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PUC DOCKET NO. 58193

APPLICATION OF COMANCHE PEAK POWER COMPANY LLC FOR REVIEW OF NUCLEAR DECOMMISSIONING COST STUDY AND FUNDING ANALYSIS UNDER 16 TAC § 25.303(F)(2)	§ § § § § §	**BEFORE THE** **PUBLIC UTILITY COMMISSION** **OF TEXAS**

TABLE OF CONTENTS

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APPLICATION FOR REVIEW OF
NUCLEAR DECOMMISSIONING COST STUDY AND FUNDING ANALYSIS

COMES NOW Comanche Peak Power Company LLC (Comanche Peak) and in accordance with 16 Tex. Admin. Code (TAC) § 25.303(f)(2), hereby files the following:

I. BACKGROUND

16 TAC § 25.303(f)(2) requires Comanche Peak, the owner of Comanche Peak Nuclear Power Plant (CPNPP), as well as its associated Nuclear Decommissioning Fund (NDF), to periodically perform or cause to be performed a study of the decommissioning costs of CPNPP. A study or re-determination of the previous study is required to be filed with the Public Utility Commission of Texas (Commission), along with an updated NDF funding analysis at least every five years. Comanche Peak's last five year cost study and funding analysis was filed at the Commission in Docket No. 50945 on June 16, 2020. This filing constitutes Comanche Peak's re-determined cost study and updated NDF funding analysis in compliance with the Commission's rules.

II. FILING PACKAGE

Comanche Peak's filing is comprised of the following:

1. Testimony of Adam M. Kaczmarek of TLG Services, LLC (TLG). Attached as exhibits to Mr. Kaczmarek's testimony are:
    a. Exhibit AMK–1: *Decommissioning Cost Study for the Comanche Peak Nuclear Power Plant*, dated April 2025; and
    b. Exhibit AMK-2: *Financial Escalation Analysis for the Comanche Peak Nuclear Power Plant*, dated April 2025

2. Testimony of William (Bill) M. Quinn, Senior Vice President & Treasurer of Vistra Corp. and its subsidiaries, including Comanche Peak. Attached as exhibits to Mr. Quinn's testimony are:
   a. Exhibit WMQ-1: *Funding Analysis for Comanche Peak Nuclear Power Plant*; and
   b. Exhibit WMQ-2: *Comanche Peak Nuclear Decommissioning Trust Investment Policy*

III. FUNDING ANALYSIS

Comanche Peak's current annual funding amount approved in Docket No. 50945 is $20,077,165, which is being collected by Oncor Electric Delivery Company LLC as the Collecting Utility. For the reasons summarized below and detailed in the testimony of Mr. Quinn, Comanche Peak proposes to reduce the annual funding amount of the CPNPP NDF to $0.

According to the *Decommissioning Cost Study for the Comanche Peak Nuclear Power Plant* (Decommissioning Cost Study), attached as Exhibit AMK-1 to Mr. Kaczmarek's testimony, and the *Financial Escalation Analysis for the Comanche Peak Nuclear Power Plant* (Financial Escalation Analysis), attached as Exhibit AMK-2 to Mr. Kaczmarek's testimony, the total estimated cost to decommission and completely dismantle CPNPP is $2,016,377,779 in 2024 dollars assuming a 10 percent contingency. Although the Decommissioning Cost Study recommended an appropriate contingency of approximately 17.38 percent for CPNPP Unit 1 and 17.74 percent for CPNPP Unit 2 for the DECON alternative (see Table C), in compliance with 16 TAC § 25.303(f)(2), an allowance for contingency of 10 percent was used in the Financial Escalation Analysis.

On July 30, 2024, the Nuclear Regulatory Commission renewed and extended the Facility Operating License for CPNPP Unit 1 to 2050 and Unit 2 to 2053. As a result of the license extension, the *Funding Analysis for Comanche Peak Nuclear Power Plant* (Funding Analysis), attached as Exhibit WMQ-1 to Mr. Quinn's testimony, shows the current NDF is sufficient to cover the total cost to decommission and completely dismantle CPNPP.

IV. REQUESTED CHANGE TO NDF COLLECTION

The attached Decommissioning Cost Study, Financial Escalation Analysis, and Funding Analysis shows the current CPNPP NDF is sufficient to cover the total cost to decommission and completely dismantle CPNPP. As a result, Comanche Peak proposes to reduce the current collection rate to $0 for the next five years.

Respectfully submitted,

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Direct Testimony of
Adam M. Kaczmarek

DOCKET NO. 58193

COMANCHE PEAK POWER COMPANY, LLC'S NUCLEAR DECOMMISSIONING COST STUDY AND FUNDING ANALYSIS FILING PURSUANT TO SUBST. R. 25.303(f)(2)	§ § § § § §	BEFORE THE PUBLIC UTILITY COMMISSION OF TEXAS

DIRECT TESTIMONY

OF

ADAM M. KACZMAREK

ON BEHALF OF

COMANCHE PEAK POWER COMPANY, LLC

JUNE 2025

DOCKET NO. 58193

COMANCHE PEAK POWER COMPANY, LLC'S
NUCLEAR DECOMMISSIONING COST STUDY AND
FUNDING ANALYSIS FILING PURSUANT TO SUBST. R. 25.303(f)(2)

DIRECT TESTIMONY OF ADAM M. KACZMAREK

TABLE OF CONTENTS

EXHIBITS

AMK-1	Decommissioning Cost Study for the Comanche Peak Nuclear Power Plant, dated April 2025
AMK-2	Financial Escalation Analysis for the Comanche Peak Nuclear Power Plant, dated April 2025

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. Adam M. Kaczmarek, 148 New Milford Road East, Bridgewater, CT 06752.

Q. WHAT IS YOUR OCCUPATION?

A. I am the Senior Manager of Decommissioning Services at TLG Services, LLC. ("TLG"). On September 19, 2000, Entergy Nuclear, Inc. acquired the stock of TLG Services with TLG thereby becoming a wholly owned, indirect subsidiary of Entergy Corporation. In 2021, Entergy restructured their subsidiaries and aligned TLG Services with Entergy Nuclear Operations, Inc. As such, I am also the Senior Manager of Decommissioning with Entergy Nuclear Operations, Inc.

Q. WHAT ARE YOUR RESPONSIBILITIES WITH THAT ORGANIZATION?

A. I am responsible for the technical and business management of the engineering consulting services in the area of decommissioning planning for nuclear generating stations.

Q. WHAT IS YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND?

A. I completed my Bachelor of Science in Electrical Engineering at State University of New York ("SUNY") at New Paltz in 2005. I joined TLG Services in May 2020. I was employed by Entergy Nuclear at Indian Point

Energy Center (IPEC) in Buchanan, NY from 2008 until I joined TLG. My prior employment was with Wagner Technical Services, Newburgh, NY.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. I am presenting the results of the 2025 decommissioning cost update and financial escalation analysis prepared for the Comanche Peak Nuclear Power Plant ("Comanche Peak") for Comanche Peak Power Company, LLC ("CPPC") by TLG. My testimony summarizes the results of the update of the 2025 decommissioning cost study, identifies major changes from the previous estimate, and provides an overview of the decommissioning process.

The 2025 decommissioning cost update is attached to my testimony as Exhibit AMK-1. The financial escalation analysis for Comanche Peak is attached to my testimony as Exhibit AMK-2. This testimony, the cost update attached as Exhibit AMK-1, and the escalation analysis attached as Exhibit AMK-2 were all prepared under my direction and control and are true and correct to the best of my knowledge and belief.

II. EXPERIENCE

Q. WHAT DECOMMISSIONING EXPERIENCE DO YOU HAVE?

A. My decommissioning experience began in 2020 with TLG. At TLG, I have been responsible for developing engineering and planning studies for nuclear plant decommissioning. These studies evaluate the options available, and provide the licensees/owners of the facilities with both the technical and financial resource requirements associated with site remediation and facility disposition. I have supervised the preparation of numerous studies since 2020. I have been involved as the Project Manager and Technical Manager for various estimates throughout North America.

Q. HAS THE NUCLEAR REGULATORY COMMISSION ("NRC") APPROVED SITE-SPECIFIC COST ESTIMATES UTILIZING THE TLG COST ESTIMATING METHODOLOGY?

A. Yes. The NRC has reviewed TLG's cost estimating methodology. The NRC approved the decommissioning plan proposed by TLG for the Pathfinder Atomic Power Station. Funding provisions were based upon a site-specific estimate developed by TLG. TLG was also selected by the following utilities to prepare site-specific cost estimates for inclusion within the decommissioning plans submitted to the NRC for the identified nuclear units:

Long Island Lighting Company/Long Island Power Authority	Shoreham
Sacramento Municipal Utility District	Rancho Seco

Portland General Electric	Trojan
Yankee Atomic Electric Company	Rowe
Maine Yankee Atomic Power Company	Maine Yankee
Pacific Gas & Electric	Humboldt Bay-3
Southern California Edison	San Onofre-1
Consumer Power Company	Big Rock Point
Duke Energy	Crystal River
Exelon Generation	Oyster Creek
Entergy Vermont Yankee	Vermont Yankee

Q. DOES THE 2025 DECOMMISSIONING COST UPDATE FOR COMANCHE PEAK DICTATE HOW THE COMANCHE PEAK SITE WILL ULTIMATELY BE DECOMMISSIONED?

A. No. The primary objective of the 2025 study was to update the previous (2020) estimate to decommission the nuclear station. The study is not a detailed decommissioning engineering plan and, therefore, does not commit the participants to a specific course of action for the station following ultimate plant shutdown.

III. SUMMARY OF ESTIMATED COSTS

Q. WOULD YOU PLEASE SUMMARIZE THE DECOMMISSIONING COSTS IDENTIFIED BY YOUR STUDY?

A. As provided on page xii of Exhibit AMK-1, the total cost to promptly decommission and completely dismantle Comanche Peak ("DECON") is estimated to be approximately $2.155 billion. The total cost to place the station into safe-storage with decommissioning deferred so that its operating licenses are terminated within a 60-year regulatory time limit is estimated to be approximately $2.411 billion (page xiii). These costs were developed in 2024 dollars and do not include future inflation, or consider the cost of money over the time period involved.

The prompt or DECON cost includes a contingency component of 17.56%, based upon a line-item analysis of uncertainty and risk. The estimate adjusted for the 10% ceiling value for contingency, identified in the Public Utility Commission of Texas ("PUCT") Substantive Rule 25.231(b)(1)(F)(i), would be approximately $2.016 billion (in 2024 dollars). However, it should be noted that this administrative reduction in the contingency may be less than is actually required to complete the decommissioning process, based upon the total cost calculated by a site-specific estimate, as I explain later in my testimony.

Q. WHAT WAS THE PREVIOUS COST ESTIMATED FOR DECOMMISSIONING AND DISMANTLING COMANCHE PEAK?

A. The total cost to promptly decommission and dismantle Comanche Peak in 2020 was estimated at $1.870 billion (in 2019 dollars and not adjusted for the 10% contingency ceiling).

Q. WHAT ARE THE MAJOR REASONS FOR THE INCREASE SINCE THE PREVIOUS STUDY?

A. TLG used the same site-specific, technical database for the physical plant, relied upon in 2020, to update the decommissioning cost presented in Exhibit AMK-1. Comanche Peak provided the financial information used to update the estimate from 2019 dollars to 2024 dollars. The 15.3% increase over the five-year period is a primarily the result of updated economic inputs to the estimate, i.e., price increases in labor, equipment and materials, and the cost of services. The areas most affected by these changes include program management, spent fuel management, site security, and removal of radioactive waste. The following sections provide more detail on the cost changes in these categories.

A. Program Management

The changes in the program management costs account for approximately 34.6% of the total increase in the cost from 2020 to 2025 ($98.7 million of the $285.2 million increase for the DECON alternative). The program management category increased 17.0% from 2020 to 2025. The average hourly rate for utility staff increased 19.4%, while the average Decommissioning Operations Contractor ("DOC") staff rate increased 13.7%.

B. Spent Fuel Management

The changes in the spent fuel management assumptions account for approximately 13.0% of the total increase in the cost from 2020 to 2025 ($37.2 of the $285.2 million increase for the DECON alternative).

The 2025 analysis assumes that the Department of Energy ("DOE") will begin accepting spent fuel from the Comanche Peak site in 2056 with all fuel off site by 2114. Based upon the 2056 start date, 378 spent fuel assemblies will be shipped from the plant's spent fuel pools directly to the DOE between 2056 and 2058. The remaining assemblies generated over the lifetime of the units were placed into dry storage. This requires a total of 222 storage casks, of which, 60 will be loaded during decommissioning. The cost for the dry fuel storage casks, including the loading and transfer costs, in the 2025 estimate, increased approximately 10.5% between the two units.

C. Site Security

The changes in the site security costs account for approximately 8.0% of the total increase in the cost from 2020 to 2025 ($22.7 million of the $285.2 million increase for the DECON alternative). The site security category increased 9.4% from 2020 to 2025. The average hourly rate for site security increased 14.7%, while the site security O&M costs decreased approximately 10.0%. The assumed starting level for site security staffing decreased by 9 FTE for the 2025 estimate, however the FTE levels remained consistent between the 2020 and 2025 estimates after the completion of transferring all fuel from the spent fuel pools into dry storage.

D. Removal of Radioactive Waste

The changes in the removal of radioactive waste costs account for approximately 17.9% of the total increase in the cost from 2020 to 2025 ($50.9 million of the $285.2 million increase for the DECON alternative). The removal of radioactive waste category increased 22.3% from 2020 to 2025. This category consists of mainly two components, labor and equipment/materials. The labor component associated with the removal of radioactive waste increased 12.3% from 2020 to 2025. The equipment/materials component associated with the removal of radioactive waste increased 28.6% from 2020 to 2025.

Q. FOR PURPOSES OF THE ESTIMATE, WHEN DID YOU ASSUME THE UNITS WOULD BE DECOMMISSIONED?

A. The nuclear units were assumed to shut down upon the expiration of their current 60-year operating licenses, February 8, 2050 for Unit 1 and February 2, 2053 for Unit 2. It was also assumed that decommissioning activities would be coordinated between the two units at Comanche Peak to the maximum extent possible.

IV. BASIS FOR DECOMMISSIONING COSTS

Q. WHAT IS THE BASIS FOR THE DECOMMISSIONING STUDY?

A. The 2025 update was developed primarily using the technical database (inventory of the physical plant) from 2020 decommissioning study. This database was updated, as required, to reflect any changes in the plant site and for compatibility with the latest cost modeling software.

Decommissioning is a labor-intensive program. Accordingly, CPPC provided updated craft labor costs, utility salaries, associated overhead and benefits, severance for the decommissioning organization, and security contractor costs for inclusion within the cost model.

Low-level radioactive waste, for purposes of this cost analysis, was assumed to be shipped to Waste Control Specialist's facility in Andrews County, Texas.

The spent fuel management requirements identified by CPPC were also incorporated into the decommissioning program and reflected CPPC's experience in the handling and storage of spent fuel.

Q. ARE THERE ANY FEDERAL REGULATIONS APPLICABLE TO DECOMMISSIONING?

A. Yes. The NRC published the Final Rule entitled "General Requirements for Decommissioning Nuclear Facilities" in the Federal Register of June 27, 1988 (53 Fed. Reg. 24018) to establish technical and financial criteria for decommissioning licensed facilities. The regulations addressed decommissioning planning needs, timing, funding methods, and environmental review requirements with the intent to assure that decommissioning of all licensed facilities would be accomplished in a safe and timely manner, and that adequate licensee funds would be available for this purpose. In 1996, the NRC published revisions to the Final Rule. The amended regulations clarified ambiguities and codified procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process. The amendments allow for greater public participation during decommissioning and better define the transition process from operations to decommissioning. The decommissioning cost analysis prepared for Comanche Peak fully satisfies the requirements set forth in this regulation.

V. COST ESTIMATING METHODOLOGY

Q. WHAT METHODOLOGY WAS USED TO PREPARE THE COST ESTIMATE?

A. The methodology used to develop the cost estimate followed the basic approach presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," and the DOE's "Decommissioning Handbook." The estimating techniques have been augmented, when appropriate, to reflect experience gained in decommissioning of several of the large commercial plants over the past 20 years, including the closure of the Crystal River, Kewaunee, and Vermont Yankee nuclear plants.

