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March 28, 2019
TMI-19-003

10 CFR 50.75
10 CFR 50.82

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT:
Three Mile Island Nuclear Station, Unit 2
Docket No. 50-320, License No. DPR-73
Decommissioning Funding Status Report for the Three Mile Island Nuclear
Station, Unit 2

Pursuant to 10 CFR 50.75 and 10 CFR 50.82, GPU Nuclear, Inc. is hereby submitting the following three reports to the Nuclear Regulatory Commission (NRC) for Three Mile Island Nuclear Station, Unit 2 for the year ending December 31, 2018. Attachment 1 provides a decommissioning funding status report based on the NRC formula described in 10 CFR 50.75(c). Attachment 2 provides a decommissioning funding status report based upon a site-specific decommissioning cost estimate (DCE). A calculation was prepared based on withdrawals made in the period which shows a surplus in 2054, and this calculation is included in Attachment 2. Since the end of 2018, when the calculation was performed, the trust fund balance has recovered from approximately \$791 million to approximately \$843 million which further assures sufficient funding to fulfill decommissioning activities. Attachment 3 contains a financial assurance status report as required by 10 CFR 50.82(a)(8)(v). Enclosure 1 is a copy of *2018 Decommissioning Cost Estimate for FirstEnergy, Three Mile Island, Unit 2*, dated December 12, 2018 which forms the basis for this report.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Michael Casey, GPU Nuclear Responsible Engineer TMI-2 at (330) 472-8589.

Sincerely,

A handwritten signature in black ink, appearing to read "Gregory H. Halnon", written over a horizontal line.

Gregory H. Halnon
President and Chief Nuclear Officer

Attachments:

1. Three Mile Island Nuclear Station, Unit 2 Decommissioning Funding Status Report – NRC Formula
2. Three Mile Island Nuclear Station, Unit 2 Decommissioning Funding Status Report – Site-Specific Decommissioning Cost Estimate
3. Three Mile Island Nuclear Station, Unit 2 Financial Assurance Status Report

Enclosures:

1. *2018 Decommissioning Cost Estimate for FirstEnergy, Three Mile Island, Unit 2*, dated December 12, 2018

cc: NRC Region I Administrator
NRC Project Manager
NRC Resident Inspector

Three Mile Island Nuclear Station, Unit 2 Decommissioning Funding
Status Report – NRC Formula
Page 1 of 3

This report reflects the FirstEnergy Corp. subsidiary ownership interests in the Three Mile Island Nuclear Station, Unit 2 as of December 31, 2018.

1. The minimum decommissioning fund estimate, pursuant to 10 CFR 50.75(b) and (c) (see Schedule 1):

Metropolitan Edison Company	\$251,098,549
Pennsylvania Electric Company	125,549,274
Jersey Central Power & Light Company	125,549,274
FirstEnergy Corp. Consolidated	<u>\$502,197,097</u>

2. The amount accumulated in external trust funds:

	After Tax
Metropolitan Edison Company	\$369,355,674
Pennsylvania Electric Company	194,608,821
Jersey Central Power & Light Company	227,863,753
FirstEnergy Corp. Consolidated	<u>\$791,828,248</u>

3. There are no longer any funds being collected from the ratepayers.
4. The assumptions used regarding escalation in decommissioning cost, rates of earnings on decommissioning funds, and rates of other factors used in funding projections:

Consolidated Ownership Interest in Unit	100%
Estimated Net Investment Rate	2.00%
Year of Site Restoration Completion	2053

Three Mile Island Nuclear Station, Unit 2 transitions from a Post-Defueling Monitored Storage status to decommissioning in 2040.

5. There are no contracts upon which the owners/licensees are relying pursuant to 10 CFR 50.75(e)(1)(v).
6. There are no modifications to the licensee's current method of providing financial assurance since the last submitted report.

7. There were no amendments to the trust agreements for the above-mentioned owners of Three Mile Island Nuclear Station, Unit 2.
8. Mathematical rounding was performed during the development of the supporting calculations.

Schedule 1
FIRSTENERGY CORP.
Calculation of Minimum Financial Assurance Amount
December 31, 2018
THREE MILE ISLAND NUCLEAR STATION, UNIT 2

Pennsylvania Regions

Labor (L) = Northeast
Energy (E) = National
Waste Burial (B) = Generic

For PWR Unit

	Adjustment Factor	Ratio	Escalation Factor ¹
L =	2.95	0.65	1.918
E =	2.365	0.13	0.307
B =	12.853	0.22	2.828
PWR Escalation Factor =			5.053

Base Amount for PWR between 1200 MWt and 3400 MWt = (\$75 + 0.0088P) million
(P = power level in megawatts thermal = 2772)

(\$75 + 0.0088(2772)) million = \$99,393,600

Escalated Amount for unit¹ =
99,393,600 x 5.053 = \$502,197,097

<u>Owner/Licensee¹</u>	<u>Ownership</u>	
Pennsylvania Electric Company	25%	\$125,549,274
Jersey Central Power & Light Company	25%	\$125,549,274
Metropolitan Edison Company	<u>50%</u>	<u>\$251,098,549</u>
FirstEnergy Corp. Consolidated	100%	<u><u>\$502,197,097</u></u>

Note 1: Mathematical rounding was performed during the development of the supporting calculations.

Three Mile Island Nuclear Station, Unit 2 Decommissioning Funding
Status Report – Site-Specific Decommissioning Cost Estimate
Page 1 of 4

1. Decommissioning funds estimated to be required pursuant to 10 CFR 50.75(b) and (c) are based upon a site-specific decommissioning cost study, *2018 Decommissioning Cost Estimate for FirstEnergy, Three Mile Island, Unit 2*, dated December 12, 2018:

NRC License Termination	\$1,320,506,000
-------------------------	-----------------

2. The amount accumulated in external trust funds as of December 31, 2018:

	After Tax
Metropolitan Edison Company	\$369,355,674
Pennsylvania Electric Company	194,608,821
Jersey Central Power & Light Company	227,863,753
FirstEnergy Corp. Consolidated	<u>\$791,828,248</u>

3. There are no longer any funds being collected from the ratepayers.
4. The assumptions used regarding escalation in decommissioning cost, rates of earnings on decommissioning funds, and rates of other factors used in funding projections:

Consolidated Ownership Interest in Unit	100%
Estimated Rate of Escalation in Decommissioning Costs	0.00%
Estimated After-Tax Rate of Return	2.00%
Year of Site Restoration Completion	2053

Three Mile Island Nuclear Station, Unit 2 transitions from a Post-Defueling Monitored Storage status to decommissioning in 2040.

All costs are based on a site-specific decommissioning cost study, *2018 Decommissioning Cost Estimate for FirstEnergy, Three Mile Island, Unit 2*, dated December 12, 2018

5. There are no contracts upon which the owners/licensees are relying pursuant to 10 CFR 50.75(e)(1)(v).
6. There are no modifications to the licensee's current method of providing financial assurance since the last submitted report.

7. There were no amendments to the trust agreements for the above-mentioned owners of Three Mile Island Nuclear Station, Unit 2.

8. Site-Specific Cost Analysis Assumptions

10 CFR 50.75(e)(1)(i), states, in part, that:

A licensee that has prepaid funds based on a site-specific estimate under 50.75(b)(1) of this section may take credit for projected earnings on the prepaid decommissioning trust funds, using up to a 2 percent annual real rate of return from the time of future funds' collection through the projected decommissioning period, provided that the site-specific estimate is based on a period of safe storage that is specifically described in the estimate.

In accordance with Regulatory Guide 1.159, Revision 2, *Assuring the Availability of Funds for Decommissioning Nuclear Reactors*, a facility specific analysis may be used to demonstrate the adequacy of decommissioning funds, provided that:

NRC-required cost estimate for decommissioning costs, as defined in 10 CFR 50.2, is equal to or greater than the amount stated in the formulas in 10 CFR 50.75(c)(1) and (2).

The site-specific radiological decommissioning cost estimate is \$1,320,506,000 which is greater than the 10 CFR 50.75(c) cost estimate of \$502,197,097. The analysis assumes a 2 percent yearly rate of return. The analysis also assumes a period of safe storage. The cash flows were contained in a decommissioning cost estimate that was prepared for Three Mile Island Nuclear Station, Unit 2. The cash flow analysis assumes the yearly expenses are incurred at the beginning of year.

Schedule 1 provides the site-specific analysis. The analysis values are in 2018 dollars. The analysis is based on TMI-2 transitioning from Post-Defueling Monitored Storage status to decommissioning in 2040 and includes expenditures for license termination costs only.

9. Mathematical rounding was performed during the development of the supporting calculations.

10. References:

A. *2018 Decommissioning Cost Estimate for FirstEnergy, Three Mile Island, Unit 2*, dated December 12, 2018 (Enclosure 1)

Schedule 1

FIRSTENERGY CORP.
Funding Analysis
December 31, 2018
THREE MILE ISLAND NUCLEAR STATION, UNIT 2

After-Tax

Estimated Net Investment Rate	2.00%
Estimated Escalation Rate	0.00%
Estimated After-Tax Rate of Return	<u>2.00%</u>

Qualified Trust Balance on December 31, 2018	<u>791,828,248</u>	After-Tax
Non-Qualified Trust Balance on December 31, 2018	-	
Total	<u>791,828,248</u>	

Year	Beginning Balance	Deposits	Earnings	Withdrawal ^{1,2,3}	Ending Balance
2019	791,828,248	-	15,801,752	(3,481,304)	804,148,696
2020	804,148,696	-	16,048,161	(3,481,304)	816,715,553
2021	816,715,553	-	16,299,498	(3,481,304)	829,533,747
2022	829,533,747	-	16,555,862	(3,481,304)	842,608,305
2023	842,608,305	-	16,817,353	(3,481,304)	855,944,354
2024	855,944,354	-	17,084,074	(3,481,304)	869,547,125
2025	869,547,125	-	17,356,129	(3,481,304)	883,421,950
2026	883,421,950	-	17,633,626	(3,481,304)	897,574,272
2027	897,574,272	-	17,916,672	(3,481,304)	912,009,641
2028	912,009,641	-	18,205,380	(3,481,304)	926,733,717
2029	926,733,717	-	18,499,861	(3,481,304)	941,752,274
2030	941,752,274	-	18,800,232	(3,481,304)	957,071,203
2031	957,071,203	-	19,106,611	(3,481,304)	972,696,510
2032	972,696,510	-	19,419,117	(3,481,304)	988,634,323
2033	988,634,323	-	19,737,873	(3,481,304)	1,004,890,893
2034	1,004,890,893	-	20,063,005	(3,481,304)	1,021,472,594
2035	1,021,472,594	-	20,394,639	(3,481,304)	1,038,385,929
2036	1,038,385,929	-	20,732,906	(3,481,304)	1,055,637,530
2037	1,055,637,530	-	21,061,398	(5,135,244)	1,071,563,684
2038	1,071,563,684	-	21,366,024	(6,524,919)	1,086,404,790
2039	1,086,404,790	-	21,662,847	(6,524,919)	1,101,542,717
2040	1,101,542,717	-	21,857,830	(17,302,419)	1,106,098,129
2041	1,106,098,129	-	21,611,711	(51,025,115)	1,076,684,725
2042	1,076,684,725	-	20,376,757	(115,693,746)	981,367,736
2043	981,367,736	-	18,452,185	(117,516,985)	882,302,936
2044	882,302,936	-	15,957,382	(168,867,661)	729,392,657

Year	Beginning Balance	Deposits	Earnings	Withdrawal ^{1,2,3}	Ending Balance
2045	729,392,657	-	12,898,334	(168,951,893)	573,339,098
2046	573,339,098	-	9,788,822	(167,795,966)	415,331,954
2047	415,331,954	-	7,832,705	(47,393,419)	375,771,240
2048	375,771,240	-	7,016,561	(49,886,381)	332,901,420
2049	332,901,420	-	5,868,519	(78,950,989)	259,818,950
2050	259,818,950	-	4,501,481	(69,489,773)	194,830,657
2051	194,830,657	-	3,198,916	(69,769,758)	128,259,815
2052	128,259,815	-	1,848,111	(71,708,500)	58,399,427
2053	58,399,427	-	798,234	(36,975,500)	22,222,160
2054 ⁴	22,222,160	-	361,149	(8,329,433)	14,253,876
				(1,320,506,090)	

(1) reflects **Safstor** method from Energy Solutions Scenario 2 Safstor 1, withdrawals assumed to be made in the middle of the period

(2) There were no funds withdrawn from the decommissioning trust fund for years 2013, 2014, 2015, 2016, and 2017

(3) In 2018 \$312,743.81 was withdrawn from the decommissioning trust fund for Decommissioning Planning

(4) 2054 costs cover potential unresolved license termination invoices and costs from the previous years.

Three Mile Island Nuclear Station, Unit 2 Financial Assurance Status Report
Page 1 of 1

1. Formal decommissioning has not started at Three Mile Island Nuclear Station, Unit 2. A special disbursement of decommissioning trust funds occurred in 2005 for \$416,400.00. Notification of this use of decommissioning funds was made to the NRC by letter dated February 1, 2005 (Accession No. ML050380143). \$312,743.81 was spent on decommissioning planning activities in 2018.
2. Decommissioning funds estimated to be required are based upon a site-specific decommissioning cost study, *2018 Decommissioning Cost Estimate for FirstEnergy, Three Mile Island, Unit 2*, dated December 12, 2018:

NRC License Termination	\$1,320,506,000
-------------------------	-----------------

As noted on Attachment 2, Schedule 1, *FirstEnergy Corp. Funding Analysis dated December 31, 2018*.

3. The amount accumulated in external trust funds as of December 31, 2018:

	After Tax
Metropolitan Edison Company	\$369,355,674
Pennsylvania Electric Company	194,608,821
Jersey Central Power & Light Company	227,863,753
FirstEnergy Corp. Consolidated	<u>\$791,828,248</u>

4. There are no longer any funds being collected from the ratepayers.
5. There are no modifications to the licensee's current method of providing financial assurance since the last submitted report.
6. There were no amendments to the trust agreements for the above-mentioned owners of Three Mile Island Nuclear Station, Unit 2.
7. Mathematical rounding was performed during the development of the supporting calculations.
8. References:

A. *2018 Decommissioning Cost Estimate for FirstEnergy, Three Mile Island, Unit 2*, dated December 12, 2018 (Enclosure 1)



Document No. 164059-DCE-01

**2018 Decommissioning Cost Estimate
for
FirstEnergy, Three Mile Island, Unit 2**

Project No. 164059

Final Rev 0

Prepared for:
GPU Nuclear Inc.

Prepared by:
EnergySolutions, LLC

Authored By:	<u>Mark Rademacher</u>	<u>Dec. 13, 2018</u>
	Mark Rademacher, Estimating Director	Date
Reviewed By:	<u>Michael S. Williams</u>	<u>12/12/18</u>
	Michael S. Williams, Senior D&D Specialist	Date
Approved By:	<u>Scott Lacey</u>	<u>12/12/18</u>
	Scott Lacey, Director of Business Operations	Date

- ☒ New Report
- ☐ Title Change
- ☐ Report Revision
- ☐ Report Rewrite

Effective
Date: December 14, 2018

Revision Log

No.	Date	Reason for Revision	Item(s) Revised
0	12/14/18	Original Submittal	

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Acronyms and Abbreviations

AIF	Atomic Industrial Forum
ALARA	As Low As Reasonably Achievable
BWR	Boiling Water Reactors
CFR	Code of Federal Regulations
D&D	Decontamination & Decommissioning
DAW	Dry Active Waste
DCE	Decommissioning Cost Estimate
DGC	Decommissioning General Contractor
DOE	U.S. Department of Energy
DSAR	Defueled Safety Analysis Report
ES	EnergySolutions
FSS	Final Status Survey
GPUN	GPU Nuclear, Inc.
GTCC	Greater Than Class C Waste
HP	Health Physics
ISFSI	Independent Spent Fuel Storage Installation
JCP&L	Jersey Central Power & Light
LLRW	Low-Level Radioactive Waste
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MET-ED	Metropolitan Edison
MWt	Megawatt thermal
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
ORISE	Oak Ridge Institute for Science and Education
PCB	Polychlorinated Biphenyl
PDMS	Post-Defueling Monitored Storage
PENELEC	Pennsylvania Electric Company
PSDAR	Post-Shutdown Decommissioning Activities Report
PWR	Pressurized Water Reactor
SNF	Spent Nuclear Fuel
TMI	Three Mile Island Nuclear Generating Station
TMI-1	Three Mile Island, Unit 1
TMI-2	Three Mile Island, Unit 2
WBS	Work Breakdown Structure
WCS	Waste Control Specialists LLC
UCF	Unit Cost Factor

1.0 EXECUTIVE SUMMARY

GPU Nuclear, Inc. (GPUN), acting for itself and for the Metropolitan Edison Company, Jersey Central Power and Light Company, and the Pennsylvania Electric Company, contracted with EnergySolutions LLC, for the preparation of this Report. The report presents the 2018 Decommissioning Cost Estimate (DCE) Study of the Three Mile Island Unit-2 Nuclear Station (TMI-2), hereinafter referred to as the 2018 Cost Study. The Three Mile Island Unit-2 Nuclear Generating Station is owned by GPU Nuclear a fully owned subsidiary of First Energy.

The March 28, 1979 nuclear accident resulted in the permanent cessation of operations at TMI-2. Following an intensive 15-year recovery process that resulted in the removal and shipment of ~99% of the damaged reactor fuel, the plant was placed into an approved monitored storage program referred to as "Post-Defueling Monitored Storage (PDMS)" in 1993. FirstEnergy via its GPU Nuclear subsidiary has the responsibility to decommission the TMI-2 station.

In April 2018 GPU Nuclear contracted with EnergySolutions to evaluate decommissioning alternatives and assist in the development of a draft decommissioning schedule, staffing plan, detailed cost tables in constant 2018 dollars, annual expenditures in constant 2018 dollars and a comparison analysis between this study and the prior TLG Services, Inc. study.

This study has been performed to furnish an estimate of the costs for license termination under three specified scenarios as follows:

DECON – based upon the TMI-2 decommissioning effort commencing in 2019 and coordinated with the TMI-1 decommissioning effort. It is assumed that the TMI-1 decommissioning effort will include appropriate time for TMI-1 fuel offload to an Independent Spent Fuel Storage Installation (ISFSI) and that the active TMI-2 decommissioning effort will start at that point. This scenario includes PDMS costs incurred between the 2018 start date and commencement of decommissioning activities. License termination for TMI-2 is not to proceed beyond 2053.

SAFSTOR1 - based on TMI-1 placed into long-term SAFSTOR upon completion of commercial operations at some point between 2019 and 2034. The TMI-1 and TMI-2 decommissioning efforts will be completed as independent activities with the assumption that TMI-2 decommissioning would complete prior to commencement of TMI-1 decommissioning. The TMI-2 PDMS activities continue under the existing TMI-2 Monitoring Agreement with Exelon through completion of TMI-1 fuel off-load to the ISFSI, at which time 100% of these activities become the responsibility of FirstEnergy (GPU Nuclear). Completion of TMI-2 SAFSTOR activities will occur in 2053.

SAFSTOR2 – based on TMI-1 shutting down between 2019 and 2034 and utilizing a 60-year SAFSTOR period. TMI-2 would seek an extension of the TMI-2 SAFSTOR period beyond its current license termination date of 2053 in order to coordinate decommissioning with the TMI-1 SAFSTOR decommissioning effort. This scenario includes PDMS costs incurred between the 2018 start date and commencement of decommissioning activities.

The cost estimate results are provided in Table 1-1. This table provides License Termination cost (corresponding to 10 CFR 50.75(c) requirements); Spent Fuel Management costs (corresponding to 10 CFR 50.54(bb) requirements) and Site Restoration costs (corresponding to activities such as clean building demolition and site grading etc.).

TABLE 1-1

Decommissioning Cost Summary (thousands of 2018 dollars)				
	License Termination	Spent Fuel	Site Restoration	Total
Scenario 1 - DECON	1,152,465	92,815	54,088	1,299,368
Scenario 2 - SAFSTOR1	1,183,939	82,662	53,905	1,320,506
Scenario 3 - SAFSTOR2	1,325,700	82,662	53,831	1,462,193

Costs for Greater Than Class C (GTCC) casks, operations, storage and disposition are included in the License Termination Costs.

This estimate is based on site-specific plant systems and buildings inventories. These inventories, EnergySolutions proprietary Unit Cost Factors (UCFs) and historical data, were used to generate required man-hours, costs, waste volume, weight and classification.

Schedules reflect the effects of sequenced activity-dependent or distributed decommissioning elements such as planning and preparations, major component removal, building decontamination, building demolition, etc.

The costs and schedule for the DECON scenario is divided into three major project phases (periods) and presented by:

Phase 1 - Source Term Risk Reduction

Phase 2 - Decommissioning and License Termination subtleties

Phase 3 – Spent Nuclear Fuel (SNF) /GTCC Storage and Disposition

The costs and schedule for the SAFSTOR scenarios are divided into major project phases (periods) and presented by:

Phase 0 – SAFSTOR

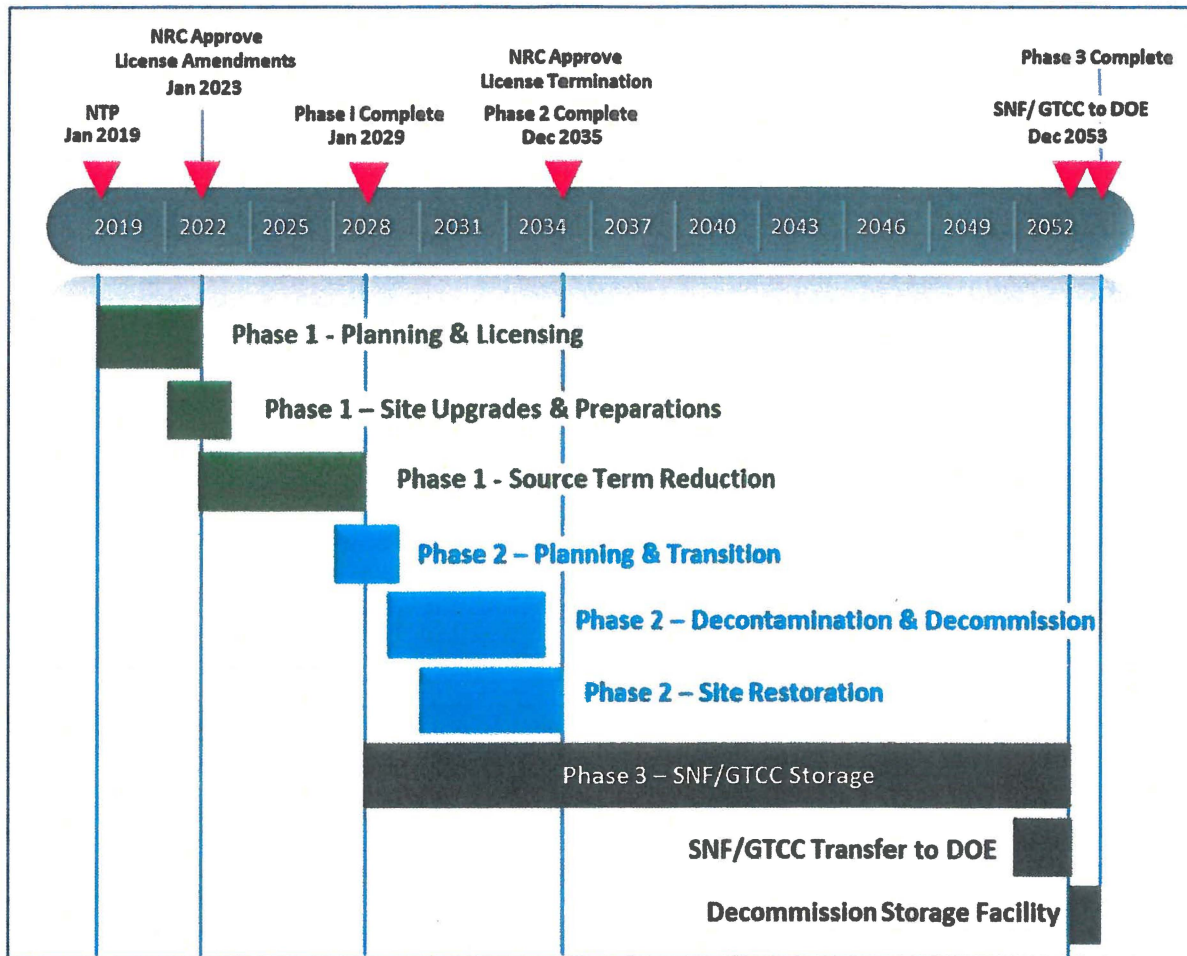
Phase 1 - Source Term Risk Reduction

Phase 2 - Decommissioning and License Termination

Figures 1-1, 1-2 and 1-3 below show summary-level schedules for each of the Scenarios.

