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DECOMMISSIONING COST STUDY

for the

HUMBOLDT BAY POWER PLANT UNIT 3

2010 SAFSTOR

prepared for

PACIFIC GAS & ELECTRIC COMPANY

prepared by

TLG Services, Inc.
Bridgewater, Connecticut

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EXECUTIVE SUMMARY

TLG Services, Inc. (TLG) has prepared a site-specific cost study for decommissioning the Humboldt Bay Power Plant Unit 3 (HBPP3) for the Pacific Gas and Electric Company (PG&E); this will be referred to as the 2010 SAFSTOR study. This estimate includes a comprehensive cost and schedule estimate for completing the decommissioning of HBPP3 based on outlined work areas of the plant. Manpower levels and activity durations were developed and are reflected within the project schedule along with other associated site programs. This estimate incorporates the site specific decommissioning tasks and detailed plans which have been identified as a result of the ongoing detailed planning effort. The projected total cost to decommission HBPP3, including costs spent to date and a 25% contingency applied to remaining work, is estimated to be approximately $499.8 million (2008 dollars).

The California Public Utility Commission (CPUC) has previously ruled that certain costs that were incurred after HBPP3 was permanently shutdown would not be included in rates for recovery of decommissioning costs. The costs associated with decommissioning activities on systems and components which have been identified by the CPUC as decommissioning disallowances is estimated at $385,520.

The major cost contributors to the overall decommissioning cost are labor, spent fuel storage and the disposition of waste generated in the decontamination and demolition of the unit. The estimate is based on several key assumptions, including regulatory requirements, estimating methodology, contingency requirements, low-level radioactive waste (LLRW) disposal availability, high-level radioactive waste disposal schedule, and site restoration requirements. A summary of decommissioning cost contributors is provided at the end of this section and a complete discussion of the assumptions used in this estimate is presented in Section 3.

Alternatives and Regulations

The Nuclear Regulatory Commission (NRC) provided general decommissioning guidance in the rule adopted on June 27, 1988.[1] In this rule the NRC sets forth technical and financial criteria for decommissioning licensed nuclear facilities. The regulation addresses planning needs, timing, funding methods, and environmental review requirements for decommissioning. The rule also defined three

1 U.S. Code of Federal Regulations, Title 10, Parts 30, 40, 50, 51, 70 and 72 "General Requirements for Decommissioning Nuclear Facilities," Nuclear Regulatory Commission, Federal Register Volume 53, Number 123 (p 24018+), June 27, 1988.

decommissioning alternatives as being acceptable to the NRC — DECON, SAFSTOR and ENTOMB.

> DECON was defined as "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." [2]
>
> SAFSTOR was defined 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." [3]
>
> ENTOMB was defined as "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 radioactive material decays to a level permitting unrestricted release of the property." [4]

In 1996, the NRC published revisions to the general requirements for decommissioning nuclear power plants to clarify ambiguities and codify procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process. The amendments allow for greater public participation and better define the transition process from operations to decommissioning. The costs and schedules presented in this estimate follow the general guidance and sequence in the amended regulations.

Methodology

The methodology used to develop the decommissioning cost estimates for HBPP3 follows the basic approach originally presented in the Guidelines.[5] This reference describes a unit factor method for determining decommissioning activity costs. The unit factors used in this analysis incorporates 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

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2 Ibid. Page FR24022, Column 3.
3 Ibid.
4 Ibid. Page FR24023, Column 2.
5 T.S. LaGuardia et al., "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986.

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.

This study assumes that utility and contractor personnel are already experienced in the techniques and technology of nuclear power plant decommissioning, and therefore performs all work (both field activities and project management) in an efficient manner.

Contingency

Consistent with industry practice, contingencies are applied to the decontamination and dismantling costs developed 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."[6] The cost elements in this estimate are based on ideal conditions; therefore, the types of unforeseeable events that are almost certain to occur in decommissioning, based on industry experience, are addressed through a percentage contingency applied on a line-item basis. This contingency factor is a nearly universal element in all large-scale construction and demolition projects. It should be noted that contingency, as used in this analysis, is based on a preliminary technical position [7] to reflect the California Public Utilities Commission's desire for owners to conservatively establish an appropriate contingency factor for inclusion in the decommissioning revenue requirements. It should also be noted that contingency, as used in this estimate, does not account for price escalation and inflation in the cost of decommissioning during the decommissioning period.

Contingency funds are expected to be fully expended throughout the program. As such, inclusion of contingency is necessary to provide assurance that sufficient funding will be available to accomplish the intended tasks.

Low-Level Radioactive Waste Disposal

The contaminated and activated material generated in the decontamination and dismantling of a commercial nuclear reactor is classified as low-level (radioactive)

6 Project and Cost Engineers' Handbook, Second Edition, American Association of Cost Engineers, Marcel Dekker, Inc., New York, New York, p. 239.+

7 "Technical Position Paper for Establishing an Appropriate Contingency Factor for Inclusion in the Decommissioning Revenue Requirements", Study Number: DECON-POS-H002, Revision A, Status: Preliminary (provided by PG&E).

waste, although not all of the material is suitable for "shallow-land" disposal. [8] With the passage of the "Low-Level Radioactive Waste Policy Act" in 1980, [9] and its Amendments of 1985, [10] the states became ultimately responsible for the disposition of low-level radioactive waste (LLRW) generated within their own borders.

Until recently, there were two facilities available to PG&E for the disposal of low-level radioactive waste generated by HBPP3. As of July 1, 2008, however, the facility in Barnwell, South Carolina was closed to generators outside the Atlantic Compact (comprised of the states of Connecticut, New Jersey and South Carolina). This leaves the facility in Clive, Utah, operated by EnergySolutions, as the only available destination for low-level radioactive waste requiring controlled disposal.

For the purpose of this analysis, the EnergySolutions' facility is used as the disposal site (for purposes of determining the cost of transportation and the cost of disposal) for the majority of the radioactive waste (Class A). There are no currently operating disposal facilities available to PG&E that have a license to dispose of the more highly radioactive waste (Classes B and C), for example, generated in the dismantling of the reactor vessel. As such, waste disposal costs and waste transportation distances, and availability must be estimated. The disposal cost and transportation distance for low-level radioactive waste is based on a study sponsored by PG&E and Southern California Edison Company, "Establishing an Appropriate Disposal Rate for Low Level Radioactive Waste During Decommissioning."[11] The study was done to reflect the California Public Utilities Commission's desire for these owners to conservatively estimate their nuclear decommissioning LLRW disposal rates. It is assumed for this estimate that Class B and C waste disposal facilities become available by 2016.

The dismantling of the components residing closest to the reactor core generates 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)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 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. As such, the GTCC radioactive waste has been packaged and disposed of as high-level waste, at a cost equivalent to that envisioned for the spent fuel.

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8 U.S. Code of Federal Regulations, Title 10, Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste"

9 "Low-Level Radioactive Waste Policy Act of 1980," Public Law 96-573, 1980.

10 "Low-Level Radioactive Waste Policy Amendments Act of 1985," Public Law 99-240, 1986.

11 "Establishing an Appropriate Disposal Rate for Low Level Radioactive Waste During Decommissioning", Robert A Snyder NEWEX, Revision 0, July 2008 (provided by PG&E).

For purposes of this study, GTCC is packaged in the same type of canister used for spent fuel. The GTCC material is either stored with the spent fuel at the ISFSI or shipped directly to a DOE facility as it is generated (depending upon the timing of the decommissioning and whether the spent fuel has been removed from the site prior to the start of decommissioning).

High-Level Waste

Congress passed the "Nuclear Waste Policy Act"[12] (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. The 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. Delays continue and, as a result, generators have initiated legal action against the DOE in an attempt to obtain compensation for DOE's breach of contract.

Operation of DOE's yet-to-be constructed repository is contingent upon the review and approval of the facility's license application by the NRC and the successful resolution of pending litigation. The DOE submitted its license application to the NRC on June 3, 2008, seeking authorization to construct the repository at Yucca Mountain, Nevada. Assuming a timely review and adequate funding, the DOE expects that receipt of fuel could begin as early as 2020. [13]

The DOE's generator allocation/receipt schedules are based upon the oldest fuel receiving the highest priority. For purposes of this analysis, acceptance of commercial spent fuel by the DOE is expected to begin in 2020. All assemblies are expected to be removed from the Humboldt Bay site in 2020.

All fuel has been transferred to the ISFSI. The ISFSI will remain operational until 2020.

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12 "Nuclear Waste Policy Act of 1982 and Amendments," DOE's Office of Civilian Radioactive Management, 1982

13 DOE-RW-0604, "Project Decision Schedule", U.S. DOE Office of Civilian Radioactive Waste Management, January 2009".

Site Restoration

The efficient removal of the contaminated materials and verification that residual radionuclide concentrations are below the NRC guidelines will result in substantial damage to many of the site structures. Blasting, coring, drilling, scarification (surface removal), and the other decontamination activities will substantially damage power block structures, potentially weakening the footings and structural supports. This study assumes that the majority of the site buildings are demolished as part of the license termination activities, and any remaining buildings are demolished immediately after license termination.

All demolition debris is assumed to be potentially radioactively contaminated, and therefore transported and disposed of at a Low-Level Radiological Waste (LLRW) disposal facility. This study assumes that structures are removed to a nominal depth of three feet below grade level. Below grade structures will be decontaminated and left in place. Below grade voids are backfilled with clean fill. The site is assumed to be graded and landscaped.

Summary

The costs to decommission HBPP3 were evaluated for a SAFSTOR decommissioning alternative. The estimate includes costs spent-to-date. The estimate assumes the eventual removal of all the contaminated and activated plant components and structural materials, such that the facility operator may then have use of the site with no further requirement for an NRC license. Decommissioning is initiated after the spent fuel has been removed from the spent fuel pool and is accomplished within the 60-year period required by current NRC regulations. The estimate assumes that the spent fuel remains in storage at the site until such time that the transfer to a DOE facility can be completed. Once the transfer is complete, the storage facility is also decommissioned.

A detailed breakdown of these major cost contributors to the decommissioning cost estimate is reported at the end of this section and in Section 6 of this document. Schedules of annual expenditures are provided in Section 3, and detailed cost, waste volume, and man-hour schedules are provided in Appendix D and E. Costs are reported in 2008 dollars. Cash flows and expenditures to date are based on schedule forecasts as of December 2008. The estimate includes the costs for storing the HBPP3 spent fuel until such time that the Department of Energy (DOE) can complete the transfer to an off-site facility.

SUMMARY OF DECOMMISSIONING COST CONTRIBUTORS

Work Category	Costs 08' $ (thousands)	Percent of Total	Costs 04' $ (thousands)
Decontamination	978	0.2%	1,865
Removal	48,360	9.7%	23,899
Packaging	9,258	1.9%	3,087
Shipping	11,722	2.3%	5,578
Waste Processing & Recycling	675	0.1%	8,877
LLRW Burial	77,596	15.5%	17,446
Demolition LLRW Burial	23,872	4.8%	38,528
Staffing	132,760	26.6%	70,516
Security	45,687	9.1%	4,149
License Termination Survey	1,958	0.4%	9,874
Insurance	1,000	0.2%	786
Energy	1,254	0.3%	827
NRC & EP Fees	5,386	1.1%	1,935
NRC ISFSI Fees	1,023	0.2%	3,745
ISFSI Capital, O&M, Fixed & Security	57,798	11.6%	66,391
Non-ISFSI Expenditures	28,015	5.6%	20,282
Equipment & Supplies	28,797	5.8%	28,520
Engineering	23,618	4.7%	11,121
Total	**499,759**	**100.0%**	**317,424**

CPUC Disallowances

Removal	193	50.1%	172
Packaging	21	5.5%	14
Shipping	4	0.9%	5
Waste Processing & Recycling	0	0.0%	30
LLRW Burial	165	42.8%	135
Equipment & Supplies	3	0.7%	2
Total	**386**	**100.0%**	**357**

1. INTRODUCTION

TLG prepared this decommissioning cost estimate to provide Pacific Gas and Electric Company (PG&E) with sufficient information to prepare the financial planning documents for decommissioning, as required by the Nuclear Regulatory Commission (NRC). It is not a detailed engineering document, but a financial analysis prepared in advance of the detailed engineering that will be required to carry out the decommissioning.