The two references describe a unit cost factor method for estimating decommissioning activity costs to standardize the estimating calculations. Unit cost factors for activities such as concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) were developed from the labor information provided by CPPC. Consumable material information was taken in large part from RSMeans, "Building Construction Cost Data 2024." The activity-dependent costs for decontamination, removal, packaging, shipping, and burial were estimated using the item quantity (cubic yards, tons, inches, etc.) originally developed from Comanche Peak plant drawings and inventory documents. The activity duration critical path derived from such key activities, *e.g.*, the disposition of the nuclear steam supply system ("NSSS"),[1] was used to determine the total decommissioning program schedule.

The program schedule is used to determine the period-dependent costs such as program management, administration, field engineering, equipment rental, quality assurance, and security. The salary and hourly rates are typical for personnel associated with period-dependent costs.

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[1] The NSSS is the collection of equipment, including the reactor vessel that produces the high pressure steam used to drive the turbines. The NSSS, and supporting cleanup systems, is where most of the highly radioactive components reside.

The costs for conventional demolition of non-radioactive structures, materials, backfill, landscaping, and equipment rental were obtained from conventional demolition references.

In addition, collateral costs were included for heavy equipment rental or purchase, safety equipment and supplies, energy costs, permits, taxes, and insurance.

The activity-dependent, period-dependent, and collateral costs were added to develop the total decommissioning costs. An overall contingency was added to allow for the effects of unpredictable program problems on costs.

One of the primary objectives of every decommissioning program is to protect public health and safety. The cost estimates for the Comanche Peak decommissioning activities include the necessary planning, engineering, and implementation to provide this protection to the public.

Q. WHAT IS THE BASIS FOR THE CONTINGENCY?

A. The purpose of the contingency is to allow for the costs of high probability program problems occurring in the field where the frequency, duration, and severity of such problems cannot be predicted accurately and have not been included in the basic estimate. The Association for the Advancement of Cost Engineering, International ("AACE") (in their Cost Engineers' Notebook) defines contingency as follows:

> Contingency - specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events, which will increase costs, are likely to occur.

Past decommissioning experience has shown that unforeseeable elements of cost are likely to occur in the field and may have a cumulative effect. In the AIF/NESP-036 Guidelines Study, TLG examined the major activity-related problems (decontamination, segmentation, equipment handling, packaging, shipping, and burial) with respect to reasons for contingency. Individual activity contingencies ranged from 10% to 75% of the related base cost, depending on the degree of difficulty judged to be appropriate from our actual decommissioning experience. The overall contingency, when applied to the appropriate components of the Comanche Peak DECON estimate, on a line-item basis, results in an average of approximately 17.56%.

Q. IS IT FAIR TO VIEW THE CONTINGENCY AS A “SAFETY FACTOR” OR CUSHION AGAINST FUTURE PRICE INCREASES?

A. No. There is a general misconception on the use and role of the contingency within decommissioning estimates, sometimes incorrectly viewed as a “safety factor.” Safety factors provide additional security and address situations that may never occur. Contingency dollars are expected to be fully expended throughout the program. They also provide assurance that sufficient funding is available to accomplish the intended tasks. An estimate without contingency, or from which contingency has been removed, can disrupt the orderly progression of events and jeopardize a successful conclusion to the decommissioning process. Contingency, as used in these estimates, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the unit. Thus, the contingency will be spent, however, since contingency dollars are intended to address complexities in the performance of the field decontamination and dismantling activities, it is difficult to identify today those activities most likely to be affected in the future.

Q. DOES THE ESTIMATED COST OF DECOMMISSIONING INCLUDE AN ALLOWANCE FOR DISPOSAL OF SPENT NUCLEAR FUEL?

A. No. It is important to note that, although decommissioning of a site cannot be complete without the removal of all spent fuel and source material, the disposition of spent nuclear fuel is outside the scope of decommissioning. In accordance with the Nuclear Waste Policy Act of 1982 (Public Law 94-425), the DOE is required by law to enter into contracts with owners and/or generators of spent fuel, pursuant to which the DOE is contractually responsible for final disposition of spent fuel as high-level nuclear waste. To cover the cost of spent fuel disposition, the DOE assesses the facility operator 1 mill/kWh based on net electrical generation (although this fee has been suspended). Therefore, the cost of disposal of spent fuel is accounted for separately and is specifically excluded from the decommissioning cost estimates.

Q. DOES THE PRESENCE OF SPENT FUEL ON-SITE, FOLLOWING PLANT SHUTDOWN, AFFECT THE DECOMMISSIONING PROCESSES?

A. Yes. Although the study does not address the removal or disposal of spent fuel from the Comanche Peak site, it does consider the constraint that the presence of spent fuel on the site can impose on other decommissioning activities. In particular, the decommissioning scheduling developed in support of the previous (2010, 2015, and 2020) and the current (2025) Comanche Peak estimates recognizes a DOE minimum cooling prerequisite for off-loading the fuel from the storage pool and the uncertainty in the timing for the removal of the spent fuel from the site. These requirements will necessarily delay the final release of the site for alternative/unrestricted use. This delay is reflected in the increased cost of the period-dependent activities. To the extent possible, the decommissioning estimates were structured around the spent fuel area of the plant and its availability for decontamination, such that delays in decommissioning other portions of the facility could be minimized. Decommissioning would proceed on the surrounding facilities and non-essential systems during the time the pools are operational. The operating license can then be amended for a partial release of the property with the remaining fuel placed in dry storage.

Q. WHY DOES THE 2025 UPDATE ASSUME THAT AN INDEPENDENT SPENT FUEL STORAGE INSTALLATION ("ISFSI") WILL BE OPERATING AT THE COMANCHE PEAK SITE PRIOR TO THE CESSATION OF PLANT OPERATIONS?

A. The storage pools at Comanche Peak are near capacity and supplemental storage is required for continued operation. Even if the DOE commenced the transfer of spent fuel today, the first assemblies would not be expected to be removed from the Comanche Peak site for several years (since it was one of the last reactors to commence operations). As such, an ISFSI has already been constructed at the Comanche Peak site (the first storage casks were loaded and placed on the pad in early 2012).

The 2025 estimates assume that the ISFSI can be expanded to accommodate the spent fuel residing in the plant's storage pools at the cessation of operations. With the pools emptied, decommissioning operations can be concluded and the operating licenses terminated/amended. Costs are included within the estimates for the continued operation of the ISFSI at the site until 2114, at which time the DOE is expected to complete the transfer of spent fuel.

Q. WHAT CONSIDERATIONS ARE MADE REGARDING THE CAPACITY OF THE ISFSI?

A. The capacity of the ISFSI is based upon a vertical spent fuel storage cask system, utilizing a Multi-Purpose Canister ("MPC") design. The ISFSI can be expanded to accommodate the residual inventory present in the spent fuel pools at the cessation of operations. Sixty casks were projected to be required for the storage of the spent fuel resident in the storage pools (post shutdown) after the required cooling period, based upon a loading of 32 fuel assemblies per cask. An additional ten casks were required for the storage of Greater-than-Class C ("GTCC")[2] material generated in the segmentation (*i.e.*, the cutting into pieces) of the reactor vessel internals. Due to the DOE's failure to meet its obligations under the Nuclear Waste Policy Act and its contracts with nuclear plant owners to provide fuel transportation casks in a timely manner, it was assumed that CPPC would supply the spent fuel storage canisters and the concrete overpacks (for radiation shielding) for both the spent fuel and GTCC casks stored at the ISFSI. For estimating purposes, the ISFSI storage pad(s) were sized to accommodate at least the total of 232 casks (222 for spent fuel from operations/decommissioning and 10 for GTCC material) from the 2025 estimate.

2. GTCC waste contains radionuclide concentrations in excess of those permitted for Class C and for shallow-land disposal. See 10 CFR §61.55. Although classified as low-level radioactive waste, this material will most likely be disposed of at the geologic repository along with the spent fuel.

Q. WHAT ISFSI CAPITAL COSTS ARE REFLECTED IN THE 2025 UPDATE?

A. Since the ISFSI is required for continued plant operation, ISFSI capital costs are reflected within the 2025 decommissioning estimates. Such expenditures include the purchase of storage canisters and concrete overpacks. The costs associated with the post-operation maintenance of spent fuel in the ISFSI are also reflected within the estimates. Caretaking costs include staffing, security, insurance, and fees, as well as costs associated with the final disposition of the facility. The decommissioning cost for the ISFSI is provided in Appendix E of Exhibit AMK-1.

Q. DOES THE PROCESS OF DECOMMISSIONING EXTEND BEYOND THE REMOVAL OF CONTAMINATED AND ACTIVATED MATERIAL FROM THE SITE?

A. Yes. There are additional activities, beyond the removal of contaminated material that will be undertaken in the process of releasing the site for alternative use. This work includes costs for the remaining dismantling and grading operations.

Q. PLEASE DESCRIBE THE SITE RESTORATION ACTIVITIES.

A. Site restoration costs include costs for dismantling the decontaminated structures. These costs also include activities to remove certain non-contaminated systems and components. This work must be accomplished to provide access to all areas of the plant for the radiation surveys required by the NRC prior to license termination and release of the site for another use.

Q. WHY IS IT NECESSARY TO DISMANTLE THE REMAINING STRUCTURES AT THE SITE?

A. Efficient removal of the contaminated materials and verification that the radionuclide concentrations are below the stringent NRC limits will require substantial damage to many of the structures. Blasting, coring, drilling, scarification (surface removal), and the other decontamination work will damage power block structures including the Reactor Buildings, Auxiliary, and the Fuel Building. Verifying that subsurface radionuclide concentrations meet NRC site release requirements may require removal of grade slabs and lower floors, potentially weakening footings and structural supports.

It is also important to remember that the Comanche Peak structures were custom designed and built to support a specific nuclear unit that went into service in the early 1990's. They would most likely be an impediment rather than a benefit to any potential future plant, if one were ever to be constructed at the site. Moreover, the facility's infrastructure degrades without continual maintenance. Unless the site is redeveloped shortly after release of its NRC license, the value in reusing plant facilities quickly diminishes.

Dismantling is clearly the most appropriate and cost-effective option and should serve as the foundation for the decommissioning cost estimates. It is unreasonable to anticipate that these structures would be repaired and preserved after the radiological contamination is removed.

VI. DECOMMISSIONING ALTERNATIVES

Q. DESCRIBE THE DECOMMISSIONING ALTERNATIVES DELINEATED IN THE NRC RULE.

A. The supplemental information to the NRC Rule (53 Fed. Reg. 24022-23) describes three decommissioning alternatives as acceptable: DECON (prompt removal/ dismantling), SAFSTOR (mothballing) and, under special circumstances, ENTOMB (entombment). They are defined as follows:

> **DECON** is the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits termination of the license and allows the property to be released for unrestricted use shortly after cessation of operations;
>
> **SAFSTOR** is the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit termination of

the license and release for unrestricted use; and

ENTOMB is the alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting termination of the license and unrestricted release of the property.

It should be noted that the NRC provides that delayed decommissioning following initial mothballing or entombment activities should not exceed 60 years, unless it can be shown necessary to protect public health and safety.[3] This rule has limited the use of the ENTOMB alternative.[4] However, both the DECON and SAFSTOR alternatives are considered reasonable options for decommissioning Comanche Peak. The rule also requires utilities to perform a periodic review of the funding plan over the life of the facility. TLG's site-specific cost estimates and decommissioning alternatives are formulated within the framework of the NRC's rule.

3. See 10 CFR 50.82(a)(3).
4. The NRC has identified certain regulatory actions that could improve the viability of the ENTOMB alternative, however, the NRC's Staff has recommended deferral of any near term rulemaking (SECY-02-0191 dated October 25, 2002). The NRC Commissioners concurred with that recommendation in a memorandum dated November 26, 2002.

Q. IS IT NECESSARY TO SELECT A SPECIFIC DECOMMISSIONING METHOD AT THIS TIME?

A. No. The actual method or combination of methods selected to decommission Comanche Peak should be based on a detailed economic, engineering, and environmental evaluation of the alternatives considering the site and surroundings at the time of decommissioning and reflecting the latest experience in the decommissioning of similar nuclear power facilities. However, for financial planning purposes, the decommissioning cost funding should be based upon the DECON methodology. The DECON methodology provides the most reasonable means for terminating the license for the site in the shortest possible time. Furthermore, this alternative avoids the long-term costs and commitments associated with the maintenance, surveillance and security requirements of the conventional delayed dismantling alternatives. The PUCT has adopted the DECON alternative as a basis for funding nuclear plant decommissioning in every case in which a TLG witness has testified.

The recommended alternative also allows use of the plant's knowledgeable operating staff, a valuable asset to a well-managed, efficient decommissioning program. Equipment needed to support decommissioning operations such as cranes, ventilation systems, and radwaste processing equipment would be fully operational. In addition, the site would be available for other use in the near term, with the exception of the area immediately surrounding the station's fuel storage facility.

VII. DECOMMISSIONING PROCESSES

Q. WOULD YOU DESCRIBE THE PROCESS OF DECOMMISSIONING A NUCLEAR POWER REACTOR UTILIZING THE DECON ALTERNATIVE?

A. Yes. The conceptual approach that the NRC has identified in their amended regulations is to divide decommissioning into three phases. The initial phase commences with the effective date of permanent cessation of operations and involves the transition of both plant and licensee from reactor operations, *i.e.* power production, to facility de-activation and closure. During Phase I, notification is to be provided to the NRC certifying the permanent cessation of operations and the removal of fuel from the reactor vessel. The licensee would then be prohibited from reactor operation. Before or within two years following cessation of operations, the licensee is required to provide a Post-Shutdown Decommissioning Activities Report ("PSDAR"). This report would provide a description of the licensee's planned decommissioning activities, a corresponding schedule, and an estimate of expected costs. The PSDAR would also address whether environmental impacts associated with the proposed decommissioning scenario have already been considered in a previously prepared environmental statement(s). Ninety days following the NRC's receipt of the PSDAR, the licensee can initiate certain decommissioning activities without specific NRC approval, under a modified 10 CFR 50.59 review process. The proposed rule would permit the licensee to expend up to 3% of the generic decommissioning cost for planning, with an additional 20% available following the 90-day waiting period and certification of permanent defueling. Remaining funds would be available to the licensee with submittal of a detailed, site-specific cost estimate.

Phases II and III pertain to the activities involved in reactor decommissioning and license termination. A termination plan is required two years prior to license termination and contains a detailed site characterization, i.e., location, type, and amount of radioactivity, a description of any remaining dismantling activities to be accomplished, detailed plans for a final survey, and the planned end use of the site. An updated cost to complete would be required along with the reporting of any new or altered environmental consequences.

TLG's estimate for DECON addresses Phase I activities in Period 1. Phase II and III activities are included in Period 2. Period 3 and Post-Period 3 are added for site restoration and long-term spent fuel management and have no NRC correlation.

A. Period 1 – Planning and Engineering

This period begins upon shutdown of the facility, and involves site preparations to initiate decommissioning. The reactors would be defueled with the fuel placed in the spent fuel pools until it is cooled sufficiently to be transferred to DOE or an alternative storage facility. As noted earlier, transportation and disposal of spent fuel at a DOE facility is not considered part of decommissioning and no costs associated with these activities are included in the decommissioning estimates. (These expenses have been funded by the owner throughout the plant's operating life, payable to DOE for future rendering of these services.) However, the impact on the decommissioning schedule due to the presence of such material on-site has been addressed in the study through the schedule. Wastes remaining from plant operations would be removed from the site and all systems nonessential to decommissioning would be isolated and drained.

B. <u>Period 2 - Decommissioning Operations</u>

This period commences once the PSDAR has been submitted to the NRC for review and with the mobilization of the decontamination and dismantling workforce. This phase addresses the removal of radioactivity from the site and concludes with termination of the NRC license (except as required for any remaining spent fuel on the site). Activities include selective decontamination of contaminated systems, *e.g.,* using aggressive chemical solvents to dissolve corrosion films holding radionuclides, thereby reducing radiation levels.