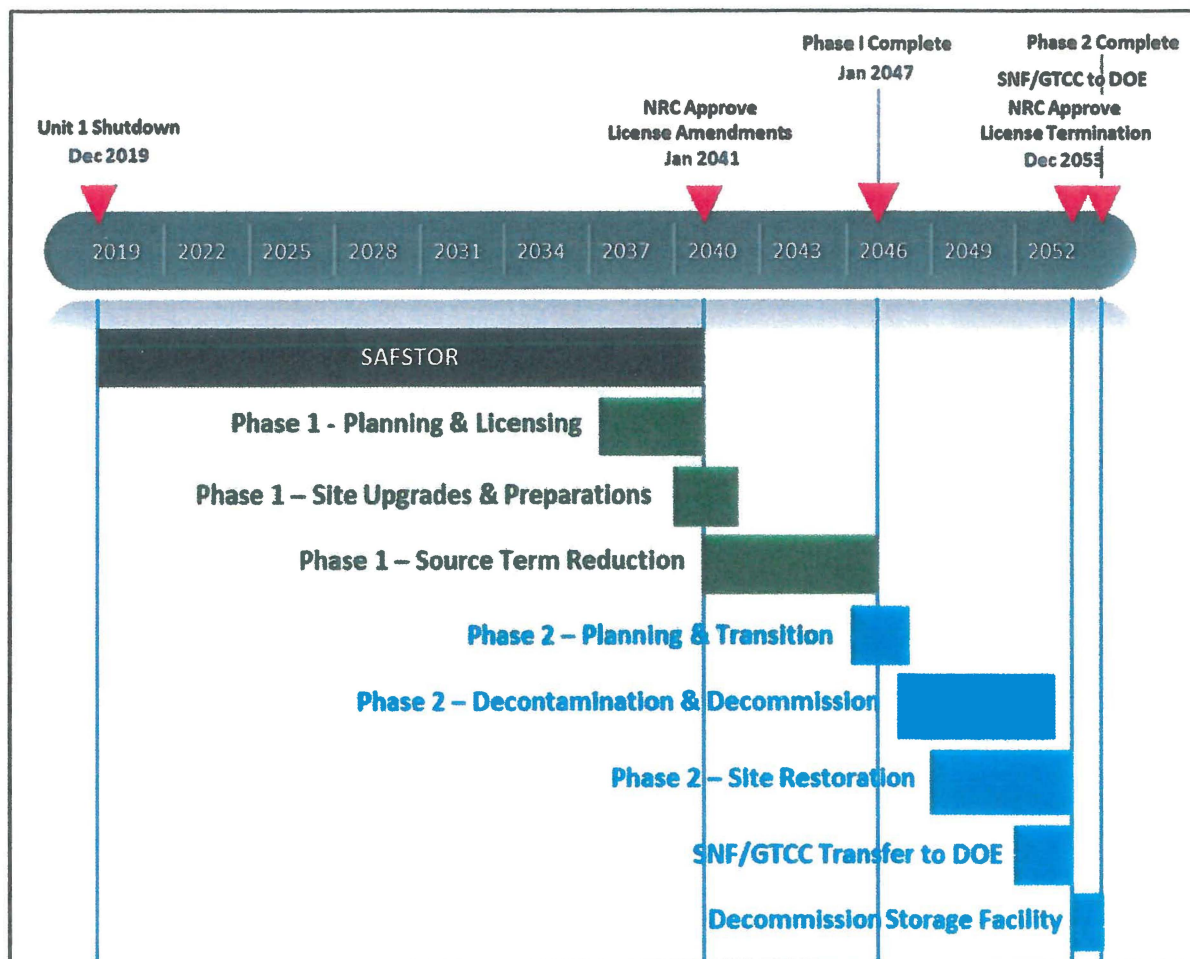
Figure 1-1 below shows a summary-level DECON schedule.

FIGURE 1-1
Summary Schedule - DECON



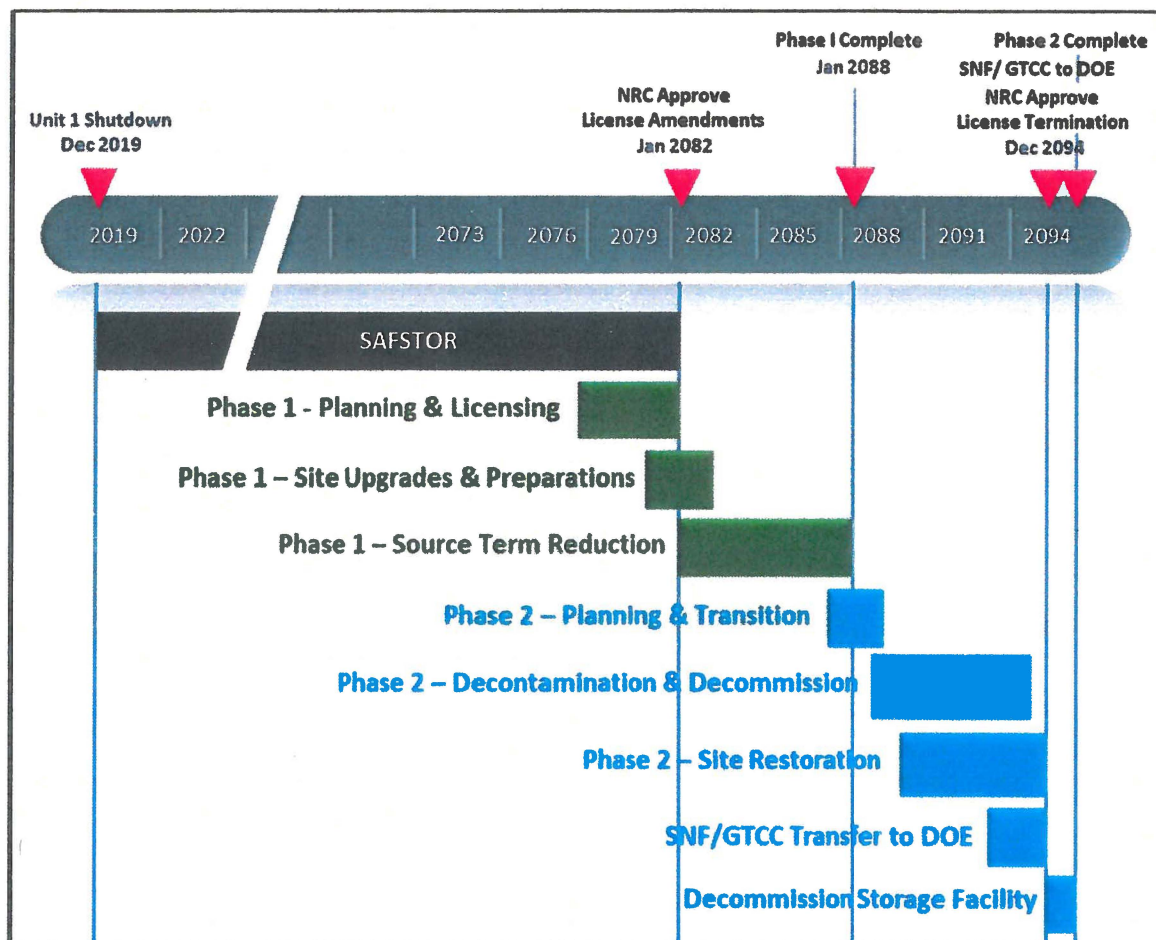
Figures 1-2 below shows a summary-level SAFSTOR1 schedule.

FIGURE 1-2
Summary Schedule – SAFSTOR1



Figures 1-3 below shows a summary-level SAFSTOR2 schedule.

FIGURE 1-3
Summary Schedule – SAFSTOR2



2.0 INTRODUCTION

2.1 Study Objective

This report presents the 2018 Decommissioning Cost Estimate Study of the Three Mile Island Unit-2 Nuclear Station, hereinafter referred to as the 2018 Cost Study. The Three Mile Island Nuclear Station is owned by FirstEnergy via its wholly owned subsidiary GPU Nuclear. The TMI-2 ownership is comprised of: Metropolitan Edison (MET-ED); Pennsylvania Electric Company (PENELEC); and Jersey Central Power and Light (JCP&L). Ownership is reflected as follows:

- MET-ED – 50%
- PENELEC – 25%
- JCP&L – 25%

This study has been performed to provide FirstEnergy with an updated Decommissioning Cost Estimate relative to the aforementioned specific decommissioning options. It addresses: (1) the decommissioning of TMI-2 to the extent required to terminate the plant's possession-only license, (2) management of residual spent fuel until acceptance by the U.S. Department of Energy (DOE), and (3) demolition of uncontaminated structures and restoration of the site.

The terms Spent Nuclear Fuel (SNF) and spent fuel are used interchangeably in this study.

The study methodology follows the basic approach originally presented in the Atomic Industrial Forum/National Environmental Studies Project Report AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates" (Ref. No. 2). The report was prepared in accordance with Nuclear Regulatory Commission (NRC) Regulatory Guide 1.202, "Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors" (Ref. No. 3). The estimate is based on compliance with current regulatory requirements and proven decommissioning technologies.

NRC requirements, set forth in Title 10 of the Code of Federal Regulations (CFR), differentiate between the post-shutdown costs associated with the decommissioning of the nuclear plant facility, those associated with storage of spent fuel on-site, and those associated with the decommissioning of a spent fuel storage facility. The Code of Federal Regulations, however, does not address the entire scope of the decommissioning liability for each nuclear facility. 10 CFR 50.75(c) requires funding by the licensee(s) of the facility for the decommissioning program, but specifically excludes the cost of removal and disposal of spent fuel and structures that do not require disposal as radioactive material. 10 CFR 50.75(c) also excludes the cost of site restoration activities that do not involve the removal of residual radioactivity necessary to terminate the NRC license(s). 10 CFR 50.54(bb) requires funding by the licensee(s) "for the management of all irradiated fuel at the reactor upon expiration of the reactor operating license(s) until title to the irradiated fuel and possession of the fuel is transferred to the Secretary of Energy for its ultimate disposal in a repository." 10 CFR 72.30 requires funding for decommissioning of the on-site spent fuel storage facility after the irradiated fuel is accepted by the DOE.

This study analyzes the following technical approaches to decommissioning as defined by FirstEnergy/GPU Nuclear.

DECON - based upon the TMI-2 decommissioning effort commencing in 2019 and coordinated with the TMI-1 decommissioning effort. It is assumed that the TMI-1 decommissioning effort will include appropriate time for TMI-1 fuel offload to an Independent Spent Fuel Storage Installation (ISFSI) and that the active TMI-2

decommissioning effort will start at that point. This scenario includes PDMS costs incurred between the 2018 start date and commencement of decommissioning activities. License termination for TMI-2 is not to proceed beyond 2053.

SAFSTOR1 - based on TMI-1 placed into long-term SAFSTOR upon completion of commercial operations at some point between 2019 and 2034. The TMI-1 and TMI-2 decommissioning efforts will be completed as independent activities with the assumption that TMI-2 decommissioning would complete prior to commencement of TMI-1 decommissioning. The TMI-2 PDMS activities continue under the existing TMI-2 Monitoring Agreement with Exelon through completion of TMI-1 fuel off-load to the ISFSI, at which time 100% of these activities become the responsibility of FirstEnergy (GPU Nuclear). Completion of TMI-2 SAFSTOR activities will occur in 2053.

SAFSTOR2 - based on TMI-1 shutting down between 2019 and 2034 and utilizing a 60-year SAFSTOR period. TMI-2 would seek an extension of the TMI-2 SAFSTOR period beyond its current license termination date of 2053 in order to coordinate decommissioning with the TMI-1 SAFSTOR decommissioning effort. This scenario includes PDMS costs incurred between the 2018 start date and commencement of decommissioning activities.

2.2 Regulatory Framework

Provisions of current laws and regulations affecting decommissioning, waste management, and spent fuel management are as follows:

1. NRC regulations require a license for on-site storage of spent fuel. Wet storage in a spent fuel pool is authorized by a facility's 10 CFR Part 50 license (Ref. 1). On-site dry storage of spent fuel at an Independent Spent Fuel Storage Installation (ISFSI) is licensed by either: (a) the general license set forth in 10 CFR 72.210, which requires that a Part 50 license be in place; or (b) a site-specific ISFSI license issued pursuant to 10 CFR Part 72.
2. 10 CFR 50.75(c) requires funding by the licensee(s) of the facility for decommissioning.
3. 10 CFR 50.54(bb) requires the licensee(s), within two years following permanent cessation of operation of the reactor or five years before expiration of the operating license(s), whichever occurs first, to submit written notification to the NRC for its review and preliminary approval of the program by which the licensee intends to manage and provide funding "for the management of all irradiated fuel at the reactor upon expiration of the reactor operating license until title to the irradiated fuel and possession of the fuel is transferred to the Secretary of Energy for its ultimate disposal in a repository."

2.3 Decommissioning Alternatives

The three basic methods for decommissioning are DECON, SAFSTOR, and ENTOMB, which are summarized as follows:

1. DECON: The equipment, structures, and portions of the facility and site that contain radioactive contaminants are promptly removed or decontaminated to a level that permits termination of the license after cessation of operations.

2. SAFSTOR: The facility is placed in a safe, stable condition and maintained in that state (safe storage). The facility is decontaminated and dismantled at the end of the storage period to levels that permit license termination. NRC regulations require decommissioning to be completed within 60 years of cessation of operation.
3. ENTOMB: Radioactive structures, systems, and components are encased in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained and monitored until radioactivity decays to a level that permits termination of the license. Since entombment will exceed the requirement for decommissioning to be completed within 60 years of cessation of operation, NRC handles entombment requests on a case-by-case basis.

2.4 Post-Shutdown Spent Fuel Management Alternatives

The options for long-term post-shutdown spent fuel management currently available to power plant operators are (1) wet storage consisting of continued maintenance and operation of the spent fuel pool, and (2) dry storage consisting of transfer of spent fuel from the fuel pool to onsite dry storage modules after a cooling period or any combination of the two. The present case at TMI-2, because it is an 'accident plant,' differs in that the bulk of the Spent Nuclear Fuel (SNF) was shipped off site during the accident recovery phase with only ~1% remaining within the plant's structures, systems and components.

Transfer of recovered spent fuel to an ISFSI requires additional expenditures for purchase and construction of the ISFSI and dismantlement and disposal of the ISFSI following completion of spent fuel transfer to DOE. GPUN is considering alternatives for the disposition of the remaining spent fuel. These options are as follows:

- (1) Transfer to the DOE under a program similar to that used during the accident recovery spent fuel disposition program.
- (2) Transfer to an as yet to be developed, privately owned Interim Spent Nuclear Fuel Storage Facility.
- (3) Storage of the TMI-2 spent fuel at the TMI-1 ISFSI per a negotiated agreement with the TMI-1 owner.

The following Table 2-1 shows the costs contained in this report associated with the construction, security operation and decommissioning of an ISFSI for the on-site storage of SNF/GTCC.

TABLE 2-1

SNF/GTCC Costs associated with ISFSI (thousands of 2018 dollars)		
1b.3	SNF/GTCC Interim Storage Facility	\$ 8,580
1f.3	Security Staff & Equipment	\$ 19,780
3a.1	SNF/GTCC Storage Facility Security & Operations	\$ 52,440
3a.3	SNF/GTCC Storage Facility Decommission	\$ 2,880
	Total	\$ 83,680

3.0 STUDY METHODOLOGY

3.1 General Description

EnergySolutions maintains a proprietary decommissioning cost model based upon the fundamental technical approach established in AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," dated May 1986 (Ref. No. 2). The cost model has been updated frequently in accordance with regulatory requirements and industry experience. The cost model includes elements for estimating distributed and undistributed costs. Distributed costs are activity specific and include planning and preparation costs as well as costs for decontamination, packaging, disposal, and removal of major components and systems. For example, costs for the segmentation, packaging, and disposal of the reactor internals are distributed costs. Undistributed costs, sometimes referred to as collateral costs, are typically time dependent costs such as utility (Licensee) and decommissioning general contractor staff, property taxes, insurance, regulatory fees and permits, energy costs, and security staff.

The methodology for preparing cost estimates for a selected decommissioning alternative requires development of a site-specific detailed work activity sequence based upon the plant inventory. The activity sequence is used to define the labor, material, equipment, energy resources, and duration required for each activity. In the case of major components, individual work sequence activity analyses are performed based on the physical and radiological characteristics of the component, and the packaging, transportation, and disposal options available.

In the case of structures and small components and equipment such as piping, pumps, and tanks, the work durations and costs are calculated based on UCFs. UCFs are economic parameters developed to express costs per unit of work output, piece of equipment, or time. They are developed using decommissioning experience, information on the latest technology applicable to decommissioning, and engineering judgment. The total cost of a specific decommissioning activity can be determined by multiplying the total number of units associated with that activity by the UCF, expressed as \$/unit, for that activity. For example, the estimated demolition cost of a non-contaminated concrete structure can be obtained by multiplying the volume of concrete in the structure by the UCF for non-contaminated reinforced concrete demolition, expressed in \$/unit volume. Each UCF has associated with it a man-hours/unit and schedule-hours/unit. From these values, total man-hours and total schedule-hours can be estimated for a particular activity.

3.2 Schedule Analysis

After the work activity durations are calculated for all distributed activities, a schedule analysis is performed using Oracle Primavera P6. The schedule accounts for constraints and regulatory reviews. The schedule is typically delineated into phases or time periods that differentiate between direct costs requirements and undistributed costs.

In order to differentiate between phase (period) elements of the decommissioning scope of work, EnergySolutions has established a Work Breakdown Structure (WBS) and cost accounting system to treat each element as a subproject. Accordingly, the overall project schedule is divided into interrelated periods with major milestones defining the beginning and ending of each period. The major milestones also serve as the basis for integrating the periods of the three subprojects.

3.3 Decommissioning Staff

EnergySolutions has assumed that the TMI-2 decommissioning project will be performed in an efficiently planned and executed manner using project personnel experienced in decommissioning and large-scale project management. This DCE also assumes that the decommissioning work will be performed by a highly experienced and qualified Decommissioning General Contractor (DGC), with oversight and management of the decommissioning operations performed by the Licensee staff. It is also assumed that the Licensee staff will be supplemented by a professional consulting engineering firm, particularly in the planning and preparation phase.

EnergySolutions analyzed the TMI-2 licensee staffing needs and developed a site-specific staffing plan. Since there is no incumbent TMI-2 staff during PDMS, there is no existing salary structure for use as the basis for calculating Licensee staff labor costs. Staff and DGC Labor costs were therefore developed by *EnergySolutions* utilizing ES historical data.

Staffing levels, for both staffing plans and for each project period, are based on the Atomic Industrial Forum (AIF) guidelines, industry and ES historical experience. The sizes of the staffs are varied in each period in accordance with the requirements of the work activities. Staffing has been organized into the following departments or functional groups:

- Management & Administrative
- Engineering
- Plant Operations & Maintenance
- Radiation Protection and Chemistry
- Health Physics
- Regulatory Affairs
- Quality
- Waste Operations
- Security
- DGC Staff

3.4 Waste Disposal

Waste management costs comprise a significant portion of the decommissioning cost estimate. Additionally, limited future access to disposal sites licensed for receipt of Class B and C wastes introduces a significant level of uncertainty with respect to the appropriateness of using existing rate structures to estimate disposal costs of these wastes. *EnergySolutions'* approach to estimating waste disposal costs is discussed in the following paragraphs.

Waste Classification

Regulations governing disposal of radioactive waste are stringent in order to ensure control of the waste and preclude adverse impact on public health and safety. At present, LLRW disposal is controlled by 10 CFR 61, which went into effect in December 1983. This regulation stipulates the criteria for the establishment and operation of shallow-land LLRW burial facilities. Embodied within this regulation are criteria and classifications for packaging LLRW such that it is acceptable for burial at licensed LLRW disposal sites.

For each waste classification, 10 CFR 61 stipulates specific criteria for physical and chemical properties that the LLRW must meet in order to be accepted at a licensed disposal site. The LLRW disposal criteria of

10 CFR 61 require that LLRW generators determine the proportional amount of a number of specific radioactive isotopes present in each container of disposable LLRW. This requirement for isotopic analysis of each container of disposable LLRW is met by employing a combination of analytical techniques such as computerized analyses based upon scaling factors, sample laboratory analyses, and direct assay methods. Having performed an isotopic analysis of each container of disposable LLRW, the waste must then be classified according to one of the classifications (Class A, B, C, or Greater Than Class C (GTCC)) as defined in 10 CFR 61.