1.1 OBJECTIVE OF STUDY

The objective of the study is to prepare a comprehensive estimate of the cost, a schedule of the associated activities, and an estimate of the volume of radioactive waste generated during decommissioning of the Humboldt Bay Power Plant Unit 3 (HBPP3).

1.2 SITE DESCRIPTION

HBPP3 is located approximately four miles southwest of Eureka, California. The site consists of approximately 143 acres located on the mainland shore of Humboldt Bay. Figure 1.1 shows the layout of the site and the surrounding area. The adjacent generating units (Units 1 and 2) are fossil-fueled and are not considered in the scope of this study, except where noted.

The Nuclear Steam Supply System (NSSS) for HBPP3 consists of a single cycle, natural circulation, boiling water reactor and the associated control and support systems. Figure 1.2 shows a schematic diagram of the reactor pressure vessel and internal components. The generating unit had a rated core thermal power of 220 MWth (thermal) with a corresponding net electrical output of 65 MWe (electric).

The NSSS is located within the "primary containment structure." The primary containment is located mostly below grade and consists of a drywell vessel and a suppression chamber. Both the drywell and the suppression chamber area are located within a reinforced concrete caisson. The drywell vessel is centrally located in the caisson and serves as the primary containment vessel. The suppression chamber is constructed of reinforced concrete and lined with carbon steel plate. Six vent pipes connect the drywell to a common ring header at the top of the suppression chamber. Downcomers drop from the ring header and terminate below the normal water level of the suppression pool. As a system, the drywell, suppression chamber, and interconnecting piping were designed to reduce the pressure increase in the event of a local process system piping failure.

Figure 1.3, a sectional view through the caisson, depicts this general arrangement and the associated concrete structure.

The turbine-generator system converts heat produced in the reactor to electrical energy. This system converted the thermal energy of steam produced in the reactor vessel into mechanical shaft power and then into electrical energy. The unit's turbine-generator consists of a tandem, compound, double flow, condensing turbine directly connected to a 13,800V, 3-phase, 60 cycle, hydrogen-cooled, synchronous generator. The turbine consists of a single flow high-pressure section and a double flow, low-pressure section with a crossover pipe connecting the two sections. The turbine was operated in a closed feedwater cycle whereby steam was condensed and the condensate/feedwater was returned to the reactor vessel. Heat rejected in the main condenser was removed by the Circulating Water System (CWS). The CWS delivers the water required to remove the heat load from the main condenser and other auxiliary equipment and returns it to the bay through the discharge pipes and a canal.

Commercial operation began in August of 1963 and continued until July of 1976, at which time the unit was shut down after approximately 13 years of operation to conduct seismic modifications. In 1983 PG&E announced the decision to decommission Unit 3. The plant has been maintained in NRC SAFSTOR since that time. Fuel transfer to the ISFSI has been completed.

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.[1]* 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,"[2] 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.

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* Annotated references for citations in Sections 1-6 are provided in Section 7.

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. The rule also placed limits on the time allowed to complete the decommissioning process. For SAFSTOR, 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. The guidelines for ENTOMB are similar, providing the NRC with both sufficient leverage and flexibility to ensure that these deferred options are only used in situations where it is reasonable and consistent with the definition of decommissioning. At the conclusion of a 60-year dormancy period (or longer for ENTOMB if the NRC approves such a case), the site would still require significant remediation to meet the unrestricted release limits for license termination.

The ENTOMB alternative has not been viewed as a viable option for power reactors due to the significant time required to isolate the long-lived radionuclides for decay to permissible levels. However, with recent rulemaking permitting the controlled release of a site, the NRC has re-evaluated this alternative.[3] The resulting feasibility study, based upon an assessment by Pacific Northwest National Laboratory, concluded that the method did have conditional merit for some, if not most, reactors. However, the staff also found that additional rulemaking would be needed before this option could be treated as a generic alternative. The NRC had considered rulemaking to alter the 60-year time for completing decommissioning and to clarify the use of engineered barriers for reactor entombments.[4] However, the NRC staff has recommended that rulemaking be deferred, based upon several factors, e.g., no licensee has committed to pursuing the entombment option, the disposition of greater-than-Class C material (GTCC) using this option, and the NRC's current priorities, at least until after the additional research studies are complete. The Commission concurred with the staff's recommendation.

The NRC published revisions to the general requirements for decommissioning nuclear power plants in 1996.[5] When the regulations were originally adopted in 1988, it was assumed that the majority of licensees would decommission at the end of the facility's operating licensed life. Since that time, several licensees permanently and prematurely ceased operations. Exemptions from certain operating requirements were required once the reactor was defueled to facilitate the decommissioning. Each case was handled individually, without clearly defined generic requirements. The NRC amended the decommissioning regulations in 1996 to clarify ambiguities and codify procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process. The new amendments allow for greater public participation and better define the transition process from operations to decommissioning.

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 will entitle the licensee to a fee reduction and eliminate the obligation to follow certain requirements needed only during operation of the reactor. Within two years of submitting notice of permanent cessation of operations, the licensee is required to submit a Post-Shutdown Decommissioning Activities Report (PSDAR) to the NRC. The PSDAR describes the planned decommissioning activities, the associated sequence and schedule, and an estimate of expected costs. Prior to completing decommissioning, the licensee is required to submit an application to the NRC to terminate the license, which will include a License Termination Plan (LTP).

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. The 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. Delays continue and, as a result, generators have initiated legal action against the DOE in an attempt to obtain compensation for DOE's breach of contract.

Operation of DOE's yet-to-be constructed repository is contingent upon the review and approval of the facility's license application by the NRC and the successful resolution of pending litigation. The DOE submitted its license application to the NRC on June 3, 2008, seeking authorization to construct the repository at Yucca Mountain, Nevada. Assuming a timely review and adequate funding, the DOE expects that receipt of fuel could begin as early as 2020. [7]

It is generally necessary that spent fuel be actively cooled and stored for a minimum period at the generating site prior to transfer. As such, the NRC requires that licensees establish a program to manage and provide funding for the management of all irradiated fuel at the reactor site until title of the fuel is transferred to the Secretary of Energy, pursuant to 10 CFR Part 50.54(bb). [8] This funding requirement is fulfilled through inclusion of certain cost elements in the decommissioning estimate, for example, associated with the continued operation of the ISFSI.

DOE's contracts with utilities order the acceptance of spent fuel from utilities based upon the oldest fuel receiving the highest priority. For purposes of this analysis, acceptance of commercial spent fuel by the DOE is expected to begin in 2020 (in accordance with DOE's latest published schedule). Since the estimate assumes that all spent fuel will be transferred to the DOE during the first year, the estimate includes spent fuel caretaking costs through the year 2020.

1.3.2 Low-Level Radioactive Waste Policy Amendments Act

The contaminated and activated material generated in the decontamination and dismantling of a commercial nuclear reactor is classified as low-level (radioactive) waste, [9] although not all of the material is suitable for "shallow-land" disposal. With the passage of the "Low-Level Radioactive Waste Policy Act" in 1980, [10] and its Amendments of 1985, [11] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

Until recently, there were two facilities available to PG&E for the disposal of low-level radioactive waste generated by Humboldt. As of July 1, 2008, however, the facility in Barnwell, South Carolina was closed to generators outside the Atlantic Compact (comprised of the states of Connecticut, New Jersey and South Carolina). This leaves the facility in Clive, Utah, operated by EnergySolutions, as the only available destination for low-level radioactive waste requiring controlled disposal.

For the purpose of this analysis, the EnergySolutions' facility is used as the disposal site for the majority of the radioactive waste (Class A). There are no currently operating disposal facilities available to PG&E that have a license to dispose of the more highly radioactive waste (Classes B and C), for example, generated in the dismantling of the reactor vessel. As such, waste disposal costs must be estimated. The disposal cost for low-level radioactive waste is based on a study sponsored by PG&E and Southern California Edison Company, "Establishing an Appropriate Disposal Rate for Low Level Radioactive Waste During Decommissioning."[12] The study was done to reflect the California Public Utilities Commission's desire for these owners to conservatively estimate their nuclear decommissioning LLRW disposal rates. Although no current licensed facility exists for Class B and C waste, the study assumes that a facility will be available by 2016 to support decommissioning.

The dismantling of the components residing closest to the reactor core generates 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)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 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. As such, the GTCC radioactive waste has been packaged and disposed of as high-level waste, at a cost equivalent to that envisioned for the spent fuel.

For purposes of this study, GTCC is packaged in the same type of canister used for spent fuel. The GTCC material is either stored with the spent fuel or shipped directly to a DOE facility as it is generated (depending upon the timing of the decommissioning and whether the spent fuel has been removed from the site prior to the start of decommissioning).

1.3.3 Radiological Criteria for License Termination

In 1997, the NRC published Subpart E, "Radiological Criteria for License Termination,"[13] amending 10 CFR §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 for HBPP3 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. The EPA has two limits that apply to radioactive materials. An EPA limit of 15 millirem per year is derived from criteria established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund).[14] An additional limit of 4 millirem per year, as defined in 40 CFR §141.16, is applied to the drinking water exposure pathway.[15]

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.