While effective, the on-site decontamination processes are not expected to reduce residual radioactivity to the levels necessary to release the material as clean scrap. Therefore, all contaminated components will have to be removed for controlled burial. However, decontamination will reduce personnel exposure and permit workers to operate in the immediate vicinity of most components, cutting and removing them for controlled disposition at a low-level radioactive waste burial facility.

Contaminated piping to and from major components will be cut and removed. Selected major components such as the reactor recirculation pumps, moisture separators and other large components will then be removed intact and sealed so that they may be transported off-site. Smaller components, such as sampling system pumps, filters, filter housings, strainers, etc., will be loaded into containers and shipped for additional processing or controlled disposal.

The reactor vessel and its internals will be segmented and remotely loaded into steel liners for transport to the burial facility in heavily shielded shipping casks. The reactor vessel and internals will have sufficiently high radiation levels to require all cutting to be done underwater or behind heavy shields, using cutting torches operated by remote control to reduce radiation exposure to the workers.

Concrete immediately surrounding the reactor vessel is expected to be radioactive and will be removed by controlled blasting. This blasting process is well-developed, safe, and is the most cost effective way to remove the heavily-reinforced concrete from the structure.

The surfaces of sections of interior floors within areas of the Reactor Building and other buildings in the power block are expected to be contaminated from exposure to contaminated air/water as a result of plant operations. This contamination will be removed by scarification (surface removal) so that the remaining surface will be clean and will not require costly controlled burial.

Contaminated process equipment, pipe hangers, supports and electrical components will be removed and routed for off-site processing or controlled disposal.

Finally, an extensive radiation survey will be performed to ensure all radioactivity above the levels specified by the NRC has been removed from the site. With NRC confirmation, the facilities may be released for unrestricted access.

C. Period 3 – Site Restoration

This period begins once license termination activities have concluded and involves the demolition of all remaining structures, typically to a depth of three feet below grade. Clean concrete rubble would be used on-site for fill and additional soil would be used to cover each subgrade structure.

D. Post Period 3 – Spent Fuel Storage

The ISFSI will continue to operate under the General Part 50 license (in accordance with 10 CFR 72, Subpart K) following the transfer of the spent fuel inventory from the Fuel Building. The transfer of spent fuel from Comanche Peak was assumed to begin in the year 2056 and continue with the final spent fuel shipment presumed to occur in the year 2114.

At the conclusion of the spent fuel transfer process, the ISFSI will be decommissioned. The NRC will terminate the Part 50 license if it determines that site remediation has been performed in accordance with a license termination plan and the terminal radiation survey and associated documentation demonstrate that the facility is suitable for release. Once the requirements are satisfied, the NRC can terminate the license for the ISFSI.

The reinforced concrete dry storage modules are then demolished, the concrete storage pad is removed, and the area graded and landscaped to conform to the surrounding environment.

Q. WHAT ASSURANCE IS THERE THAT THE ESTIMATED COST FOR DECOMMISSIONING WILL REFLECT FUTURE DEVELOPMENTS AND INCREASES OR DECREASES IN COSTS?

A. The cost estimate prepared for Comanche Peak is based on present technology, the current information available on decommissioning costs, and on existing federal regulations. No provision is made to include future costs or savings due to the uncertainties in improvements in technology, major regulatory changes, inflation factors, etc. It should be noted that contingency, as used in the estimates, only covers uncertainties within the decommissioning process and is not intended as price protection or protection against inflation. The estimate should be updated in the future to account for any future developments.

VIII. DECOMMISSIONING ESCALATION

Q. DID TLG ALSO PERFORM AN ESCALATION ANALYSIS OF THE 2025 DOLLAR ESTIMATES TO ARRIVE AT FUTURE COSTS?

A. Yes. The TLG financial escalation analysis for Comanche Peak is attached as Exhibit AMK-2.

Q. HOW WAS THE ESCALATION RATE FOR DECOMMISSIONING COST DETERMINED?

A. The TLG decommissioning cost model separates each line item in the cost estimate into five separate cost components: labor, equipment & materials, energy, low-level radioactive waste disposal, and other costs. These line-item costs were summed by period and distributed into cash flows over the expected decommissioning schedule. TLG used projected rates for labor, equipment & materials, energy, and other costs, together with a contractual index for waste disposal in order to calculate the overall escalation rate used in this analysis. The cash flows shown in Exhibit AMK-2 serve as the input to the inflation model.

Q. HOW WAS THE LABOR PORTION OF THE ESCALATION RATE DETERMINED?

A. The estimate for labor escalation was obtained from IHS-Markit, Global Insight via their DataInsight-Web online service using fourth quarter 2024 projections. TLG used the ECI Total Compensation, Private Industry Workers (ECIPCTNS) for the decommissioning period. A twenty-five year moving average was used for future years beyond the current forecast horizon of the IHS database.

Q. HOW WAS THE EQUIPMENT & MATERIAL PORTION OF THE ESCALATION RATE DETERMINED?

A. The estimate for equipment and material escalation was obtained from IHS-Markit, Global Insight via their DataInsight-Web online service using fourth quarter 2024 projections. TLG used the Producer Price Index, Machinery & Equipment (WPIP11) for escalating the decommissioning expenditures. A twenty-five year moving average was used for future years beyond the current forecast horizon of the IHS database.

Q. HOW WAS THE ENERGY PORTION OF THE ESCALATION RATE DETERMINED?

A. The estimate for energy escalation was obtained from IHS-Markit, Global Insight via their DataInsight-Web online service using fourth quarter 2024 projections. TLG used the Producer Price Index, Fuels and Related Products, and Power (WPIP05) for escalating the decommissioning expenditures. A twenty-five year moving average was used for future years beyond the current forecast horizon of the IHS database.

Q. HOW WAS THE OTHER COSTS PORTION OF THE ESCALATION RATE DETERMINED?

A. The estimate for other costs escalation was obtained from IHS-Markit, Global Insight, via their DataInsight-Web online service using fourth quarter 2024 projections. TLG used the Consumer Price Index, Services (CUSASNS) for escalating the decommissioning expenditures. A twenty-five year moving average was used for future years beyond the current forecast horizon of the IHS database.

Q. HOW WAS THE LOW-LEVEL RADIOACTIVE WASTE BURIAL PORTION OF THE ESCALATION RATE DETERMINED?

A. IHS-Markit, Global Insight does not provide historical or projected costs for disposal of radioactive waste. As such, a TLG-developed LLRW Disposal/Recycling index was used for this escalation analysis. This index is a combination of historical information through 2024 from NRC publications for disposal site rates and projections using information provided by IHS Markit, Global Insight. A disposal agreement with Waste

Control Specialists for disposal services includes a provision for the future adjustment in rates. The IHS-Markit, Global Insight index (Consumer Price Index, All Items, All Urban) equivalent to the index identified in this agreement was used to escalate low-level radioactive waste disposal costs to the year of expenditure.

Q. WHAT IS THE RESULT OF THE COMBINATION OF THESE INDIVIDUAL ESCALATION RATES?

A. The overall escalation rate when including the individual factors for labor, equipment & material, energy, low-level radioactive waste burial, and other costs is approximately 2.59% for Unit 1, and approximately 2.57% for Unit 2. These are the effective rates; the actual model used the individual rates for each of the five categories. The resulting cash flow after applying the individual escalation rates is shown in Tables 7 – 9 in Exhibit AMK-2.

Q. WHY IS THE ESCALATION RATE DIFFERENT FOR EACH UNIT?

A. Each unit's escalation rate is a composite of the five individual cost categories tracked by TLG. Since each unit has a differing fraction for these categories, the resulting overall escalation rate is unique to that unit and its associated input values.

Q. WHY IS THIS METHODOLOGY USED INSTEAD OF AN OVERALL INFLATION ESTIMATE FOR FUTURE DOLLAR COSTS?

A. While it is not specifically required that this escalation methodology be used to determine future costs, this approach focuses on specific areas of price escalation that impact the cost of decommissioning, unlike other price escalators used in the development of an overall Gross Domestic Product inflator. The weighting of the methodology takes into consideration the impacts of specific costs associated with decommissioning the Comanche Peak facility. This can be clearly seen by referring to Exhibit AMK-2, and comparing the fractions of cost by category between the two units.

IX. CONCLUSION

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes, it does.

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DECOMMISSIONING COST STUDY

for the

COMANCHE PEAK NUCLEAR POWER PLANT

prepared for

Comanche Peak Power Company LLC

prepared by

TLG Services, LLC

Bridgewater, Connecticut

April 2025

APPROVALS

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Technical Manager	Adam M. Kaczmarek	4/25/2025 Date

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

SECTION **PAGE**

TABLES

TABLE OF CONTENTS
(continued)

SECTION **PAGE**

TABLES
(continued)

FIGURES

APPENDICES

TABLE OF ACRONYMS / ABBREVIATIONS

AIF/NESP-036	Atomic Industrial Forum document delineating a standardized cost estimating model for decommissioning
ALARA	As-Low-As-Reasonably-Achievable
Comanche Peak	Comanche Peak Nuclear Power Plant
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (also referred to as Superfund)
CFR	Code of Federal Regulations
CPPC	Comanche Peak Power Company, LLC
DECCER	TLG's Proprietary Decommissioning Cost Model
DECON	Prompt Decommissioning (NRC Acronym)
DOC	Decommissioning Operations Contractor
DOE	Department of Energy
ENTOMB	Entombment or Hardened Storage (NRC Acronym)
EPA	Environmental Protection Agency
FSAR	Final Safety Analysis Report
GTCC	Greater-than-Class C (as defined by 10 CFR §61)
IP	Industrial Package
ISFSI	Independent Spent Fuel Storage Installation
LSA	Low Specific Activity
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MOU	Memorandum of Understanding (between NRC and EPA)
MPC	Multi-Purpose Canister
MTU	Metric Tons of Uranium
NRC	Nuclear Regulatory Commission (or Commission)
NSSS	Nuclear Steam Supply System
NWPA	Nuclear Waste Policy Act
OFF	Oldest Fuel First
PERT	Program Evaluation and Review Technique
PSDAR	Post-Shutdown Decommissioning Activities Report
SAFSTOR	Passive Storage (NRC Acronym)
SCO	Surface Contaminated Object
TEDE	Total Effective Does Equivalent
WDF	Work Difficulty Adjustment Factors

REVISION LOG

Rev. No.	Date	Item Revised	Reason for Revision
0	04-25-2025		Original Issue

EXECUTIVE SUMMARY

This study presents estimates of the cost to decommission (decontaminate and dismantle) the Comanche Peak Nuclear Power Plant, (Comanche Peak) following a scheduled cessation of plant operations. The estimates are designed to provide Comanche Peak Power Company LLC (CPPC) with sufficient information to assess their financial obligations as they pertain to the eventual decommissioning of the nuclear station.

This study is not a detailed engineering evaluation, but are estimates prepared in advance of the detailed engineering processes required to carry out the decommissioning of the nuclear unit. It also may not reflect the actual plan to decommission Comanche Peak; the plan may differ from the assumptions made in this study based on facts that exist at the actual time of decommissioning.

The methodology used to develop the estimates described within this document follow the basic approach originally presented in the cost estimating guidelines developed by the Atomic Industrial Forum (now Nuclear Energy Institute). This reference describes a unit factor method for determining decommissioning activity costs. The unit factors used in this study incorporate site-specific costs and the latest available information on worker productivity in decommissioning.

An activity duration critical path is used to determine the total decommissioning program schedule. The schedule is relied upon in calculating the carrying costs, which include program management, administration, field engineering, equipment rental, and support services such as quality control and security. This systematic approach for assembling decommissioning estimates ensures a high degree of confidence in the reliability of the resulting cost estimate.

The cost elements in this study are assigned to one of three subcategories: NRC License Termination (radiological remediation), Spent Fuel Management, and Site Restoration. The subcategory "NRC License Termination" is used to accumulate costs that are consistent with "decommissioning" as defined by the NRC in its financial assurance regulations (i.e., 10 CFR §50.75). The cost reported for this subcategory is generally sufficient to terminate the reactors' operating licenses. The License Termination cost subcategory also includes costs to decommission the ISFSI (i.e. 10 CFR 72.30).

The "Spent Fuel Management" subcategory contains costs associated with the containerization and transfer of spent fuel from the wet storage pools to the DOE transport vehicle and/or ISFSI for interim storage, as well as the transfer of the spent fuel in storage at the ISFSI to the DOE transport vehicle. Costs are included for the operation of the storage pools and the management of the ISFSI until such time that the transfer is complete. It does not include any spent fuel management expenses incurred prior to the cessation of plant operations, nor does it include any cost related to spent fuel after the DOE has assumed possession.

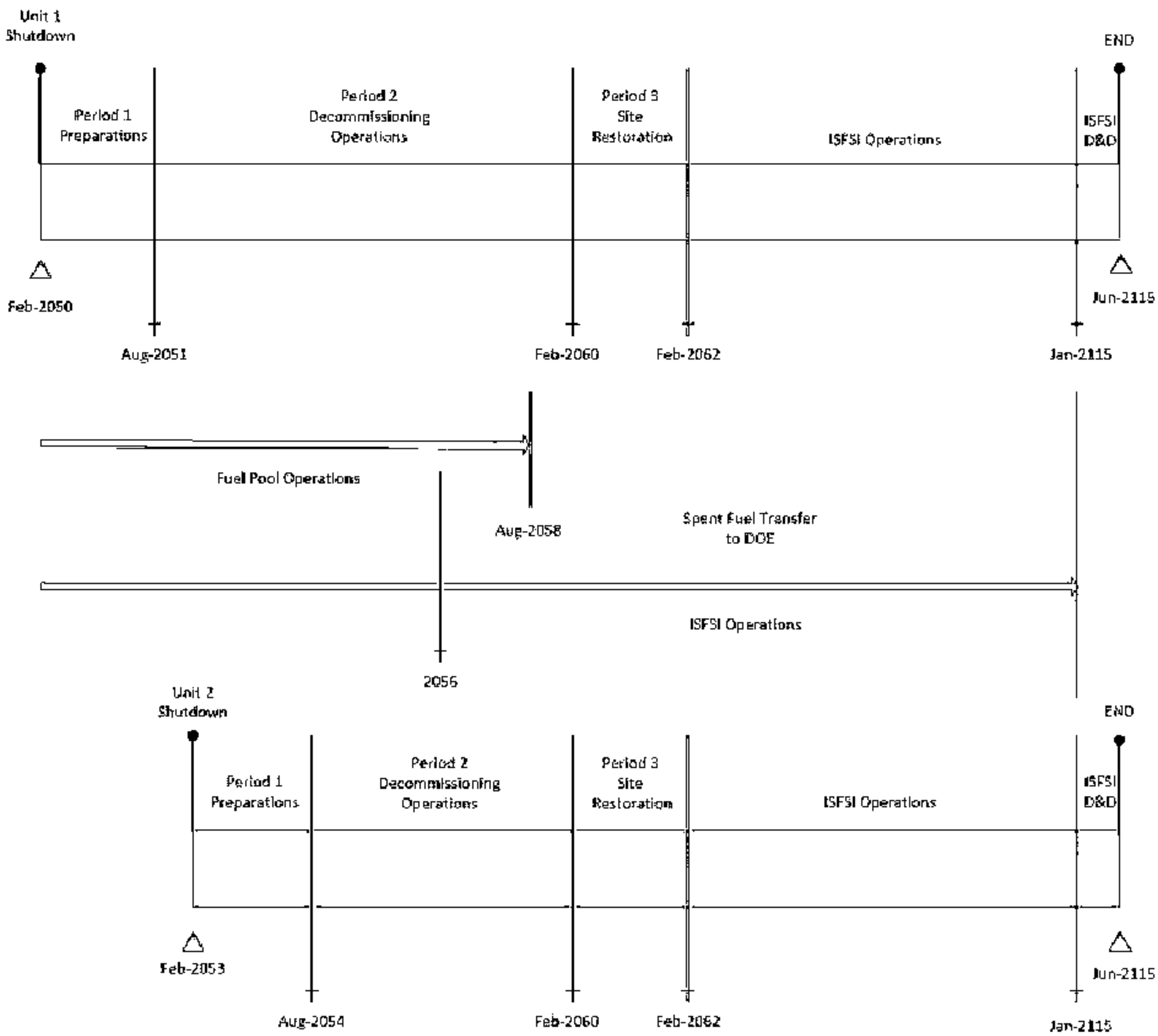
"Site Restoration" is used to capture costs associated with the dismantling and demolition of buildings and facilities demonstrated to be free from contamination. This includes structures never exposed to radioactive materials, as well as those facilities that have been decontaminated to appropriate levels. Consequently, this study assumes that the site structures addressed by this study are removed to a depth of three feet below grade and backfilled to conform to local grade.