EnergySolutions' classification of LLRW resulting from decommissioning activities is based on AIF/NESP-036 (Ref. No. 2), NUREG/CR-0130 (Ref. No. 4), plant-specific information and recent industry experience. The estimated curie content of the reactor vessel and internals at shutdown is typically derived from NUREG/CR-0130 for Pressurized Water Reactors (PWRs) and NUREG/CR-0672 for Boiling Water Reactors (BWRs) and adjusted for the different mass of components and period of decay. In the case of TMI-2 and due to the accident event, such derivations are not considered applicable and plant-specific data and information were utilized. The TMI-2 Defueling Completion Report (Ref. No. 7) and related documents and reports were used to develop the approximate and conservative wastes classifications for purposes of the 2018 DCE.

Packaging

Selection of the type and quantity of containers required for Class B and C wastes is based on the most restrictive of either Curie-content, dose-rate, container weight limit, or container volume limit. Residual spent fuel and GTCC wastes from segmentation of the reactor vessel internals and other accident related waste is normally packaged in modified spent fuel canisters and this packaging is assumed for the DCE. The selection of container type for Class A waste is based on the transportation mode (rail, truck, barge, etc.) and waste form. The quantity of Class A waste containers is determined by the most restrictive of either container weight limit or container volume limit. Large components, such as steam generators, pressurizers, and reactor recirculation pumps, are shipped as their own containers with additional shielding as required.

Container costs are obtained from manufacturers specializing in the design and fabrication of storage containers for nuclear materials. Shielded transport cask and liner costs are obtained from the cask owners and operators.

Transportation

Transportation routes to processing and disposal facilities are determined based on available transportation modes (truck, rail, barge, or combinations). Transportation costs for the selected routes and modes are obtained from vendor quotes or published tariffs whenever possible.

Class-A Disposal Options and Rates

Class A waste that meets the waste acceptance criteria are to be disposed of at EnergySolutions' LLRW disposal facility in Clive, Utah. All reported waste disposal costs include packaging, transportation and any applicable surcharges.

Class B and C Disposal Options and Rates

Currently, within the United States, there are only three operational commercial near-surface disposal facilities licensed to accept Class B and C LLRW: the Barnwell facility, operated by EnergySolutions in Barnwell, South Carolina; the U.S. Ecology facility in Richland, Washington; and the facility in Andrews County, Texas, operated by Waste Control Specialists. Barnwell only accepts waste from states within the Atlantic Compact and U.S. Ecology only accepts waste from states within the Northwest and Rocky Mountain Compacts.

However, the WCS facility will accept waste from the Texas Compact (comprised of Texas and Vermont) and from non-Compact generators. The Texas Compact Commission on March 23, 2012, approved amendments to rules allowing the import of non-compact generator LLRW for disposal at the WCS Andrews County facility.

Greater-Than-Class-C (GTCC)

Wastes identified as 10 CFR 61 Class A, B, and C may be disposed of at near-surface disposal facilities. Certain components are highly activated and may exceed the radionuclide concentration limitations for 10 CFR 61 Class C waste. In accordance with 10 CFR 61, these components, which are referred to as GTCC wastes, cannot be disposed of in a near-surface LLRW disposal facility and must be transferred to a geologic repository or a similar site approved by the NRC.

Highly activated sections of the reactor vessel internals and certain decommissioning processes will result in GTCC waste. Presently, a facility does not exist for the disposal of wastes exceeding 10 CFR 61 Class C limitations. EnergySolutions assumes that the DOE will accept this waste along with spent fuel. Although courts have held that DOE is obligated to accept and dispose of GTCC, issues regarding potential costs remain unsettled. Therefore, EnergySolutions conservatively estimates a GTCC waste disposal cost. EnergySolutions assumes that the GTCC waste will be packaged in modified spent fuel canisters, or similar containers, and will be shipped to a storage or disposal facility operated by DOE along with the spent fuel.

This DCE is based upon a negotiated agreement with the owner of TMI-1 for the storage of residual spent fuel and GTCC waste. This includes sharing costs for the design and construction of an ISFSI and/or interim storage facility, security and operations.

The DCE also assumes that costs for equipment, load out of SNF/GTCC and the decommissioning of the storage facility will be shared with the owner of TMI-1. The full cost of packaging, transportation and disposal for TMI-2 residual spent fuel and GTCC waste is included in the TMI-2 estimate.

LLRW Volume Reduction

Because current Class A LLRW disposal rates are significantly lower than LLRW volume reduction rates, EnergySolutions does not assume on-site volume reduction techniques such as waste compaction or an aggressive decontamination, survey and release effort.

Non-Radioactive Non-Hazardous Waste Disposal

EnergySolutions assumes that recyclable, non-radioactive scrap metal resulting from the decommissioning program will be sold to a scrap metal dealer.

Hazardous and Industrial Waste Disposal

Uncontaminated lead shielding remaining after shutdown was assumed to be removed from its installed locations and shipped offsite by entities having a need for the material. The entities will receive the lead at no charge in return for providing the removal and shipping services. Non-Radioactive contaminated surfaces coated with tightly adhering and undamaged lead-based paint will be removed as non-hazardous building demolition debris. All other chemicals and hazardous materials present at shutdown will be removed and properly disposed of during decommissioning.

3.5 Final Status Survey

The cost of performing a final status survey (FSS) is based on NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (Ref. No. 5). Estimates of MARSSIM Class I, II, and III survey

designations are based on radiological assumptions regarding contamination resulting from small and large component removal activities. The FSS activity cost calculation includes the in-place remote survey of underground metal and concrete pipe, soil, and groundwater sampling and analysis. Estimated costs for NRC and Oak Ridge Institute for Science and Education (ORISE) verification are also included, and the NRC review period is incorporated into the project schedule.

3.6 Contingency

Contingencies are applied to cost estimates primarily to allow for unknown or unplanned occurrences during the actual program, e.g., increased radioactive waste materials volumes over that expected; equipment breakdowns, weather delays, and labor strikes. This is consistent with the definition provided in the DOE Cost Estimating Guide, DOE G 430.1-1, 3-28-97 (DOE G) (Ref. No. 6). Contingency "covers costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties within the defined project scope. The amount of contingency will depend on the status of design, procurement, and construction; and the complexity and uncertainties of the component parts of the project. Contingency is not to be used to avoid making an accurate assessment of expected costs." *EnergySolutions* determines site-specific contingency factors to be applied to each estimate based on industry practices.

The DOE has established a recommended range of contingencies as a function of completeness of program design, DOE G. The ranges are:

<u>Type of Estimate</u>	<u>Contingency Range as a % of Total Estimate</u>
Planning Phase Estimate	20-30
Budget Estimate	15-25
Title I (Preliminary Design Estimate)	10-20
Title II (Definitive Design Estimate)	5-15

Phase 1 – Source Term Reduction poses very unique high risks considering the history of TMI-2. This includes design and procurement of remote and/or robotic equipment for remote operations, design and developed shielded transfer and storage for high source term waste, removal and consolidation remaining residual nuclear fuel, and removal of high source term non-fuel radioactive materials.

The contingencies presented in this study are consistent with industry standards as follows:

Phase 1 – Source Term Reduction	28.0%
Phase 2 – Decommissioning and License Termination	17.4%
Phase 3 – SNF / GTCC Interim Storage & Disposition	22.2%
Composite Contingency	24.3%

A reactor decommissioning program will be conducted under an NRC-approved Quality Assurance Program which meets the requirements of 10 CFR 50, Appendix B. However, the development of the quality assurance program, the performance of work under that program, and the effort required to ensure compliance with the program, is already included in the detailed cost estimate. Therefore, *EnergySolutions* does not include quality assurance as an element of the contingency allowance. The same is true for contamination. Where radioactive contamination or activated materials are dealt with, the *EnergySolutions* UCFs and associated calculations fully reflect the cost impact of that material, and a separate contingency is not required specifically due to working with contamination.

3.7 Cost Reporting

Total project costs are aggregated from the distributed activity and undistributed costs into the following categories - Labor, Materials and Equipment, Waste Packaging, Waste Transportation, Waste Disposal, and Other Costs. Other costs include property taxes, insurance, license fees, permits, and energy. Waste Disposal costs include any applicable surcharges. Health physics (HP) supplies and small tool costs are calculated as a component of each distributed activity cost and included in the category of Material and Equipment, with the exception that HP supplies for the Utility HP staff are calculated and reported as an undistributed line item. A line item specific contingency is then calculated for each activity cost element.

4.0 SITE SPECIFIC TECHNICAL APPROACH

4.1 Facility Description

The Three Mile Island Unit-2 Nuclear Plant site is co-located with the Exelon-owned Three Mile Island Unit-1 Nuclear Plant on the Three Mile Island site, approximately two miles south of Middletown, Pennsylvania. As the result of the sale of TMI-1, the TMI-2 physical plant site was reduced to essentially the footprint of the plant structures with all of the former TMI-2 grounds being transferred along with the sale of TMI-1.

The Nuclear Steam Supply System (NSSS) is a Babcock & Wilcox PWR that had a licensed Rated Thermal Power of 2772 MWt.

Appendix A provides a list of the TMI-2 systems and structures included in the material inventory for this study.

4.2 Decommissioning Phases (Periods)

Each of the specified scenarios includes three major phases, or periods.

Major Phases for Scenario 1 DECON:

Phase 1 – Source Term Risk Reduction, which includes:

1. Phase 1 Source Term Reduction preparations including: Develop removal methods; Identify specialty equipment; Develop procedures; Provide Training; Conduct mock-ups and/or “dry runs” as appropriate
2. Remove and consolidate remaining residual nuclear fuel (estimated 1% of original fuel inventory) by chemical or mechanical decontamination methods
3. Design and develop residual fuel storage system (wet or dry)
4. Procurement of the residual fuel storage system components (canisters, casks, etc.)
5. Remove high source term non-fuel radioactive materials
6. Design and procure remote and/or robotic equipment for remote operations
7. Design and developed shielded transfer and storage for high source term waste
8. Dispose of high source term waste at authorized Class B/C waste facility

Phase 2 – Decommissioning and License Termination, which includes:

1. Remove contaminated components and piping systems from the Reactor, Auxiliary, Fuel Handling, and Control & Service buildings and package/transport for disposal at the Clive facility
2. Remove and segment the reactor vessel head and package for disposal
3. Disassemble / segment the remaining reactor vessel(s) internals
4. Segment / section the reactor vessel and package for disposal
5. Remove the reactor coolant piping and pumps, steam generators, and other large components and package for disposal
6. Remove activated concrete biological shield and contaminated concrete
7. Remove steel liners from the refueling canal and containment
8. Decommission and dismantle the Spent Fuel Pool for disposal
9. Demolition of the site buildings and structures
10. Complete Final Status Surveys to confirm site meets NRC Unrestricted Release

Phase 3 – SNF/GTCC Interim Storage & Disposition, which includes:

1. Security and Operations of SNF/GTCC storage facility
2. Load out, transport and dispose of SNF/GTCC Waste to an authorized waste facility
3. Decommission and demolition of SNF/GTCC Storage Facility

Major Phases for Scenarios 2 and 3 SAFSTOR:

Phase 0 – SAFSTOR, which includes:

1. Primarily PDMS services contracted from the TMI-1 owner.

Phase 1 – Source Term Risk Reduction, which includes:

1. Phase 1 Source Term Reduction preparations including: Develop removal methods; Identify specialty equipment; Develop procedures; Provide Training; Conduct mock-ups and/or “dry runs” as appropriate
2. Remove and consolidate remaining residual nuclear fuel (estimated 1% of original fuel inventory) by chemical or mechanical decontamination methods
3. Design and develop residual fuel storage system (wet or dry)
4. Procurement of the residual fuel storage system components (canisters, casks, etc.)
5. Remove high source term non-fuel radioactive materials
6. Design and procure remote and/or robotic equipment for remote operations
7. Design and developed shielded transfer and storage for high source term waste
8. Dispose of high source term waste at authorized Class B/C waste facility

Phase 2 – Decommissioning and License Termination, which includes:

1. Remove contaminated components and piping systems from the Reactor, Auxiliary, Fuel Handling, and Control & Service buildings and package/transport for disposal at the Clive facility
2. Remove and segment the reactor vessel head and package for disposal
3. Disassemble / segment the remaining reactor vessel(s) internals
4. Segment / section the reactor vessel and package for disposal
5. Remove the reactor coolant piping and pumps, steam generators, and other large components and package for disposal
6. Remove activated concrete biological shield and contaminated concrete
7. Remove steel liners from the refueling canal and containment
8. Decommission and dismantle the Spent Fuel Pool for disposal
9. Demolition of the site buildings and structures
10. Complete Final Status Surveys to confirm site meets NRC Unrestricted Release

Sub Periods / Work Scope for Phase 1 – Source Term Risk Reduction:

Period 1a – Planning & Transition Following Dormancy

- Regulatory and Licensing activities
- Develop removal methods and procedures
- Identify specialty equipment
- Develop heavy lift and rigging plans
- Develop waste management plan

- Develop rad protection plan
- Develop emergency management plans
- Develop training programs
- Design and develop residual fuel storage system for spent fuel and GTCC waste
- Design remote and/or robotic equipment for remote operations
- Design and develop shielded transfer and storage for high source term waste
- Develop project execution baseline budgets and schedules

Period 1b – Site Upgrades & Preparations

- Procure remote and/or robotic equipment
- Conduct mock-ups, dry runs and training as appropriate
- Building preparations, modifications and access
- Crane modifications
- Procure spent fuel & GTCC Casks
- SNF/GTCC Interim Storage Facility Construction
- Rail & Transportation Upgrades
- Installation of Temporary Facilities

Period 1c – Large Component Source Term Reduction

- Mobilize equipment and robotic equipment for Dose Reduction
- Steam Generator Dose Reduction
- Reactor Internals Removal
- Pressurizer Dose Reduction
- Load and transfer spent fuel and GTCC casks to Interim Storage Facility

Period 1d – Building Source Term Reduction

- Reactor Building Dose Reduction
- Reactor Building Basement Dose Reduction
- Fuel Handling Dose Reduction
- Equipment for Building Dose Reduction
- Auxiliary Building Dose Reduction
- Dispose of Class B/C waste at authorized waste facility

Period 1e – Undistributed Direct ongoing activities

- Class A Waste Packaging, transportation and disposal
- Misc. Rad Waste Processing & Disposal
- Liquid Rad Waste Processing & Disposal

Period 1f – Undistributed Indirect and Management Costs

- Rad Protection Program
- Project Management & Engineering
- Security Staff & Equipment
- Environmental Program
- Insurance
- Property Taxes & Fees

- Safety Program & Training
- PDMS and Plant Security Services
- Corporate Allocations & Financing
- Energy Costs
- NRC Fees & Inspections
- Temporary Facilities

Sub Periods / Work Scope for Phase 2 – Decommissioning & License Termination

Period 2a – Planning & Transition following Phase 1

- Site LTP Preparation
- Site Characterization
- Develop Decon and demolition methods and procedures
- Implement Phase 2 waste management plan
- Implement Phase 2 rad protection plan
- Implement Phase 2 emergency management plans
- Implement Phase 2 training programs
- Identify specialty equipment
- Electrical & Mechanical Preparations
- Refine Phase 2 project execution baseline budgets and schedules

Period 2b – Complete Large Components Removal

- Mobilize Equipment for Large Component Removal
- Steam Generator Removal
- Reactor Vessel Removal
- Main Condensers Removal

Period 2c – Complete Rad Building Systems Removal

- Reactor Building Basement Liner Removal
- Reactor Building Systems Removal
- Fuel Handling / Auxiliary Systems Removal

Period 2d – Rad Building Demolition

- Mobilize heavy demolition equipment
- Reactor Building Demolition
- Auxiliary Building Demolition
- Control Building Demolition
- Fuel Handling Building Demolition
- Turbine Building Rad Demo
- Misc. Underground Piping
- Survey & Dispose of Clean Material
- Equipment for Building Demolition

Period 2e – License Termination

- Site Surveys
- Partial site releases
- Final Site Surveys
- Reports and submittals for License Termination

Period 2f – Site Restoration

- Air Intake Tunnel
- Turbine Building Clean Demolition
- Control Building Area
- Emergency Diesel Generator
- Processing of clean fill materials
- Building and Site Backfill
- Cooling Tower Demolition
- Final Site Restoration

Period 2g – Undistributed Indirect Costs ^{1,2}

- Rad Protection Program
- Project Management & Engineering
- Environmental Program
- PDMS and Plant Security Services
- ANI/NEIL/Other Insurance
- Property Taxes & Fees
- Energy Costs
- Safety & Training Program
- NRC Fees

Note 1, Scenario 1 – DECON Undistributed Indirect Costs are assigned to Period 2g.

Note 2, Scenarios 2 and 3 – SAFSTOR Undistributed Indirect Costs are assigned to Period 2h.

Sub Periods / Work Scope for SNF/GTCC Storage and Disposition ^{3,4}

SNF/GTCC Storage and Disposition includes:

- SNF/GTCC Storage Facility Security & Operation
- Load out, transport and dispose of SNF/GTCC Waste to an authorized waste facility
- Decommission and demolition of SNF/GTCC Storage Facility

Note 3, Scenario 1 – DECON, SNF/GTCC Disposition are assigned to Phase 3, which occurs at the tail end of the SNF/GTCC Storage period.

Note 4, Scenario 2 and 3 – SAFSTOR, SNF/GTCC Disposition are assigned to Period 2g, which occurs at the tail end of Phase 2 - Decommissioning & License Termination.

4.3 Decommissioning Staff

EnergySolutions developed staffing based on the assumption that the TMI-2 decommissioning project will be performed in an efficiently planned and executed manner using project personnel experienced in decommissioning and large scale project management. This DCE also assumes that the decommissioning work will be performed by a highly experienced and qualified Decommissioning General Contractor (DGC), with oversight and management of the decommissioning operations performed by the Licensee staff. It is also assumed that the Licensee staff will be supplemented by a professional consulting engineering firm, particularly in the planning and preparation phase.

Estimated Staff levels by functional group, are provided in Section 6.0.

4.4 Spent Fuel Management

Following completion of the defueling program at TMI-2, it is estimated that approximately 1% of spent fuel remains in the plant, predominantly within the reactor vessel. During decommissioning, the recovery and disposition of the residual spent fuel will be accomplished. GPUN is evaluating options for the long-term management of the recovered spent fuel. These options include:

- (1) Transfer to the DOE under a program similar to that used during the accident recovery spent fuel disposition program
- (2) Transfer to an as yet to be developed, privately owned Interim Spent Nuclear Fuel Storage Facility
- (3) Storage of the TMI-2 spent fuel at a TMI-1 ISFSI per a negotiated agreement with owner

This Decommissioning Cost estimate is based on Option 3, that there is a negotiated agreement with the owner of TMI-1 for the storage of residual spent fuel and GTCC waste. This includes sharing costs for the design and construction of an ISFSI and/or interim storage facility, security and operations.

4.5 Spent Fuel Shipments

Should GPUN be successful in transferal of the residual spent fuel to DOE, as was done during the accident recovery phase, then no further action would be required in as much as the DOE will already have taken possession of the TMI-2 fuel.

There is presently no guidance regarding the transfer of spent fuel to DOE from a privately owned Interim Spent Nuclear Fuel Storage Facility.

Considering that this DCE is based on Option 3, that there is a negotiated agreement with the owner of TMI-1 for the storage of residual spent fuel and GTCC waste, then it is expected that the TMI-2 SNF/GTCC will be disposed of as GTCC waste. For this DCE, it has been assumed that the owner of TMI-1 will be responsible for 75% of these costs and the owner of TMI-2 will be responsible for 25% of these costs.

This DCE assumes that costs for equipment, load out of SNF/GTCC and the decommissioning of the storage facility will be shared with the owner of TMI-1. For this DCE, it has been assumed that the owner of TMI-1 will be responsible for 75% of these costs and the owner of TMI-2 will be responsible for 25% of these costs.

EnergySolutions has conservatively estimated the spent fuel and GTCC packaging, transportation and waste disposal cost, assuming that the GTCC waste will be packaged in modified spent fuel canisters, or similar containers, and will be shipped to a storage or disposal facility operated or licensed by DOE.

5.0 BASES OF ESTIMATE AND KEY ASSUMPTIONS

The bases of, and key assumptions for, this site-specific decommissioning estimate are presented below:

1. Scenario 1 -DECON schedule is based upon the TMI-2 decommissioning effort commencing in 2019 and coordinated with the TMI-1 decommissioning effort.
2. Scenario 2 – SAFSTOR1 schedule is based on TMI-1 placed into long-term SAFSTOR upon completion of commercial operations at some point between 2019 and 2034.
3. Scenario 3 – SAFSTOR2 schedule is based on TMI-1 shutting down between 2019 and 2034 and utilizing a 60-year SAFSTOR period. TMI-2 would seek an extension of the TMI-2 SAFSTOR period beyond its current license termination date of 2053 in order to coordinate decommissioning with the TMI-1 SAFSTOR decommissioning effort.
4. A license amendment will be required to transition the license from the PDMS mode into the DECON mode. This is a complex amendment that has not been fully developed at this time, but it will require numerous revisions to the existing license and technical specifications, including License Amendment Request to enter DECON, PSDAR Update and DSAR Update.
5. Revisions will be required for other Licensing Basis Documents (e.g., Security, Emergency Planning, Fire Protection, Nuclear Safety, Quality Assurance Program, Fuel Debris issues, Spent Fuel Storage options).
6. Residual spent fuel in forms that prevent recovery in distinct concentrations suitable for packaging for ISFSI storage, are assumed to be collected for disposition as GTCC waste. For purposes of the cost analysis, it is assumed that GTCC waste will be packaged and disposed of as high-level waste. Since it is uncertain that the DOE will accept the GTCC material in a timely manner, additional costs are included for the temporary storage of GTCC material.
7. The TMI-2 DCE Spent Fuel Management Plan is based on a negotiated agreement with the owner of TMI-1 for the storage of residual TMI-2 spent fuel and GTCC waste. This includes sharing costs for the design and construction of an ISFSI and/or interim storage facility, security and operations. For this DCE, it has been assumed that the owner of TMI-1 will be responsible for 75% of these costs and the owner of TMI-2 will be responsible for 25% of these costs.
8. This DCE assumes that costs for equipment, load out of SNF/GTCC and the decommissioning of the storage facility will be shared with the owner of TMI-1. For this DCE, it has been assumed that the owner of TMI-1 will be responsible for 75% of these costs and the owner of TMI-2 will be responsible for 25% of these costs.
9. The DCE includes estimated costs for the SNF/GTCC waste disposal as GTCC waste, including that the GTCC waste will be packaged in modified spent fuel canisters, or similar containers, and will be shipped to a storage or disposal facility operated or licensed by DOE.
10. The decommissioning will be performed using currently available technologies.