FIGURE 1.1

LAYOUT OF THE NUCLEAR PLANT SITE AND SURROUNDING AREA

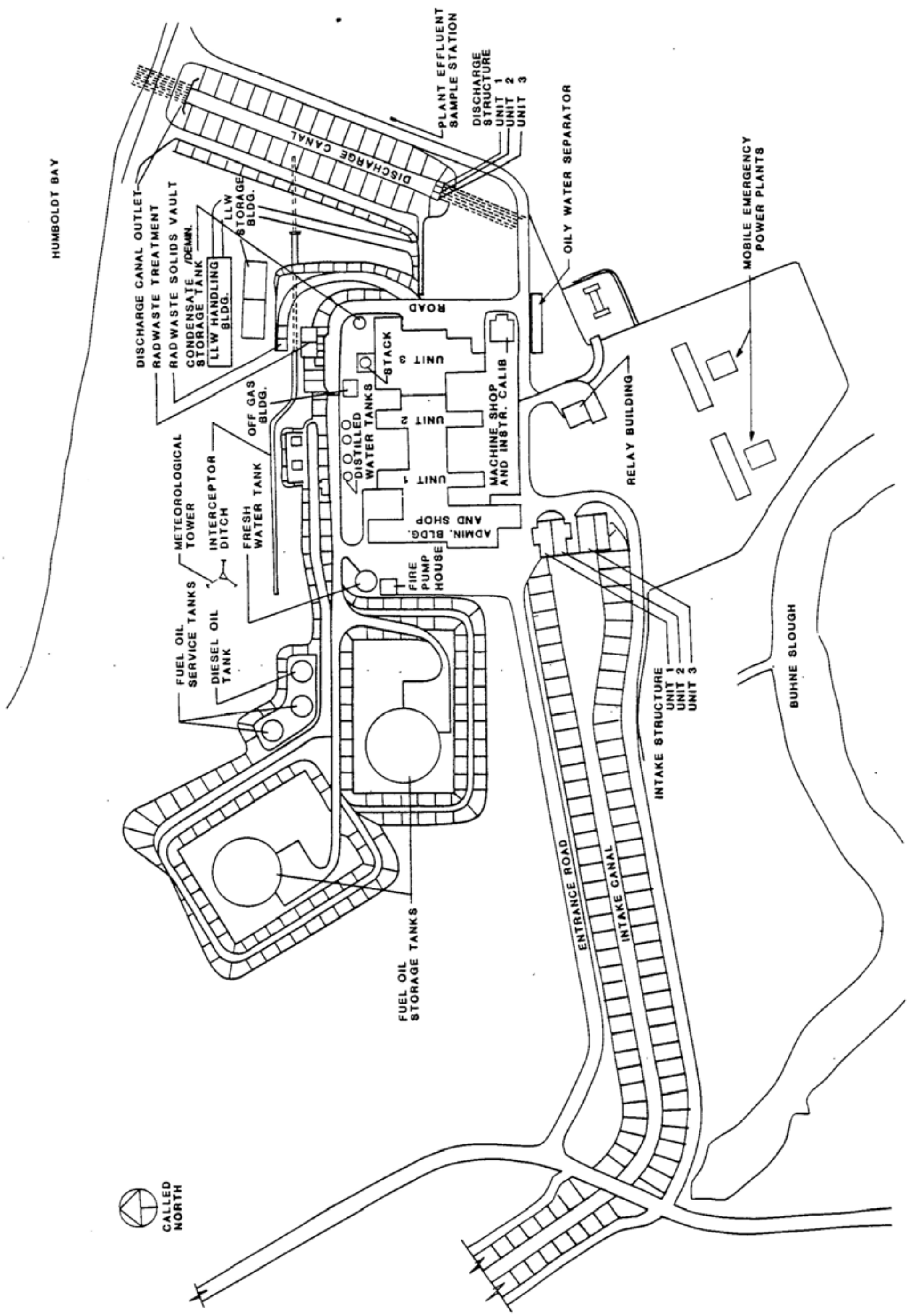


FIGURE 1.2

SCHEMATIC DIAGRAM OF THE VESSEL AND INTERNALS

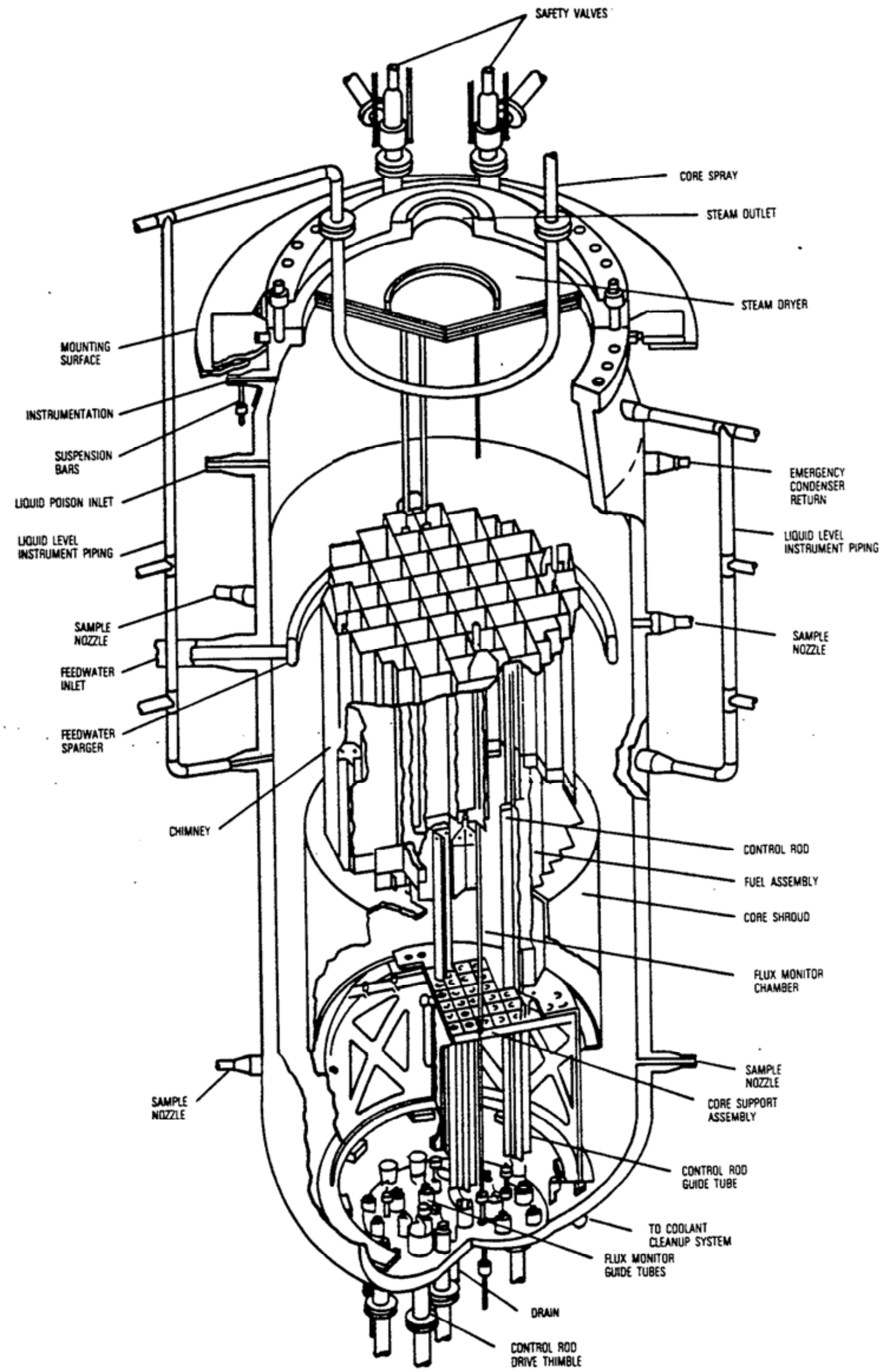
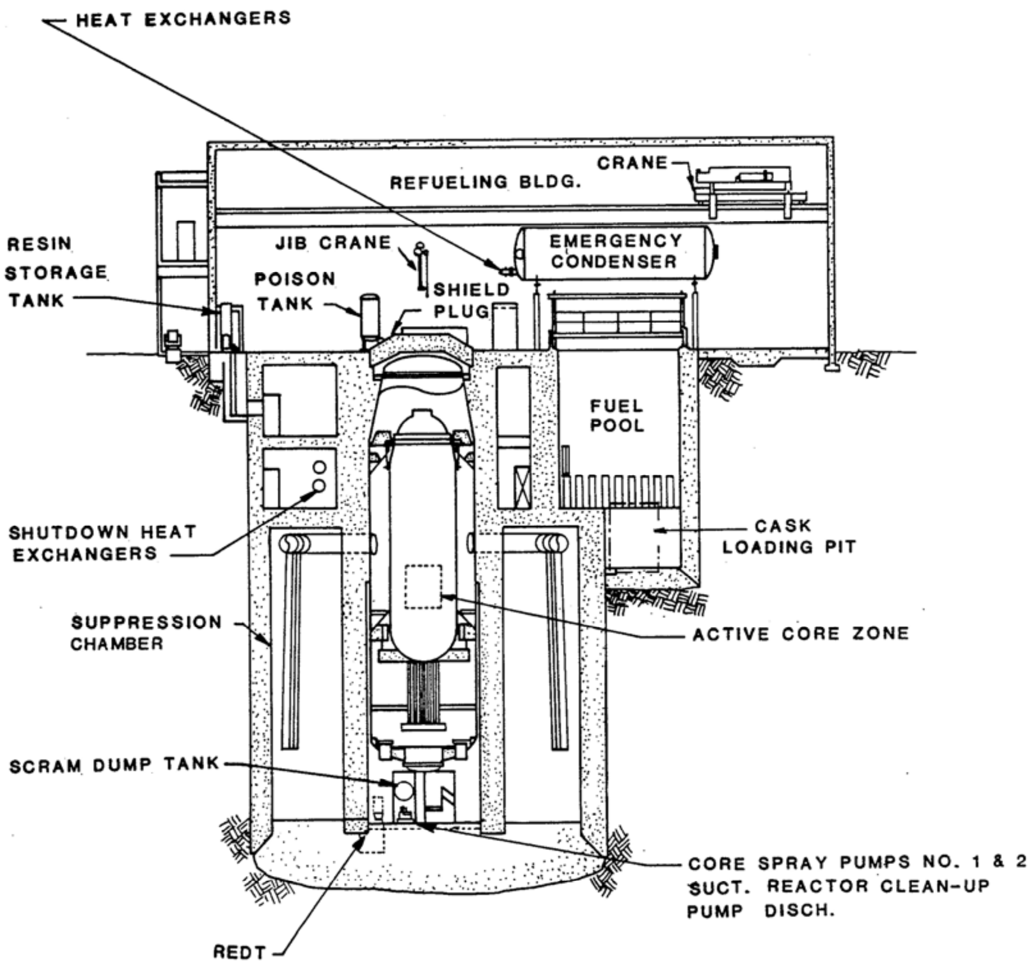


FIGURE 1.3

SECTIONAL VIEW THROUGH THE CAISSON



2. SAFSTOR DECOMMISSIONING ACTIVITIES

This section describes the activities associated with the decontamination and disassembly of the plant. 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 understanding the expected scope of work, i.e., engineering and planning at the time of decommissioning.

The operation, shut down, and safe storage of the nuclear unit were described in detail in the decommissioning plan, "SAFSTOR Decommissioning Plan for the Humboldt Bay Power Plant, Unit No. 3". [17] The activities and associated costs expended prior to 1996, and routine operations and maintenance costs for dormancy, are not included in the estimate. This study understanding specifically addresses those activities and costs associated with the conclusion of the safe storage period and the subsequent decommissioning process.

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 a level that permits release for unrestricted use." The decommissioning scenario evaluated in this study presumes that final decommissioning activities will start in 2010.

The SAFSTOR decommissioning plan prepared by PG&E primarily addressed the activities and tasks related to preparing and maintaining the facility in safe storage. The document was originally intended to be revised (updated) prior to initiating decommissioning activities in the year 2007. Under the current NRC decommissioning requirements, the SAFSTOR Decommissioning Plan was considered to be both a Preliminary Shutdown Decommissioning Activities Report (PSDAR) and a Defueled Safety Analysis Report (DSAR). As a result, PG&E submitted a PSDAR in February 1998 that describes planned decommissioning activities and associated schedule and cost.[18] The SAFSTOR Decommissioning Plan was renamed the DSAR, and it contains system descriptions, administrative controls, and accident analysis. PG&E will submit a License Termination Plan at least two years prior to license termination.

The current NRC guidance (Reg. Guide 1.184 Decommissioning of Nuclear Power Reactors) defines decommissioning in three phases. The current plant status (safe storage) is addressed in Phase II. This phase is applicable to the dormancy phase of the deferred decommissioning alternatives. Phase III pertains to the activities involved in license termination.

The TLG cost estimating methodology subdivides the decommissioning project into periods, based upon major milestones in the project. Continuing Phase II expenses are included in Period 2 of this study, Phase III, includes the activities associated with license termination, is subdivided into Periods 3 and 4 in the cost estimate. Period 5 includes those activities required for site restoration. Post-Period 5 covers ISFSI operations, fuel transfer to the DOE, and ISFSI demolition.