This study was developed and costs are presented in 2024 dollars. The costs projected to promptly decommission (DECON) Comanche Peak are estimated to be $1,065.1 million for Unit 1 and $1,089.9 million for Unit 2. The majority of the $2,155.0 million cost (approximately 63.8%) is associated with the physical decontamination and dismantling of the nuclear units, so that the operating licenses can be terminated. Caretaking and handling of the spent fuel and termination of the ISFSI license, constitutes an additional 29.7% of the cost. The remaining 6.5% is for the demolition of the remaining structures and limited restoration of the site.

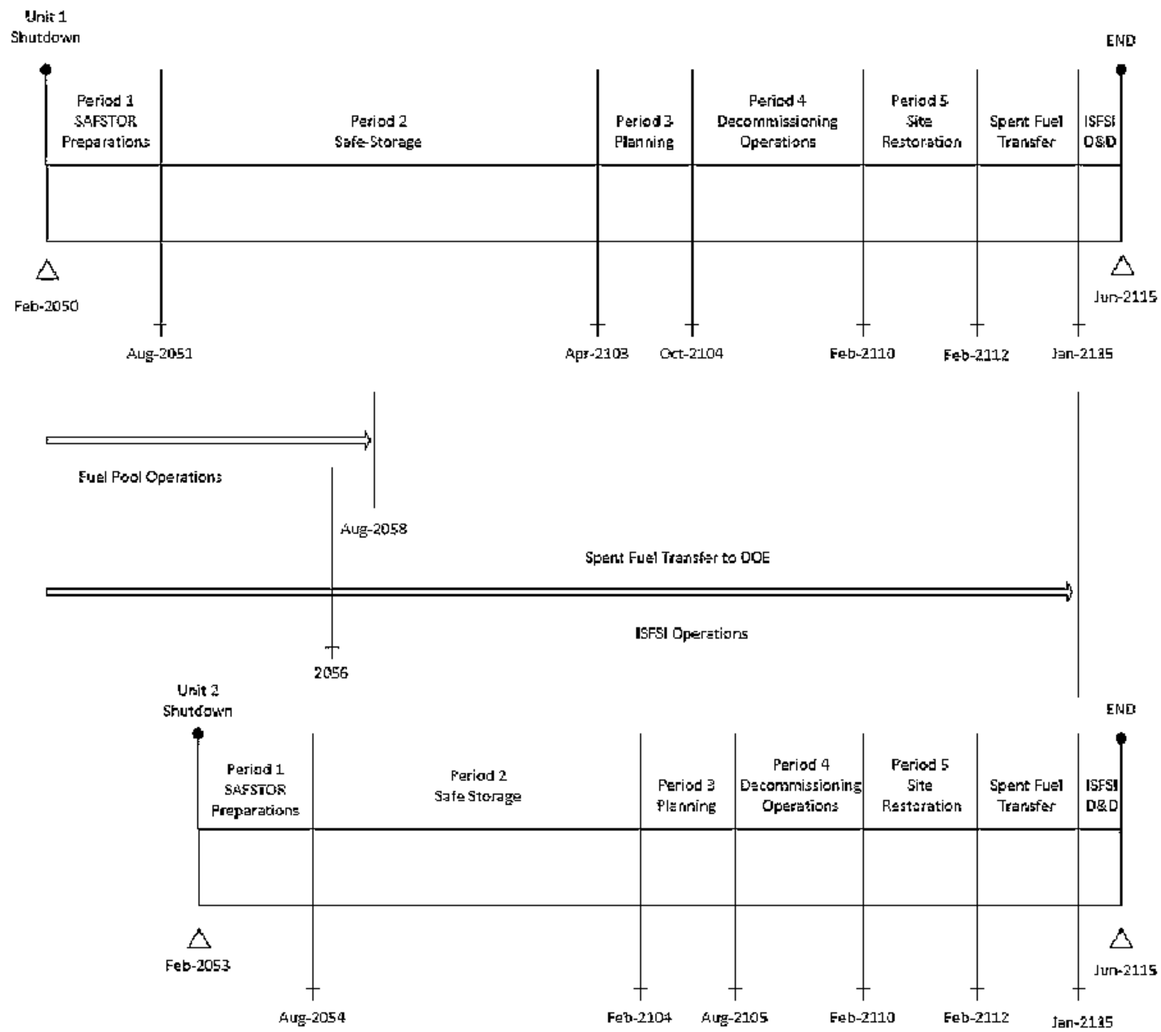
The costs projected for deferred decommissioning (SAFSTOR) of Comanche Peak are estimated to be $1,215.5 million for Unit 1 and $1,225.2 million for Unit 2. The majority of the $2,440.7 million cost (approximately 71.4%) is associated with the physical decontamination and dismantling of the nuclear units, so that the operating licenses can be terminated. Caretaking and handling of the spent fuel and termination of the ISFSI license, constitutes an additional 22.8% of the cost. The remaining 5.8% is for the demolition of the remaining structures and limited restoration of the site.

The estimates do not reflect the escalation of costs (due to inflationary and market forces) over the remaining operating life of the plant or during the decommissioning period. The figures on pages ix and x include milestone dates for the DECON and SAFSTOR alternatives, respectively. Tables summarizing the estimated costs for the DECON and SAFSTOR alternatives reflecting the various cost elements as well as a figures representing the division of costs within the subcategories follow (pages xii through xv).

DECON DECOMMISSIONING TIMELINE
(not to scale)



SAFSTOR DECOMMISSIONING TIMELINE
(not to scale)



DECON COST SUMMARY
(Thousands of 2024 Dollars)

Cost Element	Unit 1	Unit 2	Total
Decontamination	13,646	20,322	33,968
Removal	113,689	165,560	279,249
Packaging	37,756	38,219	75,975
Transportation	14,015	11,937	25,952
Waste Disposal	92,854	92,295	185,149
Off-site Waste Processing[1]	0	0	0
Program Management[2]	321,583	357,260	678,843
Security	142,249	121,883	264,132
Spent Fuel Pool Isolation	17,313	11,542	28,855
Spent Fuel Management (Direct Costs)[3]	165,526	152,144	317,670
Insurance and Regulatory Fees	34,091	27,620	61,712
Energy	22,565	16,749	39,314
Characterization and Licensing Surveys	20,959	21,759	42,718
Property Taxes	46,530	30,690	77,220
Miscellaneous Equipment	9,868	9,422	19,290
Decommissioning Staff Severance	12,470	12,470	24,941
Total[4]	1,065,116	1,089,873	2,154,989
NRC License Termination	683,696	691,713	1,375,409
Spent Fuel Management	326,525	313,790	640,314
Site Restoration	54,896	84,370	139,265
Total[4]	1,065,116	1,089,873	2,154,989

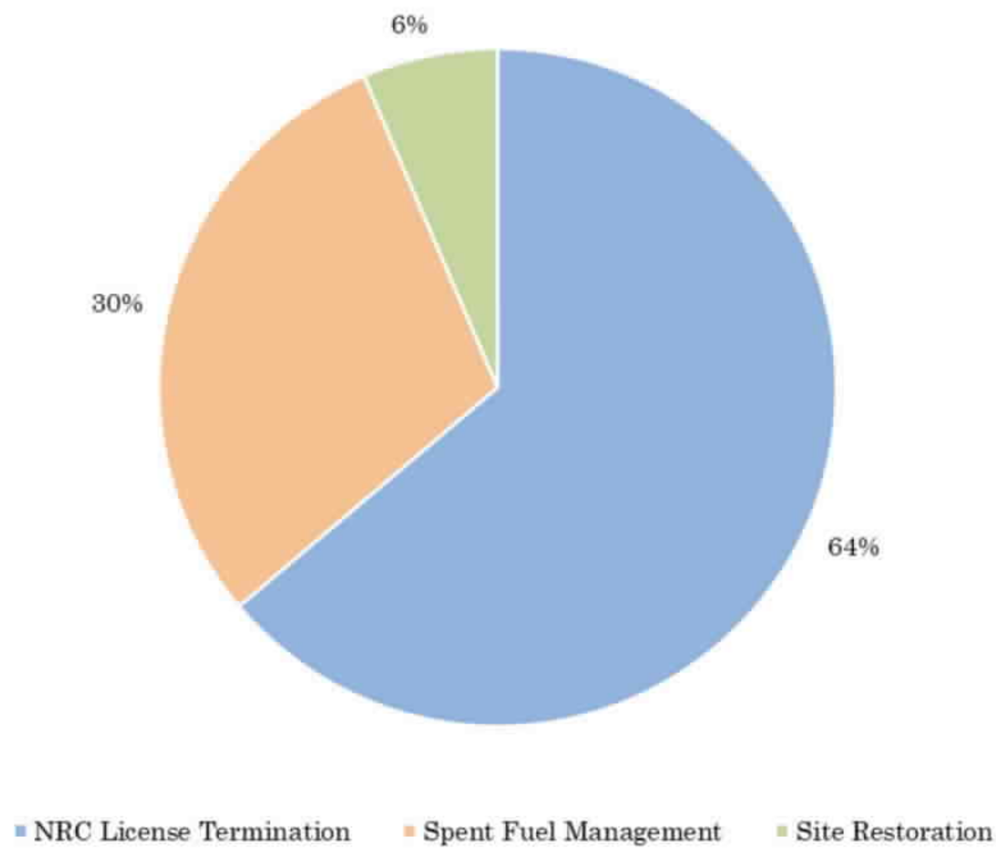
[1] Not currently cost competitive with direct waste disposal
[2] Includes engineering costs
[3] Excludes program management costs (staffing) but includes costs for spent fuel loading, transfer, spent fuel pools O&M, and EP fees
[4] Columns may not summarize to exact Estimate Total due to rounding

SAFSTOR COST SUMMARY
(Thousands of 2024 Dollars)

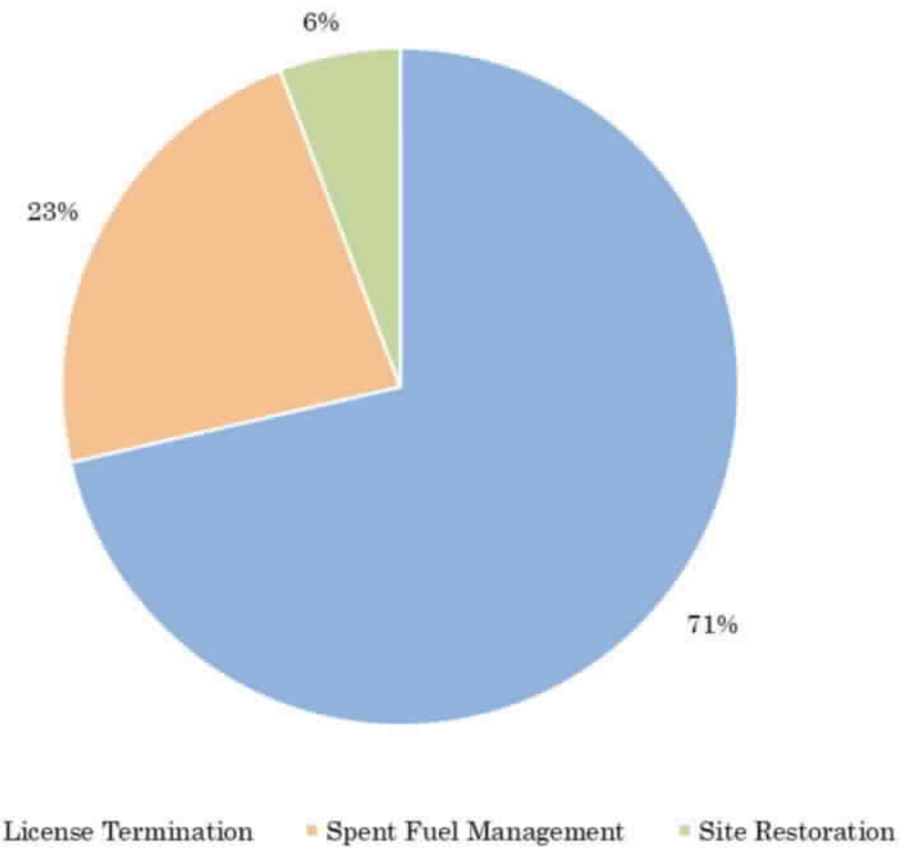
Cost Element	Unit 1	Unit 2	Total
Decontamination	11,105	18,379	29,484
Removal	123,283	171,076	294,359
Packaging	30,814	31,105	61,920
Transportation	12,551	10,093	22,644
Waste Disposal	89,249	87,849	177,098
Off-site Waste Processing[1]	0	0	0
Program Management[2]	393,228	394,349	787,577
Security	182,439	162,074	344,513
Spent Fuel Pool Isolation	17,313	11,542	28,855
Spent Fuel Management (Direct Costs)[3]	152,054	138,671	290,725
Insurance and Regulatory Fees	67,485	60,978	128,463
Energy	34,367	32,285	66,652
Characterization and Licensing Surveys	21,636	21,669	43,305
Property Taxes	46,530	30,690	77,220
Miscellaneous Equipment	20,976	41,998	62,974
Decommissioning Staff Severance	12,470	12,470	24,941
Total[2]	1,215,500	1,225,229	2,440,729
NRC License Termination	872,769	870,287	1,743,056
Spent Fuel Management	286,808	269,570	556,377
Site Restoration	55,923	85,372	141,295
Total[2]	1,215,500	1,225,229	2,440,729

[1] Not currently cost competitive with direct waste disposal
[2] Includes engineering costs
[3] Excludes program management costs (staffing) but includes costs for spent fuel loading, transfer, spent fuel pools O&M, and EP fees
[4] Columns may not summarize to exact Estimate Total due to rounding

TOTAL DECON DECOMMISSIONING COSTS BY SUBCATEGORY



TOTAL SAFSTOR DECOMMISSIONING COSTS BY SUBCATEGORY



1. INTRODUCTION

This study presents estimates of the costs to decommission (decontaminate and dismantle) the Comanche Peak Nuclear Power Plant, (Comanche Peak) following a scheduled cessation of plant operations. This study considers both prompt decommissioning (DECON) and deferred decommissioning (SAFSTOR). The estimates are designed to provide Comanche Peak Power Company LLC (CPPC) with the information to assess its current decommissioning liability, as it relates to Comanche Peak.

The study relies upon site-specific, technical information from an evaluation prepared in 2019,[1]* updated to reflect current assumptions pertaining to the disposition of the nuclear plant and relevant industry experience in undertaking such projects. The costs are based on several key assumptions in areas of regulation, component characterization, high-level radioactive waste management, low-level radioactive waste disposal, performance uncertainties (contingency) and site restoration requirements.

The study is not an engineering evaluation, but consists of estimates prepared in advance of the detailed planning required to carry out the decommissioning of the nuclear units. It may also not reflect the actual plan to decommission Comanche Peak; the plan may differ from the assumptions made in this study based on facts that exist at the time of decommissioning.

The 2019 plant inventory, the basis for the decontamination and dismantling requirements and cost, and the decommissioning waste streams were reviewed for this study and updated where necessary. Site-specific modifications are discussed in Section 3.

1.1 OBJECTIVES OF STUDY

The objectives of this study are to prepare comprehensive estimates of the costs to decommission Comanche Peak for the scenarios outlined in Section 2, to define a sequence of events, and to develop waste stream projections from the decontamination and dismantling activities.

1.2 SITE DESCRIPTION

Comanche Peak is located in Somervell County in North Central Texas, approximately 65 miles southwest of the Dallas-Fort Worth area. The nearest

* References provided in Section 7 of this study

communities are Glen Rose and Granbury, about 4 and 10 miles, respectively, from the site. The station is comprised of two nuclear units that are essentially identical except for certain auxiliary systems.