11. This estimate is based on site-specific building inventories and plant systems, as provided and determined by EnergySolutions, and includes items that may not appear on any published inventory. An example being lead shielding over the refueling canal and lead bricks covering the RB-305 seismic gap.
12. Systems and equipment formerly located within the Turbine Building comprise the majority of SSCs that have been removed. The condensate storage tanks, aqueous ammonia tank and demineralized water tank have been removed. These commodities were not included in the estimate.
13. All transformers on site following shutdown are assumed to be PCB-free; therefore, this study does not include costs for disposition of PCB contaminated transformers.
14. Cost for transportation of clean scrap metal to a recycler is included in the estimate.
15. Concrete debris and all other demolition debris is assumed to be removed from the site and disposed of at a local landfill.
16. Foundations and building exterior walls are removed to a nominal depth of three feet below grade, surveyed and backfilled with appropriate fill material.
17. Due to its location, it is assumed that the cork seam will be addressed just prior to building demolition when all other systems and components have been removed. Based upon past studies, it appears unlikely that radioactivity from the cork seam contamination has or will enter the ground water beneath the power block structures. It is very likely that the MARSSIM process will require examination of the soil and groundwater that underlie the structures.
18. The estimate is based on final site restoration, in which all existing and proposed structures, with the exception of the switchyard, will be removed. Clean demolition costs are based on the assumption that all site improvements will be removed in their entirety.
19. Clean backfill will be imported and placed to re-establish grade. The entire disturbed area of the site is to be graded, to restore the natural grade to the extent possible, and seeded.
20. We do not anticipate that a significant quantity of 'clean lead' exists at the site. Uncontaminated lead shielding remaining after shut down is assumed to be removed from its installed locations and shipped offsite by entities having a need for the material. The entities receive the lead at no charge in return for providing the removal and shipping services.
21. Costs for hazardous waste disposal, as well as asbestos and lead abatement, are included in this study. It should be noted that although the plant was free of asbestos-containing thermal insulation, TMI-2 does contain asbestos. Much of the electrical cable has asbestos in it. Explosion proof lighting fixtures have asbestos lens gaskets and there are thousands of asbestos-containing pipe and equipment gaskets. Some window grout and floor tile grout may also contain asbestos.
22. All Class A waste is assumed to be primarily disposed of at EnergySolutions' facility in Clive, Utah, in accordance with 2018 disposal rates.
23. Class A waste includes Dry Active Waste (DAW) arising from the disposal of contaminated protective clothing and health physics supplies.

24. Class B and C waste disposal costs are based on current quoted rates for disposal of activated hardware and resins at the Waste Control Specialists, Texas facility. All resins and filter waste is assumed to be Class B.
25. Shipping costs for the Class B and C waste are based on a distance of 1,735 miles one way from TMI-2 to the WCS facility.
26. GTCC waste disposal costs are estimated based on recent quoted rates for disposal at WCS or other disposal facility licensed by DOE.
27. GTCC is not subject to the same storage and security requirements as spent fuel and therefore is not required to be stored on the ISFSI pad. But for purposes of this estimate and to facilitate decommissioning, GTCC waste generated from the segmentation of the reactor internals and other abnormal waste streams is assumed to be packaged in appropriate canisters and stored in an ISFSI facility built and shared with the owner of TMI-1, pending ultimate transfer to DOE.
28. It is assumed that approximately (10) canisters will be required for GTCC waste, and (2) canisters will be required for residual spent fuel.
29. Reactor vessel and internals curie estimates were derived from pertinent TMI-2 Defueling and Spent Fuel Evaluation documents. This information will have to be confirmed and further evaluated when decommissioning operations are resumed following the Post-Defueling Monitored Storage phase.
30. The EnergySolutions site-specific classification of radioactive wastes for the TMI-2 plant determined that most of the Reactor Vessel Internals will exceed Class-C disposal criteria in their present configuration and condition.
31. EnergySolutions has assumed that the 10 CFR Part 50 license will be maintained until DOE has taken possession of the SNF/GTCC.
32. The DCE has included the annual NRC 10 CFR 171.15(c)(2) fees, for reactors in decommissioning until decommissioning is completed as a license termination expense. Following completion of decommissioning, this expense is continued as a SNF/GTCC management cost for maintenance of the 10 CFR Part 50 license.
33. EnergySolutions has included NRC inspection fees during each decommissioning period based on the type and level of activities being performed.
34. Site operating expenses expected to be incurred during decommissioning and SNF/GTCC management are included in the estimate. These costs include materials and services, utilities, telecommunications equipment, non-process computers, and tools and equipment.
35. Craft labor rates and fringe costs are based on 2018 Harrisburg area union locals.
36. This study follows the occupational exposure principles of As Low As Reasonably Achievable (ALARA) through the use of productivity loss factors that incorporate such items as the use of respiratory protection and personnel protective clothing. These factors increase the work duration and cost.

37. The water processing operations are estimated based upon an experienced decommissioning operations contractor performing the decommissioning and understanding the projected water requirements. We anticipate reuse of several in-plant tanks and flow pathways for water processing. A portable liquid waste processing system is expected to be utilized to process water. It is intended that processed water will be reused to the extent practical. This is expected to be a zero discharge operation. A large quantity of water actually leaves the site as the result of dust suppression water misting during demolition of contaminated concrete. Any residual processed water will be dispositioned off site.

38. The costs of all required safety analyses and safety measures for the protection of the general public, the environment, and decommissioning workers are included in the cost estimates. This reflects the requirements of:

10 CFR 20	Standards for Protection Against Radiation
10 CFR 50	Domestic Licensing of Production and Utilization Facilities
10 CFR 61	Licensing Requirements for Land Disposal of Radioactive Waste
10 CFR 71	Packaging and Transportation of Radioactive Material
10 CFR 72	Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste
29 CFR 1910	Occupational Safety and Health Standards
49 CFR 170-189	Department of Transportation Regulations Governing the Transport of Hazardous Materials
Reg. Guide 1.159	Assuring the Availability of Funds for Decommissioning Nuclear Reactors

6.0 STUDY RESULTS

Cost Summary by License Termination, Spent Fuel and Site Restoration

The cost estimate results for all scenarios are provided in Table 6-1 below. This table provides License Termination cost (corresponding to 10 CFR 50.75(c) requirements); Spent Fuel Management costs (corresponding to 10 CFR 50.54(bb) requirements) and Site Restoration costs (corresponding to activities such as clean building demolition and site grading etc.).

TABLE 6-1
Cost Summary by Phase

Decommissioning Cost Summary (thousands of 2018 dollars)				
	License Termination	Spent Fuel	Site Restoration	Total
Scenario 1 - DECON	1,152,465	92,815	54,088	1,299,368
Scenario 2 - SAFSTOR1	1,183,939	82,662	53,905	1,320,506
Scenario 3 - SAFSTOR2	1,325,700	82,662	53,831	1,462,193

GTCC operations, storage and disposition are included in the License Termination Costs.

Detailed cost tables are provided in Appendix D.

Summary Schedules

The costs and schedule for the DECON scenario is divided into major project phases (periods) and presented by "Source Term Risk Reduction," "Decommissioning and License Termination" or "SNF/GTCC Storage and Disposition." Figure 6-1 below shows a summary-level DECON schedule.

The costs and schedule for the SAFSTOR scenarios are divided into major project phases (periods) and presented by cost account "SAFSTOR," "Source Term Risk Reduction" or "Decommissioning and License Termination." Figures 6-2 and 6-3 below show summary-level SAFSTOR schedules.

Detailed schedules are provided in Appendix C.

FIGURE 6-1
Summary Schedule – DECON

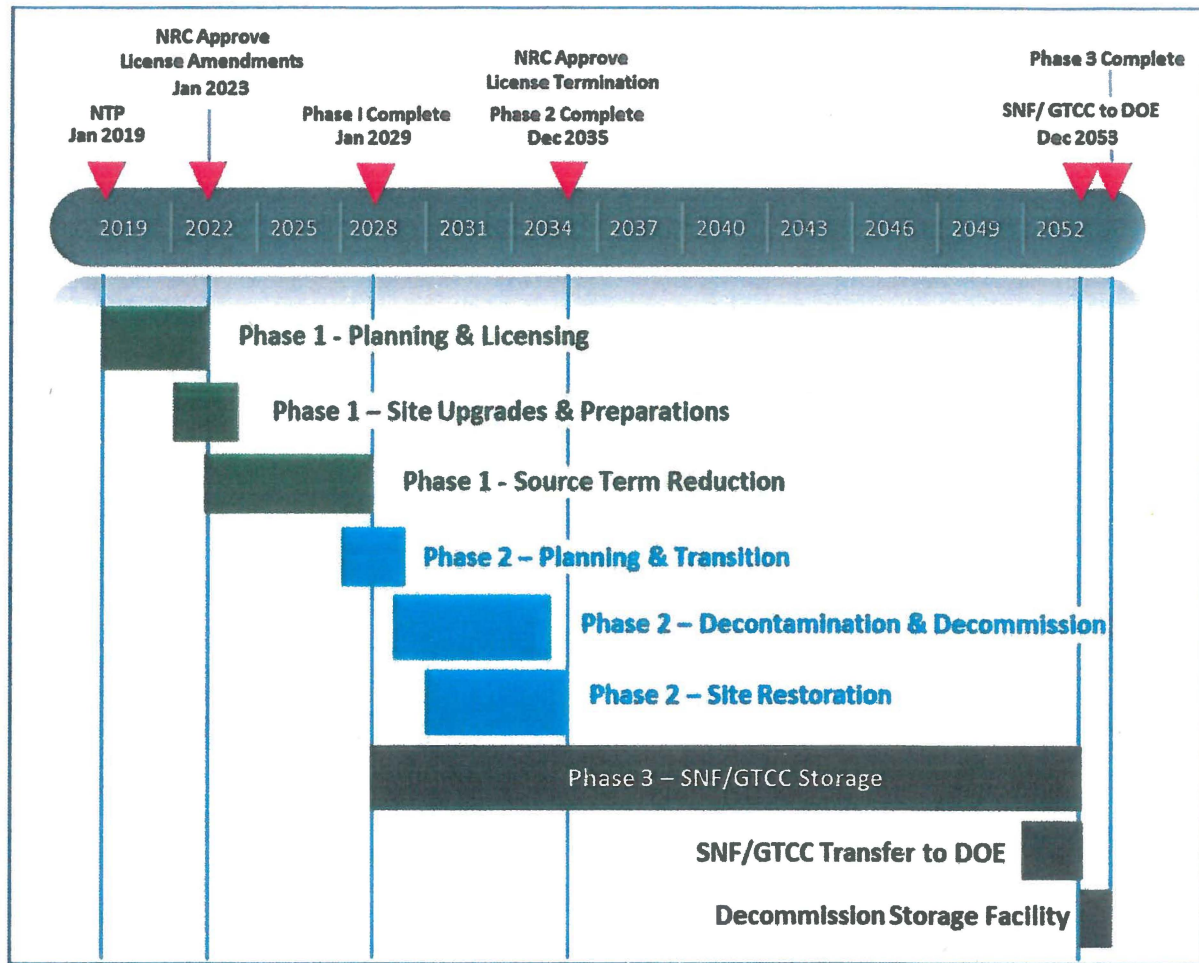


FIGURE 6-2
Summary Schedule – SAFSTOR1

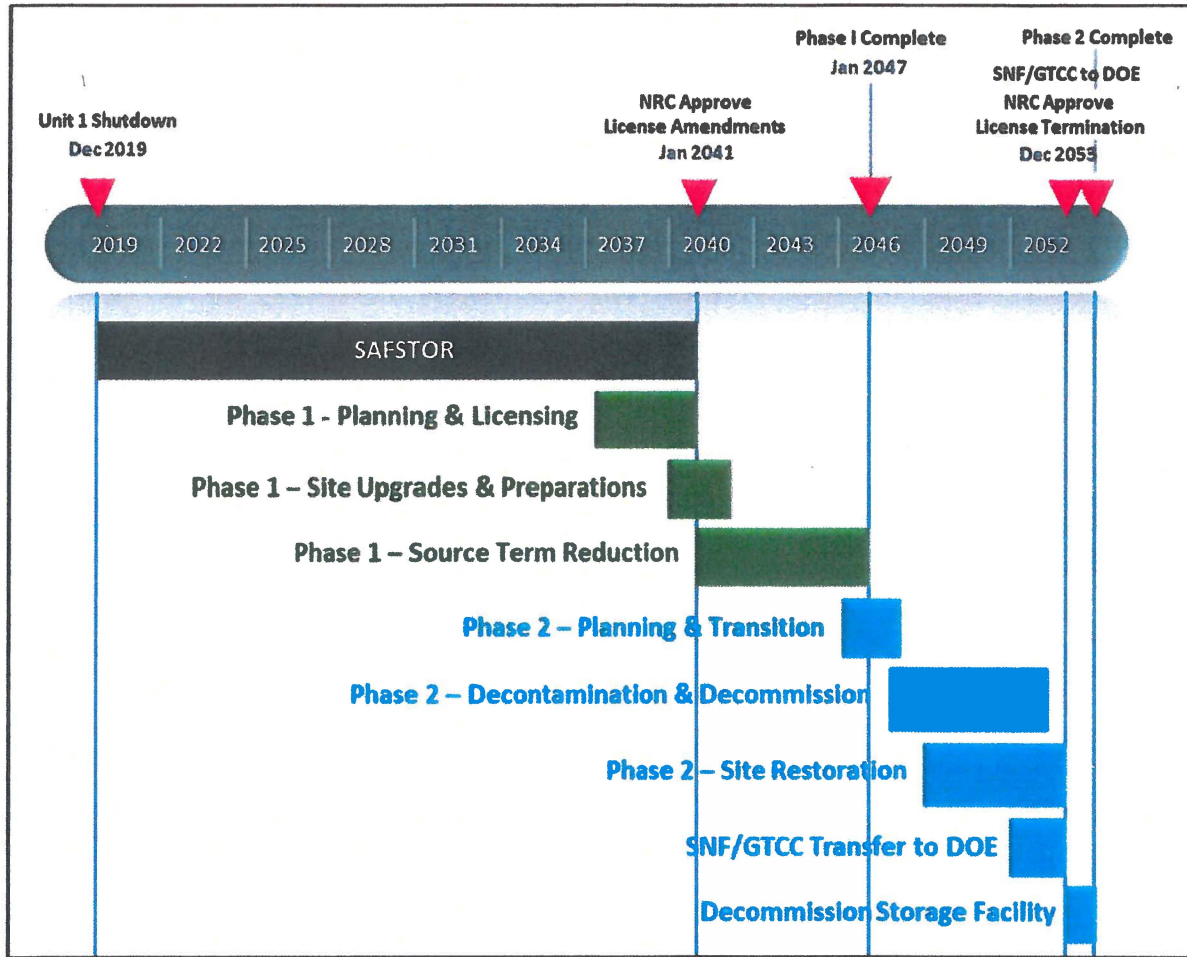
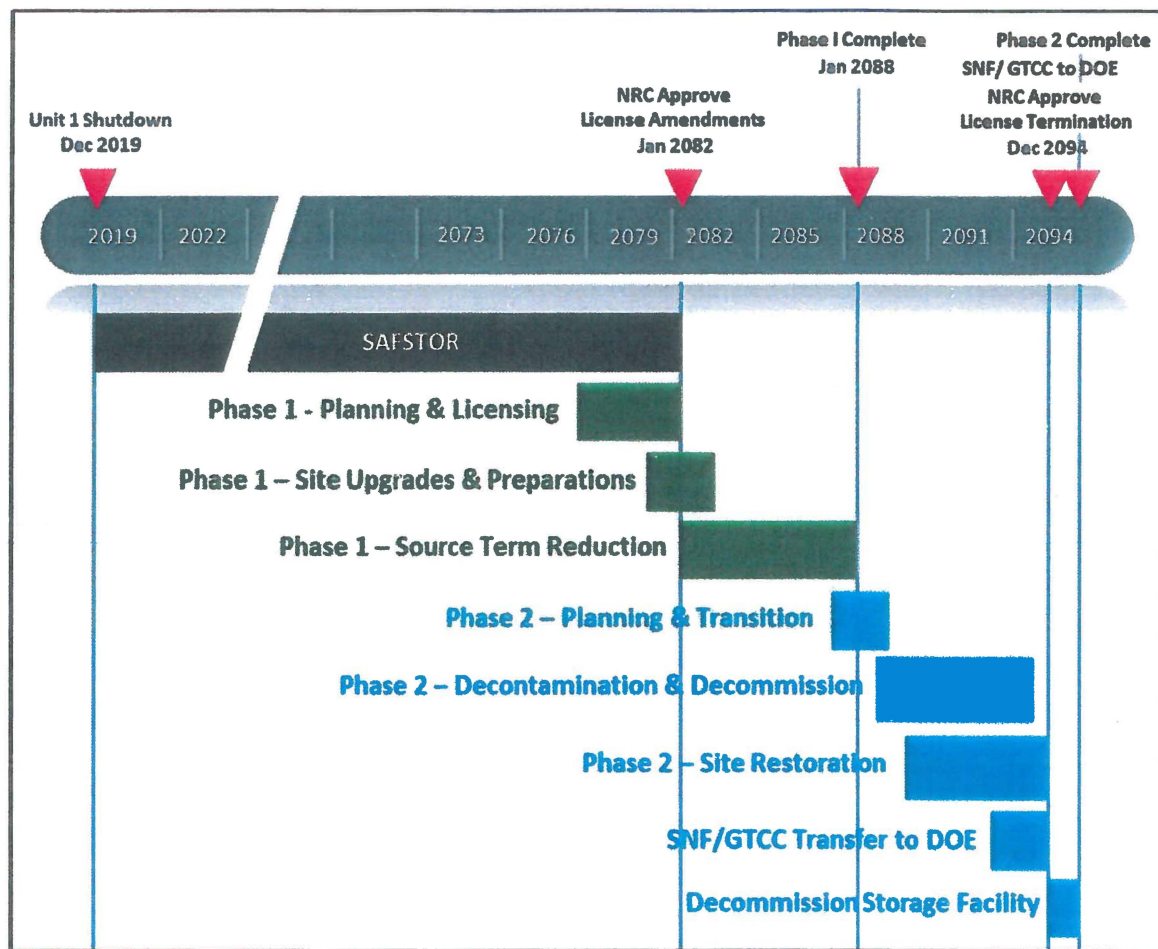


FIGURE 6-3
Summary Schedule – SAFSTOR2



Cost Summary by Phase and Cost Type

The following Tables 6-2 through 6-7 provide cost summaries for each Scenario by Phase and by Cost Type.

For Tables 6-3, 6-5 and 6-7 "Other Direct Costs" generally include subcontracted services such as PDMS costs; engineering; Design and Construction of SNF/GTCC Storage Facility; miscellaneous subcontracts; temporary facilities; Licensing costs; NRC Fees, Insurances, Taxes; Permits, etc.

Detailed Decommissioning Cost Estimates for each Scenario are provided in Appendix D.

Annual Spending Tables for each Scenario are provided in Appendix E.

TABLE 6-2
DECON Cost Summary by Phase

Scenario 1 - DECON ESTIMATE (thousands of 2018 dollars)		
Period	Item Description	Total Cost
1a Total	Planning & Transition Following Dormancy	10,203
1b Total	Site Upgrades & Preparations	51,517
1c Total	Large Component Source Term Reduction	65,152
1d Total	Building Source Term Reduction	217,338
1e Total	Undistributed Direct Costs	74,071
1f Total	Undistributed Indirect Costs	409,134
Phase 1 Total - Source Term Risk Reduction		827,415
2a Total	Planning & Transition following Phase 1	7,369
2b Total	Large Components Removal	26,665
2c Total	Rad Building Systems Removal	27,184
2d Total	Rad Building Demolition	102,032
2e Total	License Termination	15,290
2f Total	Site Restoration	30,920
2g Total	Undistributed Indirect Costs	151,386
Phase 2 Total - Decommissioning & License Termination		360,846
3a Total	SNF/GTCC Interim Storage & Disposition	111,108
Phase 3 Total - SNF/GTCC Interim Storage & Disposition		111,108
Grand Total		1,299,368

TABLE 6-3
DECON Cost Summary by Cost Type

Scenario 1 - DECON ESTIMATE (thousands of 2018 dollars)		
Labor Cost	\$	337,321
Materials & Equipment Cost	\$	119,812
Waste Packaging	\$	12,016
Waste Transportation	\$	35,980
Waste Disposal	\$	279,705
Energy Costs	\$	17,004
Other Direct Cost (ODC)	\$	243,109
Contingency	\$	254,422
Total Cost	\$	1,299,368

TABLE 6-4
SAFSTOR1 Cost Summary by Phase

Scenario 2 - SAFSTOR1 ESTIMATE (thousands of 2018 dollars)		
Period	Item Description	Total Cost
0a Total	PDMS Monitoring	62,663
Phase 0 Total - SAFSTOR		62,663
1a Total	Planning & Transition Following Dormancy	10,203
1b Total	Site Upgrades & Preparations	51,517
1c Total	Large Component Source Term Reduction	65,152
1d Total	Building Source Term Reduction	217,338
1e Total	Undistributed Direct Costs	74,071
1f Total	Undistributed Indirect Costs	409,134
Phase 1 Total - Source Term Risk Reduction		827,415
2a Total	Planning & Transition following Phase 1	7,369
2b Total	Large Components Removal	26,665
2c Total	Rad Building Systems Removal	27,184
2d Total	Rad Building Demolition	102,032
2e Total	License Termination	15,290
2f Total	Site Restoration	30,920
2g Total	SNF/GTCC Interim Storage & Disposition	70,493
2h Total	Undistributed Indirect Costs	150,475
Phase 2 Total - Decommissioning & License Termination		430,428
Grand Total		1,320,506

TABLE 6-5
SAFSTOR1 Cost Summary by Cost Type

Scenario 2 - SAFSTOR1 ESTIMATE (thousands of 2018 dollars)		
Labor Cost	\$	314,857
Materials & Equipment Cost	\$	119,812
Waste Packaging	\$	12,016
Waste Transportation	\$	35,980
Waste Disposal	\$	279,705
Energy Costs	\$	17,004
Other Direct Cost (ODC)	\$	286,273
Contingency	\$	254,859
Total Cost	\$	1,320,506

TABLE 6-6
SAFSTOR2 Cost Summary by Phase

Scenario 3 - SAFSTOR2 DETAILED ESTIMATE (thousands of 2018 dollars)		
Period	Item Description	Total Cost
0a Total	PDMS Monitoring	205,397
Phase 0 Total - SAFSTOR		205,397
1a Total	Planning & Transition Following Dormancy	10,203
1b Total	Site Upgrades & Preparations	51,517
1c Total	Large Component Source Term Reduction	65,152
1d Total	Building Source Term Reduction	217,338
1e Total	Undistributed Direct Costs	73,317
1f Total	Undistributed Indirect Costs	409,134
Phase 1 Total - Source Term Risk Reduction		826,661
2a Total	Planning & Transition following Phase 1	7,369
2b Total	Large Components Removal	26,665
2c Total	Rad Building Systems Removal	27,153
2d Total	Rad Building Demolition	101,845
2e Total	License Termination	15,290
2f Total	Site Restoration	30,845
2g Total	SNF/GTCC Storage & Transfer to DOE	70,494
2h Total	Undistributed Indirect Costs	150,475
Phase 2 Total - Decommissioning & License Termination		430,135
Grand Total		1,462,193

TABLE 6-7
SAFSTOR2 Cost Summary by Cost Type

Scenario 3 - SAFSTOR2 ESTIMATE (thousands of 2018 dollars)		
Labor Cost	\$	314,857
Materials & Equipment Cost	\$	119,812
Waste Packaging	\$	12,016
Waste Transportation	\$	35,980
Waste Disposal	\$	279,705
Energy Costs	\$	17,004
Other Direct Cost (ODC)	\$	413,373
Contingency	\$	269,446
Total Cost	\$	1,462,193

Project Staffing

The following Tables 6-8 and 6-9 are applicable to all scenarios for Phase 1 and Phase 2 work. The tables are organized by Staff Group for each Phase.