2.1 PERIOD 2 – SAFE STORAGE AND DECOMMISSIONING PREPARATIONS

With the recent completion of spent fuel transfer to the ISFSI, the emphasis has shifted to activities associated with preparation for active decommissioning tasks. Site activities include: preventive and corrective maintenance on essential systems, general building maintenance, operation and maintenance of heating and ventilation equipment, routine radiological inspections of contaminated structures, maintenance of structural integrity, and monitoring of environmental and radiation conditions.

The estimate includes some specific decommissioning preparation line items based upon the in depth planning activities which have occurred prior to and including 2008.

The following additional preparatory activities have occurred or are scheduled to occur prior to the start of formal decommissioning: abatement of remaining asbestos, performance of a vessel and internals activation analysis, performance of a radiological characterization survey of work areas, major components, and structures (including the drywell), sampling of internal piping and primary shield cores, development of cost and work control program, development of detailed work plans and schedules, development of a radioactive waste processing and disposal plan, and the development of the engineering decommissioning licensing basis.

2.2 PERIOD 3 - PREPARATIONS

In anticipation of decommissioning, preparations are undertaken to provide a smooth transition from safe storage. The organization required to plan and manage the intended decommissioning activities is assumed to be assembled from available utility staff and outside resources, as required. For purposes of this study, a combination of utility and outside contracted resources is utilized to manage the decommissioning and to manage and perform the physical decommissioning activities and associated management functions. A combination of utility staff and outside contracted resources will be employed to manage the processing and disposal of decommissioning waste, including the disposition of equipment, components, and material and the disposal of all decommissioning waste, including concrete and steel structural debris, contaminated soil, and associated hazardous and mixed waste.

2.2.1 Engineering and Planning

Significant technical and engineering planning and evaluation must be performed in preparation for physical decommissioning activities. Technical requirements documents are prepared for systems, components, and structures during each phase of the decommissioning (many of these requirements documents are already complete). These engineering requirements are then transferred into specific documents for the preparation of material and services contracts and for the preparation of detailed work plans and work authorization documents. Also, regulations require the preparation of a license termination plan. The plan is required at least two years prior to the anticipated date of license termination. The plan includes a site characterization, description of the remaining dismantling activities, plans for site remediation, procedures for the final radiation survey, designation of any reuse of the site, an updated cost estimate to complete the decommissioning, and resolution of environmental concerns. The NRC will make the plan available for public comment. Plan approval will be subject to conditions and limitations as deemed appropriate by the NRC. Much of the information needed in preparing this submittal will have been used to develop the detailed engineering plans and procedures needed to support Period 4 activities.

Other engineering and planning work activities performed during Period 3 include: evaluating alternatives for the removal of highly radioactive reactor vessel components, identifying specialty contractors, selecting the methodology and requirements for systems and structures decontamination, preparing procedures for radioactive material disposal, and designing and procuring specialty tooling.

2.2.2 Site Preparations

In preparation for the actual decommissioning, the following physical tasks are performed and included in the cost estimate:

- The design and licensing of the ISFSI facility (completed).
- Constructing and modifying site support and storage facilities, as required (in progress).

- Processing and disposal of residual liquid, solid, and mixed waste inventories (in progress).

- Procuring waste containers, including specialty containers for the disposition of highly activated and hazardous materials. The types of containers needed to support decommissioning operations include strong-tight steel boxes and drums, shielded transport casks, dry fuel storage liners, high integrity containers, intermodal containers, and shipping transportation trailers.

- Developing procedures for occupational exposure control, control and release of liquid and gaseous effluent, processing of radwaste including dry active waste (DAW), resins, filter media, metallic and non-metallic components generated in decommissioning, site security and emergency programs, hazardous waste identification and processing, and industrial safety.

2.3 PERIOD 4 - DECOMMISSIONING OPERATIONS AND LICENSE TERMINATION

The decommissioning cost estimate has divided this period into sub-periods to assist in the development of cost elements and to better understand the work sequence and its impact on the overall duration of the work phase.

2.3.1 System Removal

This phase includes: construction of temporary facilities and shielding, modification of existing storage facilities to support the dismantling activities, decontamination of selected systems and components, procurement of specialty tooling, and modifications to systems and structures to support handling of the waste from reactor vessel and spent fuel pool removal.

The following is the list of the system and component removal activities performed during this sub-period.

- Removal of major turbine components, e.g. generator, turbine and condenser.

- Removal of components and systems in the Turbine Building, including piping, pumps, heat exchangers and associated mechanical and electrical components.

- Removal of electrical control boards, distribution buses, and transformers.

- Provide equipment handling capability and personnel access to equipment and components within the Refuel Building.

- Remove equipment and components in the Refuel Building.

- Removal of Hot Machine Shop equipment and piping.

2.3.2 Reactor Vessel Removal

The following is a list of the system and component removal activities performed during this sub-period:

- Removal of the reactor vessel closure head. The head is assumed to be disposed of as low-level radioactive waste. Segmentation of the head may be desirable to increase packaging efficiency and minimize its disposal volume.

- Removal and segmenting of the steam dryer, core spray piping, feedwater sparger and chimney, as required, for transport. Component segmentation may be performed in the reactor vessel; however, relocation to the spent fuel pool would allow greater control with respect to water clarity and provide greater flexibility in packaging, i.e., homogenization of the waste forms. Material meeting 10 CFR 61 Class C criteria or less may be routed for off-site disposal at a commercial shallow-land waste disposal facility.

- Disassembly/segmentation of remaining reactor internals, including the core shroud, core support assembly, control rod guide tube and other miscellaneous components. These operations will probably be confined to the reactor vessel due to the higher activation levels of the components.

- Segmentation/sectioning of the reactor vessel, placing segments into shielded containers. The operation is performed remotely, in-air, using a shielded work platform and a contamination control envelope. Sections are placed in liners and stored in the spent fuel pool. The liners are loaded into shielded transport casks for disposal at a commercial shallow-land waste disposal facility.

- Removal of control rod drive housings from reactor vessel bottom head and packaging for controlled disposal. The bottom head may be highly contaminated from the swarf generated from in-vessel segmentation activities. It may be advantageous to relocate the head to the spent fuel pool for additional processing and preparation for disposal. This will also significantly lower the working radiation levels within the drywell and allow disassembly work to proceed.

- Removal of systems and associated components as they become non-essential to the vessel removal operation, related decommissioning activities, or worker health and safety (e.g., waste collection and processing systems, electrical and ventilation systems, etc.).

- Removal of steel drywell liner and decontamination of the steel vent pipes connecting the drywell to the suppression chamber. Contaminated surfaces can be designated for decontamination while activated portions are packaged for direct disposal. This work would also include the removal of activated concrete from behind the drywell steel and the concrete floor slab at the bottom of caisson, and packaging the material for direct disposal.

- Decontamination and removal of the suppression chamber steel, disposition of the waste as appropriate.

- Removal of contaminated equipment and material from the Radwaste Treatment and Refueling Buildings. Decontaminate the structures, e.g., scarifying concrete surfaces until residual levels of contamination are acceptable for unrestricted release.

- Decontamination of remaining contaminated site buildings and facilities. Package and dispose of all remaining low-level radioactive waste, and any remaining hazardous and toxic materials.

- Removal of remaining components, equipment, and plant services in support of the area release survey(s).

- Removal of contaminated soil and contaminated drain and catch basins. Remediation of the intake and discharge canals.

Components removed in the decontamination and dismantling of HBPP3 will be routed to an on-site central packaging and processing area. Contaminated material will be characterized and packaged for disposal at the designated low-level radioactive waste disposal facility. Material that has been surveyed and found to be free of contamination will be released as scrap.

2.3.3 Prepare Buildings for Demolition

Buildings in the Restricted Area (RA) will be decontaminated as necessary to allow conventional demolition. Structures will be removed down to three feet below grade.

Remaining systems will be removed, surveyed and either released or disposed of as radioactive waste.

Building decontamination debris and waste soil will be shipped using intermodal containers via truck to a LLRW disposal facility.

The internally contaminated pipe tunnel between the Radwaste Building and Turbine Building is expected to be filled with concrete, the soil surrounding the tunnel excavated, and the tunnel will be segmented into blocks and shipped to and disposed of at a LLRW disposal facility.

The spent fuel pool walls (the 3 exterior walls) and tremie floor beneath the pool will be removed and disposed of as radioactive waste. Removal of the walls and tremie requires special engineering controls due to the depth of the structures and soil conditions. A combination of ground freezing and sheet pile is expected to be utilized to provide access to this area.

2.3.4 Building Demolition, Yard Work, Soil Remediation

Buildings in the Restricted Area (RA) will be demolished using conventional demolition. Most structures (including the Refuel Building and Turbine Building) will be removed down to three feet below grade. Buildings entirely at grade will be completely removed. The Radwaste Building will also be removed in its entirety.

Contaminated soil will be excavated, and processed as needed to remove excess moisture.

Building demolition debris and contaminated soil will be packaged in intermodal containers and transferred via highway transport to EnergySolutions.

2.3.5 Final Site Survey – License Termination

At least two years prior to the anticipated date of license termination, an LTP is required. Submitted as a supplement to the Final Safety Analysis Report (FSAR) or its 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 Commission.

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)."[19] 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 survey is 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 terminate the operating license 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 facility is suitable for release.

2.4 PERIOD 5 - SITE RESTORATION

Excavated areas will be backfilled to grade using clean fill. The existing intake and discharge canals will also be backfilled.

Site areas affected by the dismantling activities are cleaned and the plant area graded as required to prevent ponding and inhibit the refloating of subsurface materials.

The remaining Class B & C radioactive waste will be shipped and disposed of at a yet to be approved licensed Class B/C disposal facility (assumed for purposes of the estimate to be Andrews County, Texas).

2.5 POST-PERIOD 5 - ISFSI OPERATIONS AND DEMOLITION

The ISFSI will operate under a separate and independent license (10 CFR §72) following the termination of the §50 operating license. The ISFSI will continue to operate until all spent fuel and greater than Class C (GTCC) material has been transferred to the DOE. This study assumes that the DOE will transfer all spent fuel from HBPP3 in the year 2020.

At the conclusion of the transfer process, the ISFSI will be decommissioned. The storage modules are not assumed to be activated from the storage of fuel, due to the age of the fuel when placed in the modules and the relatively short residence time. Consequently, this estimate does not include the cost of any significant decontamination of the ISFSI facility. Confirmation of the radiological status will be obtained through surveys and sampling of the modules.

The Commission will terminate the ISFSI 10 CFR 72 license when 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 structure is suitable for release. Once the requirements are satisfied, the NRC can terminate the license for the ISFSI.

The assumed design for the ISFSI is based upon the use of a multi-purpose canister installed in a steel-lined below grade engineered concrete vault. For purposes of this cost analysis, it is assumed that once the inner canisters containing the spent fuel assemblies have been removed, required decontamination performed, and the license for the facility terminated, the concrete vault can be dismantled using conventional techniques for the demolition of reinforced concrete. After removal of the concrete vault and loading ramps the area will be graded and landscaped to conform to the surrounding environment.

3. COST ESTIMATE

A site-specific cost estimate was prepared for decommissioning HBPP3. The estimate accounts for the unique features of the site, including the nuclear boiler, electric power generating systems, structures, and supporting facilities. The estimate incorporates the site specific and special tasks that have been defined as a result of the ongoing decommissioning planning. The basis of the estimate and the sources of information, methodology, site-specific considerations, assumptions, and total costs are described in this section.

