$18.9 million.

Total GISF Infrastructure costs for buildings and associated equipment are estimated to be \$31.4 million, plus a 30% contingency of \$9.4 million, for total costs of \$40.8 million. Of these costs, EPRI assumes that all of these cost elements would remain the same for the various GISF capacities examined, except that the number of canister transfer cells needed would change based on the DPC annual throughput.

Table 2-7
GISF Capital Costs: GISF Infrastructure for a 40,000 MTU GISF (Millions 2009$)

GISF Capital Cost Elements	Cost Estimate
Administration Building	
• Building construction	$1.4
• Furnishings, equipment, site improvements, utilities	$2.3
Total	**$3.7**
Security and Health Physics Building	
• Building construction	$1.0
• Furnishings, equipment, emergency diesel generator, vehicles	$1.8
Total	**$2.8**
Operations and Maintenance Building	
• Building construction	$1.7
• Furnishings, equipment,	$1.3
• Heavy lifting equipment	$3.0
Total	**$6.0**
Canister Transfer Building	
• Building Construction	$5.4
• Canister transfer cells and equipment: 3	$7.5
• Heavy lifting equipment and heavy haul equipment	$6.0
Total	**$18.9**
Subtotal GISF Infrastructure	**$31.4**
Contingency: 30%	$ 9.4
Total GISF Infrastructure	**$40.8**

2.2.3 Fuel Storage Facility – 40,000 MTU Capacity

The capital costs for the Fuel Storage Facility include the costs for excavation and grading for the concrete storage pads; construction of the concrete storage pads; security equipment such as fencing, lighting, intrusion detection equipment and closed-circuit television; area radiation monitoring equipment; and environmental monitoring equipment. In order to determine the size of the Fuel Storage Facility, EPRI assumed that each storage system would require an area that is 20 feet x 30 feet, and that the concrete pad was 3 feet thick. This is similar to the dimensions assumed for the PFS concrete storage pad described in NUREG-1714.[9] Thus, each cask stored would require 67 cubic yards (yd^3) of concrete. The area dimensions were also used to calculate the amount of security fencing required.

For a 40,000 MTU Fuel Storage Facility, a total of 4,000 DPCs would be stored at the facility, requiring 268,000 yd^3 of concrete. EPRI assumed that the costs for excavation and grading for the facility would be $3.0 million. EPRI assumed unit costs of $200/$yd^3$ for reinforced concrete, resulting in costs for the concrete storage pad of $53.6 million. Note that the storage pads would be built on a modular basis. Thus, the during the initial construction period prior to facility startup, sufficient storage pads would be built for the first year of operations – enough to house 200 DPCs, at a cost of approximately $2.7 million. The remaining storage pads would be built to support annual receipt rates.

Assuming a total array of casks that is 50 x 80 storage casks, the security perimeter fence would be required to be 1500 feet by 1600 feet, resulting in a perimeter of 6,200 linear feet. With both an inner fence and an outer nuisance fence this would result in 12,400 linear feet of security fencing. EPRI assumed that the security fencing would cost $75 per linear foot.[10] Thus, the cost of security fencing is $0.9 million. EPRI assumed costs for installation of the security equipment (lighting, intrusion detection, CCTV and monitoring equipment) to be $9.5 million. Both the fencing costs and the security equipment costs are EPRI estimates and should be considered as "placeholder costs". These unit costs should be evaluated based on current NRC security requirements. Note that the costs associated with security fencing and equipment are not cost drivers for the GISF facility cost.

Total GISF Fuel Storage Facility costs are estimated to be $67.0 million. When a 30% contingency is applied, the total cost is estimated to be $87.1 million. As noted above, the costs for the concrete storage pads would be incurred on a modular basis over the life of the facility. All of the costs associated with the Fuel Storage Facility are dependent on the capacity of the facility. Thus, one would need to recalculate the various cost elements for a 20,000 MTU or 60,000 MTU GISF. EPRI assumed that costs for larger or smaller facilities would be proportional to the number of DPCs stored at the facility. The cost of constructing storage pads is the biggest cost driver for the Fuel Storage Facility, representing more than 80% of the costs for this facility.

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[9] NUREG-1714, Section 2.1.1.2, p. 2-5 to 2-11.

[10] EPRI found that standard chain link fence would cost less than $25/linear foot. Therefore, the assumption of $75/linear foot should be a conservative assumption.

Table 2-8
GISF Capital Costs: 40,000 MTU Capacity Fuel Storage Facility

GISF Fuel Storage Facility Costs	Cost Estimate (Millions 2009$)
Excavation and grading	**$3.0**
Concrete storage pads • 20 ft x 30 ft x 3 ft, per cask stored: 67 cubic yards/cask • 4000 DPCs stored • **reinforced concrete: $200/cubic foot**	**$53.6**
Security fence • 1500 ft x 1600 ft – 6,200 linear feet • Inner and outer security fences – 12,400 linear feet • fencing: $75/linear foot	**$0.9**
Security system • lighting, intrusion detection, CCTV, monitoring equipment	**$9.5**
Subtotal: Fuel Storage Facility	**$67.0**
Contingency: 30%	**$20.1**
Total Fuel Storage Facility	**$87.1**

2.2.4 Dual-Purpose Canister Transfer and Transportation Equipment

The capital costs for DPC transfer equipment and transportation cask equipment include the costs for transportation casks, impact limiters, cask skids, and railcars. Since EPRI assumed that the GISF would use canister transfer cells (as discussed in Section 2.2.2) to transfer the DPCs from the transport cask to the storage overpack, additional canister transfer casks are not included in the cost estimate for the GISF. In addition, this cost estimate assumes that the GISF would not supply transfer casks or cask loading equipment (welding, vacuum drying and leak detection equipment) to nuclear operating companies to assist in loading DPCs for shipment to the GISF. However, EPRI has included an estimated cost for transfer casks and associated equipment in this report as it is possible that a GISF could supply transfer equipment to its users.

EPRI assumed that the costs for transportation casks and associated transport equipment (impact limiters, cask skid and railcar) would be $5.2 million per cask and cask car.[11] This estimate is based on recently published estimates for transportation overpacks and cask cars used by DOE in a recent life cycle cost estimate for the Yucca Mountain repository. A total of 28 transportation casks and transport equipment sets would be needed to support a 40,000 MTU GISF, with total

[11] 2008 TSLCC, Table 3-7, Table 3-8.

costs of $145.6 million. Applying a 30% contingency of $43.7 million, results in total costs of $189.3 million.

While EPRI did not include the cost for transfer casks and associated equipment in this GISF cost estimate, EPRI has estimated costs for this equipment since it is possible that a GISF may want to provide such equipment to users to assist in package loading. EPRI estimates that transfer casks would cost approximately $2.5 million per cask and the loading equipment would cost $600,000 per set. One set of transfer cask and loading equipment would be needed for every two rail casks shipped. Thus, for a 40,000 MTU GISF with a transportation cask fleet of 28 casks, 14 sets of transfer casks and loading equipment would be needed at a cost of $43.4 million, or $56.4 million with a 30% contingency applied.