TABLE 6-8
Staffing for Phase 1 – Source Term Reduction

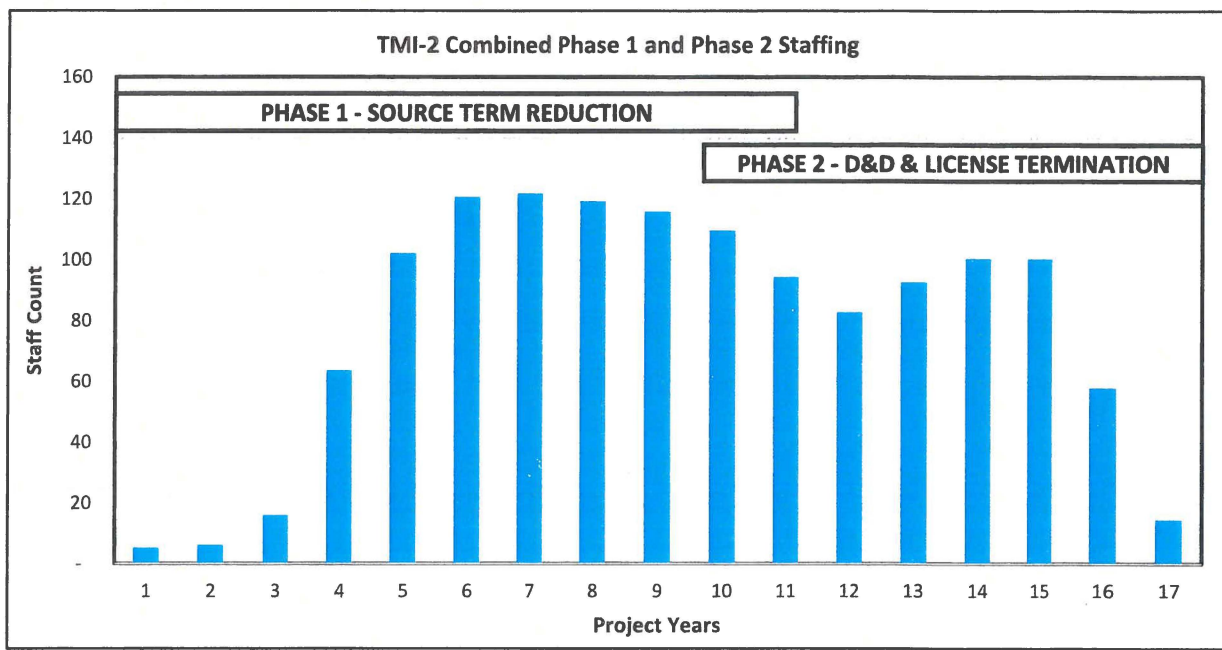
PHASE 1 - SOURCE TERM REDUCTION											
STAFF GROUP	Project Year										
	1	2	3	4	5	6	7	8	9	10	11
Management & Administrative	2	2	3	15	22	28	28	28	28	18	9
Engineering	1	1	3	8	8	8	8	8	8	4	3
Plant Operations & Maintenance	-	-	-	6	16	19	19	16	15	10	8
Radiation Protection and Chemistry	1	1	2	15	35	42	42	42	42	28	21
Health Physics	-	-	-	3	3	3	3	3	3	2	2
Regulatory Affairs	2	3	4	4	3	3	3	3	3	2	2
Quality	-	-	0	1	1	2	2	2	2	1	1
Waste Operations	-	-	0	3	4	4	5	5	5	3	2
Security *											
Decommissioning Contractor			4	10	10	12	12	12	10	6	4
TOTAL	5	6	16	64	102	121	122	119	116	75	53
* Security Staff shared with TMI-1 owner											

TABLE 6-9
Staffing for Phase 2 – D&D and License Termination

PHASE 2 - D&D and LICENSE TERMINATION									
STAFF GROUP	Project Year								
	10	11	12	13	14	15	16	17	
Management & Administrative	9	9	20	26	24	24	15	6	
Engineering	2	2	6	6	6	6	0	-	
Plant Operations & Maintenance	5	4	10	10	10	10	5	2	
Radiation Protection and Chemistry	14	21	34	34	45	45	28	5	
Health Physics	1	1	2	3	3	3	2	-	
Regulatory Affairs	1	1	4	4	4	4	4	-	
Quality	1	1	2	3	3	3	1	-	
Waste Operations	2	3	5	6	6	6	3	2	
Security *									
Decommissioning Contractor	6	8	14	15	15	14	10	2	
TOTAL	35	42	83	93	101	101	58	15	
* Security Staff shared with TMI-1 owner									

Figure 6-4 below shows the combined staff levels for Phase 1 and Phase 2.

FIGURE 6-4
Combined Staffing for Phase 1 and Phase 2



Waste Disposal Volumes

Table 6-10 below provides a summary of Waste Disposal Volumes by Waste Class.

TABLE 6-10
Waste Disposal Volumes

Waste Class	Volume (cf)
Class A	1,704,247
Class B & C	12,558
SNF / GTCC	2,530

Appendix B provides a Waste Disposal Summary itemized by volumes, waste form, waste class, weight, volume and costs for packaging, transportation and disposal.

Comparison of Current Cost Study and Previous Cost Study

EnergySolutions has performed several comparison analyses to previous Decommissioning Cost Estimates and reports. These comparisons are complex in that none of the current DCE Scenarios is the same as previous scenarios. The closest comparison is the current Scenario 2 - SAFSTOR1 compared to the PSDAR estimate dated December 4, 2015. Table 6-11 below shows this comparison.

TABLE 6-11
Current DCE Comparison to PSDAR Estimate

TABLE 1 * TMI-2 DECOMMISSIONING COST SUMMARY (Thousands of 2014 dollars) (2014 - 2059)		12/4/15 PSDAR Escalated ** to 2018 dollars (2019 - 2053)***	EnergySolutions 2018 DCE (2019 - 2053)
Decontamination	36,384	40,592	31,800
Removal	194,301	216,774	212,643
Packaging	28,794	32,124	34,116
Transportation, Off-site Waste Processing, and Disposal	322,278	359,554	332,948
Program Management	497,930	555,522	509,325
Miscellaneous Equipment	24,512	27,347	46,060
Insurance and Regulatory Fees	16,203	18,077	61,534
Other Decommissioning Costs	101,096	95,844	92,081
Total Decommissioning Costs	1,221,498	1,345,835	1,320,506
<p>* TABLE 1 from Revision to Post-Shutdown Decommissioning Activities Report, December 4, 2015.</p> <p>** Escalation Table based on TLG ESCALATION ANALYSIS, February 2015</p> <p>*** Reduced ODC by 30,376 due to reduced SAFSTOR period (2019 - 2053) in lieu of (2014 - 2053)</p>			

Additional comparisons were done based on current annual spending compared to the Annual Spending Tables included with the 2013 Decommissioning Cost Study. These comparisons are provided in Appendix F.

7.0 REFERENCES

1. U.S. Nuclear Regulatory Commission, "Domestic Licensing of Production and Utilization Facilities," 10 CFR Part 50, 2008.
2. Atomic Industrial Forum, Inc., "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986.
3. U.S. Nuclear Regulatory Commission, "Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors," Regulatory Guide 1.202, February 2005.
4. U.S. Nuclear Regulatory Commission, "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station," NUREG/CR- 0130, June 1978.
5. U.S. Nuclear Regulatory Commission, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," NUREG-1575, Rev. 1, August 2000.
6. U.S. Department of Energy, "Cost Estimating Guide," DOE G 430.1-1, March 1997.
7. TMI-2 Defueling Completion Report (Final)

APPENDIX A

List of Systems and Structures

TMI-2 Plant Systems and Structure List

Structure	Reactor Building
Structure	Turbine Building
Structure	Auxiliary Building
Structure	Fuel Handling Building
Structure	Natural Draft Cooling Towers (2)
Structure	Mechanical Draft Cooling Tower
Structure	Circulating Water Pump House
Structure	Circulating Water Chlorinator House
Structure	Control Building
Structure	Service Building
Structure	Emergency Diesel Generator Building
Structure	River Water Pump House
System	Main and Reheat Steam
System	Bleed Steam
System	Auxiliary Steam
System	Feedwater & Condensate
System	Makeup Water Polishing Treatment & Condensate
System	Demineralized Water – Turbine Building
System	Demineralized Water – Auxiliary, Control, Service and Reactor Buildings
System	Feedwater Heater Vents, Relief and Miscellaneous Drains
System	Feedwater Heater Drains
System	Condenser Air Extraction
System	Lube Oil Purification & Transfer
System	Instrument Air
System	Domestic Water
System	Service Air
System	Secondary Plant Sampling
System	Secondary Services Closed Cooling Water
System	Circulating Water & River Water Chemical Treatment
System	Circulating & and Secondary Services Water
System	Reactor Coolant Makeup & Purification
System	Chemical Addition
System	Spent Fuel Cooling & Decay Heat Removal
System	Radwaste Disposal – Reactor Coolant Liquid
System	Radwaste Disposal – Gas
System	Intermediate Closed Cooling Water
System	Nuclear Services Closed Cooling Water
System	Sampling Nuclear System
System	Nuclear Services River Water
System	Reactor Building Emergency Spray & Core Flooding
System	Decay Heat Closed Cooling Water
System	Nitrogen for Nuclear & Radwaste Systems
System	Fire Protection
System	Diesel Fuel – Emergency Diesel Generator

System	Radwaste Disposal – Solid
System	Heating & Ventilation – Turbine Building & Control Building Area
System	Reactor Building – Ventilation & Purge
System	Heating & Ventilation – Auxiliary Building
System	Heating, Ventilation & Air Conditioning – Control Building
System	Radwaste Disposal – Miscellaneous Liquids
System	Reactor Building Normal Cooling
System	Heating & Ventilation – Circulating and River Water Pump Houses
System	Fire Pump House & Fire Deluge House
System	Heating & Ventilation – Emergency Diesel Generator
System	Heating & Ventilation – Air Intake and Exhaust
System	Heating & Ventilation – Fuel Handling Building
System	Heating, Ventilation & Air Conditioning – Service Building
System	Service & Control Bldg – Domestic Water, Sanitary Waste & Contam Drains
System	Steam Generator Secondary Side Vents and Drains
System	Condensate Return – Main, Bleed, Gland & Auxiliary Traps
System	HVAC – Circ Water, Chlorinator & Mech Draft Cooling Tower Pump Houses
System	Radwaste Pumps Seal Water
System	Building Sump Pump Discharge System
System	Reactor Building Penetrations Forced Air Cooling
System	Reactor Building Leakrate Test
System	Feedwater Heating Nitrogen Blanketing
System	Hydrogen & Carbon Dioxide for Air Conditioning – Turbine Building
System	Jacket Coolant System – Emer Diesel Generator
System	Lube Oil System – Emergency Diesel Generator
System	Starting Air System – Emergency Diesel Generator
System	Hydraulic & Pneumatic Fuel Transfer System
System	Reactor Coolant Pump Seal Recirculating & Cooling Water
System	OTSG Chemical Cleaning System
System	Lab & Penetration Pressurization Gas System & Hydrogen for Makeup Tank
System	Radwaste Disposal – Reactor Leakage Recovery
System	Oil Splash Shield Drain Piping for Reactor Coolant Pump Motors
System	Gland Steam Seal System Turbine Building
System	Environmental Barrier System
System	Secondary Plant Sampling
Recovery System	Auxiliary Building Emergency Liquid Cleanup System
Recovery System	Condenser Air Extraction Filtration System
Recovery System	Long-term B Steam Generator Cooldown
Recovery System	Fuel Pool Waste Storage System
Recovery System	Auxiliary Building Emergency Liquid Cleanup System Sampling
Recovery System	Temporary Auxiliary & Fuel Handling Building HVAC
Recovery System	Standby Reactor Coolant Pressure Control System
Recovery System	Mini-Decay Heat Removal System
Recovery System	Temporary Nuclear Sampling
Recovery System	Nuclear Sampling System
Recovery System	Submerged Demineralizer System (SDS)
Recovery System	Makeup & Purification Cesium Elution System

Recovery System	RCS Processing System
Recovery System	Defueling Water Cleanup System
Recovery System	Internals Indexing Fixture Waster Processing System
Recovery Structure	Interim Solid Waste Staging Facility
Recovery Structure	Containment Air-Control Envelope (CACE)

APPENDIX B

Waste Disposal Summary

Appendix B

**Three Mile Island - Unit 2
Waste Disposal Summary - by Facility and Waste Class
(Thousands of 2018 dollars)**

Facility	Waste Form	Waste Class	Waste Weight (LBs)	Waste Volume (CF)	Burial Volume (CF)	Packaging Cost	Transportation Cost	Burial Cost	Total Waste Cost
Bear Creek	CWF	A	3,125,386	148,068	149,125	\$ -	\$ 2,108	\$ 10,666	\$ 12,774
			3,125,386	148,068	149,125	\$ -	\$ 2,108	\$ 10,666	\$ 12,774
WCS	Cask	B/C	1,380,988	12,541	12,558	\$ 3,607	\$ 7,586	\$ 125,994	\$ 137,188
Clive	Cask	A	172,272	3,573	3,850	\$ 907	\$ 1,045	\$ 1,455	\$ 3,407
Clive	Debris	A	80,603,416	1,349,842	1,358,759	\$ 412	\$ 10,462	\$ 81,845	\$ 92,719
Clive	Large Component	A	5,767,161	39,902	45,303	\$ 5,256	\$ 3,416	\$ 13,500	\$ 22,172
Clive	Mixed Waste	A	2,049,300	8,197	8,280	\$ 304	\$ 393	\$ 2,790	\$ 3,487
Clive	Contaminated Soil	A	8,000,000	135,000	138,930	\$	\$ 408	\$ 6,947	\$ 7,354
Not Determined	Dry Fuel / GTCC	GTCC *	226,387	1,502	2,530	\$ 1,530	\$ 1,584	\$ 36,680	\$ 39,794
			98,199,524	1,550,558	1,570,210	\$ 12,016	\$ 24,894	\$ 269,212	\$ 306,122
Other									
Local Landfill	Clean/Exempt	F	165,460,295	2,927,374	2,927,935	\$ -	\$ 7,930	\$ 3,901	\$ 11,831
Local Recycler	Recycled Metals	F	40,674,691	2,038,297	2,039,256	\$ -	\$ 1,049	\$ (4,079)	\$ (3,030)
On Site	Clean/Exempt	F	248,449,769	2,939,469	2,923,200	\$ -	\$ -	\$ -	\$ -
			454,584,755	7,905,140	7,890,391	\$ -	\$ 8,979	\$ (177)	\$ 8,802
Grand Total			555,909,666	9,603,766	9,609,726	\$ 12,016	\$ 35,980	\$ 279,701	\$ 327,698

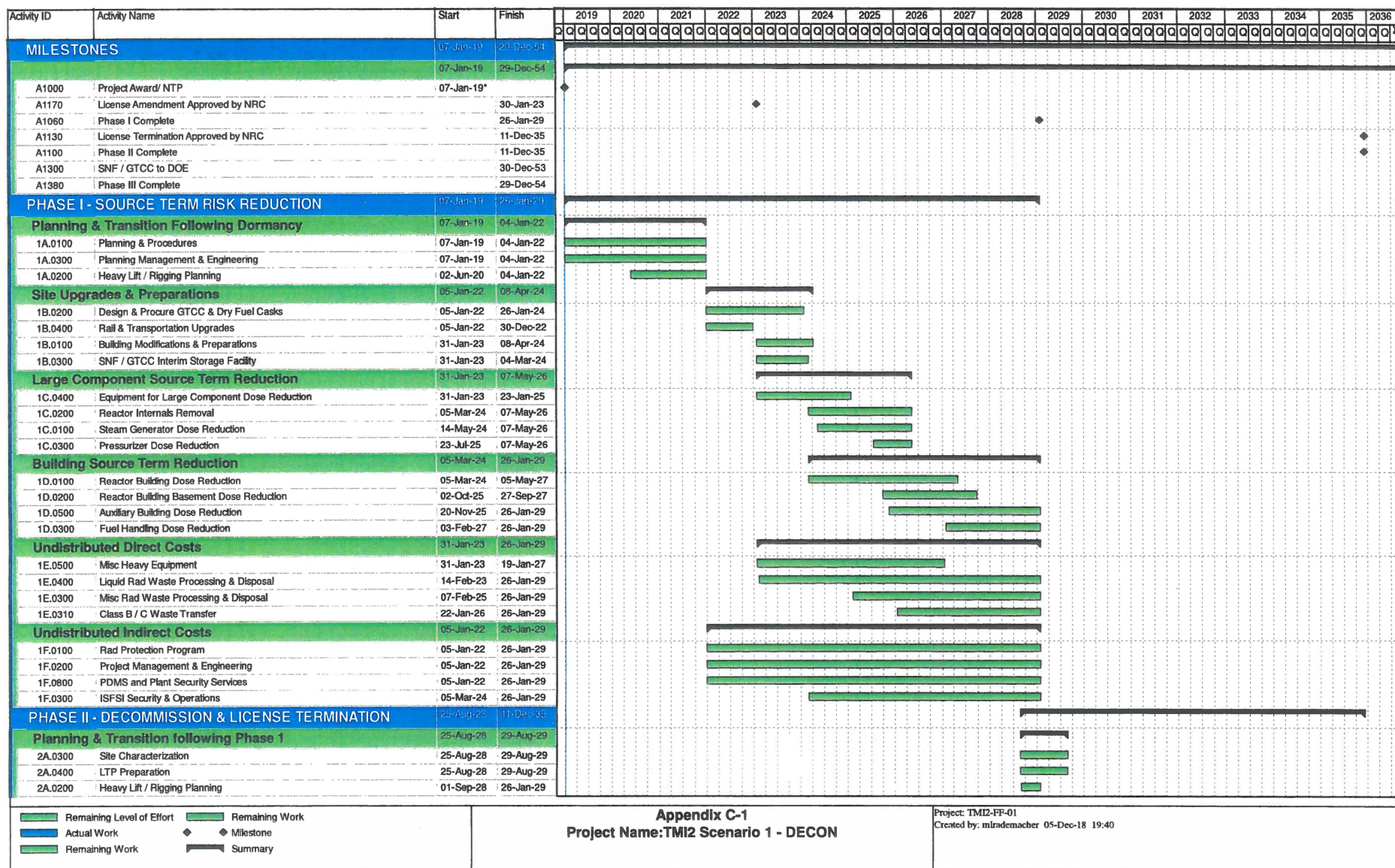
Note: GTCC costs do not include procurement of casks estimated at \$17,680,000.