The two nuclear steam supply systems (NSSS) each consist of a pressurized water reactor and a four-loop reactor coolant system. They are authorized to operate at 3,612 megawatts (thermal), following approval of a stretch power uprate application in 2008. Each of the four loops of the reactor coolant system contains a vertical U-tube type steam generator and a single speed centrifugal reactor coolant pump. In addition, the system includes an electrically heated pressurizer, a pressurizer relief tank, and interconnected piping. The reactor coolant system is housed within a containment vessel, a free-standing cylindrical steel structure enclosed by a separate reinforced concrete reactor building. The containment shell is anchored to the Containment Building foundation with a steel liner plate encased in concrete forming the base of the containment. A turbine-generator system converts the thermal energy of steam produced in the steam generators into mechanical shaft power and then into electrical energy. The turbine generators consist of a tandem (single shaft) arrangement of a double-flow high-pressure turbine and two identical double-flow, low-pressure turbines driving a direct-coupled generator at 1800 rpm. The turbines are operated in a closed feedwater cycle, which condenses the steam. The heated feedwater is then returned to the steam generators. The condenser circulating water system removes heat rejected in the main condensers. The heat is dissipated to Squaw Creek Reservoir.

1.3 REGULATORY GUIDANCE

The Nuclear Regulatory Commission (NRC or Commission) provided initial decommissioning requirements in its rule "General Requirements for Decommissioning Nuclear Facilities," issued in June 1988.[2] This rule set forth financial criteria for decommissioning licensed nuclear power facilities. The regulation addressed decommissioning planning needs, timing, funding methods, and environmental review requirements. The intent of the rule was to ensure that decommissioning would be accomplished in a safe and timely manner and that adequate funds would be available for this purpose. Subsequent to the rule, the NRC issued Regulatory Guide 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors"[3] which provided additional guidance to the licensees of nuclear facilities on the financial methods acceptable to the NRC staff for complying with the requirements of the rule. The regulatory guide addressed the funding requirements and provided guidance on the content and form of the financial assurance mechanisms indicated in the rule.

The rule defined three decommissioning alternatives as being acceptable to the NRC: DECON, SAFSTOR, and ENTOMB. The DECON alternative assumes that any contaminated or activated portion of the plant's systems, structures and facilities are removed or decontaminated to levels that permit the site to be released for unrestricted use shortly after the cessation of plant operations, while the SAFSTOR and ENTOMB alternatives defer the process. This study considers the DECON and SAFSTOR alternatives.

The rule also placed limits on the time allowed to complete the decommissioning process. For all alternatives, the process is restricted in overall duration to 60 years, unless it can be shown that a longer duration is necessary to protect public health and safety. At the conclusion of a 60-year dormancy period (or longer if the NRC approves such a case), the site would still require significant remediation to meet the unrestricted release limits for license termination.

In 1996, the NRC published revisions to the general requirements for decommissioning nuclear power plants.[4] Under the revised regulations, licensees will submit written certification to the NRC within 30 days after the decision to cease operations. Certification will also be required once the fuel is permanently removed from the reactor vessel. Submittal of these notices, along with related changes to Technical Specifications, entitle the licensee to a fee reduction and eliminate the obligation to follow certain requirements needed only during operation of the reactor.

In 2011, the NRC published amended regulations to improve decommissioning planning and thereby reduce the likelihood that any current operating facility will become a legacy site.[5] The amended regulations require licensees to conduct their operations to minimize the introduction of residual radioactivity into the site, which includes the site's subsurface soil and groundwater. Licensees also may be required to perform site surveys to determine whether residual radioactivity is present in subsurface areas and to keep records of these surveys with records important for decommissioning. The amended regulations require licensees to report additional details in their decommissioning cost estimate as well as requiring additional financial reporting and assurances. The additional details, including a decommissioning estimate for the Independent Spent Fuel Storage Installation (ISFSI), are included in this study.

1.3.1 Nuclear Waste Policy Act

Congress passed the "Nuclear Waste Policy Act"[6] (NWPA) in 1982, assigning the federal government's long-standing responsibility for disposal of the spent nuclear fuel created by the commercial nuclear generating plants to the DOE. The NWPA provided that DOE would enter into contracts with utilities in which DOE would promise to take the utilities' spent fuel and high-level radioactive waste and utilities would pay the cost of the disposition services for that material. NWPA, along with the individual contracts with the utilities, specified that the DOE was to begin accepting spent fuel by January 31, 1998.

Since the original legislation, the DOE has announced several delays in the program schedule. By January 1998, the DOE had failed to accept any spent fuel or high level waste, as required by the NWPA and utility contracts. In 2010, the Obama Administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal.[7] One recommendation to come out of the Blue Ribbon Commissions 2012 "Report to the Secretary of Energy" was for the United States to implement a program that leads to the development of permanent deep geological facilities.[8] In 2015, the NRC completed a review of DOE's license application to construct a geologic repository at Yucca Mountain. A supplement to DOE's environmental impact statement and an adjudicatory hearing on the contentions filed by interested parties must be completed before a licensing decision can be made. Delays continue and, as a result, generators have initiated legal action against the DOE in an attempt to obtain compensation for DOE's partial breach of contract. To date no spent fuel has been accepted from commercial generating sites for disposal.

In 2015, DOE began soliciting general public feedback on consent-based siting of a federal interim storage site for spent nuclear fuel. In April 2023, the DOE, still soliciting general public feedback, issued an update to its "road map for implementing a consent-based siting process".[9] The DOE is currently focused on siting only consolidated interim storage facilities (CISF), while supporting ongoing research and development on options for permanent disposal. The DOE roadmap includes the following phases: 1) Planning and Capacity Building (est. 2–3 years); 2) Site Screening and Assessment (est. 4–7 years); and 3) Negotiation and Implementation Stage (est. 4–5 years for initial operation readiness). Consequently, the DOE estimates that it would be at least 10-15 years (i.e. 2033-2038) before an interim site would be operational. However, on August 25, 2023, the U.S. Court of Appeals for the Fifth Circuit vacated the license for a CISF in Texas asserting that the NRC did not have the requisite statutory authority under federal law to issue the license.[10] The Fifth Circuit opinion creates a split with a D.C. Circuit opinion and may prompt the U.S. Supreme Court to review the decision. This will likely result in additional delays. At this time, neither storage facility is in service and therefore has not been considered in this study. Furthermore, due to the lack of progress in recent years and DOE's inability to meet its previous milestones, the DOE site spent fuel pickup date for this study is assumed to be 2056 and will continue to be adjusted in future studies to align with DOE's progress.

Completion of the decommissioning process is dependent upon the DOE's ability to remove spent fuel from the site in a timely manner. DOE's repository program assumes that spent fuel allocations will be accepted for disposal from the nation's commercial nuclear plants, with limited exceptions, in the order (the "queue") in which it was discharged from the reactor.[11] The NRC requires that licensees establish a program to manage and provide funding for the caretaking of all irradiated fuel at the reactor site until title of the fuel is transferred to the DOE.[12] Interim storage of the fuel, until the DOE has completed the transfer, will be in the fuel handling building's storage pools as well as at an on-site ISFSI. For purposes of this study, it is assumed that DOE will accept already-canistered fuel. Ultimate disposition of the spent fuel is within the province of the DOE's Waste Management System, as defined by the Nuclear Waste Policy Act. As such, the disposal cost is financed by a surcharge paid into the DOE's waste fund during operations. On November 19, 2013, the U.S. Court of Appeals for the D.C. Circuit ordered the Secretary of the Department of Energy to suspend collecting annual fees for nuclear waste disposal from nuclear power plant operators until the DOE has conducted a legally adequate fee assessment. To date, no progress has been made on this assessment and the suspension remains in place.

The CPPC position is that the DOE has an obligation to accept Comanche Peak's fuel earlier than the projections set out above, consistent with its contract commitments. No assumption made in this study should be interpreted to be inconsistent with this claim. However, including the cost of storing spent fuel in this study is appropriate to ensure the availability of sufficient decommissioning funds at the end of the station's life if the DOE has not met its obligation. The cost for the interim storage of spent fuel has been calculated and is separately presented as "Spent Fuel Management" expenditures in this study.

1.3.2 Low-Level Radioactive Waste Regulations

The majority of radioactive waste to be dispositioned during the decommissioning of a nuclear facility can be designated for shallow-land disposal in accordance with the Low-Level Radioactive Waste Policy Act of 1980.[13] The dismantling of the components residing closest to the reactor core generates radioactive waste that may be considered unsuitable for shallow-land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985, [14] assigned the federal government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such radioactive waste bear all reasonable costs of disposing of such waste. However, to date, the federal government has not identified a cost for disposing of GTCC or a schedule for acceptance.

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to CPPC. Section 5 details the waste destinations and associated costs.

1.3.3 Radiological Criteria for License Termination

In 1997, the NRC published Subpart E, "Radiological Criteria for License Termination," [15] amending 10 CFR Part 20. This subpart provides radiological criteria for releasing a facility for unrestricted use. The regulation states that the site can be released for unrestricted use if radioactivity levels are such that the average member of a critical group would not receive a Total Effective Dose Equivalent (TEDE) in excess of 25 millirem per year, and provided that residual radioactivity has been reduced to levels that are As Low As Reasonably Achievable (ALARA). The decommissioning estimates assume that the site will be remediated to a residual level consistent with the NRC-prescribed level.

It should be noted that the NRC and the Environmental Protection Agency (EPA) differ on the amount of residual radioactivity considered acceptable in site remediation. On October 9, 2002, the NRC signed an agreement with the EPA on the radiological decommissioning and decontamination of NRC-licensed sites. The Memorandum of Understanding (MOU)[16] provides that EPA will defer exercise of authority under CERCLA for the majority of facilities decommissioned under NRC authority. The MOU also includes provisions for NRC and

EPA consultation for certain sites when, at the time of license termination, (1) groundwater contamination exceeds EPA-permitted levels; (2) NRC contemplates restricted release of the site; and/or (3) residual radioactive soil concentrations exceed levels defined in the MOU.

The MOU does not impose any new requirements on NRC licensees and should reduce the involvement of the EPA with NRC licensees who are decommissioning. Most sites are expected to meet the NRC criteria for unrestricted use, and the NRC believes that only a few sites will have groundwater or soil contamination in excess of the levels specified in the MOU that trigger consultation with the EPA. However, if there are other hazardous materials on the site, the EPA may be involved in the cleanup. As such, the possibility of dual regulation remains for certain licensees. The present study does not include any costs for this occurrence.

2. DECOMMISSIONING ALTERNATIVE

Detailed cost estimates were developed to decommission Comanche Peak based upon the approved decommissioning alternatives: DECON and SAFSTOR.

Two decommissioning scenarios were evaluated for Comanche Peak. The scenarios selected are representative of alternatives available to CPPC and are defined as follows:

1. The first scenario assumes that the units would be promptly decommissioned (DECON alternative) upon the expiration of the operating license following a twenty-year extension to the current operating licenses, i.e., 2050 and 2053 for Units 1 and 2, respectively. Spent fuel in the wet storage pools would be relocated to the ISFSI for interim storage until such time that the DOE can complete the transfer, presumed to be in the year 2114.

2. In the second scenario, the nuclear units are placed into safe-storage (SAFSTOR alternative) at the end of their extended operating licenses. Spent fuel in wet storage pools at that time would be relocated to the ISFSI for interim storage so as to minimize caretaking costs. The fuel would be transferred to the DOE (consistent with the assumptions in the DECON scenario) until the process is presumed to be complete in the year 2114. Decommissioning is deferred to the maximum extent (approximately 50 years) such that the property is released for unrestricted use within the generally required 60-year period (i.e., 2110 based upon the current Unit 1 shutdown date).

The following section describes the basic activities associated with each alternative. Although detailed procedures for each activity identified are not provided, and the actual sequence of work may vary, the activity descriptions provide a basis not only for estimating, but also for the expected scope of work, i.e., engineering and planning at the time of decommissioning.

The conceptual approach that the NRC has described in its regulations divides decommissioning into three phases. The initial phase commences with the effective date of permanent cessation of operations and involves the transition of both plant and licensee from reactor operations (i.e., power production) to facility de-activation and closure. During the first phase, notification is provided to the NRC certifying the permanent cessation of operations and the removal of fuel from the reactor vessel. The licensee is then prohibited from reactor operation.

The second phase encompasses activities during the storage period or during major decommissioning activities, or a combination of the two. The third phase pertains to the activities involved in license termination. The decommissioning estimates developed are also divided into phases or periods; however, demarcation of the phases is based upon major milestones within the project or significant changes in the projected expenditures.

2.1 DECON

The DECON alternative, as defined by the NRC, is "the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations." This study does not address the cost to dispose of the spent fuel residing at the site; such costs are funded through a surcharge on electrical generation. However, the study does estimate the costs incurred with the interim on-site storage of the fuel pending shipment by the DOE to an off-site disposal facility.

2.1.1 Period 1 - Preparations

In anticipation of the cessation of plant operations, detailed preparations are undertaken to provide a smooth transition from plant operations to site decommissioning. Through implementation of a staffing transition plan, the organization required to manage the intended decommissioning activities is assembled from available plant staff and outside resources. Preparations include the planning for permanent defueling of the reactor, revision of technical specifications applicable to the operating conditions and requirements, a characterization of the facility and major components, and the development of the Post-Shutdown Decommissioning Activities Report (PSDAR).

<u>Engineering and Planning</u>

The PSDAR, required within two years of the notice to cease operations, provides a description of the licensee's planned decommissioning activities, a timetable, and the associated financial requirements of the intended decommissioning program. Upon receipt of the PSDAR, the NRC will make the document available to the public for comment in a local hearing to be held in the vicinity of the reactor site. Ninety days following submittal and NRC receipt of the PSDAR, the licensee may begin to perform major decommissioning activities under a modified 10 CFR §50.59, i.e., without specific NRC approval. Major activities are defined as any activity that results in permanent removal of major radioactive components, permanently modifies the structure of the containment, or results in dismantling components (for shipment) containing greater than Class C waste (GTCC), as defined by 10 CFR §61. Major components are further defined as comprising the reactor vessel and internals, large bore recirculation system piping, and other large components that are radioactive. The NRC includes the following additional criteria for use of the §50.59 process in decommissioning. The proposed activity must not:

- foreclose release of the site for possible unrestricted use,
- significantly increase decommissioning costs,
- cause any significant environmental impact, or
- violate the terms of the licensee's existing license.

Existing operational technical specifications are reviewed and modified to reflect plant conditions and the safety concerns associated with permanent cessation of operations. The environmental impact associated with the planned decommissioning activities is also considered. Typically, a licensee is not allowed to proceed if the consequences of a particular decommissioning activity are greater than that bounded by previously evaluated environmental assessments or impact statements. In this instance, the licensee must submit a license amendment for the specific activity and update the environmental report.

The decommissioning program outlined in the PSDAR will be designed to accomplish the required tasks within the ALARA guidelines (as defined in 10 CFR §20) for protection of personnel from exposure to radiation hazards. It will also address the continued protection of the health and safety of the public and the environment during the dismantling activity. Consequently, with the development of the PSDAR, activity specifications, cost-benefit and safety analyses, and work packages and procedures, would be assembled to support the proposed decontamination and dismantling activities.

<u>Site Preparations</u>

During the transition from operations to decommissioning existing warehouses will be cleared of non-essential material and remain for use by CPPC and its subcontractors. The warehouses may be dismantled as they become surplus to the decommissioning program. The station's operating staff will perform the following activities at no additional cost or credit to the project during the transition period:

- Drain and collect fuel oils, lubricating oils, and transformer oils for recycle and/or sale.
- Drain and collect acids, caustics, and other chemical stores for recycle and/or sale. It is assumed that these chemicals will have some value; therefore, the cost for their removal will be compensated through their subsequent sale.
- Process operating waste inventories. Disposal of operating wastes (e.g., filtration media, resins) during this initial period is not considered a decommissioning expense. The estimates do not address the disposition of any legacy components, with the exception of the contaminated operations / maintenance tools and equipment.