3.1 BASIS OF ESTIMATE

The estimate was developed using work areas as the incremental unit. As part of the 1997 cost estimate, each accessible area was visually inspected and a physical inventory of equipment, commodities and structural components of each area was documented. Specific consideration included material accessibility and egress, radiological conditions, and physical limitations for staging work crews. The current estimate maintains these work area designations and incorporates changes in decontamination and dismantling techniques based on ongoing on-site planning. The current estimate reflects the changes in the inventory which have occurred since the original estimate was performed.

Drawings and other documentation were used to plan and schedule activities in high radiation areas and areas currently inaccessible due to the plant's configuration. The unit factors used in developing equipment and component removal costs were adjusted for the working conditions determined for each area. Adaptation of the unit factors was accomplished by the manipulation of the duration adjustment variables or "Work Difficulty Factors" (WDF's).

The waste stream is assumed to be transferred to an on-site radioactive waste handling area for packaging and disposal preparation. Class A low-level radioactive waste generated in the decontamination and dismantling of HBPP3 is assumed to be buried at a LLRW disposal facility. Class B and C low-level radioactive waste is assumed to be stored onsite until a Class B/C disposal facility becomes available.

Spent fuel has been relocated to the ISFSI. This allows for decontamination and dismantling activities to proceed on the refueling building without the constraint to maintain active spent fuel storage pool systems and services, as well as to eliminate any safety issues associated with dismantling activities in the vicinity of the pool.

HBPP3 above grade structures will be demolished using standard methods and all demolition debris will be shipped off site to a LLRW disposal facility. Below grade portions of structures such as the Refuel and Turbine Buildings will be decontaminated and left in place. The Radwaste Building will be removed in its entirety.

As the licensee, PG&E will oversee the decommissioning operations. The plant staff will be augmented with the resources necessary to ensure a safe and efficient operation. This organization will supervise the decontamination and dismantling of the nuclear unit. Oversight will continue in a reduced capacity during site restoration and beyond, as dictated by the management of the spent fuel.

3.2 METHODOLOGY

The methodology used to develop the estimates follows the basic approach originally presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,"[20] and the DOE "Decommissioning Handbook."[21] 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. The activity-dependent costs were 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 relied upon information available in the industry publication, "Building Construction Cost Data," published by R.S. Means.[22]

This analysis reflects lessons learned from TLG's involvement in the Shippingport Station Decommissioning Project, completed in 1989, as well as the decommissioning of the Cintichem reactor, hot cells, and associated facilities, completed in 1997. In addition, the planning and engineering for the Pathfinder, Shoreham, Rancho Seco, Trojan, Yankee Rowe, Big Rock Point, Maine Yankee, Humboldt Bay-3, Oyster Creek, Connecticut Yankee, and San Onofre-1 nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

The unit factor method provides a demonstrable basis for establishing reliable cost estimates. The detail available in the unit cost factors for activity time, labor (by craft), and equipment and consumable costs provide assurance that cost elements has not been omitted. These detailed unit cost factors, coupled with the plant-specific inventory of piping, components, and structures provide a high degree of confidence in the reliability of the cost estimates.

Work Difficulty Factors

WDF were assigned to each area, commensurate with the inefficiencies associated with working in confined hazardous environments. The ranges used for the WDFs are as follows:

Access Factor	0% - 75%
Respirator Protection Factor	0% - 100%
Radiation/ALARA Factor	0% - 100%
Protective Clothing Factor	0% - 100%
Work Break Factor	8.33%
Alpha Adjustment Factor	0% - 200%

These factors and their associated range of values were developed in conjunction with the Atomic Industrial Forum's guideline. The factors (and their suggested application) are discussed in more detail in that publication. The WDF assigned to each work area is delineated in Appendix A.

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 radiologically 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 are based upon productivity information available from the "Building Construction Cost Data" publication.

PG&E established the work sequence and duration based upon the length of time and resources required to prepare for and remove the reactor vessel and internals. 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.

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 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 the 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 analysis 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"[23] 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 analysis are based upon ideal conditions and maximum efficiency; therefore, consistent with industry practice, contingency is included. 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 analysis, includes contingency based on a preliminary technical position[24] to reflect the California Public Utilities Commission's desire for owners to conservatively establish an appropriate contingency factor for inclusion in the decommissioning revenue requirements.

Contingency Based on AIF Guidelines

As stated in the AIF study 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 ranged 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%
• 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%
• Taxes and Fees	10%
• Insurance	10%
• Staffing	15%

The contingency values are applied to the appropriate components of the estimates on a line item basis. The composite contingency value (excluding additional contingency described in the Preliminary Technical Position) is 21.7%.

<u>Contingency Based on Preliminary Technical Position</u>

In addition to the contingency based on the AIF guidelines additional contingency was added to reflect the California Public Utilities Commission desire for owners to conservatively establish an appropriate contingency factor for inclusion in the decommissioning revenue requirements. Based on the previously referenced technical position, additional contingency was added to reflect an overall project contingency of 25%. This contingency was incorporated on a line item basis, with each line item receiving a pro-rated share of the increase.

3.3.2 Financial Risk

In addition to the routine uncertainties addressed by contingency, another cost element that is sometimes necessary to consider when bounding decommissioning costs relates to uncertainty, or risk. 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." Included within the category of financial risk are:

- Transition activities and costs: ancillary expenses associated with eliminating 50% to 80% of the site labor force shortly after the cessation of plant operations, added cost for worker separation packages throughout the decommissioning program, national or company-mandated retraining, and retention incentives for key personnel.

- Delays in approval of the decommissioning plan due to intervention, public participation in local community meetings, legal challenges, and national and local hearings.

- Changes in the project work scope from the baseline estimate, involving the discovery of unexpected levels of contaminants, contamination in places not previously expected, contaminated soil previously undiscovered (either radioactive or hazardous material contamination), variations in plant inventory or configuration not indicated by the as-built drawings.

- Regulatory changes, for example, affecting worker health and safety, site release criteria, waste transportation, and disposal.

- Policy decisions altering national commitments (e.g., in the ability to accommodate certain waste forms for disposition), or in the timetable for such, for example, the start and rate of acceptance of spent fuel by the DOE.

- Pricing changes for basic inputs such as labor, energy, materials, and disposal. Items subject to widespread price competition (such as materials) may not show significant variation; however, others such as waste disposal could exhibit large pricing uncertainties, particularly in markets where limited access to services is available.

It has been TLG's experience that the results of a risk analysis, when compared with the base case estimate for decommissioning, indicate that the chances of the base decommissioning estimate's being too high is a low probability, and the chances that the estimate is too low is a higher probability. This is mostly due to the pricing uncertainty for low-level radioactive waste burial, and to a lesser extent due to schedule increases from changes in plant conditions and to pricing variations in the cost of labor (both craft and staff). This cost study, however, does not add any additional costs to the estimate 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 CONSIDERATIONS

3.4.1 Spent Fuel Disposition

The ISFSI design consists of a multi-purpose (storage and transport) dry canister within a vertical multi-purpose steel cask. The ISFSI is also designed and sized to handle one container of greater than Class C (GTCC) waste that will be generated during the reactor vessel dismantling. The ISFSI will operate until 2020, the current projected date for the DOE to remove all spent fuel from the facility. Any delays in the transfer date to the DOE will increase the overall operations and maintenance cost.

The cost estimate includes the cost for the ISFSI canisters, the concrete storage facility, the road to the storage facility, and all engineering, construction, licensing, and cask handling (most of these costs have been incurred, see cost table ISFSI Completed Projects). The decommissioning cost estimate includes costs for operation, maintenance, inspections, and security.

3.4.2 Reactor Vessel and Internal Components

The reactor vessel and internal components will be segmented in place and transported for disposal in shielded transportation casks. Segmentation of the less activated components is performed in the spent fuel storage pool to the extent practical. The highly activated components can be disassembled in the vessel as long as water clarity is maintained. The vessel is segmented in place, using a mast-mounted cutter.

The dismantling of the reactor internals will generate radioactive waste considered unsuitable for shallow land disposal, i.e., GTCC. Although the material is not classified as high-level waste, the DOE has indicated it will accept this waste for disposal at the future high-level waste repository.[25] However, the DOE has not been forthcoming with an acceptance criteria or disposition schedule for this material, and numerous questions remain as to the ultimate disposal cost and waste form requirements. As such, for purposes of this study, the GTCC has been packaged and disposed of as high-level waste, at a cost equivalent to that envisioned for the spent fuel. It is not anticipated that the DOE would 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 HBPP3 site.

Feedwater 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) is dropped below the nozzles.

The estimate further assumes that the fuel failures that occurred released fission products at sufficiently low levels that the buildup of quantities of long-lived isotopes has been prevented from reaching levels exceeding those which permit the major NSSS components to be shipped under current DOT regulations and to be buried within the requirements of 10 CFR 61.

The cost to remove and dispose of 48 control rod blades is included in the estimate.

3.4.3 Main Turbine and Condenser

Due to the internal alpha particle contamination within the turbine, condenser and the associated components, PG&E plans to dismantle the components intact (disassemble pack, and ship without disassembly as much as possible) thereby minimizing the potential spread of radioactive contamination. The current estimate reflects these methods. Each component is surveyed, packaged and shipped a LLRW disposal facility.

3.4.4 Plant Systems

Due to the high levels of alpha contamination, mechanical cutting using saws and portable pipe cutters is the primary method of removing mechanical and electrical components. The cut areas for internally contaminated components will be sealed prior to mechanical cutting to mitigate the spread of internal contamination. The work difficulty factors and the unit cost factors for component removal and for selective building structural decontamination have been adjusted to account for the impact of working in areas containing alpha contamination. Mechanical cutting using saws and portable pipe cutters is the primary method of component removal used in the estimate.

3.4.5 Humboldt Bay Unit 3 Facilities

Typically surface contamination can be removed by scarification where the contamination is limited to a thin surface layer. This technique is most effective on smooth, unbroken surfaces. The concrete surfaces were originally uncoated and were subject to additional contamination deposits due to failed fuel in early cycles. As such, the contamination has likely migrated to depths greater than can be effectively removed by surface scarification techniques. This condition was observed during the plant stack removal project where the vendor had difficulty in meeting the free-release criteria for the stack material, even after extensive surface decontamination. As a result of this expected plant condition and for the purposes of this estimate, structural material removed as part of the decommissioning project was assumed to be disposed of at a LLRW disposal facility. Although this same condition is expected to exist in below grade structures, due to the high water table and resulting cost to remove below grade structures, most of these structures will be decontaminated and surveyed in place. Decontaminating below-grade structures to free-release is expected to be more cost-effective than complete removal.

The spent fuel pool walls and tremie concrete beneath the pool is not expected to be cost effectively decontaminated to meet free-release limits. Consequently the estimate assumes an engineered approach to allow the excavation of the soil and, removal of the spent fuel pool walls and floor. A combination of sheet pile and a freeze seal in the soil surrounding the spent fuel pool will be installed to facilitate the excavation and to prevent the in-leakage of groundwater into the area requiring remediation. Contaminated concrete and soil will be disposed of as radioactive material.

The concrete pipe tunnel (connecting the radwaste, refueling and turbine buildings) is not expected to be able to be cost effectively decontaminated to meet free-release limits. This structure will be removed in its entirety by excavating the soil surrounding the tunnel, filling the free space with grout, removing, packaging and disposal of the material as radioactive material.

Significant alpha contamination exists within primary systems and as fixed contamination in the Refueling, Radwaste, and Turbine buildings as a result of failed fuel. The presence of alpha contamination will result in the need for additional radiological controls and will reduce overall worker productivity and the efficiency of component removal activities. The additional controls are designed to protect personnel from receiving internal alpha dose. These controls will include: additional time for the set up of localized control of the contamination, additional respiratory protection requirements and controls, additional resources to perform surveys and establish contamination controls, additional time to obtain, dry, and prepare for counting alpha samples, and additional nonproductive time for personnel involved in removal activities due to the alpha contamination. Therefore, the WDF for building decontamination activities in specified work areas has been increased from 50 to 100% to account for these activities.