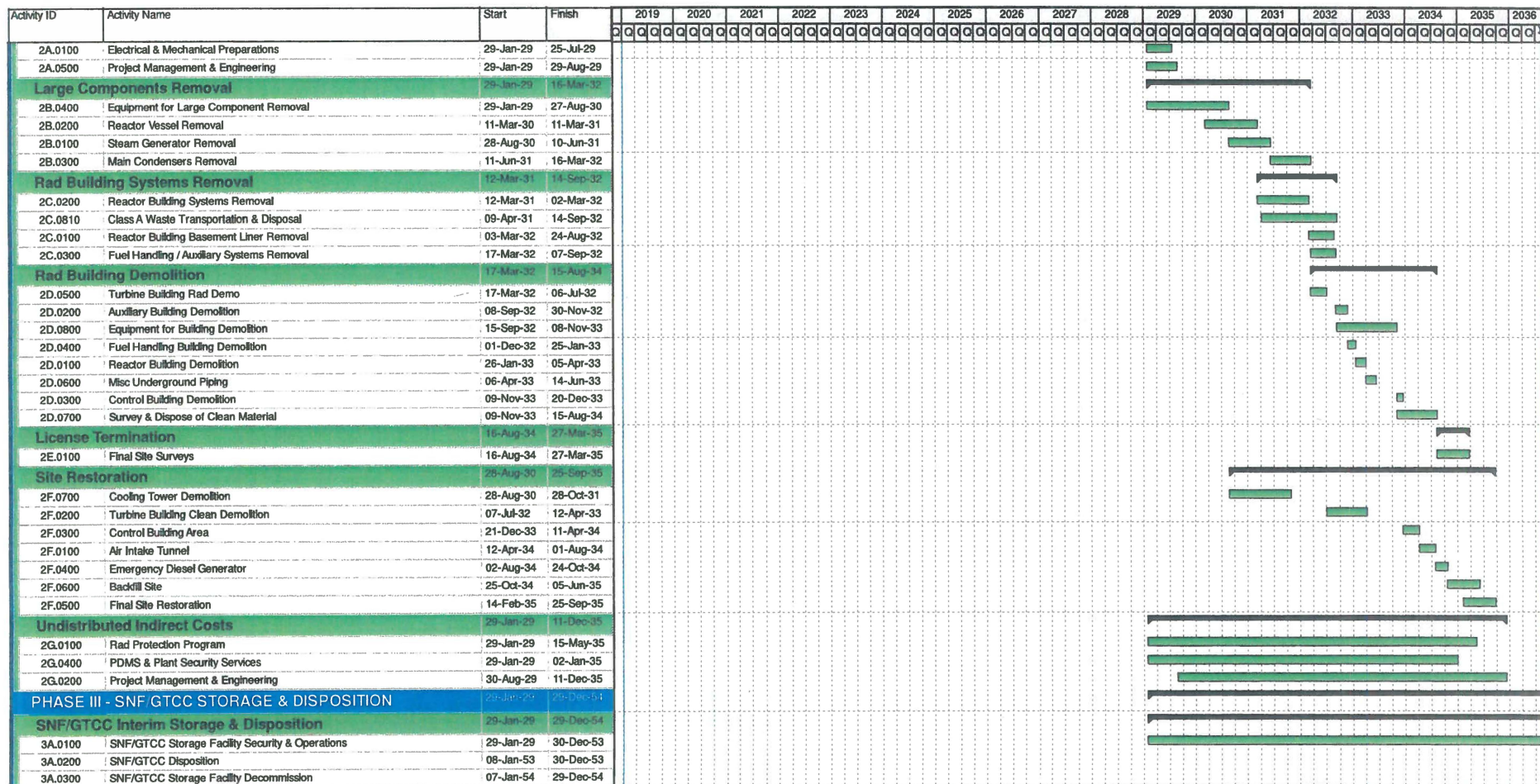
APPENDIX C

C-1 – Detailed Project Schedule – DECON

C-2 – Detailed Project Schedule – SAFSTOR1

C-3 – Detailed Project Schedule – SAFSTOR2

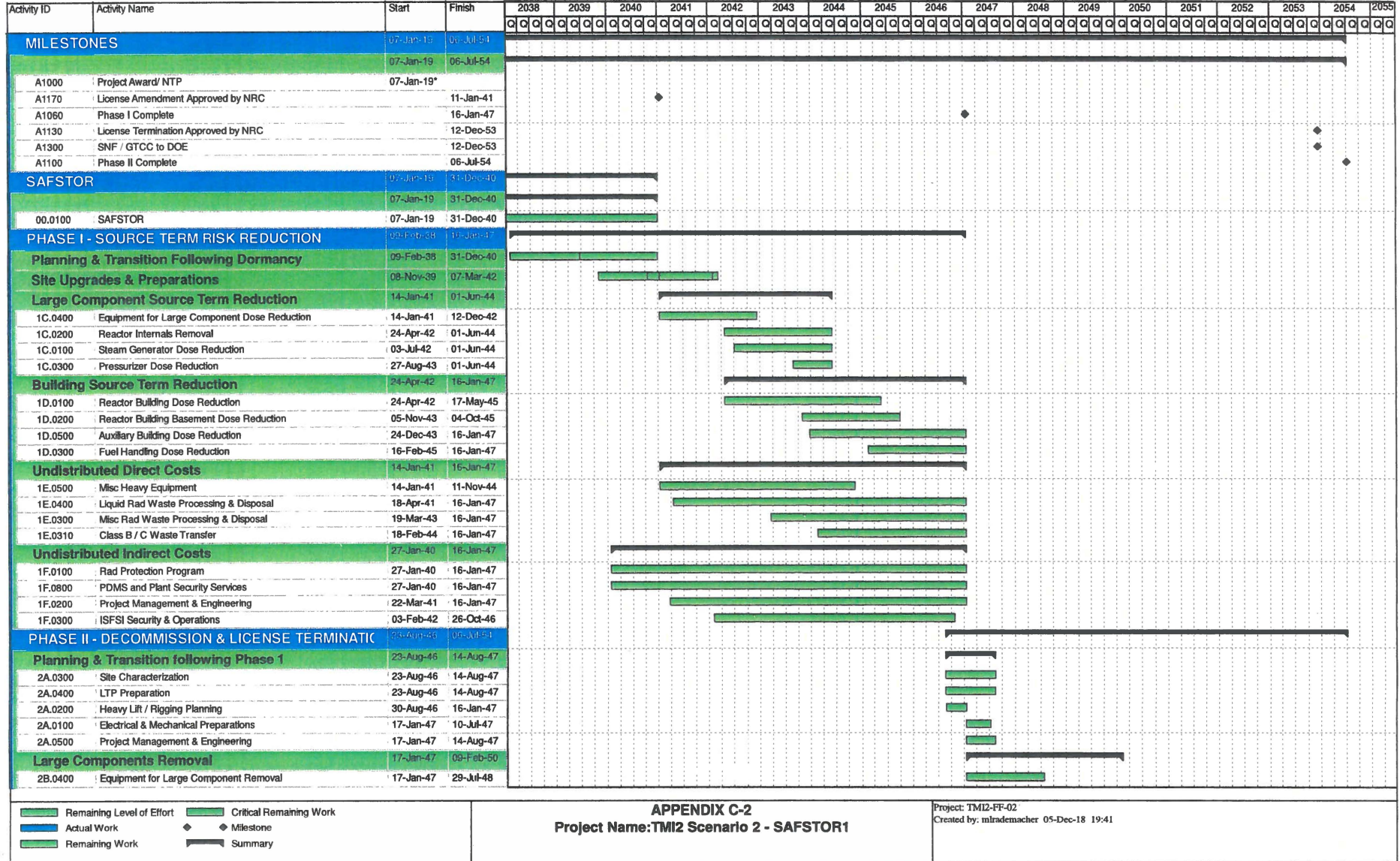


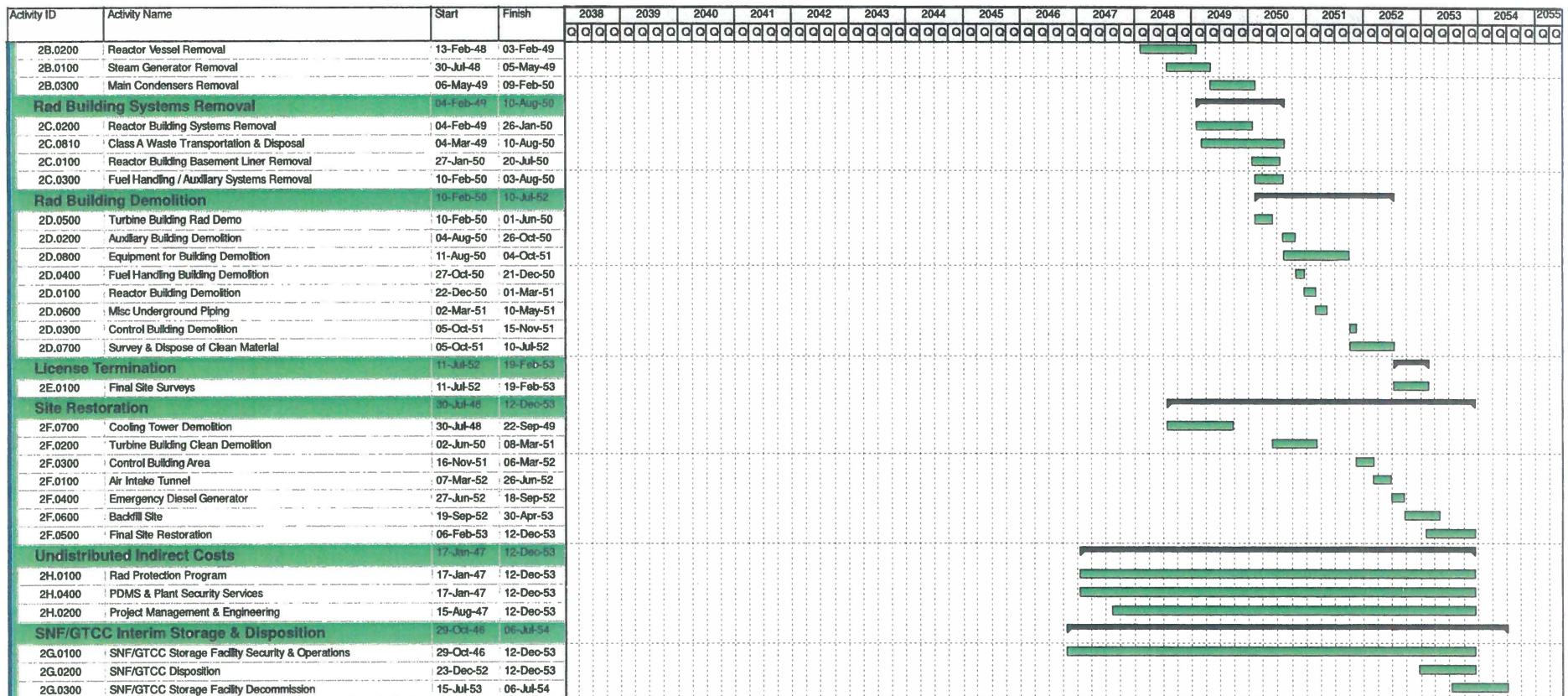


Remaining Level of Effort Remaining Work
 Actual Work Milestone
 Remaining Work Summary

Appendix C-1
Project Name: TMI2 Scenario 1 - DECON

Project: TMI2-FF-01
Created by: mlrmdemacher 05-Dec-18 19:40

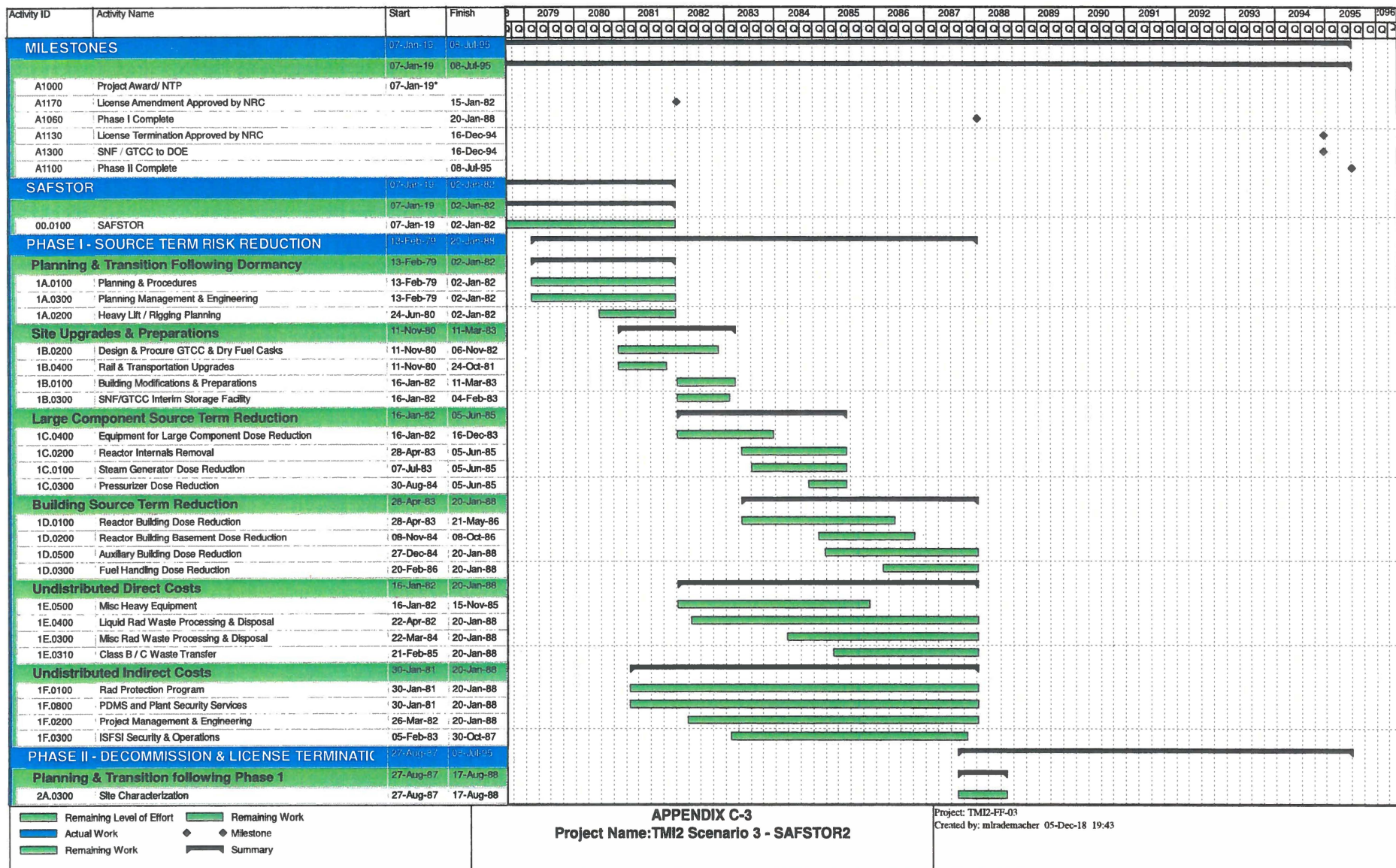


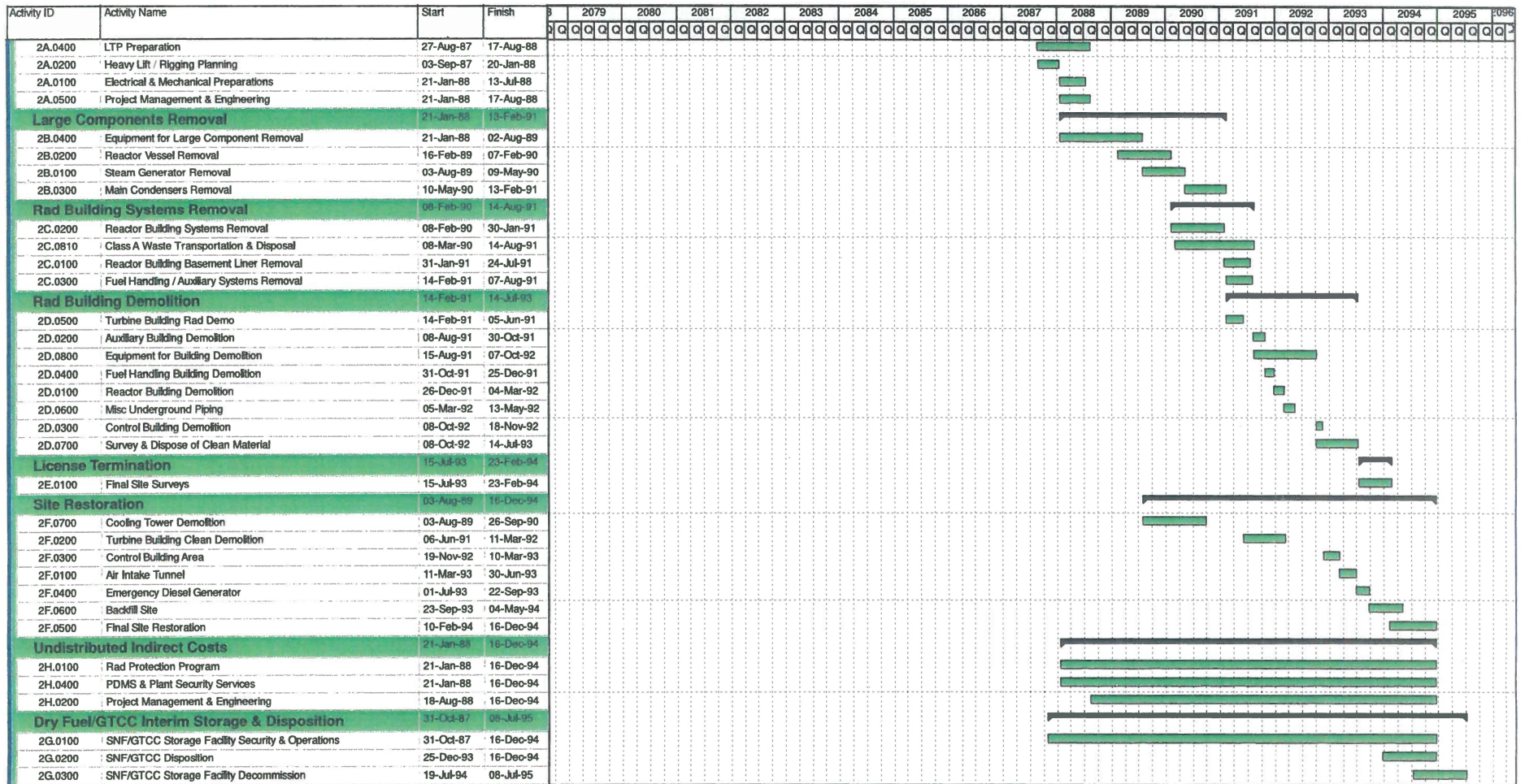


Remaining Level of Effort Critical Remaining Work
 Actual Work Milestone
 Remaining Work Summary

APPENDIX C-2
Project Name: TMI2 Scenario 2 - SAFSTOR1

Project: TMI2-FF-02
 Created by: mlrademacher 05-Dec-18 19:41





Remaining Level of Effort Remaining Work
 Actual Work Milestone
 Remaining Work Summary

APPENDIX C-3

Project Name: TMI2 Scenario 3 - SAFSTOR2

Project: TMI2-FF-03
Created by: mlrademacher 05-Dec-18 19:43

APPENDIX D

D-1 – Detailed Cost Estimate – DECON

D-2 – Detailed Cost Estimate – SAFSTOR1

D-3 – Detailed Cost Estimate – SAFSTOR2

Appendix D-1

**Three Mile Island Unit 2
Scenario 1 - DECON ESTIMATE**
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost (Estimated)	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
	1a.1	Planning & Procedures	-	218	-	-	-	4,945	1,549	6,713	5,370	1,343	-	-
	1a.2	Heavy Lift / Rigging Planning	-	-	-	-	-	1,019	510	1,529	1,529	-	-	-
	1a.3	Planning Management & Engineering	-	371	-	-	-	930	661	1,962	1,962	-	-	-
	1a Total	Planning & Transition Following Dormancy	-	589	-	-	-	6,894	2,720	10,203	8,861	1,343	-	-
	1b.1	Building Modifications & Preparations	1,171	1,246	-	-	-	11,276	4,793	18,486	18,486	-	-	11,695
	1b.2	Design & Procure GTCC & SNF Casks	-	17,680	-	-	-	-	4,420	22,100	16,575	5,525	-	-
	1b.3	SNF/GTCC Interim Storage Facility	-	-	-	-	-	7,800	780	8,580	6,435	2,145	-	-
	1b.4	Rail & Transportation Upgrades	-	-	-	-	-	1,681	671	2,352	2,352	-	-	-
	1b Total	Site Upgrades & Preparations	1,171	18,926	-	-	-	20,757	10,664	51,517	43,847	7,670	-	11,695
	1c.1	Steam Generator Dose Reduction	2,652	562	1,532	2,906	8,434	-	5,630	21,717	17,374	4,343	-	8,776
	1c.2	Reactor Internals Removal	8,180	774	504	165	2,592	-	9,240	21,455	17,164	4,291	-	72,358
	1c.3	Pressurizer Dose Reduction	332	5	288	158	1,897	437	935	4,052	4,052	-	-	1,240
	1c.4	Equipment for Large Component Dose Reduction	-	12,806	-	-	-	-	5,122	17,929	14,343	3,586	-	-
	1c Total	Large Component Source Term Reduction	11,164	14,148	2,325	3,228	12,923	437	20,927	65,152	52,932	12,220	-	82,374
	1d.1	Reactor Building Dose Reduction	4,737	251	1,686	4,088	67,729	-	20,320	98,812	98,812	-	-	43,144
	1d.2	Reactor Building Basement Dose Reduction	1,792	1,239	1,209	3,136	59,214	-	20,705	87,295	87,295	-	-	17,887
	1d.3	Fuel Handling Dose Reduction	2,446	258	116	298	4,315	-	1,924	9,356	9,356	-	-	24,422
	1d.4	Equipment for Building Dose Reduction	-	2,374	-	-	-	-	1,187	3,562	3,562	-	-	-
	1d.5	Auxiliary Building Dose Reduction	1,265	388	398	785	11,251	-	4,226	18,314	18,314	-	-	12,628
	1d Total	Building Source Term Reduction	10,240	4,510	3,409	8,307	142,509	-	48,362	217,338	217,338	-	-	98,081
	1e.1	Small Tools & Consumables	-	8,872	-	-	-	-	2,297	11,169	11,169	-	-	-
	1e.2	Decon Equipment & Supplies	422	16,815	794	1,024	1,501	4,699	7,292	32,547	32,547	-	-	4,212
	1e.3	Misc Rad Waste Processing & Disposal	5,685	2,951	347	494	3,205	968	5,460	19,110	19,110	-	-	66,577
	1e.4	Liquid Rad Waste Processing & Disposal	-	455	-	1,953	3,205	785	2,559	8,957	8,957	-	-	-
	1e.5	Misc Heavy Equipment	-	1,133	1	28	387	86	654	2,288	2,288	-	-	-
	1e Total	Undistributed Direct Costs	6,107	30,226	1,142	3,499	8,297	6,538	18,262	74,071	74,071	-	-	70,790
	1f.1	Rad Protection Program	42,108	17,651	-	-	-	102	16,162	76,023	68,421	7,602	-	525,212
	1f.2	Project Management & Engineering	114,489	-	-	-	-	13,536	31,590	159,614	143,653	15,961	-	866,539
	1f.3	Security Staff & Equipment	7,301	569	-	-	-	8,420	3,491	19,780	14,835	4,945	-	93,600
	1f.4	Environmental Program	2,146	-	-	-	-	1,375	1,331	4,852	4,367	485	-	28,710
	1f.5	Insurance	-	-	-	-	-	14,885	4,046	18,931	17,038	1,893	-	-
	1f.6	Property Taxes & Fees	-	-	-	-	-	1,021	510	1,531	1,378	153	-	-
	1f.7	Safety Program & Training	2,934	1,300	-	-	-	4,497	3,056	11,787	10,608	1,179	-	37,620
	1f.8	PDMS and Plant Security Services	-	-	-	-	-	37,278	3,728	41,005	41,005	-	-	-
	1f.9	Corporate Allocations & Financing	-	-	-	-	-	25,174	5,035	30,209	27,188	3,021	-	-