2.3 GISF Annual Operating Costs

Annual operating costs include the administrative costs associated with operating the GISF, annual costs for concrete overpacks, and other non-capital, non-labor costs such as railroad fees, regulator fees, etc. The estimates for annual operating costs are described in more detail below.

2.3.1 Annual Administrative Costs

Administrative costs include expenses such as travel and living expenses for GISF crews that assist in transportation cask loading operations at reactor sites. Administrative operating costs also include costs for office supplies and operations, equipment leases, postage, insurance, etc.

EPRI assumed a 40,000 MTU capacity GISF that accepts 200 DPCs annually, in 100 rail shipments. Assuming that living and travel expenses for a 2 person crew are $3500 per shipment, this results in living and travel costs of approximately $350,000 per year, as shown in Table 2-9. Other administrative costs include costs for communications and reproduction, office supplies, office equipment and leases, office equipment maintenance and repair, postage, dues and subscriptions, and insurance. EPRI assumed a placeholder cost of $1.5 million for insurance for the facility. This would include nuclear liability insurance premiums, liability, property and workers compensation insurance. The remaining administrative costs were estimated to be $600,000 per year. Total annual administrative costs are estimated to be $3.2 million, with a 30% contingency applied. Administrative costs are not a cost driver for annual operating costs.

Table 2-9
GISF Annual Operating Costs: Administrative Costs, 40,000 MTU GISF

GISF Administrative Operating Costs	Cost Estimate (Millions 2009$)
Travel and Living Expenses • person crew • 100 rail shipments for 200 casks • $3,500 per rail shipment	$0.35
Annual office expenses: • Communications and reproduction, office supplies, office equipment and leases, office equipment maintenance and repair, postage, dues and subscriptions, insurance	$2.1
Subtotal: Annual Administrative Operating Costs	$2.5
Contingency: 30%	$0.7
Total Administrative Operating Costs	$3.2

2.3.2 Annual Operating Costs for Dual-Purpose Canisters and Concrete Storage Overpacks

Many nuclear power plants will have loaded SNF into DPCs prior to a GISF beginning operation. If these sites ship SNF to the GISF, these sites may either ship DPCs that were loaded previously or the sites may load a new DPC for shipment to the GISF. New nuclear power plant sites would likely load a new DPC for shipment to the GISF. Sites that already have DPCs in dry storage would also have transfer casks and cask loading equipment, thus this equipment (discussed in Section 2.2.4) would not have to be supplied by the GISF. EPRI has included an estimate of the costs of DPCs as well as concrete storage overpacks in this report. However, it should be noted that the DPC cost would not be incurred if a nuclear operating company were shipping an already-loaded DPC to the GISF. Note that the costs summarized in Table 2-15 at the end of this section do not include the costs for DPCs.

As shown in Table 2-10, EPRI assumed that the costs for a BWR DPC would be $800,000 and a PWR DPC would be $700,000.[12] This estimate is based on recently published estimates for BWR and PWR transport, aging and disposal (TAD) canisters used by DOE in a recent life cycle cost estimate for the Yucca Mountain repository. EPRI assumed that 58% of the packages accepted at the GISF would contain PWR SNF and 42% would contain BWR SNF, resulting in 116 PWR canisters and 84 BWR canisters being accepted on an annual basis for a 40,000 MTU GISF. The total cost for these DPCs is estimated to be $148.4 million, or $192.9 million assuming a contingency of 30%. EPRI estimates that the unit cost for concrete storage overpacks is $200,000 per overpack. Thus, the cost to purchase 200 overpacks on an annual basis is estimated to be $52.0 million with a 30% contingency applied.

[12] 2008 TSLCC, Table 3-7.

Table 2-10
GISF Annual Operating Costs: Dual Purpose Canisters and Overpacks, 40,000 MTU GISF

Dual Purpose Canister and Concrete Overpack Assumptions	Cost Estimate (Millions 2009$)
Dual Purpose Canister Costs • 21 PWR, $700,000 per canister: 116 PWR canisters/year • 44 BWR, $800,000 per canister: 84 BWR canisters/year	$148.4
Concrete Overpack Costs • $200,000 per overpack: 200 per year	$40.0
Contingency: • Dual Purpose Canisters • Concrete Overpacks	 $44.5 $12.0
Total costs: • Dual Purpose Canisters • Concrete Overpacks	 $192.9 $ 52.0

2.3.3 Other Annual Operating Costs

Other annual operating costs not associated with administrative costs or DPC and concrete overpack costs, include railroad freight fees to transport empty transportation casks from the GISF to reactor sites for loading and return of the loaded casks to the GISF. Other operating costs also include state inspection fees during transport; equipment, spare parts, and maintenance fees; regulatory fees and licenses; quality assurance and environmental inspection fees; utilities; federal, state and local taxes; and disposal of any low-level radioactive waste (LLW) generated at the GISF.

As noted earlier, EPRI assumed that two loaded transportation casks would be shipped from reactor sites in one train shipment by dedicated train. EPRI estimates that the round-trip cost to transport a single cask is $140,000. This is based on the author's knowledge of estimated costs for transport of SNF and is slightly less than the total costs assumed by DOE in its recent estimate of costs for transportation operations ($3.120 billion to transport 20,858 casks, or $150,000 per cask transported). For shipment of two casks per dedicated train, EPRI estimates rail freight costs of $280,000 per train shipment. As shown in Table 2-11, for 100 rail shipments each transporting two rail casks, the round-trip rail fees would be $28.0 million. In addition to the freight fees, EPRI also estimated that state inspection fees would be $10,000 per train, or $1.0 million for 100 rail shipments.

EPRI estimated placeholder costs for equipment, spare parts and maintenance to be $1.9 million per year. Placeholder costs for regulatory fees and license fees were estimated to be $750,000 per year. These cost elements are not cost drivers for other annual operating costs.

EPRI estimated placeholder costs for utilities for the GISF to be $72,000 annually. While the GISF is not expected to generate any LLW, EPRI included placeholder fees for LLW disposal for 50 cubic feet of LLW per year, at an estimated disposal cost of $1500 per cubic foot. This results in total LLW disposal costs of $75,000 per year. Total Other Operating Costs are $31.8 million per year. With a 30% contingency applied, these costs are estimated to be $41.3 million. Railroad freight fees are the major cost driver for other operating costs as shown in Table 2-11.

There may also be federal, state and local taxes assessed on the facility. These costs will be site specific and will depend upon the jurisdiction in which the facility is built.