The caisson surrounding the reactor vessel, which constitutes the containment structure, will remain in place. The estimate assumes that the removal of the suppression pool liner and the decontamination of the concrete surfaces beneath the liner should be adequate to preclude wholesale removal of the entire caisson structure.

Additional facilities will be required in support of decommissioning activities. This estimate provides for the following: personnel decontamination facility, protective clothing change-out facility, new radiological area access control point, relocation of the radiological counting room, additional laydown areas (paved and unpaved) for storage or radioactive material, storage area for waste shipping containers, radwaste shipment truck weighing & monitoring area, a bulk material drying and storage area. An allowance has also been provided in the Period 3 costs for modification and upgrade of the Refueling Building crane. These upgrades are required prior to the start of decommissioning work in the buildings.

The HBPP site is physically small and the current restricted area is within 100 feet of the sites boundary. As such, the Radwaste Process

Facility must be situated in a location to minimize the potential radiation exposure to the public.

The estimate assumes perimeter fence and in-plant security barriers will be moved as appropriate to maintain public exposures ALARA.

All buildings scheduled for demolition will be removed to a nominal depth of three feet below grade, with the decontaminated or non-contaminated sub grade foundations remaining in place. Holes will be drilled in each of the foundation basemats to allow for natural drainage. Building foundations will be backfilled with clean backfill, and the site will be graded and landscaped. All areas affected by dismantling activities will be cleaned up, covered with loam, and seeded.

A cost has been included for the survey of structures after decontamination and prior to the demolition and disposal of the debris. Decontamination and survey of the structures will allow more efficient structures demolition with reduced radioactive materials monitoring and controls.

Yard drainage piping and surrounding soils are contaminated and will be excavated and removed as radioactive material.

The existing circulating water discharge piping will be abandoned in place.

The discharge canals and portions of the intake canal will be remediated. Contaminated material will be excavated and disposed of as low-level radioactive waste. The existing intake and discharge canals will be permanently backfilled with clean material. One third of the intake and discharge backfill cost is assigned to HBPP3.

A small volume of clean asphalt paving will be shipped to a facility (Portland, Oregon) for disposal.

3.4.6 Transportation Methods

Class A waste (including waste from the reactor vessel segmentation) will be shipped by truck to the EnergySolutions disposal site. Class B and C low-level radioactive waste will be moved overland by truck or shielded van to a yet to be determined site but assumed to be Andrews County, Texas. Building demolition debris and waste soil will be shipped using intermodal containers via truck to EnergySolutions.

Portions of the reactor vessel and internal components will be transported in accordance with 10 CFR 71, as Type B and C waste. It is conceivable that the reactor, due to its limited specific activity, could qualify as Low Specific Activity (LSA) II or III. However, the high radiation levels on the outer surface would require that additional shielding be incorporated with the packaging to attenuate the dose to levels acceptable for transport under 49 CFR 173.[26] Contaminated piping, components, and structural steel other than the reactor vessel and internals, will qualify as LSA – I, II, or III or SCO-I, or II, as described in 49 CFR Part 173. The contaminated material will be packaged in Industrial Packages (IP I, II, or III) for transport unless demonstrated to qualify as their own shipping containers.

Shielded truck casks will be used to transport highly activated metal produced in the segmentation of the reactor vessel and internal components. Cask shipments may exceed 95,000 pounds due to the weight of the vessel segments(s), supplementary shielding, cask tie-downs and the tractor-trailer. The maximum curies per shipment assumed permissible is based upon the license limits of available shielded shipping casks. The number and curie content of vessel segments are selected to meet these limits. The number of cask shipments out of the Refueling Building is expected to average one per week. Non-cask shipments will be limited to five per week.

An allowance has been provided in the estimate for the purchase of 28 special trailer beds. State law restricts the size of the trucks on local roads. Since shortened truck beds are not readily available for lease, PG&E has decided to purchase the equipment.

Transportation costs are estimated using published tariffs from Tri-State Motor Transit.[27]

3.4.7 <u>Coordination with Units 1 and 2</u>

Unit 1 and 2 are scheduled to be dismantled concurrent with the decommissioning of Unit 3.

This estimate includes the cost of removal of the entire site drainage network. A portion of the excavated soil will require remediation and will be disposed of as radioactive waste. The estimate includes a cost element for the replacement of essential portions of the yard drainage system that may still be required for Units 1 or 2.

Wherever shared process systems exist, between the fossil units and Unit 3, the Unit 3 systems will be isolated from the remaining operational portions. Unit 1 and 2 portions of these systems that contain residual contamination will be remediated and decontaminated.

In accordance with NRC requirements, and based upon known radioactive contamination, limited exterior radiological surveys of Units 1 and 2 will be conducted as part of the Final Site Survey.

3.4.8 Site Conditions Following Decommissioning

It is assumed that the Unit 3 structures and site facilities will be dismantled following their decontamination. Most structures which contain below-grade areas (such as the Refuel and Turbine Buildings) will be removed to a nominal depth of 3 feet below grade. Due to expected radiological conditions, the Radwaste Building will be demolished in its entirety. The below-grade voids would be backfilled with clean debris and capped with soil. The site would then be graded to conform to the adjacent landscape. Vegetation would be established to inhibit erosion.

The canals will be backfilled with clean material. The switchyard will remain in place, as well as the site access road.

3.5 ASSUMPTIONS

The following additional factors and conditions were used in developing the decommissioning cost estimate for HBPP3. Radwaste estimating assumptions are contained in Section 5.

3.5.1 Estimating Basis

The estimate is performed in accordance with the methodology described in the AIF/NESP-036 study. Decommissioning costs are reported in the year of projected expenditures; however, the values are reported in 2008 dollars for the current estimate. Costs are not inflated or escalated over the period of performance.

Plant drawings, equipment, and structural specifications, including construction details, were provided by PG&E. TLG personnel prepared the inventory of plant equipment.

3.5.2 Labor Costs

Although PG&E will oversee the decommissioning operations, this study assumes that PG&E augments its workforce with contractors to support planning, engineering, procurement, field supervision, and labor. This outside contracted managerial and professional workforce is referred to as the "DOC Staff Cost" in the Period-Dependent Costs line items in the Appendix D detailed cost table.

Utility staffing requirements will vary with the level of effort associated with the various phases of the project. Once the decommissioning program starts, only those staff positions necessary to support the decommissioning program are included. There are no costs reflected within the estimate for the transition of the maintenance organization to decommissioning, e.g., separation packages, re-training, severance, incentives, etc.

The craft labor required to decontaminate and dismantle the nuclear unit will be acquired through standard contracting practices. Current local craft labor rates were used in the estimate. Costs for site administrative, operations, construction and maintenance personnel are based upon current PG&E salary information. Engineering services for such items as writing activity specifications, detailed procedures, and work procedures are assumed to be provided by the DOC.

3.5.3 General

The existing plant equipment inventory is obsolete and only suitable for scrap as deadweight quantities. No equipment is salvageable. Scrap generated during decommissioning is not recognized as having any value because (1) scrap value generally offsets scrap removal and processing costs and (2) scrap materials have a relatively low market value. Scrap processing and site removal costs are not included in the estimate.

Clean asbestos will be disposed in an approved landfill. Contaminated asbestos will be buried as radioactive waste.

PG&E will provide the electrical power for decommissioning.

PG&E will remove all items of furniture, tools, mobile equipment such as forklifts, trucks, bulldozers, other similar mobile equipment, and other such items of personal property owned by PG&E that will be easily removed without the use of special equipment at no cost or credit to the project.

Existing warehouses will remain for use by PG&E and its subcontractors.

The study follows the principles of ALARA through the use of work duration adjustment factors. These factors adjust the time and cost for performing tasks after consideration of factors such as use of protective clothing and respirators and the effect of indoctrination and mock-up training. These items lengthen a task's duration, which increase the costs and lengthen the overall schedule. ALARA planning is considered in the costs for engineering and planning, and in the development of activity specifications and detailed procedures.

Nuclear liability insurance provides coverage for off-site damage or injuries due to radiation exposure from equipment and material. Nuclear property insurance provides protection against direct physical damage to on-site property by a broad range of causes including, radioactive contamination, fires, floods, etc. This estimate includes the premium cost for both liability and property insurance. The premiums are adjusted to reflect the relative changes in risk during the various phases of decommissioning. Insurance is required until both the Part 50 and Part 72 licenses are terminated.

The perimeter fence and in-plant security barriers will be moved as appropriate to conform with the Security Plan in force at the various stages in the project. Additional survey equipment will be purchased to support the large radiological protection program and the Final Status Survey (FSS) effort.

The existing electrical switchyard will remain after decommissioning in support of the remaining site generating units and the utility's electrical transmission and distribution system.

Underground concrete pipe will be decontaminated and abandoned. Underground steel pipe will be removed, surveyed for contamination, removed from the site, and disposed of as clean scrap. Electrical manholes will be backfilled with suitable earthen material and abandoned.

The caisson encapsulating the reactor vessel compartment will be decontaminated and abandoned in place.

A series of groundwater monitoring wells will be installed to sample groundwater for ^{90}Sr and other mobile radionuclides. A nominal amount of mixed waste will be disposed of and 169,000 cubic feet (packaged volume) of contaminated soil will require removal and disposal.

3.6 COST ESTIMATE SUMMARY

A summary of the decommissioning costs and annual expenditures is provided in the cash flow summary in Table 3.1a. Table 3.1b is a similar table of annual expenditures but omits those costs disallowed by the California Public Utility Commission (CPUC). Table 6.1 provides a breakdown of those same decommissioning costs into the components of decontamination, removal, packaging, etc. The costs were extracted from the detailed reports in Appendices D & E, which provide a detailed listing of activities and associated costs for the decommissioning scenario.

TABLE 3.1a

SCHEDULE OF EXPENDITURES
(thousands, 2008 dollars)[1]

Year	PG&E Labor	Equipment & Materials	Contractor Labor	Process & Burial	Other	Yearly Totals
1996 - 2008	-	-	-	-	81,801	81,801
2009	7,023	10,371	20,392	5,780	14,860	58,427
2010	7,350	4,383	19,966	7,514	6,288	45,501
2011	7,689	10,291	19,872	11,224	6,225	55,301
2012	7,858	11,278	21,964	19,917	7,400	68,416
2013	7,605	7,059	24,274	34,549	9,647	83,133
2014	6,594	3,271	13,084	12,515	5,981	41,446
2015	6,127	2,432	14,093	8,383	6,079	37,115
2016	697	0	3,830	1,850	2,006	8,382
2017	370	-	3,471	-	525	4,365
2018	370	-	3,471	-	525	4,365
2019	370	-	3,471	-	525	4,365
2020	363	258	3,587	426	2,506	7,139
	52,417	49,345	151,474	102,157	144,367	499,759

1 Columns may not add due to rounding

TABLE 3.1b

SCHEDULE OF EXPENDITURES, EXCLUDING CPUC DISALLOWANCES (thousands, 2008 dollars)[1]

Year	PG&E Labor	Equipment & Materials	Contractor Labor	Process & Burial	Other	Yearly Totals
1996 - 2008	-	-	-	-	81,801	81,801
2009	7,023	10,371	20,392	5,780	14,860	58,427
2010	7,350	4,352	19,848	7,354	6,276	45,179
2011	7,689	10,291	19,872	11,224	6,225	55,301
2012	7,858	11,278	21,964	19,917	7,400	68,416
2013	7,605	7,059	24,274	34,549	9,647	83,133
2014	6,594	3,253	13,040	12,515	5,980	41,383
2015	6,127	2,432	14,093	8,383	6,079	37,115
2016	697	0	3,830	1,850	2,006	8,382
2017	370	-	3,471	-	525	4,365
2018	370	-	3,471	-	525	4,365
2019	370	-	3,471	-	525	4,365
2020	363	258	3,587	426	2,506	7,139
	52,417	49,295	151,312	101,997	144,353	499,373

1 Columns may not add due to rounding

4. SCHEDULE ESTIMATE

The schedule for the decommissioning scenario considered in this study follows the sequence presented in the AIF/NESP-036 study, with minor changes to reflect current planning and site-specific constraints. In addition, the schedule reflects the spent fuel management plan outlined for HBPP3.