Appendix D-1

Three Mile Island Unit 2
Scenario 1 - DECON ESTIMATE
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost (Estimated)	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
	1f.10	Energy Costs	-	-	-	-	-	10,262	2,565	12,827	11,545	1,283	-	-
	1f.11	NRC Fees & Inspections	3,361	-	-	-	-	17,232	7,208	27,801	20,851	6,950	-	44,055
	1f.12	Temporary Facilities	32	-	-	-	-	3,536	1,204	4,771	4,294	477	-	288
	1f Total	Undistributed Indirect Costs	172,371	19,519	-	-	-	137,317	79,926	409,134	365,184	43,950	-	1,596,024
	Phase 1 Total - Source Term Risk Reduction		201,053	87,918	6,877	15,034	163,729	171,942	180,861	827,415	762,232	65,183	-	1,858,963
	2a.1	Electrical & Mechanical Preparations	-	343	-	-	-	1,182	263	1,788	1,430	-	358	-
	2a.2	Heavy Lift / Rigging Planning	-	-	-	-	-	941	162	1,103	883	-	221	-
	2a.3	Site Characterization	252	267	-	-	-	1,735	389	2,643	2,643	-	-	3,720
	2a.4	LTP Preparation	670	-	-	-	-	600	219	1,489	1,489	-	-	3,720
	2a.5	Project Management & Engineering	-	-	-	-	-	296	51	347	277	-	69	-
	2a Total	Planning & Transition following Phase 1	922	609	-	-	-	4,753	1,085	7,369	6,722	-	648	7,440
	2b.1	Steam Generator Removal	-	1	0	3	36	1,075	193	1,308	1,308	-	-	-
	2b.2	Reactor Vessel Removal	2,715	-	3,155	352	1,736	-	1,374	9,332	9,332	-	-	28,320
	2b.3	Main Condensers Removal	29	1	2	38	472	-	93	635	635	-	-	316
	2b.4	Equipment for Large Component Removal	480	5,492	3	86	1,064	6,000	2,265	15,390	15,390	-	-	5,158
	2b Total	Large Components Removal	3,224	5,494	3,161	478	3,308	7,075	3,925	26,665	26,665	-	-	33,794
	2c.1	Reactor Building Basement Liner Removal	238	383	5	247	1,207	0	390	2,470	2,470	-	-	2,583
	2c.2	Reactor Building Systems Removal	779	454	9	228	2,835	-	743	5,048	5,048	-	-	8,438
	2c.3	Fuel Handling / Auxiliary Systems Removal	3,443	1,110	39	970	11,209	0	2,895	19,666	19,666	-	-	37,310
	2c Total	Rad Building Systems Removal	4,461	1,946	53	1,446	15,251	0	4,028	27,184	27,184	-	-	48,331
	2d.1	Reactor Building Demolition	1,393	248	211	5,378	30,367	1	6,515	44,112	44,112	-	-	15,089
	2d.2	Auxiliary Building Demolition	61	55	24	758	5,060	-	1,090	7,049	7,049	-	-	661
	2d.3	Control Building Demolition	409	480	54	475	2,282	0	698	4,397	4,397	-	-	4,427
	2d.4	Fuel Handling Building Demolition	1,744	75	10	873	2,772	15	988	6,477	6,477	-	-	18,897
	2d.5	Turbine Building Rad Demo	33	147	8	187	2,327	-	466	3,168	3,168	-	-	357
	2d.6	Misc Underground Piping	267	3	-	11	(39)	-	42	283	283	-	-	2,896
	2d.7	Survey & Dispose of Clean Material	3,038	880	72	8,859	12,440	-	4,365	29,654	29,654	-	-	32,916
	2d.8	Equipment for Building Demolition	-	5,877	-	-	-	-	1,014	6,892	6,892	-	-	-
	2d Total	Rad Building Demolition	6,944	7,764	379	16,540	55,209	16	15,179	102,032	102,032	-	-	75,243
	2e.1	Final Site Surveys	2,962	1,104	-	-	-	422	775	5,264	5,264	-	-	43,725
	2e.2	Misc Materials & Supplies	-	-	-	-	-	1,196	206	1,403	1,403	-	-	-
	2e.3	Disposal of Contaminated Soils	-	-	-	408	6,947	-	1,269	8,623	8,623	-	-	-
	2e Total	License Termination	2,962	1,104	-	408	6,947	1,618	2,251	15,290	15,290	-	-	43,725

Appendix D-1

Three Mile Island Unit 2
Scenario 1 - DECON ESTIMATE
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost (Estimated)	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
	2f.1	Air Intake Tunnel	201	146	0	52	(91)	15	56	378			378	2,173
	2f.2	Turbine Building Clean Demolition	1,640	206	16	191	(432)	15	321	1,957			1,957	17,769
	2f.3	Control Building Area	511	822	0	200	(723)	-	165	975			975	5,538
	2f.4	Emergency Diesel Generator	373	59	0	48	(172)	-	64	373			373	4,044
	2f.5	Final Site Restoration	-	-	-	-	-	15	8	23			23	-
	2f.6	Backfill Site	6,865	4,223	-	-	-	176	1,944	13,208			13,208	74,380
	2f.7	Cooling Tower Demolition	452	-	-	-	-	11,492	2,062	14,005			14,005	4,894
	2f Total	Site Restoration	10,041	5,457	17	492	(1,419)	11,713	4,619	30,920	-	-	30,920	108,799
	2g.1	Rad Protection Program	15,916	9,519	-	-	-	3,593	5,011	34,039	34,039			204,057
	2g.2	Project Management & Engineering	62,578	-	-	-	-	5,903	11,811	80,292	64,233		16,058	560,010
	2g.3	Environmental Program	1,139	-	-	-	-	726	322	2,186	1,749		437	14,685
	2g.4	PDMS & Plant Security Services	-	-	-	-	-	11,160	1,926	13,086	10,469		2,617	-
	2g.5	ANI/NEIL/Other Insurance	-	-	-	-	-	6,120	1,056	7,176	5,741		1,435	-
	2g.6	Property Taxes & Fees	-	-	-	-	-	34	10	44	35		9	-
	2g.7	Energy Costs	-	-	-	-	-	3,562	615	4,176	3,341		835	-
	2g.8	Safety & Training Program	-	-	-	-	-	2,354	406	2,761	2,209		552	-
	2g.9	NRC Fees	-	-	-	-	-	6,503	1,123	7,626	7,626			-
	2g Total	Undistributed Indirect Costs	79,633	9,519	-	-	-	39,955	22,280	151,386	129,442	-	21,944	778,752
	Phase 2 Total - Decommissioning & License Termination		108,187	31,894	3,609	19,363	79,295	65,131	53,366	360,846	307,334	-	53,512	1,096,085
	3a.1	SNF/GTCC Storage Facility Security & Operations	28,080	-	-	-	-	17,520	6,840	52,440	39,330	13,110		390,000
	3a.2	SNF/GTCC Disposition	-	-	1,530	1,584	36,680	3,120	12,874	55,788	41,841	13,947		-
	3a.3	SNF/GTCC Storage Facility Decommission	-	-	-	-	-	2,400	480	2,880	1,728	576	576	-
	3a Total	SNF/GTCC Interim Storage & Disposition	28,080	-	1,530	1,584	36,680	23,040	20,194	111,108	82,899	27,633	576	390,000
	Phase 3 Total - SNF/GTCC Interim Storage & Disposition		28,080	-	1,530	1,584	36,680	23,040	20,194	111,108	82,899	27,633	576	390,000
	Grand Total		337,321	119,812	12,016	35,980	279,705	260,113	254,422	1,299,368	1,152,465	92,815	54,088	3,345,047

Appendix D-2

Three Mile Island Unit 2
Scenario 2 - SAFSTOR1 ESTIMATE
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
	0a.1	PDMS Monitoring	-	-	-	-	-	55,800	6,863	62,663	62,663	-	-	-
	0a Total	PDMS Monitoring	-	-	-	-	-	55,800	6,863	62,663	62,663	-	-	-
	Phase 0 Total - SAFSTOR		-	-	-	-	-	55,800	6,863	62,663	62,663	-	-	-
	1a.1	Planning & Procedures	-	218	-	-	-	4,945	1,549	6,713	5,370	1,343	-	-
	1a.2	Heavy Lift / Rigging Planning	-	-	-	-	-	1,019	510	1,529	1,529	-	-	-
	1a.3	Planning Management & Engineering	-	371	-	-	-	930	661	1,962	1,962	-	-	-
	1a Total	Planning & Transition Following Dormancy	-	589	-	-	-	6,894	2,720	10,203	8,861	1,343	-	-
	1b.1	Building Modifications & Preparations	1,171	1,246	-	-	-	11,276	4,793	18,486	18,486	-	-	11,695
	1b.2	Design & Procure GTCC & SNF Casks	-	17,680	-	-	-	-	4,420	22,100	16,575	5,525	-	-
	1b.3	SNF/GTCC Interim Storage Facility	-	-	-	-	-	7,800	780	8,580	6,435	2,145	-	-
	1b.4	Rail & Transportation Upgrades	-	-	-	-	-	1,681	671	2,352	2,352	-	-	-
	1b Total	Site Upgrades & Preparations	1,171	18,926	-	-	-	20,757	10,664	51,517	43,847	7,670	-	11,695
	1c.1	Steam Generator Dose Reduction	2,652	562	1,532	2,906	8,434	-	5,630	21,717	17,374	4,343	-	8,776
	1c.2	Reactor Internals Removal	8,180	774	504	165	2,592	-	9,240	21,455	17,164	4,291	-	72,320
	1c.3	Pressurizer Dose Reduction	332	5	288	158	1,897	437	935	4,052	4,052	-	-	1,240
	1c.4	Equipment for Large Component Dose Reduction	-	12,806	-	-	-	-	5,122	17,929	14,343	3,586	-	-
	1c Total	Large Component Source Term Reduction	11,164	14,148	2,325	3,228	12,923	437	20,927	65,152	52,932	12,220	-	82,374
	1d.1	Reactor Building Dose Reduction	4,737	251	1,686	4,088	67,729	-	20,320	98,812	98,812	-	-	43,144
	1d.2	Reactor Building Basement Dose Reduction	1,792	1,239	1,209	3,136	59,214	-	20,705	87,295	87,295	-	-	17,887
	1d.3	Fuel Handling Dose Reduction	2,446	258	116	298	4,315	-	1,924	9,356	9,356	-	-	24,422
	1d.4	Equipment for Building Dose Reduction	-	2,374	-	-	-	-	1,187	3,562	3,562	-	-	-
	1d.5	Auxiliary Building Dose Reduction	1,265	388	398	785	11,251	-	4,226	18,314	18,314	-	-	12,628
	1d Total	Building Source Term Reduction	10,240	4,510	3,409	8,307	142,509	-	48,362	217,338	217,338	-	-	98,081
	1e.1	Small Tools & Consumables	-	8,872	-	-	-	-	2,297	11,169	11,169	-	-	-
	1e.2	Decon Equipment & Supplies	422	16,815	794	1,024	1,501	4,699	7,292	32,547	32,547	-	-	4,212
	1e.3	Misc Rad Waste Processing & Disposal	5,685	2,951	347	494	3,205	968	5,460	19,110	19,110	-	-	66,577
	1e.4	Liquid Rad Waste Processing & Disposal	-	455	-	1,953	3,205	785	2,559	8,957	8,957	-	-	-
	1e.5	Misc Heavy Equipment	-	1,133	1	28	387	86	654	2,288	2,288	-	-	-
	1e Total	Undistributed Direct Costs	6,107	30,226	1,142	3,499	8,297	6,538	18,262	74,071	74,071	-	-	70,790
	1f.1	Rad Protection Program	42,108	17,651	-	-	-	102	16,162	76,023	68,421	7,602	-	525,212
	1f.2	Project Management & Engineering	114,489	-	-	-	-	13,536	31,590	159,614	143,653	15,961	-	866,539
	1f.3	Security Staff & Equipment	7,301	569	-	-	-	8,420	3,491	19,780	14,835	4,945	-	93,600
	1f.4	Environmental Program	2,146	-	-	-	-	1,375	1,331	4,852	4,367	485	-	28,710
	1f.5	Insurance	-	-	-	-	-	14,885	4,046	18,931	17,038	1,893	-	-
	1f.6	Property Taxes & Fees	-	-	-	-	-	1,021	510	1,531	1,378	153	-	-

Appendix D-2

Three Mile Island Unit 2
Scenario 2 - SAFSTOR1 ESTIMATE
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
	1f.7	Safety Program & Training	2,934	1,300	-	-	-	4,497	3,056	11,787	10,608	1,179		37,620
	1f.8	PDMS & Plant Security Services	-	-	-	-	-	37,278	3,728	41,005	41,005			-
	1f.9	Corporate Allocations & Financing	-	-	-	-	-	25,174	5,035	30,209	27,188	3,021		-
	1f.10	Energy Costs	-	-	-	-	-	10,262	2,565	12,827	11,545	1,283		-
	1f.11	NRC Fees & Inspections	3,361	-	-	-	-	17,232	7,208	27,801	20,851	6,950		44,055
	1f.12	Temporary Facilities	32	-	-	-	-	3,536	1,204	4,771	4,294	477		288
	1f Total	Undistributed Indirect Costs	172,371	19,519	-	-	-	137,317	79,926	409,134	365,184	43,950	-	1,596,024
	Phase 1 Total - Source Term Risk Reduction		201,053	87,918	6,877	15,034	163,729	171,942	180,861	827,415	762,232	65,183	-	1,858,963
	2a.1	Electrical & Mechanical Preparations	-	343	-	-	-	1,182	263	1,788	1,430		358	-
	2a.2	Heavy Lift / Rigging Planning	-	-	-	-	-	941	162	1,103	883		221	-
	2a.3	Site Characterization	252	267	-	-	-	1,735	389	2,643	2,643			3,720
	2a.4	LTP Preparation	670	-	-	-	-	600	219	1,489	1,489			3,720
	2a.5	Project Management & Engineering	-	-	-	-	-	296	51	347	277		69	-
	2a Total	Planning & Transition following Phase 1	922	609	-	-	-	4,753	1,085	7,369	6,722	-	648	7,440
	2b.1	Steam Generator Removal	-	1	0	3	36	1,075	193	1,308	1,308			-
	2b.2	Reactor Vessel Removal	2,715	-	3,155	352	1,736	-	1,374	9,332	9,332			28,320
	2b.3	Main Condensers Removal	29	1	2	38	472	-	93	635	635			316
	2b.4	Equipment for Large Component Removal	480	5,492	3	86	1,064	6,000	2,265	15,390	15,390			5,158
	2b Total	Large Components Removal	3,224	5,494	3,161	478	3,308	7,075	3,925	26,665	26,665	-	-	33,794
	2c.1	Reactor Building Basement Liner Removal	238	383	5	247	1,207	0	390	2,470	2,470			2,583
	2c.2	Reactor Building Systems Removal	779	454	9	228	2,835	-	743	5,048	5,048			8,438
	2c.3	Fuel Handling / Auxiliary Systems Removal	3,443	1,110	39	970	11,209	0	2,895	19,666	19,666			37,310
	2c Total	Rad Building Systems Removal	4,461	1,946	53	1,446	15,251	0	4,028	27,184	27,184	-	-	48,331
	2d.1	Reactor Building Demolition	1,393	248	211	5,378	30,367	1	6,515	44,112	44,112			15,089
	2d.2	Auxiliary Building Demolition	61	55	24	758	5,060	-	1,090	7,049	7,049			661
	2d.3	Control Building Demolition	409	480	54	475	2,282	0	698	4,397	4,397			4,427
	2d.4	Fuel Handling Building Demolition	1,744	75	10	873	2,772	15	988	6,477	6,477			18,897
	2d.5	Turbine Building Rad Demo	33	147	8	187	2,327	-	466	3,168	3,168			357
	2d.6	Misc Underground Piping	267	3	-	11	(39)	-	42	283	283			2,896
	2d.7	Survey & Dispose of Clean Material	3,038	880	72	8,859	12,440	-	4,365	29,654	29,654			32,916
	2d.8	Equipment for Building Demolition	-	5,877	-	-	-	-	1,014	6,892	6,892			-
	2d Total	Rad Building Demolition	6,944	7,764	379	16,540	55,209	16	15,179	102,032	102,032	-	-	75,243
	2e.1	Final Site Surveys	2,962	1,104	-	-	-	422	775	5,264	5,264			43,725
	2e.2	Misc Materials & Supplies	-	-	-	-	-	1,196	206	1,403	1,403			-
	2e.3	Disposal of Contaminated Soils	-	-	-	408	6,947	-	1,269	8,623	8,623			-
	2e Total	License Termination	2,962	1,104	-	408	6,947	1,618	2,251	15,290	15,290	-	-	43,725

Appendix D-2

Three Mile Island Unit 2
Scenario 2 - SAFSTOR1 ESTIMATE
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
	2f.1	Air Intake Tunnel	201	146	0	52	(91)	15	56	378			378	2,173
	2f.2	Turbine Building Clean Demolition	1,640	206	16	191	(432)	15	321	1,957			1,957	17,769
	2f.3	Control Building Area	511	822	0	200	(723)	-	165	975			975	5,538
	2f.4	Emergency Diesel Generator	373	59	0	48	(172)	-	64	373			373	4,044
	2f.5	Final Site Restoration	-	-	-	-	-	15	8	23			23	-
	2f.6	Backfill Site	6,865	4,223	-	-	-	176	1,944	13,208			13,208	74,380
	2f.7	Cooling Tower Demolition	452	-	-	-	-	11,492	2,062	14,005			14,005	4,894
	2f Total	Site Restoration	10,041	5,457	17	492	(1,419)	11,713	4,619	30,920	-	-	30,920	108,799
	2g.1	SNF/GTCC Storage Facility Security & Operations	5,616	-	-	-	-	4,884	1,325	11,825	8,869	2,956		93,600
	2g.2	SNF/GTCC Disposition	-	-	1,530	1,584	36,680	3,120	12,874	55,788	41,841	13,947		-
	2g.3	SNF/GTCC Storage Facility Decommission	-	-	-	-	-	2,400	480	2,880	1,728	576	576	-
	2g Total	SNF/GTCC Interim Storage & Disposition	5,616	-	1,530	1,584	36,680	10,404	14,679	70,493	52,438	17,479	576	93,600
	2h.1	Rad Protection Program	15,916	9,519	-	-	-	3,593	5,011	34,039	34,039			204,057
	2h.2	Project Management & Engineering	62,578	-	-	-	-	5,903	10,900	79,380	63,504		15,876	560,010
	2h.3	Environmental Program	1,139	-	-	-	-	726	322	2,186	1,749		437	14,685
	2h.4	PDMS & Plant Security Services	-	-	-	-	-	11,160	1,926	13,086	10,469		2,617	-
	2h.5	ANI/NEIL/Other Insurance	-	-	-	-	-	6,120	1,056	7,176	5,741		1,435	-
	2h.6	Property Taxes & Fees	-	-	-	-	-	34	10	44	35		9	-
	2h.7	Energy Costs	-	-	-	-	-	3,562	615	4,176	3,341		835	-
	2h.8	Safety & Training Program	-	-	-	-	-	2,354	406	2,761	2,209		552	-
	2h.9	NRC Fees	-	-	-	-	-	6,503	1,123	7,626	7,626			-
	2h Total	Undistributed Indirect Costs	79,633	9,519	-	-	-	39,955	21,368	150,475	128,713	-	21,762	778,752
	Phase 2 Total - Decommissioning & License Termination		113,803	31,894	5,140	20,946	115,976	75,535	67,134	430,428	359,043	17,479	53,905	1,189,685
	Grand Total		314,857	119,812	12,016	35,980	279,705	303,277	254,859	1,320,506	1,183,939	82,662	53,905	3,048,647

Appendix D-3

Three Mile Island Unit 2
Scenario 3 - SAFSTOR2 DETAILED ESTIMATE
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost (Estimated)	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
0a.1	PDMS Monitoring		-	-	-	-	-	182,900	22,497	205,397	205,397			-
0a Total	PDMS Monitoring		-	-	-	-	-	182,900	22,497	205,397	205,397	-	-	-
Phase 0 Total - SAFSTOR			-	-	-	-	-	182,900	22,497	205,397	205,397	-	-	-
1a.1	Planning & Procedures		-	218	-	-	-	4,945	1,549	6,713	5,370	1,343		-
1a.2	Heavy Lift / Rigging Planning		-	-	-	-	-	1,019	510	1,529	1,529			-
1a.3	Planning Management & Engineering		-	371	-	-	-	930	661	1,962	1,962			-
1a Total	Planning & Transition Following Dormancy		-	589	-	-	-	6,894	2,720	10,203	8,861	1,343	-	-
1b.1	Building Modifications & Preparations		1,171	1,246	-	-	-	11,276	4,793	18,486	18,486			11,695
1b.2	Design & Procure GTCC & SNF Casks		-	17,680	-	-	-	-	4,420	22,100	16,575	5,525		-
1b.3	SNF/GTCC Interim Storage Facility		-	-	-	-	-	7,800	780	8,580	6,435	2,145		-
1b.4	Rail & Transportation Upgrades		-	-	-	-	-	1,681	671	2,352	2,352			-
1b Total	Site Upgrades & Preparations		1,171	18,926	-	-	-	20,757	10,664	51,517	43,847	7,670	-	11,695
1c.1	Steam Generator Dose Reduction		2,652	562	1,532	2,906	8,434	-	5,630	21,717	17,374	4,343		8,776
1c.2	Reactor Internals Removal		8,180	774	504	165	2,592	-	9,240	21,455	17,164	4,291		72,320
1c.3	Pressurizer Dose Reduction		332	5	288	158	1,897	437	935	4,052	4,052			1,240
1c.4	Equipment for Large Component Dose Reduction		-	12,806	-	-	-	-	5,122	17,929	14,343	3,586		-
1c Total	Large Component Source Term Reduction		11,164	14,148	2,325	3,228	12,923	437	20,927	65,152	52,932	12,220	-	82,374
1d.1	Reactor Building Dose Reduction		4,737	251	1,686	4,088	67,729	-	20,320	98,812	98,812			43,144
1d.2	Reactor Building Basement Dose Reduction		1,792	1,239	1,209	3,136	59,214	-	20,705	87,295	87,295			17,887
1d.3	Fuel Handling Dose Reduction		2,446	258	116	298	4,315	-	1,924	9,356	9,356			24,422
1d.4	Equipment for Building Dose Reduction		-	2,374	-	-	-	-	1,187	3,562	3,562			-
1d.5	Auxiliary Building Dose Reduction		1,265	388	398	785	11,251	-	4,226	18,314	18,314			12,628
1d Total	Building Source Term Reduction		10,240	4,510	3,409	8,307	142,509	-	48,362	217,338	217,338	-	-	98,081
1e.1	Small Tools & Consumables		-	8,872	-	-	-	-	2,297	11,169	11,169			-
1e.2	Decon Equipment & Supplies		422	16,815	794	1,024	1,501	4,699	6,538	31,793	31,793			4,212
1e.3	Misc Rad Waste Processing & Disposal		5,685	2,951	347	494	3,205	968	5,460	19,110	19,110			66,577
1e.4	Liquid Rad Waste Processing & Disposal		-	455	-	1,953	3,205	785	2,559	8,957	8,957			-
1e.5	Misc Heavy Equipment		-	1,133	1	28	387	86	654	2,288	2,288			-
1e Total	Undistributed Direct Costs		6,107	30,226	1,142	3,499	8,297	6,538	17,508	73,317	73,317	-	-	70,790
1f.1	Rad Protection Program		42,108	17,651	-	-	-	102	16,162	76,023	68,421	7,602		525,212
1f.2	Project Management & Engineering		114,489	-	-	-	-	13,536	31,590	159,614	143,653	15,961		866,539
1f.3	Security Staff & Equipment		7,301	569	-	-	-	8,420	3,491	19,780	14,835	4,945		93,600
1f.4	Environmental Program		2,146	-	-	-	-	1,375	1,331	4,852	4,367	485		28,710