Table 2-11
GISF Annual Operating Costs: Other Operating Costs, 40,000 MTU GISF

Assumptions for Other Operating Costs	Cost Estimate (Millions 2009$)
Railroad Freight Fees • **Estimated cost for 100 shipments of 2 SNF transport casks by dedicated train: $280,000 per rail shipment**	**$28.00**
State Inspection Fees	**$1.00**
Equipment, spare parts, and maintenance	**$1.90**
Regulatory fees and license fees	**$0.75**
Utilities	**$0.07**
LLW Disposal (50 cubic feet, $1500/cubic foot)	**$0.08**
Subtotal: Other Operating Costs	**$31.8**
Contingency: 30%	**$ 9.5**
Total: Other Operating Costs	**$41.3**

2.4 GISF Annual Labor Costs

EPRI estimated annual labor costs for three possible periods of GISF operation: periods of loading or unloading; caretaker periods when no SNF is accepted or shipped offsite; and periods of loading and unloading. Subsequent to the period of initial loading, any combination of loading, unloading, and caretaker operations is possible. EPRI based its estimate in part on the numbers and types of staff assumed in NUREG-1714. However, EPRI's estimate is somewhat larger than that assumed in NUREG-1714. The additional staff include additional security staff, staff to assist in loading activities at reactor sites, additional maintenance and equipment operating staff to support two shifts of operation, and additional engineering and technical staff. EPRI's estimate also includes several additional administrative staff than the estimate in NUREG-1714, including accounting and payroll and government affairs staff.

2.4.1 Annual Labor During Loading or Unloading Periods

EPRI's estimate of annual labor costs during loading or unloading assumes a total of ten administrative staff including a site general manager, administrative assistants, public relations and governmental affairs staff, finance and purchasing specialists, and accounting and payroll staff. Total administrative staff costs were estimated to be $830,000 or an average salary of $82,500 per person. EPRI estimated that the GISF would have security staffing to cover three shifts per day, with 4 persons per shift or an estimated 18 security personnel plus two security captains for a total security staff of 20. The average salary assumed is $55,000 per year for a total security labor cost of $1.1 million annually. EPRI estimated that there would be an engineering and technical staff of 18 FTE, at an average salary of $80,000 per year for total annual costs of $1.42 million per year. The engineering and technical staff includes nuclear and licensing engineers, health physics managers and technicians, quality assurance technicians, a transportation specialist, and training staff. EPRI estimated that there would be a maintenance and equipment operating staff of 19 FTE, assuming that there are two eight-hour shifts per day for five days per week. The average salary is $58,000 with total annual costs of $1.1 million. If the GISF utilizes at-reactor loading crews, EPRI estimated that a crew of 18 FTE would be needed to assist in loading SNF at nine sites per month. The average salary was assumed to be $70,000 per year with total annual costs of $1.26 million. EPRI estimated fringe benefits and contingency of 40%, resulting in total labor costs of $8.0 million per year during period of loading or unloading.

Table 2-12
GISF Annual Labor Costs: Loading or Unloading, 40,000 MTU GISF

Labor Categories During Loading or Unloading	Estimated Annual FTE	Average Cost per FTE ($K)	Cost Estimate (Millions 2009$)
Administrative staff: • General manager, administrative assistants, public relations, financing and purchasing, accounting and payroll, governmental affairs	10	$82.5	$0.83
Security staff: assumes 4 staff per shift, 3 shifts	20	$55.0	$1.10
Engineering and technical staff • Nuclear and licensing engineers, health physics managers and technicians, quality assurance managers and technicians, transportation specialist, training	18	$80.0	$1.42
Maintenance and equipment operating staff: • Mechanical and electrical maintenance, crane and equipment operators, general plant workers, fire and EMT	19	$58.0	$1.10
At-reactor loading crews: • 2 per site, 9 sites per month	18	$70	$1.26
Subtotal: Labor during Loading or Unloading	85	$67.2	$5.7
Fringe benefits and contingency: 40%			$2.3
Total Labor Costs During Loading or Unloading			$8.0

2.4.2 Annual Labor During Caretaker Periods

EPRI's estimate of annual labor costs during caretaker periods assumes a total of seven administrative staff including a site general manager, administrative assistants, public relations and governmental affairs staff, finance and purchasing specialists, and accounting and payroll staff. Total administrative staff costs were estimated to be $625,000 or an average salary of $89,300 per person. EPRI estimated that the GISF would have the same security staffing as during the period of loading or unloading - 18 security personnel plus two security captains for a total security staff of twenty. The average salary assumed is $55,000 per year for a total security labor cost of $1.1 million annually. EPRI estimated that there would be an engineering and technical staff of 7 FTE, at an average salary of $80,000 per year for total annual costs of $560,000 per year. EPRI estimated that there would be a maintenance and equipment operating staff of 6 FTE, assuming that there is one eight-hour shifts per day for five days per week. The average salary is $58,000 with total annual costs of $349,000. EPRI estimated fringe benefits and contingency of 40%, resulting in total labor costs of $3.7 million per year during the caretaker period.

Table 2-13
GISF Annual Labor Costs: Caretaker Periods, 40,000 MTU GISF

Labor Categories During Caretaker Period	Estimated Annual FTE	Average Cost per FTE ($K)	Cost Estimate (Millions 2009$)
Administrative staff: • General manager, administrative assistants, public relations, financing and purchasing, accounting and payroll, governmental affairs	7	$89.3	$0.63
Security staff: assumes 4 staff per shift, 3 shifts	20	$55.0	$1.10
Engineering and technical staff • Nuclear and licensing engineers, health physics managers and technicians, quality assurance managers and technicians, transportation specialist, training	7	$80.0	$0.56
Maintenance and equipment operating staff: • Mechanical and electrical maintenance, crane and equipment operators, general plant workers, fire and EMT	6	$57.0	$0.35
Subtotal: Labor during Caretaker	40	$66.0	$2.6
Fringe benefits and contingency: 40%			$1.16
Total Labor Costs During Caretaker			$3.7

2.4.3 Annual Labor During Loading and Unloading Periods

EPRI's estimate of annual labor costs during loading and unloading periods assumes a total of ten administrative staff, the same staffing assumed in Section 2.4.1 for the period of loading or unloading. Total administrative staff costs were estimated to be $830,000 or an average salary of $82,500 per person. EPRI assumed the same security staffing as the period of loading or unloading, - 18 security personnel plus two security captains for a total security staff of twenty. The average salary assumed is $55,000 per year for a total security labor cost of $1.1 million annually. EPRI estimated that there would be an engineering and technical staff of 19 FTE, at an average salary of $78,900 per year for total annual costs of $1.5 million per year. EPRI estimated that there would be a maintenance and equipment operating staff of 24 FTE, assuming that there are two eight-hour shifts per day for five days per week. The average salary is $57,000 with total annual costs of $1.37 million. If the GISF utilizes at-reactor loading crews, EPRI assumed the same size loading crew as estimated in Section 2.4.1. A crew of 18 FTE would have an average salary of $70,000 per year with total annual costs of $1.26 million. EPRI estimated fringe benefits and contingency of 40% , resulting in total labor costs of $8.5 million per year during period of loading and unloading.