Appendix F presents a GANTT chart schedule for the 2010 SAFSTOR decommissioning alternative. The key activities listed in the schedule do not reflect a one-to-one correspondence with those activities in the Appendix D cost table, but reflect sub-dividing some activities to facilitate understanding and combining others for clarity. The schedule was prepared using the "Microsoft Project for Windows" computer software. [28]

4.1 SCHEDULE ESTIMATE ASSUMPTIONS

The schedule estimate reflects the results of a precedence network developed for the site decommissioning activities, i.e., a PERT (Program Evaluation and Review Technique) software package. The schedule forecast is current as of December 2004. The following assumptions were made in the development of the decommissioning schedule:

- Spent fuel transfer to the ISFSI was completed in 2008. Only limited decommissioning activities have occurred up until now.

- All work (except vessel and internals removal) is performed during an 10-hour workday, 4 days per week, with no overtime.

- Vessel and internals removal activities are performed by using separate crews for different activities working on different shifts, with a corresponding backshift charge for the second shift.

- Multiple crews work parallel activities to the maximum extent possible, consistent with: optimum efficiency; adequate access for cutting, removal and laydown space; and the stringent safety measures necessary during demolition of heavy components and structures.

- For removal of plant systems by area, the areas with the longest removal durations on the critical path are considered to determine the duration.

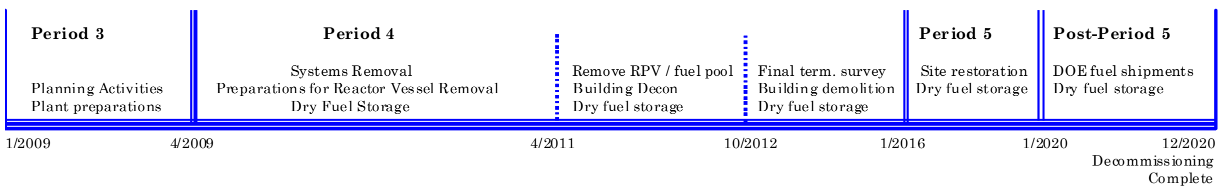
4.2 PROJECT SCHEDULE

The period-dependent costs presented in the cost table in Appendix D are based upon the durations developed in the decommissioning project schedule. Durations are established between several milestones in each project period; these durations are used to establish a critical path for the entire project. In turn, the critical path duration for each period is used as the basis for determining the total costs for these period-dependent items.

A project timeline for the decommissioning alternative is included in this section as Figure 4.1.

FIGURE 4.1

DECOMMISSIONING TIMELINE
(not to scale)



Key Assumptions:
1. Decommissioning commences on January of 2009.
2. Use of a Decommissioning Operations Contractor (DOC) in later Period 3 planning activities.
3. USDOE acceptance of spent fuel shipments occurs in 2020.
4. GTCC wastes are removed from the plant site with the spent fuel.

Critical Path Discussion:
Following removal of all spent fuel to long term dry storage, the decommissioning critical path is assumed to be sequentially composed of preparations for and removing the reactor vessel and spent fuel pool, decontamination of buildings, performing final site termination surveys, site restoration, and final spent fuel acceptance and removal by the USDOE.

5. RADIOACTIVE WASTE

The objectives of the decommissioning process are the removal of all radioactive material from the site that would restrict its future use and the termination of the NRC license. This currently requires the remediation of all radioactive material at the site in excess of applicable legal limits. Under the Atomic Energy Act,[29] the NRC is responsible for protecting the public from sources of ionizing radiation. Title 10 of the Code of Federal Regulations delineates the production, utilization, and disposal of radioactive materials and processes. In particular, Part 71 defines radioactive material as it pertains to transportation and Part 61 specifies its disposition.

Most of the materials being transported for controlled burial are categorized as Low Specific Activity (LSA) or Surface Contaminated Object (SCO) materials containing Type A quantities, as defined in 49 CFR Parts 173-178. Shipping containers are required to be Industrial Packages (IP-1, IP-2 or IP-3, as defined in 10 CFR §173.411). For this study, commercially available steel containers are presumed to be used for the disposal of piping, and small components. Larger components can serve as their own containers, with proper closure of all openings, access ways, and penetrations. Demolition debris (including concrete) and contaminated soil is packaged and transported in reusable 25-yard steel intermodal containers.

The volumes of radioactive waste generated during the various decommissioning activities at the site are shown on a line-item basis in Appendices D, and summarized in Tables 5.1. The quantified waste volume summaries shown in these tables are consistent with Part 61 classifications. The volumes are calculated based on the exterior dimensions for containerized material and on the displaced volume of components serving as their own waste containers.

The reactor vessel and internals are categorized as large quantity shipments and, accordingly, will be shipped in reusable, shielded truck casks with disposable liners. In calculating disposal costs, the burial fees are applied against the liner volume, as well as the special handling requirements of the payload. Packaging efficiencies are lower for the highly activated materials (greater than Type A quantity waste), where high concentrations of gamma-emitting radionuclides limit the capacity of the shipping canisters.

No process system containing/handling radioactive substances at shutdown is presumed to meet material release criteria by decay alone (i.e., systems radioactive at shutdown will still be radioactive over the time period during which the decommissioning is accomplished, due to the presence of long-lived radionuclides).

While the dose rates decrease with time, radionuclides such as ^{137}Cs will still control the disposition requirements.

The waste material produced in the decontamination and dismantling of the nuclear plants is primarily generated during Period 4 of SAFSTOR. Material that is removed from the radiological controlled areas is routed for controlled disposal. Structural demolition debris and soil will be loaded onto intermodal containers and shipped by truck to a LLRW disposal facility. The estimate assumes that PG&E will purchase 28 shipping trailers that are sized to meet the overland road shipping limitations of local highways. The cost of the facility and the trailers are included in the estimate.

For the purpose of this analysis, the EnergySolutions' facility is used as the disposal site for the majority of the radioactive waste (Class A). This waste was disposed of at a rate of $62 per cubic foot for "Bulk" waste, and a rate of $252 per cubic foot for "General" waste. These rates include State of Utah taxes and Southwest Compact fees. There are no currently operating disposal facilities available to PG&E that have a license to dispose of the more highly radioactive waste (Classes B and C), for example, generated in the dismantling of the reactor vessel. As such, waste disposal costs and waste transportation distances were estimated. For purposes of estimating the Class B and C waste transportation cost it was assumed that this waste was shipped to Andrews County, Texas. The cost for disposal for Class B and C waste was $2,916 per cubic foot. This rate includes Southwest Compact fees. These disposal costs for low-level radioactive waste are based on a study sponsored by PG&E and Southern California Edison Company. The study was done to reflect the California Public Utilities Commission's desire for these owners to conservatively estimate their nuclear decommissioning LLRW disposal rates.

TABLE 5.1

DECOMMISSIONING WASTE DISPOSAL SUMMARY

	Waste Volume[3] (cubic feet)
Low-Level Radioactive Waste[1]	
Class A[2]	328,201
Class B	3,083
Class C	566
GTCC	17
Subtotal	**331,866**
Miscellaneous Wastes	
Demolition Debris	327,036

Notes:
1 Radioactive waste is classified according to the requirements as delineated in Title 10 of the Code of Federal Regulations, Part 61.55.
2 Class A waste includes soil, discharge canal sediment and reactor caisson mixed waste.
3 Column may not add due to rounding.

6. RESULTS

The analysis to estimate the costs to decommission HBPP3 relied upon the site-specific, technical information developed for previous analyses prepared in 1997, 2001, and 2004. The estimate also incorporates additional activities and considerations which have been identified as a result of the ongoing planning. While not an engineering study, the analysis provides PG&E with sufficient information to assess its financial obligations, as they pertain to the eventual decommissioning of the nuclear station.

The estimates described in this report are based on numerous fundamental assumptions, including regulatory requirements, project contingencies, low-level radioactive waste disposal practices, high-level radioactive waste management options, and site restoration requirements. The decommissioning scenario reflects the fact that all spent fuel has been transferred to the ISFSI and it will remain in the ISFSI until such time that the DOE can complete the transfer of the assemblies to its repository.

The cost projected to decommission (SAFSTOR 2010) HBPP3 is $499.8 million (including 25% contingency) in 2008 dollars. This total includes $385,520 that has been classified as CPUC's disallowances. The majority of this cost (84.3%) is associated with the physical decontamination and dismantling of the nuclear units so that the licenses can be terminated. Another 15.3% is associated with the management, interim storage, and eventual transfer of the spent fuel. The remaining 0.4% is for the demolition of the designated structures and limited restoration of the site.

The primary cost contributors, identified in Table 6.1 are either labor-related or associated with the management and disposition of the radioactive waste. Program management (staffing) is the largest single contributor to the overall cost. The magnitude of the expense is a function of both the size of the organization required to manage the decommissioning, as well as the duration of the program. It is assumed, for purposes of this analysis, that PG&E will oversee the decommissioning program, using a DOC to manage the decommissioning labor force and the associated subcontractors. The size and composition of the management organization varies with the decommissioning phase and associated site activities. However, once the operating license is terminated, the staff is substantially reduced for the conventional demolition and restoration of the site, and the long-term care of the spent fuel.

As described in this report, spent fuel has been transferred to the ISFSI and will remain there until the DOE is able to receive it. Dry storage of the fuel under a separate license provides additional flexibility in the event the DOE is not able to meet the current timetable for completing the transfer of assemblies to an off-site facility and minimizes the associated caretaking expenses.

The cost for waste disposal includes only those costs associated with the controlled disposition of the low-level radioactive waste generated from decontamination and dismantling activities, including plant equipment and components, structural material, filters, resins and dry-active waste. As described in Section 5, disposal of the radioactive material, including concrete and structural steel, as well as the highly radioactive material, is sent to either a currently licensed LLRW facility (Class A waste) or the a yet to be licensed (Class B and C waste) burial site. Highly activated reactor vessel components (GTCC), requiring additional isolation from the environment, are packaged for geologic disposal. The cost of geologic disposal is based upon a cost equivalent for spent fuel.

Removal costs reflect the labor-intensive nature of the decommissioning process, as well as the management controls required to ensure a safe and successful program. Decontamination and packaging costs also have a large labor component that is based upon prevailing wages.

The reported cost for transport includes the tariffs and surcharges associated with moving large components and/or overweight shielded casks overland, as well as the general expense, e.g., labor and fuel, of transporting material to the destinations identified in this report. For purposes of this analysis, material is primarily moved overland by truck.

License termination survey costs are associated with the labor intensive and complex activity of verifying that contamination has been removed from the site to the levels specified by the regulating agency. This process involves a systematic survey of all remaining plant surface areas and surrounding environs, sampling, isotopic analysis, and documentation of the findings. The status of any plant components and materials not removed in the decommissioning process will also require confirmation and will add to the expense of surveying the facilities alone.