Appendix D-3

Three Mile Island Unit 2
Scenario 3 - SAFSTOR2 DETAILED ESTIMATE
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost (Estimated)	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
	1f.5	Insurance	-	-	-	-	-	14,885	4,046	18,931	17,038	1,893		-
	1f.6	Property Taxes & Fees	-	-	-	-	-	1,021	510	1,531	1,378	153		-
	1f.7	Safety Program & Training	2,934	1,300	-	-	-	4,497	3,056	11,787	10,608	1,179		37,620
	1f.8	PDMS & Plant Security Services	-	-	-	-	-	37,278	3,728	41,005	41,005			-
	1f.9	Corporate Allocations & Financing	-	-	-	-	-	25,174	5,035	30,209	27,188	3,021		-
	1f.10	Energy Costs	-	-	-	-	-	10,262	2,565	12,827	11,545	1,283		-
	1f.11	NRC Fees & Inspections	3,361		-	-	-	17,232	7,208	27,801	20,851	6,950		44,055
	1f.12	Temporary Facilities	32	-	-	-	-	3,536	1,204	4,771	4,294	477		288
1f Total	Undistributed Indirect Costs		172,371	19,519	-	-	-	137,317	79,926	409,134	365,184	43,950	-	1,596,024
Phase 1 Total - Source Term Risk Reduction			201,053	87,918	6,877	15,034	163,729	171,942	180,107	826,661	761,478	65,183	-	1,858,963
	2a.1	Electrical & Mechanical Preparations	-	343	-	-	-	1,182	263	1,788	1,430		358	-
	2a.2	Heavy Lift / Rigging Planning	-	-	-	-	-	941	162	1,103	883		221	-
	2a.3	Site Characterization	252	267	-	-	-	1,735	389	2,643	2,643			3,720
	2a.4	LTP Preparation	670	-	-	-	-	600	219	1,489	1,489			3,720
	2a.5	Project Management & Engineering	-	-	-	-	-	296	51	347	277		69	-
2a Total	Planning & Transition following Phase 1		922	609	-	-	-	4,753	1,085	7,369	6,722	-	648	7,440
	2b.1	Steam Generator Removal	-	1	0	3	36	1,075	193	1,308	1,308			-
	2b.2	Reactor Vessel Removal	2,715	-	3,155	352	1,736	-	1,374	9,332	9,332			28,320
	2b.3	Main Condensers Removal	29	1	2	38	472	-	93	635	635			316
	2b.4	Equipment for Large Component Removal	480	5,492	3	86	1,064	6,000	2,265	15,390	15,390			5,158
2b Total	Large Components Removal		3,224	5,494	3,161	478	3,308	7,075	3,925	26,665	26,665	-	-	33,794
	2c.1	Reactor Building Basement Liner Removal	238	383	5	247	1,207	0	359	2,440	2,440			2,583
	2c.2	Reactor Building Systems Removal	779	454	9	228	2,835	-	743	5,048	5,048			8,438
	2c.3	Fuel Handling / Auxiliary Systems Removal	3,443	1,110	39	970	11,209	0	2,895	19,666	19,666			37,310
2c Total	Rad Building Systems Removal		4,461	1,946	53	1,446	15,251	0	3,997	27,153	27,153	-	-	48,331
	2d.1	Reactor Building Demolition	1,393	248	211	5,378	30,367	1	6,490	44,087	44,087			15,089
	2d.2	Auxiliary Building Demolition	61	55	24	758	5,060	-	1,029	6,987	6,987			661
	2d.3	Control Building Demolition	409	480	54	475	2,282	0	639	4,338	4,338			4,427
	2d.4	Fuel Handling Building Demolition	1,744	75	10	873	2,772	15	947	6,436	6,436			18,897
	2d.5	Turbine Building Rad Demo	33	147	8	187	2,327	-	466	3,168	3,168			357
	2d.6	Misc Underground Piping	267	3	-	11	(39)	-	42	283	283			2,896
	2d.7	Survey & Dispose of Clean Material	3,038	880	72	8,859	12,440	-	4,365	29,654	29,654			32,916
	2d.8	Equipment for Building Demolition	-	5,877	-	-	-	-	1,014	6,892	6,892			-
2d Total	Rad Building Demolition		6,944	7,764	379	16,540	55,209	16	14,991	101,845	101,845	-	-	75,243
	2e.1	Final Site Surveys	2,962	1,104	-	-	-	422	775	5,264	5,264			43,725

Appendix D-3

Three Mile Island Unit 2
Scenario 3 - SAFSTOR2 DETAILED ESTIMATE
(thousands of 2018 dollars)

Period	Item Number	Item Description	Labor Cost	Materials & Equipment	Waste Packaging	Waste Transportation	Waste Disposal	Other Direct Cost (ODC)	Contingency	Total Cost (Estimated)	License Termination	Spent Fuel Management	Site Restoration	Man-Hours
	2e.2	Misc Materials & Supplies	-	-	-	-	-	1,196	206	1,403	1,403			-
	2e.3	Disposal of Contaminated Soils	-	-	-	408	6,947	-	1,269	8,623	8,623			-
2e Total	License Termination		2,962	1,104	-	408	6,947	1,618	2,251	15,290	15,290	-	-	43,725
	2f.1	Air Intake Tunnel	201	146	0	52	(91)	15	56	378			378	2,173
	2f.2	Turbine Building Clean Demolition	1,640	206	16	191	(432)	15	282	1,919			1,919	17,769
	2f.3	Control Building Area	511	822	0	200	(723)	-	140	950			949,761	5,538
	2f.4	Emergency Diesel Generator	373	59	0	48	(172)	-	53	362			362	4,044
	2f.5	Final Site Restoration	-	-	-	-	-	15	8	23			23	-
	2f.6	Backfill Site	6,865	4,223	-	-	-	176	1,944	13,208			13,208	74,380
	2f.7	Cooling Tower Demolition	452	-	-	-	-	11,492	2,062	14,005			14,005	4,894
2f Total	Site Restoration		10,041	5,457	17	492	(1,419)	11,713	4,545	30,845	-	-	30,845	108,799
	2g.1	SNF/GTCC Storage Facility Security & Operations	5,616	-	-	-	-	4,884	1,326	11,826	8,870	2,957		93,600
	2g.2	SNF/GTCC Transfer to DOE	-	-	1,530	1,584	36,680	3,120	12,874	55,788	41,841	13,947		-
	2g.3	SNF/GTCC Storage Facility Decommission & Demolition	-	-	-	-	-	2,400	480	2,880	1,728	576	576	-
2g Total	SNF/GTCC Storage & Transfer to DOE		5,616	-	1,530	1,584	36,680	10,404	14,680	70,494	52,438	17,479	576	93,600
	2h.1	Rad Protection Program	15,916	9,519	-	-	-	3,593	5,011	34,039	34,039			204,057
	2h.2	Project Management & Engineering	62,578	-	-	-	-	5,903	10,900	79,380	63,504		15,876	560,010
	2h.3	Environmental Program	1,139	-	-	-	-	726	322	2,186	1,749		437	14,685
	2h.4	PDMS & Plant Security Services	-	-	-	-	-	11,160	1,926	13,086	10,469		2,617	-
	2h.5	ANI/NEIL/Other Insurance	-	-	-	-	-	6,120	1,056	7,176	5,741		1,435	-
	2h.6	Property Taxes & Fees	-	-	-	-	-	34	10	44	35		9	-
	2h.7	Energy Costs	-	-	-	-	-	3,562	615	4,176	3,341		835	-
	2h.8	Safety & Training Program	-	-	-	-	-	2,354	406	2,761	2,209		552	-
	2h.9	NRC Fees	-	-	-	-	-	6,503	1,123	7,626	7,626			-
2h Total	Undistributed Indirect Costs		79,633	9,519	-	-	-	39,955	21,368	150,475	128,713	-	21,762	778,752
Phase 2 Total - Decommissioning & License Termination			113,803	31,894	5,139	20,946	115,976	75,535	66,842	430,135	358,825	17,479	53,831	1,189,685
Grand Total			314,857	119,812	12,016	35,980	279,705	430,377	269,446	1,462,193	1,325,700	82,662	53,831	3,048,647

APPENDIX E

E-1 – Annual Spending Table – DECON

E-2 – Annual Spending Table – SAFSTOR1

E-3 – Annual Spending Table – SAFSTOR2

Appendix E-1 Scenario 1 - DECON Projected Annual Spending (thousands of 2018 dollars)				
Year	License Termination	Spent Fuel	Site Restoration	Total
2018				-
2019	4,752	383		5,135
2020	6,045	480		6,525
2021	6,045	480		6,525
2022	11,777	5,525		17,302
2023	45,035	5,990		51,025
2024	101,096	14,598		115,694
2025	102,919	14,598		117,517
2026	154,270	14,598		168,868
2027	162,007	6,945		168,952
2028	166,315	1,481		167,796
2029	46,961	527		47,488
2030	49,454	527		49,981
2031	74,174	527	3,781	78,482
2032	52,982	527	17,770	71,279
2033	53,633	527	14,043	68,203
2034	35,181	527	13,596	49,304
2035	8,136	527	4,321	12,985
2036	1,573	527	-	2,100
2037	1,573	527	-	2,100
2038	1,573	527	-	2,100
2039	1,573	527	-	2,100
2040	1,573	527	-	2,100
2041	1,573	527	-	2,100
2042	1,573	527	-	2,100
2043	1,573	527	-	2,100
2044	1,573	527	-	2,100
2045	1,573	527	-	2,100
2046	1,573	527	-	2,100
2047	1,573	527	-	2,100
2048	1,573	527	-	2,100
2049	1,573	527	-	2,100
2050	1,573	527	-	2,100
2051	3,373	1,127	-	4,500
2052	21,493	7,220	-	28,713
2053	21,493	7,220	-	28,713
2054	1,728	576	576	2,880
	1,152,465	92,815	54,088	1,299,368

Appendix E-2 Scenario 2 - SAFSTOR1 Projected Annual Spending (thousands of 2018 dollars)				
Year	License Termination	Spent Fuel	Site Restoration	Total
2018				-
2019	3,481			3,481
2020	3,481			3,481
2021	3,481			3,481
2022	3,481			3,481
2023	3,481			3,481
2024	3,481			3,481
2025	3,481			3,481
2026	3,481			3,481
2027	3,481			3,481
2028	3,481			3,481
2029	3,481			3,481
2030	3,481			3,481
2031	3,481			3,481
2032	3,481			3,481
2033	3,481			3,481
2034	3,481			3,481
2035	3,481			3,481
2036	3,481			3,481
2037	4,752	383		5,135
2038	6,045	480		6,525
2039	6,045	480		6,525
2040	11,777	5,525		17,302
2041	45,035	5,990		51,025
2042	101,096	14,598		115,694
2043	102,919	14,598		117,517
2044	154,270	14,598		168,868
2045	162,007	6,945		168,952
2046	166,315	1,481		167,796
2047	46,961	432		47,393
2048	49,454	432		49,886
2049	74,174	432	4,345	78,951
2050	52,982	432	16,076	69,490
2051	53,633	1,032	15,105	69,770
2052	51,102	7,124	13,483	71,709
2053	25,532	7,124	4,320	36,976
2054	7,177	576	576	8,329
				-
	1,183,939	82,662	53,905	1,320,506

Appendix E-3 Scenario 3 - SAFSTOR2 Projected Annual Spending (thousands of 2018 dollars)				
Year	License Termination	Spent Fuel	Site Restoration	Total
2018				-
2019	3,481			3,481
2020	3,481			3,481
2021	3,481			3,481
2022	3,481			3,481
2023	3,481			3,481
2024	3,481			3,481
2025	3,481			3,481
2026	3,481			3,481
2027	3,481			3,481
2028	3,481			3,481
2029	3,481			3,481
2030	3,481			3,481
2031	3,481			3,481
2032	3,481			3,481
2033	3,481			3,481
2034	3,481			3,481
2035	3,481			3,481
2036	3,481			3,481
2037	3,481			3,481
2038	3,481			3,481
2039	3,481			3,481
2040	3,481			3,481
2041	3,481			3,481
2042	3,481			3,481
2043	3,481			3,481
2044	3,481			3,481
2045	3,481			3,481
2046	3,481			3,481
2047	3,481			3,481
2048	3,481			3,481
2049	3,481			3,481
2050	3,481			3,481
2051	3,481			3,481
2052	3,481			3,481
2053	3,481			3,481
2054	3,481			3,481
2055	3,481			3,481
2056	3,481			3,481
2057	3,481			3,481

Appendix E-3 Scenario 3 - SAFSTOR2 Projected Annual Spending (thousands of 2018 dollars)				
Year	License Termination	Spent Fuel	Site Restoration	Total
2058	3,481			3,481
2059	3,481			3,481
2060	3,481			3,481
2061	3,481			3,481
2062	3,481			3,481
2063	3,481			3,481
2064	3,481			3,481
2065	3,481			3,481
2066	3,481			3,481
2067	3,481			3,481
2068	3,481			3,481
2069	3,481			3,481
2070	3,481			3,481
2071	3,481			3,481
2072	3,481			3,481
2073	3,481			3,481
2074	3,481			3,481
2075	3,481			3,481
2076	3,481			3,481
2077	3,481			3,481
2078	3,827	383		4,210
2079	6,045	480		6,525
2080	6,045	480		6,525
2081	11,777	5,525		17,302
2082	45,035	5,990		51,025
2083	101,096	14,598		115,694
2084	102,919	14,598		117,517
2085	154,270	14,598		168,868
2086	162,007	6,945		168,952
2087	166,315	1,481		167,796
2088	46,961	432		47,393
2089	49,454	432		49,886
2090	74,174	432	4,306	78,912
2091	52,982	432	16,042	69,455
2092	53,633	1,032	15,073	69,737
2093	51,102	7,124	13,458	71,683
2094	25,532	7,124	4,377	37,033
2095	7,177	576	576	8,329
	1,325,700	82,662	53,831	1,462,193

APPENDIX F

F-1 – Annual Spending Comparison to Previous Estimates – DECON

F-2 – Annual Spending Comparison to Previous Estimates – SAFSTOR1

F-3 – Annual Spending Comparison to Previous Estimates – SAFSTOR2

Appendix F-1 Scenario 1 - DECON Annual Spending Comparison to prior TLG Study (thousands of 2018 dollars)				
Year	Current Cost Study in 2018 dollars	* TLG Previous DECON Cost Study in 2013 dollars	*** TLG DECON Cost Study Escalated to 2018 dollars	Variance between current estimate & TLG in 2018 dollars
2018	-	see note**		
2019	5,135	3,036	3,481	1,654
2020	6,525	3,044	3,490	3,035
2021	6,525	3,036	3,481	3,044
2022	17,302	3,036	3,481	13,821
2023	51,025	53,427	61,260	(10,235)
2024	115,694	88,337	101,288	14,406
2025	117,517	110,929	127,192	(9,675)
2026	168,868	110,929	127,192	41,675
2027	168,952	111,233	127,541	41,411
2028	167,796	110,929	127,192	40,603
2029	47,488	97,858	112,205	(64,717)
2030	49,981	73,063	83,775	(33,793)
2031	78,482	73,263	84,004	(5,522)
2032	71,279	73,063	83,775	(12,496)
2033	68,203	78,671	90,205	(22,002)
2034	49,304	70,671	81,032	(31,728)
2035	12,985	31,354	35,951	(22,966)
2036	2,100	3,044	3,490	(1,390)
2037	2,100	3,036	3,481	(1,381)
2038	2,100	3,036	3,481	(1,381)
2039	2,100	3,036	3,481	(1,381)
2040	2,100	3,044	3,490	(1,390)
2041	2,100	3,036	3,481	(1,381)
2042	2,100	3,036	3,481	(1,381)
2043	2,100	3,036	3,481	(1,381)
2044	2,100	3,044	3,490	(1,390)
2045	2,100	3,036	3,481	(1,381)
2046	2,100	3,036	3,481	(1,381)
2047	2,100	3,036	3,481	(1,381)
2048	2,100	3,044	3,490	(1,390)
2049	2,100	3,036	3,481	(1,381)
2050	2,100	3,036	3,481	(1,381)
2051	4,500	3,036	3,481	1,019
2052	28,713	14,209	16,292	12,421
2053	28,713	14,209	16,292	12,421
2054	2,880	-	-	2,880
	-	-	-	
	1,299,368	1,172,905	1,344,866	(45,499)

* from TLG DECOMMISSIONING COST ANALYSIS, December 2014

** years 2013 -2018 not included with TLG previous costs

*** from TLG ESCALATION ANALYSIS, February 2015

Appendix F-2 Scenario 2 - SAFSTOR1 Annual Spending Comparison to prior TLG DELAYED DECON Study (thousands of 2018 dollars)				
Year	Current Cost Study in 2018 dollars	* TLG Previous DELAYED DECON Cost Study (2013 dollars)	*** TLG DELAYED DECON Cost Study Escalated to 2018 dollars	Variance between current estimate & TLG in 2018 dollars
2018		see note**		
2019	3,481	3,036	3,481	0
2020	3,481	3,044	3,490	(9)
2021	3,481	3,036	3,481	0
2022	3,481	3,036	3,481	0
2023	3,481	3,036	3,481	0
2024	3,481	3,044	3,490	(9)
2025	3,481	3,036	3,481	0
2026	3,481	3,036	3,481	0
2027	3,481	3,036	3,481	0
2028	3,481	3,044	3,490	(9)
2029	3,481	3,036	3,481	0
2030	3,481	3,036	3,481	0
2031	3,481	3,036	3,481	0
2032	3,481	3,044	3,490	(9)
2033	3,481	3,036	3,481	0
2034	3,481	2,112	2,422	1,060
2035	3,481	1,724	1,977	1,505
2036	3,481	1,728	1,981	1,500
2037	5,135	1,724	1,977	3,158
2038	6,525	1,724	1,977	4,548
2039	6,525	1,724	1,977	4,548
2040	17,302	1,728	1,981	15,321
2041	51,025	1,724	1,977	49,048
2042	115,694	1,724	1,977	113,717
2043	117,517	1,724	1,977	115,540
2044	168,868	1,728	1,981	166,886
2045	168,952	27,776	31,848	137,104
2046	167,796	79,404	91,046	76,750
2047	47,393	107,381	123,124	(75,731)
2048	49,886	111,194	127,496	(77,610)
2049	78,951	110,890	127,148	(48,197)
2050	69,490	110,890	127,148	(57,658)
2051	69,770	110,890	127,148	(57,378)
2052	71,709	71,322	81,779	(10,070)
2053	36,976	71,128	81,556	(44,581)
2054	8,329	71,128	81,556	(73,227)
2055		71,128	81,556	(81,556)
2056		71,322	81,779	(81,779)
2057		39,461	45,246	(45,246)
2058		38,859	44,556	(44,556)
2059		1,619	1,856	(1,856)
	1,320,506	1,159,328	1,329,299	(8,793)

* from TLG DECOMMISSIONING COST ANALYSIS, December 2014

** years 2013 -2018 not included with TLG previous costs

*** from TLG ESCALATION ANALYSIS, February 2015

Appendix F-3 Scenario 3 - SAFSTOR2 Annual Spending Comparison to prior TLG Study (thousands of 2018 dollars)				
Year	Current Cost Study (2018 dollars)	* TLG Previous SAFSTOR Cost Study (2013 dollars)	** TLG SAFSTOR Cost Study Escalated to 2018 dollars	Variance between current estimate & TLG in 2018 dollars
2018	-	see note **		
2019	3,481	3,036	3,481	(1)
2020	3,481	3,044	3,490	(10)
2021	3,481	3,036	3,481	(1)
2022	3,481	3,036	3,481	(1)
2023	3,481	3,036	3,481	(1)
2024	3,481	3,044	3,490	(10)
2025	3,481	3,036	3,481	(1)
2026	3,481	3,036	3,481	(1)
2027	3,481	3,036	3,481	(1)
2028	3,481	3,044	3,490	(10)
2029	3,481	3,036	3,481	(1)
2030	3,481	3,036	3,481	(1)
2031	3,481	3,036	3,481	(1)
2032	3,481	3,044	3,490	(10)
2033	3,481	3,036	3,481	(1)
2034	3,481	2,107	2,416	1,065
2035	3,481	1,716	1,968	1,513
2036	3,481	1,721	1,973	1,507
2037	3,481	1,716	1,968	1,513
2038	3,481	1,716	1,968	1,513
2039	3,481	1,716	1,968	1,513
2040	3,481	1,721	1,973	1,507
2041	3,481	1,716	1,968	1,513
2042	3,481	1,716	1,968	1,513
2043	3,481	1,716	1,968	1,513
2044	3,481	1,721	1,973	1,507
2045	3,481	1,716	1,968	1,513
2046	3,481	1,716	1,968	1,513
2047	3,481	1,716	1,968	1,513
2048	3,481	1,721	1,973	1,507
2049	3,481	1,716	1,968	1,513
2050	3,481	1,716	1,968	1,513
2051	3,481	1,716	1,968	1,513
2052	3,481	1,721	1,973	1,507
2053	3,481	1,716	1,968	1,513
2054	3,481	1,716	1,968	1,513
2055	3,481	1,716	1,968	1,513
2056	3,481	1,721	1,973	1,507
2057	3,481	1,716	1,968	1,513
2058	3,481	1,716	1,968	1,513

Appendix F-3 Scenario 3 - SAFSTOR2 Annual Spending Comparison to prior TLG Study (thousands of 2018 dollars)				
Year	Current Cost Study (2018 dollars)	* TLG Previous SAFSTOR Cost Study (2013 dollars)	** TLG SAFSTOR Cost Study Escalated to 2018 dollars	Variance between current estimate & TLG in 2018 dollars
2059	3,481	1,716	1,968	1,513
2060	3,481	1,721	1,973	1,507
2061	3,481	1,716	1,968	1,513
2062	3,481	1,716	1,968	1,513
2063	3,481	1,716	1,968	1,513
2064	3,481	1,721	1,973	1,507
2065	3,481	1,716	1,968	1,513
2066	3,481	1,716	1,968	1,513
2067	3,481	1,716	1,968	1,513
2068	3,481	1,721	1,973	1,507
2069	3,481	1,716	1,968	1,513
2070	3,481	1,716	1,968	1,513
2071	3,481	1,716	1,968	1,513
2072	3,481	1,721	1,973	1,507
2073	3,481	1,716	1,968	1,513
2074	3,481	1,716	1,968	1,513
2075	3,481	1,716	1,968	1,513
2076	3,481	1,721	1,973	1,507
2077	3,481	1,716	1,968	1,513
2078	4,210	1,716	1,968	2,243
2079	6,525	1,716	1,968	4,557
2080	6,525	1,721	1,973	4,552
2081	17,302	8,330	9,551	7,751
2082	51,025	76,021	87,167	(36,141)
2083	115,694	101,178	116,012	(318)
2084	117,517	111,171	127,470	(9,953)
2085	168,868	110,867	127,121	41,746
2086	168,952	110,867	127,121	41,831
2087	167,796	110,867	127,121	40,675
2088	47,393	81,802	93,795	(46,402)
2089	49,886	71,017	81,429	(31,543)
2090	78,912	71,017	81,429	(2,516)
2091	69,455	71,017	81,429	(11,974)
2092	69,737	71,211	81,651	(11,914)
2093	71,683	51,259	58,774	12,909
2094	37,033	35,434	40,629	(3,597)
2095	8,329	12,086	13,858	(5,529)
	1,462,193	1,220,819	1,399,805	62,388

* from TLG DECOMMISSIONING COST ANALYSIS, December 2014

** years 2013 -2018 not included with TLG previous costs

*** from TLG ESCALATION ANALYSIS, February 2015