Table 2-14
GISF Annual Labor Costs: Loading and Unloading, 40,000 MTU GISF

Labor Categories During Loading and Unloading	Estimated Annual FTE	Average Cost per FTE ($K)	Cost Estimate (Millions 2009$)
Administrative staff: • General manager, administrative assistants, public relations, financing and purchasing, accounting and payroll, governmental affairs	10	$82.5	$0.83
Security staff: assumes 4 staff per shift, 3 shifts	20	$55.0	$1.10
Engineering and technical staff • Nuclear and licensing engineers, health physics managers and technicians, quality assurance managers and technicians, transportation specialist, training	19	$79.0	$1.50
Maintenance and equipment operating staff: • Mechanical and electrical maintenance, crane and equipment operators, general plant workers, fire and EMT	24	$58.0	$1.37
At-reactor loading crews: • 2 per site, 9 sites per month	18	$70.0	$1.26
Subtotal: Labor during Loading and Unloading	91	$67.2	$6.1
Fringe benefits and contingency: 40%			$2.4
Total Labor Costs During Loading and Unloading			$8.5

2.5 Estimated Decommissioning Costs

In estimating the decommissioning costs for the GISF, EPRI assumed that decommissioning costs would be 20% of the GISF Fuel Storage Facility costs ($67 million, see Table 2-8) and 20% of the total costs of storage overpacks ($800 million assuming 200 overpacks/year for 20 years, see Table 2-10). Estimated decommissioning costs total $173.4 million (13.4 million plus $160 million) plus an assumed 30% contingency, for total decommissioning costs of $225 million.

2.6 Estimated Workforce During Construction and Operation

In estimating the construction workforce during the period of construction prior to the start of GISF operations, EPRI assumed the same workforce assumed in NUREG-1714 - 130 FTE during what was referred to as Phase 1 construction. This includes the cost to construct the GISF infrastructure as well as the initial storage pads for the Fuel Storage Facility. NUREG-1714 did not specify how large the construction workforce might be after facility operations begin. Since the Fuel Storage Facility storage pads and concrete overpacks will be constructed on a modular basis to support annual receipt of SNF, some amount of construction will continue as long as the GISF is receiving SNF for storage. In order to estimate the size of the construction workforce during operations, EPRI examined the estimated construction staff size for at-reactor spent fuel storage facilities. The Environmental Report for the Diablo Canyon Independent Spent Fuel Storage Installation estimated a construction workforce of 20 to 25 construction workers during initial construction and a lower, unspecified workforce after the start of ISFSI operations.[13] EPRI assumed that the Fuel Storage Facility site preparation and grading for the entire facility would be completed during initial construction. Therefore, construction after the start of facility operations would be associated with construction of additional storage pads and concrete overpacks. EPRI assumed a workforce of 20 construction workers after facility operations begin.

EPRI's estimate of construction workforce does not include construction staff for building the rail line and rail siding. This is because the workforce required would be site specific, based on the length of rail line required. NUREG-1714 assumed 125 FTE for construction of the rail line.

2.7 Summary of Costs for a 40,000 MTU GISF

Table 2-15 summarizes the cost to design, license, construct and operate a 40,000 MTU GISF. Total costs for design, licensing and startup activities are estimated to be $67.4 million. Total facility capital cost including the transportation infrastructure, GISF infrastructure, Fuel Storage Facility, and transportation cask equipment are estimated to be $493.7 million. It should be noted that the costs for the Fuel Storage Facility would not all occur prior to the start of facility operations since the storage pads would be constructed on a modular basis to support annual receipt of 200 DPCs per year. If the GISF also incurred costs for transfer equipment to load SNF into DPCs at reactor sties, an additional capital cost of $56.4 million would be incurred (see Section 2.2.4).

Annual operating costs for administrative costs, concrete overpacks for the Fuel Storage Facility and transportation fees and other expenses are estimated to be $96.5 million. Note that if the GISF also incurs the cost of DPCs to be loaded at reactor sites, this would increase the operating costs by $192.9 million per year (see Table 2-10).

Annual labor costs are estimated to range from a low of $3.7 million per year during periods in which the facility is in care taker mode to as high as $8.5 million per year when SNF is being accepted for loading into storage and unloaded for shipment offsite. The workforce during caretaker periods is estimated to be 40 FTE. The workforce during periods of loading or unloading is estimated to be 85 FTE. However, if the GISF does not provide staff to oversee the loading of transportation casks at reactor sites, this workforce would be reduced to 67 FTE. The workforce during periods of loading and unloading is estimated to be 91 FTE. However, if the GISF does not provide staff to oversee the loading of transportation casks at reactor sites, this workforce would be reduced to 73 FTE. The workforce during initial construction is estimated to be 130 FTE. Once the facility begins operation, the construction workforce is estimated to be approximately 20 FTE.

[13] Pacific Gas & Electric Corporation, Diablo Canyon Independent Spent Fuel Storage Installation, Environmental Report, Docket 72-26., p. 4.1-3 (Diablo Canyon ER)

Table 2-15
Summary of Costs for a 40,000 MTU GISF

Cost Category	Cost Estimate (Millions 2009$)
Design, Engineering, Licensing and Startup Professional Services	**$ 67.4**
Capital Costs	
Transportation Infrastructure	**$176.5**
GISF Infrastructure	**$ 40.8**
Fuel Storage Facility (Note 1)	**$ 87.1**
Transportation Casks and Transport Equipment	**$189.3**
Subtotal Capital Costs	**$493.7**
Annual Operating Costs	
Administrative	**$ 3.2**
Concrete Overpacks	**$52.0**
Other: Transportation, License Fees	**$41.3**
Subtotal Annual Operating Costs	**$96.5**
Annual Operating Labor Costs	
During Loading or Unloading	**$8.0**
During Caretaker Period	**$3.7**
During Loading and Unloading	**$8.5**
Decommissioning	**$225.0**
Construction Staff (FTE)	
• **Pre-License Construction**	**130**
• **Modular construction during operations**	**20**
Operations Staff (FTE)	
• **During Loading or Unloading**	**85**
• **During Caretaker Period**	**40**
• **During Loading and Unloading**	**91**
Note 1: The Fuel Storage Facility would be built over the first 20 years of operation. The costs associated with initial construction of the Fuel Storage Facility are estimated to be $16.1 million (all excavation and grading, fencing and security system costs, plus sufficient storage pads to store the first 200 storage systems).	

3

GISF CAPITAL AND OPERATING COSTS FOR DIFFERENT FACILITY CAPACITIES

In Section 2, EPRI summarized its capital and operating costs for a base case 40,000 MTU capacity GISF, using SNF storage technology with a capacity of 10 MTU per storage container. EPRI also calculated the capital and operating costs assuming that the 40,000 MTU GISF uses storage containers with capacities of 13 MTU per storage container. The use of higher capacity storage containers results in the need for fewer containers being transported and stored and therefore lower capital and operating costs. These costs are summarized in Section 3.1.