Following final plant shutdown, and in preparation for actual decommissioning activities, the following activities are initiated:

- Characterization of the site and surrounding environs. This includes (1) performing detailed radiation surveys of work areas and major components (including the reactor vessel and its internals), and (2) performing contamination surveys of internal piping components levels and primary shield cores.
- Isolation of the spent fuel storage pools and fuel handling systems. This allows decommissioning operations to be performed in plant areas to the greatest extent, with minimum impact to the project schedule. The fuel will be transferred from the spent fuel pools once it decays to the point that it meets the heat load criteria of the spent fuel casks. It is therefore assumed that the fuel pools will remain operational for a minimum of five and one-half years following the cessation of plant operations.
- Specification of transport and disposal requirements for activated materials and/or hazardous materials, including shielding and waste stabilization.
- Development of procedures for occupational exposure control, control and release of liquid and gaseous effluent, processing of radwaste (including dry-active waste, resins, filter media, metallic and non-metallic components generated in decommissioning), site security and emergency programs, and industrial safety.

2.1.2 Period 2 – Decommissioning Operations

This period includes physical decommissioning activities associated with the removal and disposal of systems and structures containing contamination and radioactivity including the successful termination of the Part 50 operating licenses, exclusive of the ISFSI. Significant decommissioning activities in this phase include:

- Construction of temporary facilities and/or modification of existing facilities to support dismantling activities. This may include a centralized processing area to facilitate equipment removal and component preparations for off-site disposal.
- Reconfiguration and modification of site structures and facilities as needed to support decommissioning operations. This may include the upgrading of roads (on and off site) to facilitate hauling and transport. Building modifications may be required to facilitate access of large/heavy equipment. Modifications may also be required to support the segmentation of the reactor vessel internals and component extraction.
- Design and fabrication of temporary and permanent shielding to support removal and transportation activities, construction of contamination control envelopes, and the procurement of specialty tooling.
- Procurement (lease or purchase) of shipping canisters, cask liners, and industrial packages.
- Decontamination of components and piping systems as required to control (minimize) worker exposure.
- Removal of piping and components no longer essential to support decommissioning operations.
- Removal of control rod drive housings and the head service structure from the reactor vessel head. Segmentation of the vessel closure head.
- Removal and segmentation of the upper internals assemblies. Segmentation will maximize the loading of the shielded transport casks, i.e., by weight and activity. The operations are conducted under water using remotely operated tooling and contamination controls.
- Disassembly and segmentation of the remaining reactor internals, including core former and lower core support assembly.

- Segmentation of the reactor vessel. This requires installation of a shielded work platform. Cutting operations are performed in-air using remotely operated equipment within a contamination control envelope, with the water level maintained just below the cut to minimize the working area dose rates. Segments are transferred in-air to containers that are stored under water.
- Removal of the activated portions of the concrete biological shield and accessible contaminated concrete surfaces. If dictated by the steam generator and pressurizer removal scenarios, those portions of the associated cubicles necessary for access and component extraction are removed.
- Removal of the steam generators and pressurizer for controlled disposal. Decontaminate exterior surfaces, as required, and seal-weld openings (nozzles, inspection hatches, and other penetrations). These components can serve as their own burial containers provided that all penetrations are properly sealed and the internal contaminants are stabilized. Steel shielding will be added as necessary to meet transportation limits and regulations.

At least two years prior to the anticipated date of license termination, a License Termination Plan (LTP) will be required. Submitted as a supplement to the Final Safety Analysis Report (FSAR), or equivalent, the plan must include: a site characterization, description of the remaining dismantling activities, plans for site remediation, procedures for the final radiation survey, designation of the end use of the site, an updated cost estimate to complete the decommissioning, and any associated environmental concerns. The NRC will notice the receipt of the plan, make the plan available for public comment, and schedule a local hearing. LTP approval will be subject to any conditions and limitations as deemed appropriate by the NRC. The licensee may then commence with the final remediation of site facilities and services, including:

- Removal of remaining plant systems and associated components as they become nonessential to the decommissioning program or worker health and safety (e.g., waste collection and treatment systems, electrical power and ventilation systems).
- Removal of the steel liners from refueling canal, disposing of the activated and contaminated sections as radioactive waste. Removal of any activated/contaminated concrete.
- Surveys of the decontaminated areas of the containment structure.

- Remediation and removal of the contaminated equipment and material from the auxiliary building and any other contaminated facility. Radiation and contamination controls will be utilized until radiation and contamination levels are reduced such that the structures and equipment can be released for unrestricted access and conventional demolition. This activity may necessitate the dismantling and disposition of most of the systems and components (both clean and contaminated) located within these buildings. This activity facilitates surface decontamination and subsequent verification surveys required prior to obtaining release for demolition.
- Removal of the remaining components, equipment, and plant services in support of the area release survey(s).
- Routing of material removed in the decontamination and dismantling to a central processing area. Material certified to be free of contamination is released for unrestricted disposition, e.g., as scrap, recycle, or general disposal. Contaminated material is characterized and segregated for additional off-site processing (disassembly, chemical cleaning, volume reduction, and waste treatment), and/or packaged for controlled disposal at a low-level radioactive waste disposal facility.

Incorporated into the LTP is the Final Survey Plan. This plan identifies the radiological surveys to be performed once the decontamination activities are completed and is developed using the guidance provided in the "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM).[17] This document incorporates the statistical approaches to survey design and data interpretation used by the EPA. It also identifies state-of-the-art, commercially available instrumentation and procedures for conducting radiological surveys. Use of this guidance ensures that the surveys are conducted in a manner that provides a high degree of confidence that applicable NRC criteria are satisfied. Once the surveys are complete, the results are provided to the NRC in a format that can be verified. The NRC then reviews and evaluates the information, performs an independent confirmation of radiological site conditions, and makes a determination on final termination of the license.

The NRC will amend the operating licenses to reduce the licensed area to the ISFSI area if it determines that site remediation has been performed in accordance with the LTP, and that the terminal radiation survey and associated documentation demonstrate that the property (exclusive of the ISFSI) is suitable for release.

2.1.3 Site Restoration

Following completion of decommissioning operations, site restoration activities may begin. Efficient removal of the contaminated materials and verification that residual radionuclide concentrations are below the NRC limits may result in substantial damage to many of the structures. Although performed in a controlled and safe manner, blasting, coring, drilling, scarification (surface removal), and the other decontamination activities will substantially degrade power block structures, including the reactor and auxiliary buildings. Verifying that subsurface radionuclide concentrations meet NRC site release requirements may require removal of grade slabs and lower floors, potentially weakening footings and structural supports. This removal activity will be necessary for those facilities and plant areas where historical records, when available, indicate the potential for radionuclides having been present in the soil, where system failures have been recorded, or where it is required to confirm that subsurface process and drain lines were not breached over the operating life of the station.

It is not currently anticipated that these structures would be repaired and preserved after the radiological contamination is removed. The cost to dismantle site structures with a work force already mobilized on site is more efficient than if the process were deferred. This cost study presumes that non-essential structures and site facilities are dismantled as a continuation of the decommissioning activity. Foundations and exterior walls are removed to a nominal depth of three feet below grade. The three-foot depth allows for the placement of gravel for drainage, and topsoil so that vegetation can be established for erosion control. Site areas affected by the dismantling activities are restored and the plant area graded as required to prevent ponding and inhibit the refloating of subsurface materials.

Non-contaminated concrete rubble produced by demolition activities is processed to remove rebar and miscellaneous embedments. The processed material is then used on site to backfill voids. Excess non-contaminated materials are trucked to an off-site area for disposal as construction debris.

2.1.4 ISFSI Operations & Demolition

An ISFSI, operated under a Part 50 General License (in accordance with 10 CFR 72, Subpart K [18]), has been constructed to support continued plant operations and will continue as such following the amendment of the operating licenses to release the adjacent (power block) property. Any delay in the transfer process, for example, due to a delay in the scheduled opening of the geologic repository, a slower acceptance rate, or a combination of a delayed start date and lower transfer rate, results in a longer on-site residence time for the spent fuel and therefore additional caretaking expenses.

At the conclusion of the spent fuel transfer process, the ISFSI is decommissioned. The NRC terminates the Part 50 license if it determines that the remediation of the ISFSI has been performed in accordance with an ISFSI license termination plan and that the final radiation survey and associated documentation demonstrate that the facility is suitable for release.

For purposes of these estimates, it is assumed that once the MPCs containing the spent fuel assemblies have been removed, and any residual radioactivity removed from the concrete overpack, the license for the ISFSI will be terminated. Following license termination, the concrete overpacks will be dismantled using conventional reinforced concrete demolition techniques. The concrete storage pad will then be removed, and the area graded and landscaped to conform to the surrounding environment.

2.2 SAFSTOR

The NRC defines SAFSTOR as "the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use." The facility is left intact (during the dormancy period), with structures maintained in a sound condition. Systems that are not required to support the spent fuel pools or site surveillance and security are drained, de-energized, and secured. Minimal cleaning/removal of loose contamination and/or fixation and sealing of remaining contamination is performed. Access to contaminated areas is secured to provide controlled access for inspection and maintenance.

The engineering and planning requirements are similar to those for the DECON alternative, although they are limited in scope with no large scale dismantling activities anticipated. Site preparations are also similar to those for the DECON alternative. However, with the exception of the required radiation surveys and site characterizations, the mobilization and preparation of site facilities is less extensive.

2.2.1 Period 1 - Preparations

Preparations for long-term storage include the planning for permanent defueling of the reactor, revision of technical specifications appropriate to the operating conditions and requirements, a characterization of the facility and major components, and the development of the PSDAR.

The process of placing the station in safe-storage includes, but is not limited to, the following activities:

- Isolating of the spent fuel storage services and fuel handling systems so that safe-storage operations may commence on the balance of the plant. This activity may be carried out by plant personnel in accordance with existing operating technical specifications. Activities are scheduled around the fuel handling systems to the greatest extent possible.
- Transferring of the spent fuel from the storage pools to the ISFSI for interim storage, following the minimum required cooling period in the spent fuel pools.
- Draining and de-energizing of the non-contaminated systems not required to support continued site operations or maintenance.
- Disposing of contaminated filter elements and resin beds not required for processing wastes from layup activities for future operations.
- Draining of the reactor vessel, with the internals left in place and the vessel head secured.
- Draining and de-energizing non-essential, contaminated systems with decontamination as required for future maintenance and inspection.
- Preparing lighting and alarm systems whose continued use is required; de-energizing portions of fire protection, electric power, and HVAC systems whose continued use is not required.
- Cleaning of the loose surface contamination from building access pathways.
- Performing an interim radiation survey of the plant, posting warning signs where appropriate.
- Erecting physical barriers and/or securing all access to radioactive or contaminated areas, except as required for inspection and maintenance.

- Installing security and surveillance monitoring equipment and relocating security fence around secured structures, as required.

2.2.2 Period 2 - Dormancy

The second phase identified by the NRC in its rule addresses licensed activities during a storage period and is applicable to the dormancy phases of the deferred decommissioning alternatives. Dormancy activities include a 24-hour security force, preventive and corrective maintenance on security systems, area lighting, general building maintenance, heating and ventilation of buildings, routine radiological inspections of contaminated structures, maintenance of structural integrity, and a site environmental and radiation monitoring program. Site maintenance personnel perform equipment maintenance, inspection activities, routine services to maintain safe conditions, adequate lighting, heating, and ventilation, and periodic preventive maintenance on essential site services.

An environmental surveillance program is carried out during the dormancy period to ensure that releases of radioactive material to the environment are prevented and/or detected and controlled. Appropriate emergency procedures are established and initiated for potential releases that exceed prescribed limits. The environmental surveillance program constitutes an abbreviated version of the program in effect during normal plant operations.

Security during the dormancy period is conducted primarily to prevent unauthorized entry and to protect the public from the consequences of its own actions. The security fence, sensors, alarms, and other surveillance equipment provide security. Fire and radiation alarms are also monitored and maintained.

Consistent with the DECON alternative, the spent fuel storage pools are emptied within five and one half years of the cessation of operations. The transfer of the spent fuel to the DOE begins during the dormancy period in year 2056 and continues throughout (and beyond) the delayed decommissioning phase.

After a period of storage (such that license termination is accomplished within 60 years of the cessation of Unit 1 operations), it is required that the licensee submit an application to terminate the license, along with an LTP (described in Section 2.1.2), thereby initiating the third phase.

2.2.3 Periods 3 and 4 - Delayed Decommissioning

Prior to the commencement of decommissioning operations, preparations are undertaken to reactivate site services and prepare for decommissioning. Preparations include engineering and planning, a detailed site characterization, and the assembly of a decommissioning management organization. Final planning for activities and the writing of activity specifications and detailed procedures are also initiated at this time.

Much of the work in developing a termination plan is relevant to the development of the detailed engineering plans and procedures. The activities associated with this phase and the follow-on decontamination and dismantling processes are detailed in Sections 2.1.1 and 2.1.2. The primary difference between the sequences anticipated for the DECON and this deferred scenario is the absence, in the latter, of any constraint on the availability of the fuel storage facilities for decommissioning.

Variations in the length of the dormancy period are expected to have some effect upon the quantities of radioactive wastes generated from system and structure removal operations. Given the levels of radioactivity and spectrum of radionuclides expected from sixty years of plant operation, no plant process system identified as being contaminated upon final shutdown will become releasable due to the decay period alone. The delay in decommissioning yields lower working area radiation levels. As such, the estimates for this delayed scenario incorporate reduced ALARA controls for the SAFSTOR's lower occupational exposure potential.

Although the initial radiation levels due to ^{60}Co will decrease during the dormancy period, the internal components of the reactor vessel will still exhibit sufficiently high radiation dose rates to require remote sectioning under water due to the presence of long-lived radionuclides such as ^{94}Nb, ^{59}Ni, and ^{63}Ni. Therefore, the dismantling procedures described for the DECON alternative would still be employed during this scenario. Portions of the biological shield wall will still be radioactive due to the presence of activated trace elements with long half-lives (^{152}Eu and ^{154}Eu). Decontamination will require controlled removal and disposal. It is assumed that radioactive corrosion products on inner surfaces of piping and components will not have decayed to levels that will permit unrestricted use or allow conventional removal. These systems and components will be surveyed as they are removed and disposed of in accordance with the existing radioactive release criteria.

2.2.4 Period 5 - Site Restoration

Following completion of decommissioning operations, site-restoration activities can begin. Dismantling, as a continuation of the decommissioning process, is clearly the most appropriate and cost-effective option, as described in Section 2.1.3. The basis for the dismantling cost in this scenario is consistent with that described for DECON, presuming the removal of structures and site facilities to a nominal depth of three feet below grade and the limited restoration of the site.

2.2.5 ISFSI Operations and Demolition

Completion of the spent fuel transfer operations is currently assumed to be in year 2114. Once complete, the ISFSI will be decommissioned as described in Section 2.1.4.

3. COST ESTIMATES

The cost estimates prepared for decommissioning Comanche Peak consider the unique features of the site, including the nuclear steam supply system, power generation systems, support services, site buildings, and ancillary facilities. The basis of the estimates, including the sources of information relied upon, the estimating methodology employed, site-specific considerations and other pertinent assumptions are described in this section.

3.1 BASIS OF ESTIMATES

The estimates were developed using the site-specific, technical information from the 2019 study. The information was reviewed for the current study and updated, as deemed appropriate. The site-specific considerations and assumptions used in the previous estimates were also revisited. Modifications were incorporated where new information was available or where experience from ongoing decommissioning programs provided viable alternatives or improved processes.

3.2 METHODOLOGY

The methodology used to develop these cost estimates follows the basic approach originally presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,"[19] and the DOE "Decommissioning Handbook."[20] These documents present a unit factor method for estimating decommissioning activity costs, which simplifies the estimating calculations. Unit factors for concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) were developed using local labor rates provided by CPPC. The activity-dependent costs are estimated with the item quantities (cubic yards and tons), developed from plant drawings and inventory documents. Removal rates and material costs for the conventional disposition of components and structures rely upon information available in the industry publication, "Building Construction Cost Data," published by RSMeans.[21]

The unit factor method provides a demonstrable basis for establishing reliable cost estimates. The detail provided in the unit factors, including activity duration, labor costs (by craft), and equipment and consumable costs, provides a high level of confidence that essential elements have not been omitted. Appendix A presents the detailed development of a typical unit factor. Appendix B provides the values contained within one set of factors developed for this study.