EPRI also examined the capital and operating costs associated for a GISF with capacities of 20,000 MTU and 40,000 MTU. These costs are summarized in Section 3.2.

3.1 40,000 MTU GISF Assuming 10 MTU and 13 MTU DPC Capacity

EPRI assumed that the costs associated with Design, Engineering, Licensing and Startup Professional Services would be the same no matter what the GISF capacity is. Thus, these costs are estimated to be $67.4 million for all of the scenarios discussed in this section.

Table 3-1 compares the capital costs for a GISF with a capacity of 40,000 MTU assuming that two different capacities of DPCs are accepted for storage – DPCs with a 10 MTU capacity discussed in Section 2 and DPCs with a 13 MTU capacity. As shown in Table 3-1, the capital costs that are calculated based on the total number of DPCs to be stored at the GISF will be higher for a 40,000 MTU GISF using 10 MTU-capacity DPCs than for a facility that uses 13 MTU-capacity DPCs. Rail transportation infrastructure costs will have higher costs for the purchase of additional rail transport equipment costs. The GISF using 10 MTU-capacity DPCs will require 14 locomotives, 14 escort cars and 28 buffer cars to transport 200 DPCs annually. A facility using 13 MTU-capacity DPCs, will require 11 locomotives, 11 escort cars, and 22 buffer cars to transport 154 DPCs annually. Total transport infrastructure costs are estimated to be decreased from $176.5 million to $142.6 million if a 40,000 MTU GISF used the higher capacity 13 MTU DPCs.

As shown in Table 3-1, EPRI assumed that the costs for the Administration Building, Security/Health Physics Building, and Operations/Maintenance Building would be the same for a GISF of any capacity. The Canister Transfer Building costs would vary somewhat in that a facility that has a higher annual throughput of DPCs will require more canister transfer cells. EPRI estimated that the 40,000 MTU GISF using 10 MTU-capacity DPCs would need three canister transfer cells to handle transfer 200 DPCs per year but that facility using 13 MTU-capacity DPCs would only require two canister transfer cells to transfer 154 DPCs per year. As discussed in Section 2.2.2., EPRI assumed that for a facility throughput of 200 canisters per year, there would be an average of 18 DPCs transferred per month. EPRI assumed that each canister transfer station could transfer up to 8 DPCs per month (2 per week), resulting in a need to have three canister transfer facilities for the 40,000 MTU facility receiving DPCs with a 10 MTU capacity. A facility transferring 154 DPCs per year or an average of 13 DPCs per month would only require two transfer cells. Thus, the total costs for GISF infrastructure for a 40,000 MTU capacity GISF using 13 MTU-capacity DPCs decrease from $40.8 million to $37.4 million compared to the facility using 10 MTU capacity DPCs.

The Fuel Storage Facility costs will be dependent upon the total number of DPCs stored at the facility over its lifetime. Thus, a GISF that stores 4,000 10-MTU-capacty DPCs will have a higher cost than one that stores 3,076 13-MTU-capacity DPCs. As discussed in Section 2.2.3, the Fuel Storage Facility costs are primarily a function of cost to build the storage pads. As shown in Table 3-1, concrete storage pad costs for a 40,000 MTU GISF using 13 MTU-capacity DPCs are estimated to be $41.6 million compared to $53.6 million for the facility using 10 MTU-capacity DPCs. This decrease in costs as well as the related decrease in contingency costs results in the cost for the Fuel Storage Facility being reduced to $71.4 million compared to $87.1 million if the facility used 10 MTU-capacity DPCs.

The estimated cost of transportation casks and related equipment will vary depending upon the annual number of DPCs being transported from reactor sites to the GISF. A 40,000 MTU GISF that uses 13 MTU-capacity DPCs would transport 154 DPCs annually requiring a cask fleet of 22 casks and related equipment, as shown in Table 2-4. Transportation costs would be $148.7 million. In comparison, a facility that uses 10 MTU-capacity DPCs would require a cask fleet of 28 casks and related equipment at a cost of $189.3 million.

Total capital costs for a 40,000 MTU GISF are reduced from $493.7 million to $400.1 million assuming the use of a 13 MTU-capacity DPC. As noted in Table 2-15, the entire cost for the Fuel Storage Facility would not be built during initial construction.

In estimating the decommissioning costs for the GISF using 10 MTU-capacity DPCs, EPRI assumed that decommissioning costs would be 20% of the GISF Fuel Storage Facility costs ($67 million, see Table 2-8) and 20% of the total costs of storage overpacks ($800 million assuming 200 overpacks/year for 20 years, see Table 2-10). Estimated decommissioning costs total $173.4 million (13.4 million plus $160 million) plus an assumed 30% contingency, for total decommissioning costs of $225 million. Thus, the decommissioning costs for the 13 MTU-capacity DPC case would be $11 million to decommission the Fuel Storage Facility, $123 million to decommission 3,079 storage overpacks, plus 30% contingency, or a total cost of $174 million.

Table 3-2 compares the annual operating costs for a 40,000 MTU GISF facility using either 10 MTU-capacity DPCs or 13 MTU-capacity DPCs. Regarding the administrative expenses, annual costs are estimated to be $3.1 million for a GISF that utilizes 13 MTU-capacity DPCs and $3.3 million per year for a GISF that utilizes 10 MTU-capacity DPCs. The difference is related to the amount of travel and living expenses associated with crews who assist in cask loading at reactor sites. Travel and living expenses are calculated to load 154 casks annually in 78 cask loading campaigns assuming a 13 MTU capacity DPC is loaded. For a 10 MTU-capacity DPC, 200 casks would be loaded annually in 100 cask loading campaigns.

EPRI estimates that a total of 154 concrete overpacks per year, at an estimated cost of $40 million, would be needed for a 40,000 MTU GISF that utilizes DPCs with a 13 MTU capacity. If DPCs with a 10 MTU capacity are utilized for storage, a total of 200 concrete overpacks per year would be needed at a cost of $52.0 million. EPRI did not include the cost of the DPCs in its cost estimate since it is possible that reactor sites would ship already-loaded DPCs to the GISF. However, as noted in Section 2.3.2, the annual cost for 200 DPCs per year for a GISF that utilizes DPCs with a 10 MTU capacity would be $192.9 million, including contingency. If DPCs with a 13 MTU capacity were used, the annual cost for 154 DPCs would be $148.6 million, including contingency.

Other operating costs include the costs associated with railroad fees, state inspection fees during transport and other costs including regulatory fees, license fees, utilities, and LLW disposal. The annual operating costs for railroad freight and state inspections are dependent upon the number of casks shipped annually. Assuming a 40,000 MTU GISF that utilized 13 MTU capacity DPCs, a total of 154 casks are shipped annual in 78 train shipments. This results in estimated railroad shipping fees of $21.8 million and state inspection fees of $0.8 million. If DPCs with a 10 MTU capacity are utilized, a total of 200 casks are shipped annually in 100 train shipments with railroad fees of $28 million and state inspection fees of $1 million. All other annual operating costs associated with regulatory fees, license fees, utilities and LLW disposal are assumed to be the same for both cases, totaling $2.8 million. Total Other Operating Costs are estimated to be $33.0 million for the 13 MTU DPC case and $41.3 million for the 10 MTU DPC case. Total annual operating costs are estimated to be $76.1million assuming the use of 13 MTU capacity DPCs; or $96.5 million assuming 10 MTU capacity DPCs.

Table 3-3 compares the annual labor costs for a 40,000 MTU GISF for the 10 MTU-capacity DPC case and the 13 MTU-capacity DPC case. EPRI assumed that staffing for the GISF would be the same for both cases, with the exception of the number of staff needed to assist in loading transport casks at reactor sites. EPRI assumed that two DPCs would be shipped with each rail shipment to the site. Thus, EPRI assumed that the 10 MTU-capacity DPC case would require a total of 18 crew members to support shipment of 200 DPCs per year and the 13 MTU-capacity DPC case would require 14 crew members to support the shipment of 154 DPCs per year.

During periods of Loading or Unloading, total staffing for the 10 MTU-capacity DPC case are estimated to be 85 FTE at a cost of $8.0 million per year. This is reduced to 81 FTE at a cost of $7.6 million per year under the 13 MTU-capacity DPC case. Costs during the Caretaker phase, when no fuel is received or shipped, are estimated to remain at $3.7 million per year independent of the facility capacity. An annual staff of 40 FTE is projected during the Caretaker phase.

During periods of Loading and Loading, total staffing for the 10 MTU-capacity DPC case are estimated to be 91 FTE at a cost of $8.5 million per year. This is reduced to 97 FTE at a cost of $8.1 million per year under the 13 MTU-capacity DPC case. The lower FTE and costs are associated with a smaller number of FTE in the at-reactor loading crews, as discussed above.

Table 3-4 summarizes the cost comparisons found in Table 3-1 through 3-3. It also summarizes the number of construction staff and operations staff.

Table 3-1
Comparison of Capital Costs for a 40,000 MTU GISF Assuming 10 MTU and 13 MTU Capacity Storage Systems

Cost Category	40,000 MTU GISF (Millions 2009$)			
	10 MTU Capacity DPC		13 MTU Capacity DPC	
Transportation Infrastructure				
• Access roads/rail spur/land improvements		$14.0		$14.0
• Railcar locomotive	14 locomotives	$56.0	11 locomotives	$44.0
• Rail escort cars	14 escort cars	$51.8	11 escort cars	$40.7
• Rail buffer cars	28 buffer cars	$14.0	22 buffer cars	$11.0
Contingency		$40.7		$32.9
Subtotal Transportation Infrastructure		**$176.5**		**$142.6**
GISF Infrastructure				
• Administration building	$ 3.7		$ 3.7	
• Security/health physics building	$ 2.8		$ 2.8	
• Operations/maintenance building	$ 6.0		$ 6.0	
• Canister transfer building	$18.9		$16.3	
Contingency	$ 9.4		$ 8.6	
Subtotal GISF Infrastructure	**$ 40.8**		**$ 37.4**	
Fuel Storage Facility (Note 1)				
• Excavation and grading	4000 Overpacks	$ 3.0	3076 Overpacks	$ 3.0
• Concrete storage pads	12,400 lin. ft.	$53.6	11,080 lin. ft.	$41.6
• Security fence		$ 0.9		$ 0.8
• Security System		$ 9.5		$ 9.5
Contingency		$20.1		$16.5
Subtotal Fuel Storage Facility		**$87.1**		**$71.4**
Transportation Casks and Transport Equipment				
• **Transportation cask, impact limiter, railcar, cask skid**	28 casks	$145.6	22 casks	$114.4
• **Contingency**		$ 43.7		$ 34.3
Subtotal Transportation Casks and Equipment		**$189.3**		**$148.7**
Subtotal Capital Costs	**$493.7**		**$400.1**	
Decommissioning	**$225.0**		**$174.0**	

Note 1: The Fuel Storage Facility would be built over the first 20 years of operation. The costs associated with initial construction of the Fuel Storage Facility are estimated to be $20.0 to $20.9 million, for a 13-MTU or 10 MTU-capacity DPC, respectively (all excavation and grading, fencing and security system costs, plus sufficient storage pads to store the first 200 storage systems).

Table 3-2
Comparison of Annual Operating Costs for a 40,000 MTU GISF Assuming 10 MTU and 13 MTU Capacity Storage Systems

Cost Category	40,000 MTU GISF (Millions 2009$)			
	10 MTU Capacity DPC		13 MTU Capacity DPC	
Annual Operating Costs: Administrative				
• Administrative: Travel and living expenses		$ 0.4		$ 0.3
• Administrative: Office expenses		$ 2.1		$ 2.1
Contingency		$ 0.7		$ 0.7
Subtotal Administrative Operating Costs		**$ 3.2**		**$ 3.1**
Annual Operating costs: Concrete Overpacks	200 Overpacks/Yr	$40.0	154 Overpacks/Yr	$30.8
Contingency		$12.0		$ 9.2
Subtotal Concrete Overpack Operating Costs		**$52.0**		**$40.0**
Annual Operating Costs: Other Operating Costs				
• Railroad fees	100 trains	$28.0	78 trains	$21.8
• State Inspection Fees	100 trains	$ 1.0	78 trains	$ 0.8
• All other costs: regulatory fees, license fees, utilities, LLW disposal		$ 2.8		$ 2.8
Contingency		$ 9.5		$ 7.6
Subtotal Other Operating Costs		**$41.3**		**$33.0**
Total Annual Operating Costs		**$96.5**		**$76.1**

Table 3-3
Comparison of Annual Labor Costs for a 40,000 MTU GISF Assuming 10 MTU and 13 MTU Capacity Storage Systems

Annual Labor Periods	40,000 MTU GISF			
	10 MTU Capacity DPC		13 MTU Capacity DPC	
Annual Labor Costs: Loading or Unloading	**FTE**	**Millions 2009$**	**FTE**	**Million 2009$**
• Administrative staff	10	$0.8	10	$0.8
• Security staff	20	$1.1	20	$1.1
• Engineering and technical staff	18	$1.4	18	$1.4
• Maintenance and equipment operating staff	19	$1.1	19	$1.1
• At-reactor loading crews	18	$1.3	14	$1.0
• Fringe benefits and contingency		$2.3		$2.2
Total: Annual Labor During Loading or Unloading	**85**	**$8.0**	**81**	**$7.6**
Annual Labor Costs: Caretaker				
• Administrative staff	7	$0.6	7	$0.6
• Security staff	20	$1.1	20	$1.1
• Engineering and technical staff	7	$0.6	7	$0.6
• Maintenance and equipment operating staff	6	$0.4	6	$0.4
• At-reactor loading crews		$0.0		$0.0
• Fringe benefits and contingency		$1.1		$1.0
Total: Annual Labor Caretaker	40	**$3.7**	40	**$3.7**
Annual Labor Costs: Loading and Unloading				
• Administrative staff	10	$0.8	10	$0.8
• Security staff	20	$1.1	20	$1.1
• Engineering and technical staff	19	$1.5	19	$1.5
• Maintenance and equipment operating staff	24	$1.4	24	$1.4
• At-reactor loading crews	18	$1.3	14	$1.0
Fringe benefits and contingency		$2.4		$2.3
Total: Annual Labor During Loading and Unloading	**91**	**$8.5**	**87**	**$8.1**