Regulatory Guide 1.184[22] describes the methods and procedures that are acceptable to the NRC staff for implementing the requirements that relate to the initial activities and the major phases of the decommissioning process. The costs and schedules presented in this study follow the general guidance and sequence in the regulations. The format and content of this study is also consistent with the recommendations of Regulatory Guide 1.202.[23]

This study reflects lessons learned from TLG's involvement in the planning and decommissioning of nuclear facilities, including but not limited to domestic and international commercial nuclear plants and research facilities. These experiences, along with TLG's frequent involvement in industry discussions, have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

Work Difficulty Factors

TLG has historically applied work difficulty adjustment factors (WDFs) to account for the inefficiencies in working in radiologically controlled areas and in a power plant environment. WDFs are assigned to each unique set of unit factors, commensurate with the inefficiencies associated with working in confined, hazardous environments. The ranges used for the WDFs are as follows:

- Access Factor 10% to 20%
- Respiratory Protection Factor 10% to 50%
- Radiation/ALARA Factor 10% to 37%
- Protective Clothing Factor 10% to 30%
- Work Break Factor 8.33%

The factors and their associated range of values were developed in conjunction with the AIF/NESP-036 study. The application of the factors is discussed in more detail in that publication.

Scheduling Program Durations

The unit factors, adjusted by the WDFs as described above, are applied against the inventory of materials to be removed in the radiological controlled areas. The resulting man-hours, or crew-hours, are used in the development of the decommissioning program schedule, using resource loading and event sequencing considerations. The scheduling of conventional removal and dismantling activities is based upon productivity information available from the "Building Construction Cost Data" publication. Dismantling of the fuel pool systems and decontamination of the spent fuel pools is also dependent upon the timetable for the transfer of the spent fuel assemblies from the pools to the DOE and/or ISFSI.

An activity duration critical path is used to determine the total decommissioning program schedule. The schedule is relied upon in calculating the carrying costs, which include program management, administration, field engineering, equipment rental, and support services such as quality control and security. This systematic approach for assembling decommissioning estimates provides a high degree of confidence in the reliability of the resulting cost estimates.

3.3 FINANCIAL COMPONENTS OF THE COST MODEL

TLG's proprietary decommissioning cost model, DECCER, produces a number of distinct cost elements. These direct expenditures, however, do not comprise the total cost to accomplish the project goal, i.e., license termination, spent fuel management, and site restoration.

Inherent in any cost estimate that does not rely on historical data is the inability to specify the precise source of costs imposed by factors such as tool breakage, accidents, illnesses, weather delays, and labor stoppages. In TLG's DECCER cost model, contingency fulfills this role. Contingency is added to each line item to account for costs that are difficult or impossible to develop analytically. Such costs are historically inevitable over the duration of a job of this magnitude; therefore, this cost study includes funds to cover these types of expenses.

3.3.1 Contingency

The activity- and period-dependent costs are combined to develop the total decommissioning cost. A contingency is then applied on a line-item basis, using one or more of the contingency types listed in the AIF/NESP-036 study. "Contingencies" are defined in the American Association of Cost Engineers "Project and Cost Engineers' Handbook"[24] as "specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur." The cost elements in this study are based upon ideal conditions and maximum efficiency; therefore, consistent with industry practice, a contingency factor has been applied. In the AIF/NESP-036 study, the types of unforeseeable events that are likely to occur in decommissioning are discussed and guidelines are provided for percentage contingency in each category. It should be noted that contingency, as used in this study, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station.

Contingency funds are an integral part of the total cost to complete the decommissioning process. Exclusion of this component puts at risk a successful completion of the intended tasks and, potentially, subsequent related activities. For this study, TLG examined the major activity-related problems (decontamination, segmentation, equipment handling, packaging, transport, and waste disposal) that necessitate a contingency. Individual activity contingencies range from 10% to 75%, depending on the degree of difficulty judged to be appropriate from TLG's actual decommissioning experience. The contingency values used in this study are as follows:

- Decontamination 50%
- Contaminated Component Removal 25%
- Contaminated Component Packaging 10%
- Contaminated Component Transport 15%
- Low-Level Radioactive Waste Disposal 25%

- Low-Level Radioactive Waste Processing 15%
- Reactor Segmentation 75%
- NSSS Component Removal 25%
- Reactor Waste Packaging 25%
- Reactor Waste Transport 25%

- Reactor Vessel Component Disposal 50%
- GTCC Disposal 15%
- Non-Radioactive Component Removal 15%
- Heavy Equipment and Tooling 15%
- Supplies 25%

- Engineering 15%
- Energy 15%
- Characterization and Termination Surveys 30%
- Construction 15%
- Insurance and Taxes 10%

- Staffing 15%
- NRC and Emergency Planning Fees 10%
- Spent Fuel Storage (Dry) Systems 15%
- Spent Fuel Transfer Costs 15%

- Operations and Maintenance Expenses 15%

The contingency values are applied to the appropriate components of the estimates on a line item basis. A composite value is then reported at the end of each detailed estimate. A flat 25% contingency is added to the total ISFSI decommissioning cost estimate with no other contingencies applied to the subtotals.

3.3.2 Financial Risk

In addition to the routine technology-related uncertainties addressed by contingency, there is a broader level of project uncertainty that is sometimes necessary to consider when bounding decommissioning costs. Examples can include changes in work scope, pricing, job performance, and other variations that could conceivably, but not necessarily, occur. Consideration is sometimes necessary to generate a level of confidence in the estimate, within a range of probabilities. TLG considers these types of costs under the broad term "financial risk."

This cost study does not add any additional costs to the estimates for financial risk, since there is insufficient historical data from which to project future liabilities. Consequently, the areas of uncertainty or risk are revisited periodically and addressed through repeated revisions or updates of the base estimates.

3.4 SITE-SPECIFIC BASIS AND INPUTS

There are a number of site-specific considerations that affect the method for dismantling and removal of equipment from the site and the degree of restoration required. The cost impact of the considerations identified below is included in this cost study. Table 3.1 includes important site-specific inputs and assumptions for the estimate.

TABLE 3.1
SITE-SPECIFIC INPUTS AND ASSUMPTIONS

Unit 1 Initial License Issue Date	4/17/1990
Unit 2 Initial License Issue Date	4/6/1993
Unit 1 Licensed Thermal Rating	3,612 MWt
Unit 2 Licensed Thermal Rating	3,612 MWt
Shutdown Date Unit 1	2/8/2050
Shutdown Date Unit 2	2/2/2053
Staffing Structure	Utility & DOC
Date of First Fuel Pickup from Site	2056
Spent Fuel Pool Cooling Period	5 years
Total Assemblies Generated	7,459
Assemblies shipped from the pools to the DOE	378
Assemblies transferred from pools to ISFSI (after shutdown)	1,897
Total Casks on ISFSI (eventually shipped to DOE)	222
Date of last fuel shipment to DOE	2114
Cask System	HI-STORM 100s
MPC Capacity	32
ISFSI Expansion during decommissioning	No

3.4.1 Spent Fuel

The cost to dispose the spent fuel generated from plant operations is not reflected within the estimates to decommission the site as the responsibility lies with DOE per the Nuclear Waste Policy Act. However, costs are included for the management of spent fuel throughout the decommissioning project.

The DOE's repository program assumes that spent fuel will be accepted for disposal from the nation's commercial nuclear plants in the order (the "queue") in which it was removed from service ("oldest fuel first").[25] The DOE contracts provide mechanisms for altering the oldest fuel first allocation scheme, including emergency deliveries, exchanges of allocations amongst utilities and the option of providing priority acceptance from permanently shut down nuclear reactors. Because it is unclear how these mechanisms may operate once DOE begins accepting spent fuel from commercial reactors, this study assumes that DOE will accept spent fuel in an oldest fuel first order.

CPPC's current spent fuel management plan for the Comanche Peak spent fuel is based in general upon: 1) a 2056 start date for DOE initiating transfer of Comanche Peak spent fuel to a federal facility (not necessarily a final repository), and 2) a spent fuel transfer 2114 completion date. The management of the spent fuel inventory is delineated in Table 3.2. Different DOE acceptance assumptions would result in different completion dates. Costs are included to operate the storage pools for approximately five and one-half years after shutdown, after which decommissioning operations can be carried out and the operating licenses terminated.

ISFSI

An ISFSI has been constructed at Comanche Peak to hold 84 storage casks (overpacks). It is assumed the facility will be expanded during operations to accommodate the total number of casks expected to be required at decommissioning. The facility is assumed to be available to support spent fuel management once the units cease operation, until the DOE is able to removal all spent fuel from the site.

The ISFSI will continue to operate throughout decommissioning, and beyond the amended operating licenses, until such time that the transfer of spent fuel to the DOE can be completed. Assuming that DOE begins to remove spent fuel from the Comanche Peak site in 2056, shipments are expected to be completed by the year 2114.

Post-shutdown and maintenance costs for the spent fuel pools and the ISFSI are also included and address the cost for staffing the facility, as well as security, insurance, and licensing fees. Costs are provided for the final disposition of the facilities once the transfer is complete. These costs are allocated on a 50:50 basis between Units 1 and 2.

Canister and Overpack

A Holtec HI-STORM 100S Version B system is assumed for future ISFSI capacity expansions. For fuel assemblies transferred from the pools to the ISFSI, 32 assemblies are loaded into a canister. The cost of the concrete overpacks and canisters are included in the decommissioning estimates.

Canister Loading and Transfer

The estimates include the cost for the labor and equipment to transfer and load each spent fuel canister into the DOE transport cask or to the ISFSI from the wet storage pools. Since the DOE has not published details about its cask system, an CPPC-provided allowance is used to estimate the cost to transfer the fuel from the ISFSI into the DOE transport cask. However, use of this allowance should not be used to infer that CPPC has any detailed information on the cask system DOE will ultimately provide.

ISFSI Decommissioning

In accordance with 10 CFR §72.30, licensees must have a proposed decommissioning plan for the ISFSI site and facilities that includes a cost estimate for the plan. The plan should contain sufficient information on the proposed practices and procedures for the decontamination of the ISFSI and for the disposal of residual radioactive materials after all spent fuel, high-level radioactive waste, and reactor-related GTCC waste have been removed.

A multi-purpose (storage and transport) canister (MPC) with a concrete overpack is used as a basis for the cost analyses. The majority of the overpacks are assumed to be disposed of as “clean” material. As an allowance, 14 overpacks are assumed to have residual radioactivity due to some minor level of neutron-induced activation as a result of the long-term storage of the spent fuel, i.e., contain residual radioactivity. The allowance is based upon the number of modules required for the final core off-load (i.e., 193 offloaded assemblies, 32 assemblies per canister) which results in 7 overpacks per unit. It is assumed that these modules contain the final assemblies offloaded; consequently, they have the least time for radioactive decay of the neutron activation products.

No contamination or activation of the ISFSI pad is assumed. It is expected that procedure-driven confirmatory surveys will be performed for potentially impacted areas after each spent fuel transfer campaign. As such, only verification surveys are included for the pads in the decommissioning estimates. The estimates are limited to costs necessary to terminate the ISFSI’s NRC license and meet the §20.1402 criteria for unrestricted use.

In accordance with the specific requirements of 10 CFR §72.30 for the ISFSI work scope, the cost estimate for decommissioning the ISFSI reflect: 1) the cost of an independent contractor performing the decommissioning activities; 2) an adequate contingency factor; and 3) the cost of meeting the criteria for unrestricted use. The decommissioning cost for the ISFSI is identified as a separate line item in the Unit 1 and 2 cost tables in Appendices C and D, and as a stand-alone table in Appendix E.

GTCC

The dismantling of the reactor internals is expected to generate radioactive waste considered unsuitable for shallow land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)).

For purposes of this study, the GTCC has been packaged and disposed of in the same manner as high-level waste, at a cost equivalent to that envisioned for the spent fuel. The number of canisters required and the packaged volume for GTCC was based upon experience at Maine Yankee (e.g., the constraints on loading as identified in the canister's certificate of compliance), but adjusted for the increased spent fuel capacity of the current MPCs.

It is assumed that the DOE would not accept this waste prior to completing the transfer of spent fuel. Therefore, until such time the DOE is ready to accept GTCC waste, it is reasonable to assume that this material would remain in storage at the site. GTCC costs have been segregated and included within the "License Termination" expenditures.

3.4.2 Reactor Vessel and Internal Components

The reactor pressure vessel and internal components are segmented in order to meet transportation and disposal requirements. Segmentation is performed in the refueling canal, where a turntable and remote cutter are installed. The vessel is segmented in place, using a mast-mounted cutter supported off the lower head and directed from a shielded work platform installed overhead in the reactor well. Transportation cask specifications and transportation regulations will dictate segmentation and packaging methodology. Material is loaded into single use cask liners that are loaded into shielded and reusable transportation casks.

The curie contents of the vessel and internals at final shutdown were derived from those listed in NUREG/CR-3474.[26] Actual estimates were derived from the curie/gram values contained therein and adjusted for the different mass of Comanche Peak components, projected operating life, and different periods of decay. Additional short-lived isotopes are derived from NUREG/CR-0130[27] and NUREG/CR-0672,[28] and benchmarked to the long-lived values from NUREG/CR-3474. The control elements are disposed of along with the spent fuel, i.e., there is no additional cost provided for their disposal.

3.4.3 Primary System Components

The reactor coolant system is assumed to be decontaminated using chemical agents prior to the start of dismantling operations. This type of decontamination can be expected to have a significant ALARA impact, since in this scenario the removal work is done within the first few years of shutdown. A decontamination factor (average reduction) of 10 is assumed for the process. Disposal of the decontamination solution effluent is included within the estimates as a "process chemical waste" charge. In the SAFSTOR alternative, radionuclide decay is expected to provide the same benefit and, therefore, a chemical decontamination is not included.

The following discussion deals with the removal and disposition of the steam generators, but the techniques involved are also applicable to other large components, such as heat exchangers, component coolers, and the pressurizer. The steam generators' size, weight, and location within the containment will ultimately determine the removal strategy.

A trolley crane is set up for the removal of the generators. It can also be used to move portions of the steam generator cubicle walls and floor slabs from the Containment Building to a location where they can be decontaminated and transported to the material handling area. Interferences within the work area, such as grating, piping, and other components are removed to create sufficient laydown space for processing these large components.

The generators are rigged for removal, disconnected from the surrounding piping and supports, and maneuvered into the open area where they are lowered onto a dolly. Each generator is rotated into the horizontal position for extraction from the containment and placed onto a multi-wheeled vehicle for transport to an on-site processing and storage area.

The generators are disassembled on-site for transport to the disposal site. The interior volume is filled with low-density cellular concrete for stabilization of the internal contamination.

Reactor coolant piping is cut from the reactor vessel once the water level in the vessel (used for personnel shielding during dismantling and cutting operations in and around the vessel) drops below the nozzle zone. The piping is boxed and transported by shielded van. The reactor coolant pumps and motors are lifted out intact, packaged, and transported by rail for disposal.

3.4.4 Main Turbine and Condenser

The main turbine is dismantled using conventional maintenance procedures. The turbine rotors and shafts are removed to a laydown area. The lower turbine casings are removed from their anchors by controlled demolition. The main condenser is disassembled and moved to a laydown area. Material is surveyed and if free of radioactive contamination, released as scrap.

3.4.5 Retired Components

The estimates include the disposition, from Unit 1, of four retired steam generators, a retired reactor vessel closure head, one high-pressure and two low-pressure turbine rotors. The components, currently in storage at the site, will be prepared for transport and disposal. Similar to the disposition of the operating units, the steam domes of the generators are assumed to be removed to meet transport clearances. The estimates for the retired components include the project management, contractor and supporting costs necessary to execute the tasks assuming that the disposition would be a coordinated effort (i.e., single mobilization effort).

3.4.6 Site Conditions Following Decommissioning

The NRC terminates the site licenses (Part 50) if it determines that site remediation has been performed in accordance with the license termination plan, and that the terminal radiation survey and associated documentation demonstrate that the facility is suitable for release. The NRC's involvement in the decommissioning process ends with the termination of the Part 50 license. Building codes, environmental regulations and future plans for the site dictate the next steps in the decommissioning process. As an example, the estimates assume that the electrical switchyard will remain operational in support of the electrical transmission and distribution system.

Only existing site structures are considered in the dismantling cost. The existing electrical switchyard and access roads will remain in support of the electrical transmission and distribution system. The site access road will be left intact.