Table 3-4
Comparison of Cost and Staffing for a 40,000 MTU GISF Assuming 10 MTU and 13 MTU Capacity Storage Systems

Cost Category	40,000 MTU GISF 10 MTU-Capacity DPCs	40,000 MTU GISF 13 MTU-Capacity DPCs
Design, Engineering, Licensing and Startup Professional Services (Millions 2009$)	$67.4	$67.4
Capital Costs (Transportation and GISF infrastructure, Fuel Storage Facility, and Transportation Cask Equipment) (Millions 2009$)	$493.7	$400.1
Decommissioning (Millions 2009$)	$225.0	$174.0
Annual Operating Costs (Millions 2009$)	$96.6	$76.2
Annual Labor Costs (Millions 2009$) • During Periods of Loading or Unloading • During Caretaker Periods • During Periods of Loading and Unloading	$8.0 $3.7 $8.5	$7.6 $3.7 $8.1
Construction Staff • Pre-License Construction • Modular construction during operations	130 20	130 20
Operations Staff • During Loading or Unloading • During Caretaker Period • During Loading and Unloading	85 40 91	81 40 87

3.2 Comparison of Costs for a GISF with 20,000 MTU, 40,000 MTU and 60,000 MTU Capacity

EPRI assumed that the costs associated with Design, Engineering, Licensing and Startup Professional Services would be the same no matter what the GISF capacity is. Thus, these costs are estimated to be $67.4 million for all of the scenarios discussed in this section.

Table 3-5 summarizes the capital costs for a GISF with capacities of 20,000 MTU, 40,000 MTU, and 60,000 MTU using DPCs with a capacity of 10 MTU. For a 40,000 MTU facility with a capacity of 4,000 storage systems, capital costs are estimated to be $493.7 million. Estimated decommissioning costs for the Fuel Storage Facility and concrete overpacks are $225 million. For a 20,000 MTU facility with a capacity of 2,000 storage systems, capital costs are estimated to be $273.3 million and decommissioning costs are estimated to be $112.8 million. For a 60,000 MTU facility with a capacity of 6,000 storage systems, capital costs are estimated to be $690.3 million and decommissioning costs for the Fuel Storage Facility and concrete overpacks are estimated to be $338.0 million. Costs elements associated with the difference in capital costs for the various facility capacities are transportation equipment (escort cars, locomotives, and buffer cars required); the number of fuel transfer cells in the Canister Transfer Building; the capacity of the Fuel Storage Facility, the number of rail casks and related equipment required.

Table 3-6 summarizes the annual operating costs for a GISF with capacities of 20,000 MTU, 40,000 MTU and 60,000 MTU using DPCs with a capacity of 10 MTU. This includes administrative operating costs, the annual cost of concrete overpacks and other operating costs such as railroad fees, state inspection fees, and regulatory fees. Annual operating costs are estimated to be $96.5 million for a GISF with a 40,000 MTU capacity. These costs are estimated to be $50.3 million for a 20,000 MTU GISF and $142.6 million for a 60,000 MTU GISF. These costs depend, primarily, upon the number of concrete overpacks needed annually and the number of train shipments per year. Note that the annual operating costs do not include the costs of DPCs, since this analysis assumes that the DPCs that are shipped to the GISF have already been loaded at reactor sites. However, in order to be complete, EPRI has estimated the costs associated with DPCs for each of the facility capacities using the bases described in Section 2. For a 20,000 MTU GISF, a total of 2000 DPCs would cost $96.5 million, including 30% contingency. For a 40,000 MTU GISF, a total of 4000 DPCs would cost $192.9 million including contingency as described in Table 2-10. For a 60,000 MTU GISF, a total of 6000 DPCs would cost $289.4 million, including contingency.

Table 3-7 summarizes the annual labor costs and staffing needs for a GISF with capacities of 20,000 MTU, 40,000 MTU, and 60,000 MTU. Staffing costs for the 40,000 MTU facility are estimated to be $8.0 million per year during periods of loading or unloading, with a staff of 85 FTE; $3.7 million per year during caretaker periods with a staff of 40 FTE; and $8.5 million per year during periods of loading and unloading, with a staff of 91. Staffing costs for the 20,000 MTU facility are estimated to be $5.3 million per year during periods of loading or unloading, with a staff of 58 FTE; $3.7 million per year during caretaker periods, with a staff of 40 FTE; and $5.7 million per year during periods of loading and unloading, with a staff of 61 FTE. Staffing costs for the 60,000 MTU facility are estimated to be $9.9 million per year during periods of loading or unloading with a staff of 106 FTE; $3.7 million per year during caretaker periods, with a staff of 40 FTE; and $10.6 million per year during periods of loading and unloading, with a staff of 115 FTE. The differences in staffing are primarily related to the cask throughput for the facility. This will drive the number of maintenance and equipment operations staff and the number of staff needed to support at-reactor loading. The larger facilities also have somewhat more administrative staff as well as additional health physics and quality assurance personnel.

Table 3-5
Comparison of Capital Costs for a 20,000, 40,000, and 60,000 MTU GISF Assuming 10 MTU Capacity Storage Systems