Structures are removed to a nominal depth of three feet below grade. Concrete rubble generated from demolition activities is processed and used as clean fill. Excess concrete waste is trucked and disposed of at a commercial landfill. The site is graded following the removal of non-essential structures to conform to the adjacent landscape, and vegetation is established to inhibit erosion.

A significant amount of the below grade piping is located around the perimeter of the power block. The estimates include a cost to excavate this area to an average depth of six feet so as to expose the piping, duct bank, conduit, and any near-surface grounding grid. The overburden is surveyed and stockpiled on site for future use in backfilling the below grade voids.

3.4.7 Labor Costs

CPPC will hire a Decommissioning Operations Contractor (DOC) to manage the decommissioning. The licensee will provide site security, radiological health and safety, quality assurance and overall site administration during the decommissioning and demolition phases. Contract personnel will provide engineering services, e.g., for preparing the activity specifications, work procedures, activation, and structural analyses, under the direction of the owner.

Personnel costs are based upon average salary information provided by CPPC. Overhead costs are included for site and corporate support, reduced commensurate with the staffing of the project. The costs associated with the transition of the operating organization to decommissioning, e.g., separation packages, retraining, severance, and incentives are not included in the estimates and were considered to be ongoing operating expenses.

The craft labor required to decontaminate and dismantle the nuclear units is acquired through standard site contracting practices. The current cost of craft and utility labor at the site is used as an estimating basis. DOC costs for site administration, operations, construction, and maintenance personnel are based upon salary information provided by CPPC.

Security, while reduced from operating levels, is maintained throughout the decommissioning for access control, material control, and to safeguard the spent fuel (in accordance with the requirements of 10 CFR Part 37, Part 72, and Part 73). Security costs include provisions for recurring expenses. Once the fuel has been transferred to the DOE in 2114, the security organization will be reduced to Part 37 requirements.

The estimates incorporate economies of scale. Examples include the reduction in the man-hours and dollars for the preparation of common engineering work packages for the two units. Cost sharing is also reflected within the estimates for selective and joint decommissioning activities and in the purchase of specialty decommissioning equipment.

3.4.7 General

Scrap and Salvage

The existing plant equipment is considered obsolete and only suitable for scrap as deadweight quantities. Economically reasonable efforts will be made to salvage equipment following final plant shutdown. However, dismantling techniques assumed by TLG for equipment in these estimates are not consistent with removal techniques required for salvage (resale) of equipment. Experience indicates that some buyers want equipment stripped down to very specific requirements before they will consider purchase. This requires expensive rework after the equipment has been removed from its installed location. Since placing salvage value on this machinery and equipment is speculative, and the value is small in comparison to the overall decommissioning expenses, these estimates do not attempt to quantify the scrap value.

It is assumed, for purposes of this study, that any value received from the sale of scrap generated in the dismantling process would be more than offset by the on-site processing costs. With a volatile market, the potential profit margin in scrap recovery is highly speculative, regardless of the ability to free release this material. Therefore, no scrap material cost or credit was included in the estimates.

Furniture, tools, mobile equipment such as forklifts, trucks, bulldozers, and other items of property owned by the utility will be removed at no cost or credit to the decommissioning project. Disposition may include relocation to other generating facilities. Spare parts will also be made available for alternative use.

The concrete debris resulting from building demolition activities is crushed on site to reduce the size of the debris. The resulting crushed concrete is used to backfill below grade voids. The rebar removed from the concrete crushing process is disposed of as scrap steel in a similar fashion as other scrap metal as discussed previously.

Energy

For estimating purposes, the plant is assumed to be de-energized, with the exception of those facilities associated with spent fuel storage. Replacement power costs are used to calculate the cost of energy consumed during decommissioning for tooling, lighting, ventilation, and essential services.

Emergency Planning

FEMA fees associated with emergency planning are assumed to continue for approximately 18 months following the cessation of operations. At this time, the fees are discontinued, based upon the anticipated condition of the spent fuel (i.e., the hottest spent fuel assemblies are assumed to be cool enough that no substantial Zircaloy oxidation and off-site event would occur with the loss of spent fuel pool water). State fees remain at operating levels until all fuel has been transferred from the pools to the ISFSI. After all spent fuel is in dry storage, the state and local fees are reduced. These fees are eliminated after all spent fuel is off site.

Insurance

Costs for continuing coverage (nuclear liability and property insurance) following cessation of plant operations and during decommissioning are included and based upon current operating premiums. Reductions in premiums, throughout the decommissioning process, are based upon the guidance provided in SECY-00-0145, "Integrated Rulemaking Plan for Nuclear Power Plant Decommissioning."[29] The NRC's financial protection requirements are based on various reactor (and spent fuel) configurations.

Property Taxes

A nominal property tax (land only) during the decommissioning period is considered in the estimates.

Site Modifications

Based upon a review of the 2019 inventory and site modifications since, it was determined the only change to the existing inventory is additional concrete for the Vehicle Barrier System (VBS) on site. The perimeter fence and in-plant security barriers are moved, as appropriate, to conform to the site security plan in force during the various stages of the project. Costs are also included for remediation of the firing range on site.

3.5 IMPACT OF DECOMMISSIONING MULTIPLE REACTOR UNITS

In estimating the near simultaneous decommissioning of two co-located reactor units there can be opportunities to achieve economies of scale, by sharing costs between units, and coordinating the sequence of work activities. There will also be schedule constraints, particularly where there are requirements for specialty equipment and staff, or practical limitations on when final status surveys can take place. For purposes of the estimates, Units 1 and 2 are assumed to be essentially identical. Common facilities have been assigned to Unit 2. A summary of the principal impacts is listed below.

- The sequence of work generally follows the principle that the work is done at Unit 1 first, followed by similar work at Unit 2. This permits the experience gained at Unit 1 to be applied by the workforce at the second unit. The estimates do not consider productivity improvements at the second unit, because there is little documented experience with decommissioning two units simultaneously. The work associated with developing activity specifications and procedures can be considered essentially identical between the two units, therefore the second unit costs are assumed to be a fraction of the first unit (~ 43%).
- Segmenting the reactor vessel and internals will require the use of special equipment. The decommissioning project will be scheduled such that Unit 2's reactor internals and vessel are segmented after the activities at Unit 1 have been completed.
- Some program management and support costs, particularly costs associated with the more senior positions, can be avoided with two reactors undergoing decommissioning simultaneously. As a result, the estimates are

based on a "lead" unit that includes these senior positions, and a "second" unit that excludes these positions.

- Unit 1, as the first unit to enter decommissioning, incurs the majority of site characterization costs.
- Unit 1, as the first unit to enter decommissioning, incurs a greater fraction of the NRC hourly charges.
- The final radiological survey schedule is affected by a two-unit decommissioning schedule. It would be extremely difficult to complete the final status survey of Unit 1, while Unit 2 has ongoing radiological remediation work and waste handling in progress. As such, the final status surveys of Units 1 and 2 are conducted concurrently.
- The final demolition of buildings at Units 1 and 2 are considered to take place concurrently.
- Costs for operating and maintaining the ISFSI (after other part 50 facilities undergo partial site release) are allocated equally between Units 1 and 2.
- Shared systems and common structures are generally assigned to Unit 2.
- Station costs such as emergency response fees, corporate overhead, and insurance are generally allocated on an equal basis between the two units.

3.6 COST ESTIMATE SUMMARY

Summary level costs, license termination, spent fuel and site restoration costs projected for the decommissioning of each of the two units are provided in Tables 3.3 through 3.6. The tables delineate the cost contributors by year of expenditures as well as cost contributor (e.g., labor, materials, and waste disposal). The tables in Appendices C and D provide additional detail.

Decommissioning costs are reported in 2024 dollars. Costs are not inflated, escalated, or discounted over the period of expenditure (or projected lifetime of the plant). The schedules are based upon the detailed activity costs reported in Appendices C and D, along with the timelines presented in Section 4.

As discussed in Section 3.4.1, it is not anticipated that the DOE will accept the GTCC waste prior to completing the transfer of spent fuel. Therefore, the cost of GTCC disposal is shown in the final year of ISFSI operation. While designated for disposal at the geologic repository along with the spent fuel, GTCC waste is still classified as low-level radioactive waste and, as such, included as a "License Termination" expense.

TABLE 3.2
COMANCHE PEAK NUCLEAR POWER PLANT
SPENT FUEL MANAGEMENT

Fuel Assembly Inventory (End of Year)

Year	Pool	ISFSI	DOE Acceptance
2009	2,078	0	0
2010	2,171	0	0
2011	2,353	0	0
2012	2,154	288	0
2013	1,959	576	0
2014	2,143	576	0
2015	2,040	768	0
2016	1,969	928	0
2017	2,153	928	0
2018	2,014	1,152	0
2019	1,911	1,344	0
2020	2,093	1,344	0
2021	1,990	1,536	0
2022	1,891	1,728	0
2023	2,073	1,728	0
2024	1,970	1,920	0
2025	1,871	2,112	0
2026	2,053	2,112	0
2027	1,950	2,304	0
2028	1,851	2,496	0
2029	2,033	2,496	0
2030	1,930	2,688	0
2031	1,831	2,880	0
2032	2,013	2,880	0
2033	1,910	3,072	0
2034	1,811	3,264	0
2035	1,993	3,264	0
2036	1,890	3,456	0
2037	1,791	3,648	0
2038	1,973	3,648	0
2039	1,870	3,840	0

TABLE 3.2 (continued)
COMANCHE PEAK NUCLEAR POWER PLANT
SPENT FUEL MANAGEMENT

Fuel Assembly Inventory (End of Year)

Year	Pool	ISFSI	DOE Acceptance
2040	1,771	4,032	0
2041	1,953	4,032	0
2042	1,850	4,224	0
2043	1,751	4,416	0
2044	1,933	4,416	0
2045	1,830	4,608	0
2046	1,731	4,800	0
2047	1,913	4,800	0
2048	1,810	4,992	0
2049	1,711	5,184	0
2050	1,993	5,184	0
2051	1,769	5,408	0
2052	1,634	5,632	0
2053	1,603	5,856	0
2054	1,379	6,080	0
2055	931	6,528	0
2056	645	6,688	126
2057	327	6,880	126
2058	0	7,081	126
2059	0	6,953	128
2060	0	6,825	128
2061	0	6,697	128
2062	0	6,569	128
2063	0	6,441	128
2064	0	6,313	128
2065	0	6,185	128
2066	0	6,057	128
2067	0	5,929	128
2068	0	5,801	128
2069	0	5,673	128
2070	0	5,545	128

TABLE 3.2 (continued)
COMANCHE PEAK NUCLEAR POWER PLANT
SPENT FUEL MANAGEMENT

Fuel Assembly Inventory (End of Year)

Year	Pool	ISFSI	DOE Acceptance
2071	0	5,417	128
2072	0	5,289	128
2073	0	5,161	128
2074	0	5,033	128
2075	0	4,905	128
2076	0	4,777	128
2077	0	4,649	128
2078	0	4,521	128
2079	0	4,393	128
2080	0	4,265	128
2081	0	4,137	128
2082	0	4,009	128
2083	0	3,881	128
2084	0	3,753	128
2085	0	3,625	128
2086	0	3,497	128
2087	0	3,369	128
2088	0	3,241	128
2089	0	3,113	128
2090	0	2,985	128
2091	0	2,857	128
2092	0	2,729	128
2093	0	2,601	128
2094	0	2,473	128
2095	0	2,345	128
2096	0	2,217	128
2097	0	2,089	128
2098	0	1,961	128
2099	0	1,833	128
2100	0	1,705	128
2101	0	1,577	128

TABLE 3.2 (continued)
COMANCHE PEAK NUCLEAR POWER PLANT
SPENT FUEL MANAGEMENT

Fuel Assembly Inventory (End of Year)

Year	Pool	ISFSI	DOE Acceptance
2102	0	1,449	128
2103	0	1,321	128
2104	0	1,193	128
2105	0	1,065	128
2106	0	937	128
2107	0	809	128
2108	0	681	128
2109	0	553	128
2110	0	425	128
2111	0	297	128
2112	0	169	128
2113	0	41	128
2114	0	0	41
Total			7,459

TABLE 3.3
UNIT 1, DECON ALTERNATIVE
TOTAL ANNUAL EXPENDITURES
(Thousands of 2024 Dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2050	60,213	2,746	2,492	15	10,173	75,639
2051	84,451	43,360	4,114	16,369	30,590	178,884
2052	77,599	53,501	2,650	38,114	16,794	188,657
2053	58,269	32,553	2,247	13,474	8,122	114,664
2054	50,542	24,134	2,086	3,565	4,639	84,966
2055	35,823	21,249	2,086	2,143	4,782	66,083
2056	8,269	430	2,092	10	5,010	15,812
2057	8,246	429	2,086	10	4,996	15,768
2058	10,580	3,345	1,493	1,787	4,979	22,185
2059	17,799	1,742	556	8	2,107	22,213
2060	16,023	7,217	324	2	1,313	24,880
2061	13,766	8,090	278	0	1,167	23,302
2062	4,109	1,576	44	0	1,133	6,862
2063	2,285	345	0	0	1,126	3,756
2064	2,290	345	0	0	1,129	3,765
2065	2,285	345	0	0	1,126	3,756
2066	2,285	345	0	0	1,126	3,756
2067	2,285	345	0	0	1,126	3,756
2068	2,290	345	0	0	1,129	3,765
2069	2,285	345	0	0	1,126	3,756
2070	2,285	345	0	0	1,126	3,756
2071	2,285	345	0	0	1,126	3,756
2072	2,290	345	0	0	1,129	3,765
2073	2,285	345	0	0	1,126	3,756
2074	2,285	345	0	0	1,126	3,756
2075	2,285	345	0	0	1,126	3,756
2076	2,290	345	0	0	1,129	3,765
2077	2,285	345	0	0	1,126	3,756
2078	2,285	345	0	0	1,126	3,756
2079	2,285	345	0	0	1,126	3,756

TABLE 3.3 (continued)
UNIT 1, DECON ALTERNATIVE
TOTAL ANNUAL EXPENDITURES
(Thousands of 2024 Dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2080	2,290	345	0	0	1,129	3,765
2081	2,285	345	0	0	1,126	3,756
2082	2,285	345	0	0	1,126	3,756
2083	2,285	345	0	0	1,126	3,756
2084	2,290	345	0	0	1,129	3,765
2085	2,285	345	0	0	1,126	3,756
2086	2,285	345	0	0	1,126	3,756
2087	2,285	345	0	0	1,126	3,756
2088	2,290	345	0	0	1,129	3,765
2089	2,285	345	0	0	1,126	3,756
2090	2,285	345	0	0	1,126	3,756
2091	2,285	345	0	0	1,126	3,756
2092	2,290	345	0	0	1,129	3,765
2093	2,285	345	0	0	1,126	3,756
2094	2,285	345	0	0	1,126	3,756
2095	2,285	345	0	0	1,126	3,756
2096	2,290	345	0	0	1,129	3,765
2097	2,285	345	0	0	1,126	3,756
2098	2,285	345	0	0	1,126	3,756
2099	2,285	345	0	0	1,126	3,756
2100	2,285	345	0	0	1,126	3,756
2101	2,285	345	0	0	1,126	3,756
2102	2,285	345	0	0	1,126	3,756
2103	2,285	345	0	0	1,126	3,756
2104	2,290	345	0	0	1,129	3,765
2105	2,285	345	0	0	1,126	3,756
2106	2,285	345	0	0	1,126	3,756
2107	2,285	345	0	0	1,126	3,756
2108	2,290	345	0	0	1,129	3,765
2109	2,285	345	0	0	1,126	3,756

TABLE 3.3 (continued)
UNIT 1, DECON ALTERNATIVE
TOTAL ANNUAL EXPENDITURES
(Thousands of 2024 Dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2110	2,285	345	0	0	1,126	3,756
2111	2,285	345	0	0	1,126	3,756
2112	2,290	345	0	0	1,129	3,765
2113	2,285	345	0	0	1,126	3,756
2114	2,227	1,423	0	0	13,235	16,885
2115	5,705	3,063	15	4,036	3,838	16,657
Total	570,203	222,453	22,565	79,535	170,360	1,065,116