Cost Category	Millions 2009$					
	40,000 MTU GISF		20,000 MTU GISF		60,000 MTU GISF	
Transportation Infrastructure						
• Access roads/rail spur/land improvements		$14.0		$14.0		$14.0
• Railcar locomotive	14 locomotives	$56.0	7 locomotives	$28.0	20 locomotives	$80.0
• Rail escort cars	14 escort cars	$51.8	7 escort cars	$25.9	20 escort cars	$74.0
• Rail buffer cars	28 buffer cars	$14.0	14 buffer cars	$ 7.0	40 buffer cars	$20.0
Contingency		$40.7		$22.5		$56.4
Subtotal Transportation Infrastructure		**$176.5**		**$97.4**		**$244.4**
GISF Infrastructure						
• Administration building		$ 3.7		$ 3.7		$ 3.7
• Security/health physics building		$ 2.8		$ 2.8		$ 2.8
• Operations/maintenance building		$ 6.0		$ 6.0		$ 6.0
• Canister transfer building	3 transfer cells	$18.9	2 transfer cells	$16.3	4 transfer cells	$21.3
Contingency		$ 9.4		$ 8.6		$10.1
Subtotal GISF Infrastructure		**$40.8**		**$37.4**		**$43.9**
Fuel Storage Facility (Note 1)						
• Excavation and grading	Storage pads for	$ 3.0	Storage pads for	$ 1.5	Storage pas for	$ 4.5
• Concrete storage pads	4000 Overpacks	$53.6	2000 Overpacks	$26.8	6000 Overpacks	$80.4
• Security fence	12,400 lin. ft.	$ 0.9	9,200 lin. ft.	$ 0.7	15,600 lin. ft.	$ 1.2
• Security System		$ 9.5		$ 4.7		$15.1
Contingency		$20.1		$10.1		$30.4
Subtotal Fuel Storage Facility		**$87.1**		**$43.8**		**$131.6**
Transportation Casks and Transport Equipment						
• **Transportation cask equipment**	28 casks	$145.6	14 casks	$72.8	40 casks	$208.0
• **Contingency**		$ 43.7		$21.8		$ 62.4
Subtotal Transportation Casks and Equipment		**$189.3**		**$94.6**		**$270.4**
Subtotal Capital Costs	**$493.7**		**$273.2**		**$690.3**	
Decommissioning	**$225.0**		**$112.8**		**$338.0**	

Note 1: The Fuel Storage Facility would be built over the first 20 years of operation. The costs associated with initial construction of the Fuel Storage Facility are estimated to be $20.9 million (40,000 MTU); $10.7 million (20,000 MTU) and $32.3 million (60,000 MTU) . This includes costs for all excavation and grading, fencing and security system costs, plus sufficient storage pads for the first year of storage.

Table 3-6
Comparison of Annual Operating Costs for a 20,000 MTU, 40,000 MTU, and 60,000 MTU GISF Assuming 10 MTU Capacity Storage Systems

Annual Operating Cost Category	**Millions 2009$**					
	40,000 MTU GISF		**20,000 MTU GISF**		**60,000 MTU GISF**	
Annual Operating Costs: Administrative						
• Administrative: Travel and living expenses		$ 0.4		$ 0.2		$ 0.5
• Administrative: Office expenses		$ 2.1		$ 1.9		$ 2.3
• Contingency		$ 0.7		$ 0.6		$ 0.8
Subtotal Administrative Operating Costs		**$ 3.2**		**$ 2.7**		**$ 3.6**
Annual Operating costs: Concrete Overpacks	200 Overpacks/Yr	$40.0	100 Overpacks/Yr	$20.0	300 Overpacks/Yr	$60.0
Contingency		$12.0		$ 6.0		$18.0
Subtotal Concrete Overpack Operating Costs		**$52.0**		**$26.0**		**$78.0**
Annual Operating Costs: Other Operating Costs						
• Railroad fees	100 trains	$28.0	50 trains	$14.0	150 trains	$42.0
• State Inspection Fees	100 trains	$ 1.0	50 trains	$ 0.5	150 trains	$1.5
• All other costs: regulatory fees, license fees, utilities, LLW disposal		$ 2.8		$ 2.1		$3.4
Contingency		$ 9.5		$ 5.0		$14.1
Subtotal Other Operating Costs		**$41.3**		**$21.6**		**$61.0**
Total Annual Operating Costs	**$96.5**		**$50.3**		**$142.6**	

Table 3-7
Annual Labor Costs and Staffing Needs for a 20,000 MTU, 40,000 MTU, and 60,000 MTU GISF Assuming 10 MTU Capacity Storage Systems

Cost Category	Millions 2009$					
	40,000 MTU GISF		20,000 MTU GISF		60,000 MTU GISF	
	FTE	Millions 2009$	FTE	Millions 2009$	FTE	Millions 2009$
Annual Labor Costs: Loading or Unloading						
• Administrative staff	10	$0.8	8	$0.7	11	$0.9
• Security staff	20	$1.1	20	$1.1	20	$1.1
• Engineering and technical staff	18	$1.4	11	$0.9	23	$1.8
• Maintenance and equipment operating staff	19	$1.1	11	$0.6	28	$1.6
• At-reactor loading crews	18	$1.3	8	$0.5	24	$1.7
Fringe benefits and contingency		$2.3		$1.5		$2.8
Total: Annual Labor During Loading or Unloading	**85**	**$8.0**	**58**	**$5.3**	**106**	**$9.9**
Annual Labor Costs: Caretaker						
• Administrative staff	7	$0.6	7	$0.6	7	$0.6
• Security staff	20	$1.1	20	$1.1	20	$1.1
• Engineering and technical staff	7	$0.6	7	$0.6	7	$0.6
• Maintenance and equipment operating staff	6	$0.4	6	$0.4	6	$0.4
• At-reactor loading crews		$0.0		$0.0		$0.0
Fringe benefits and contingency		$1.0		$1.0		$1.0
Total: Annual Labor Caretaker	**40**	**$3.7**	40	**$3.7**	40	**$3.7**
Annual Labor Costs: Loading and Unloading						
• Administrative staff	10	$0.8	8	$0.7	11	$0.9
• Security staff	20	$1.1	20	$1.1	20	$1.1
• Engineering and technical staff	19	$1.5	11	$0.9	25	$1.9
• Maintenance and equipment operating staff	24	$1.4	14	$0.8	35	$2.0
• At-reactor loading crews	18	$1.3	8	$0.6	24	$1.7
Fringe benefits and contingency		$2.4		$1.6		$3.0
Total: Annual Labor During Loading & Unloading	**91**	**$8.5**	**61**	**$5.7**	**115**	**$10.6**

Table 3-8
Comparison of Cost and Staffing for a 20,000 MTU, 40,000 MTU and 60,000 MTU GISF Assuming 10 MTU Capacity Storage Systems

Cost Category	40,000 MTU GISF	20,000 MTU GISF	60,000 MTU GISF
Design, Engineering, Licensing and Startup Professional Services (Millions 2009$)	$67.4	$67.4	$67.4
Capital Costs (Transportation and GISF infrastructure, Fuel Storage Facility, and Transportation Cask Equipment) (Millions 2009$)	$493.7	$273.2	$690.3
Decommissioning (Millions 2009$)	$225.0	$112.8	$338.0
Annual Operating Costs (Millions 2009$)	$96.6	$50.3	$142.6
Annual Labor Costs (Millions 2009$) • During Periods of Loading or Unloading • During Caretaker Periods • During Periods of Loading and Unloading	$8.0 $3.7 $8.5	$5.3 $3.7 $5.7	$9.9 $3.7 $10.6
Construction Staff • Pre-License Construction • Modular construction during operations	130 20	130 15	130 25
Operations Staff • During Loading or Unloading • During Caretaker Period • During Loading and Unloading	85 40 91	58 40 61	106 40 115

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