The remaining costs include allocations for heavy equipment and temporary services, as well as for other expenses such as regulatory fees and the premiums for nuclear insurance. While site operating costs are greatly reduced following the final cessation of plant operations, certain administrative functions do need to be maintained either at a basic functional or regulatory level.

TABLE 6.1

SUMMARY OF DECOMMISSIONING COST CONTRIBUTORS

Work Category	Costs 08' $ (thousands)	Percent of Total	Costs 04' $ (thousands)
Decontamination	978	0.2%	1,865
Removal	48,360	9.7%	23,899
Packaging	9,258	1.9%	3,087
Shipping	11,722	2.3%	5,578
Waste Processing & Recycling	675	0.1%	8,877
LLRW Burial	77,596	15.5%	17,446
Demolition LLRW Burial	23,872	4.8%	38,528
Staffing	132,760	26.6%	70,516
Security	45,687	9.1%	4,149
License Termination Survey	1,958	0.4%	9,874
Insurance	1,000	0.2%	786
Energy	1,254	0.3%	827
NRC & EP Fees	5,386	1.1%	1,935
NRC ISFSI Fees	1,023	0.2%	3,745
ISFSI Capital, O&M, Fixed & Security	57,798	11.6%	66,391
Non-ISFSI Expenditures	28,015	5.6%	20,282
Equipment & Supplies	28,797	5.8%	28,520
Engineering	23,618	4.7%	11,121
Total	**499,759**	**100.0%**	**317,424**

CPUC Disallowances

Removal	193	50.1%	172
Packaging	21	5.5%	14
Shipping	4	0.9%	5
Waste Processing & Recycling	0	0.0%	30
LLRW Burial	165	42.8%	135
Equipment & Supplies	3	0.7%	2
Total	**386**	**100.0%**	**357**

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25. "Strategy for Management and Disposal of Greater-Than-Class C Low-Level Radioactive Waste," Federal Register Volume 60, Number 48 (p 13424 et seq.), March 1995

26. U.S. Department of Transportation, Title 49 of the Code of Federal Regulations, "Transportation," Parts 173 through 178, 1996.U.S. Code of Federal Regulations, Title 10, Parts 30, 40, 50, 51, 70 and 72, "General Requirements for Decommissioning Nuclear Facilities," Nuclear Regulatory Commission, Federal Register Volume 53, Number 123 (p 24018+), June 27, 1988

27. Tri-State Motor Transit Company, published tariffs, Interstate Commerce Commission (ICC), Docket No. MC-427719 Rules Tariff, March 2004, Radioactive Materials Tariff, January 2008

28. "Microsoft Project 2003," Microsoft Corporation, Redmond, WA, 2002

29. "Atomic Energy Act of 1954." (68 Stat. 919)

APPENDIX A

WORK DIFFICULTY FACTOR ADJUSTMENTS

APPENDIX A

WORK DIFFICULTY FACTOR ADJUSTMENT

AREA	AREA DESCRIPTION	Access %	Respiratory Protection %	ALARA %	Protective clothing %	Alpha Adjust. %
RB1-1	Emergency Condenser	20	25	10	30	200
RB1-2	Spent Fuel Pool	20	25	10	30	200
RB1-3	Cask Shipping Area	10	25	10	30	150
RB1-4	SFP Pumps/Filters	0	25	10	30	150
RB1-5	Laydown/Cask Washdown General Area	10	25	10	30	150
RB1-6	Reactor Vessel Cavity	30	50	40	50	150
RB2-1	El -2 Suppression Pool Cooler	10	25	10	30	150
RB2-2	Elev. -14, Manlift	10	25	10	30	150
RB2-3	Elev. -24, CRD Hydraulic Filters	30	50	40	50	150
RB2-4	Elev. -34, Suppression Pool Access Hatch	10	25	20	30	150
RB2-5	Elev. -44, CRD Piping	10	50	20	30	150
RB2-6	Elev. -54, CRD Trip Accumulators	10	25	20	30	150
RB2-7	Elev. -66, Caisson Sump, REDT	10	25	20	30	150
RB2-8	Suppression Pool - North	30	50	40	50	150
RB2-9	Suppression Pool - South	30	50	40	50	150
RB3-1	Cleanup Heat Exchangers	10	50	20	30	150
RB3-2	New Fuel Storage/Fuel Pool Coolers	20	25	20	30	150
RB4-1	Shutdown Heat Exchangers/Pumps	50	50	20	50	200
RB4-2	TBDT/Floor Drain Pumps	20	50	20	50	200
RB5-1	RFB Roof (HVAC only)	0	25	10	30	100
RB5-1	RFB Roof	0	25	10	30	100
TB1-1	Main Turbine	75	75	20	50	200
TB1-2	Main Generator/Exciter House	0	0	0	0	100
TB1-3	Hydrogen Yard	0	0	10	30	100
TB2-1	Main Condenser	75	75	20	50	200
TB2-2	Seal Oil Unit/Exciter Swgr	0	0	10	30	100
TB3-1	Reactor Feed/Lube Oil/Air Sytems	10	25	10	30	150
TB3-2	Propane Engine Generator	0	0	0	0	100
TB3-3	2400/480V Transformers	0	0	10	0	100
TB4-1	Laundry Drain Tank/Pipe Tunnel	10	25	20	30	150
TB4-2	Pipe Gallery	50	50	20	50	200
TB5-1	Anion/Cation/Resin Tanks	10	25	20	30	150
TB5-2	Condensate Demineralizers	10	25	20	30	150
TB6-1	Air Ejector/Gland Seal Condenser	10	25	10	30	150
TB6-2	Vacuum Pump/Condensate Pumps	0	25	10	30	150

APPENDIX A

WORK DIFFICULTY FACTOR ADJUSTMENT (continued)

AREA	AREA DESCRIPTION	Access %	Respiratory Protection %	ALARA %	Protective clothing %	Alpha Adjust. %
TB7-1	Main Control Room	0	25	10	30	100
TB7-2	Instr Repair/Counting Room/Vent Equip	0	0	10	0	100
TB7-3	Locker Room/Personnel Decon	0	0	10	0	100
TB7-4	Hot Lab	10	25	10	30	150
TB7-5	Demin Control Panel/RFB Access	0	0	10	0	100
TB7-6	Hot Lab Attic	10	25	10	30	100
TB7-7	RP Office/Count Room	0	0	0	0	100
RW1-1	RWB - Concentrator/Pumps/Filters	10	25	20	30	150
RW1-2	RWB - Waste Receiver/Hold Tanks	10	25	20	30	150
RW1-3	Radwaste Demineralizer	30	50	40	50	150
RW1-4	Concentrated Waste Tanks	50	50	20	50	200
RW1-5	Resin Disposal Tank	50	50	40	50	200
RW1-6	Upper Elevation - RWB	0	25	10	30	100
RW1-7	Packaged Radwaste Storage Bldg	0	0	10	0	100
RW1-8	Low Level Waste Storage Bldg	0	0	10	0	100
RW1-9	Solid Waste Vault	10	25	20	30	100
YD1-1	Main Transformers	0	0	0	0	100
YD1-2	CCW Heat Exchangers/Pumps	0	25	10	30	100
YD1-5	Intake Structure	0	0	10	30	100
YD2-1	Stack - Elev 0'0"	10	25	10	30	150
YD2-2	Stack - Elev. 12'0"	10	25	10	30	100
YD2-3	Stack - Elev. 26'0"	10	25	10	30	100
YD2-4	Condensate/Demin Water Storage Tank	0	25	10	30	150
YD2-5	Plant Exhaust Fans	25	50	20	30	150
YD2-6	Gaseous Radwaste Holdup Tunnel	30	50	40	50	150
HMS1-1	HMS Decon Area	0	25	10	30	100
HMS1-2	Calibration Lab	10	25	20	30	100

APPENDIX A

WORK DIFFICULTY FACTOR ADJUSTMENT
(continued)

AREA	AREA DESCRIPTION	Access %	Respiratory Protection %	ALARA %	Protective clothing %	Alpha Adjust. %
OTS-1	Hydrogen Analyzer/MCC #14	0	0	0	0	100
OTS-2	Moisture Skid/Sump Pump	0	0	0	0	100
OTS-3	Jet Compressor/Recombiner/Carbon Guard	0	0	0	0	100
OTS-4	Carbon Adsorbers	0	0	0	0	100
OTS-5	Pipe Tunnel	25	50	20	30	150
OTS-6	HEPA Filter (outside access only)	0	0	0	0	100
YARD	General Yard	0	0	0	0	100
RBP	Refueling Building - Embedded Piping	10	50	20	30	150
TBP	Turbine Building - Embedded Piping	25	50	20	30	150
YDP	Buried Yard Piping/Catch Basins, Etc.	20	0	0	0	100
RWP	Radwaste Building - Embedded Piping	10	50	20	30	150
HMSP	Hot Machine Shop - Embedded Piping	10	50	20	30	150

APPENDIX B

UNIT COST FACTOR DEVELOPMENT

APPENDIX B
UNIT COST FACTOR DEVELOPMENT

Example: Unit Factor for Removal of Contaminated Heat Exchanger < 3,000 lbs.

1. SCOPE

Heat exchangers weighing < 3,000 lbs. will be removed in one piece using a crane or small hoist. They will be disconnected from the inlet and outlet piping. The heat exchanger will be sent to the waste processing area.

2. CALCULATIONS

Activity Description	Critical Duration (minutes)
Install contamination controls, remove insulation, and mount pipe cutters	60
Foam pipe	15
Disconnect inlet and outlet lines, cap openings	60
Rig for removal	30
Unbolt from mounts	30
Remove contamination controls	15
Remove heat exchanger, wrap in plastic, and send to packing area	60
Critical Duration	270
Work Adjustments (Work Difficulty Factors)	
+Duration adjustment(s)	
Area-specific alpha adjustment (50% of Critical Duration)	135
	405
+ Respiratory Protection (25% of Critical Duration)	101
+ Radiation/ALARA (10% of Critical Duration)	41
Adjusted Work Duration	547
+ Protective Clothing (30% of Adjusted Work Duration)	164
Productive Work Duration	711
+ Work break adjustment (8.33 % of Productive Work Duration)	59
Total Work Duration	770

***** Total Work Duration = 770 minutes or 12.833 hours *****

APPENDIX B
(continued)

3. LABOR REQUIRED

Crew	Number	Duration (hours)	Rate ($/hr)	Cost
Laborers	3.00	12.833	$51.54	$1,984.24
Craftsmen	2.00	12.833	$62.62	$1,607.20
Foreman	1.00	12.833	$65.45	$839.92
General Foreman	0.25	12.833	$68.59	$220.05
Fire Watch	0.05	12.833	$51.54	$33.07
Health Physics Technician	1.00	12.833	$50.45	$647.42
Total Labor Cost				$5,331.90

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	
-Portable electric band saw 1 @ $0.30/hr x 12.833 hrs {97}	$3.85
Consumables/Materials Costs	
-Blotting paper 50 @ $0.60 sq ft {2}	$30.00
-Plastic sheets/bags 50 @ $0.18/sq ft {3}	$9.00
-Band Saw blades 1 @ $8.92/hr x .25/ hr {1}	$2.23
-Foam sealant .7 @ $31.92 / cubic foot {99}	22.34
Subtotal Cost Of Equipment And Materials	$67.42
Overhead & Sales Tax On Equipment And Materials @ 17.25%	$11.63
Total Costs, Equipment & Material	$79.05

TOTAL COST: Removal of Contaminated Heat Exchanger <3000 Pounds:
$5,410.95

Total Labor Cost:	$5,331.90
Total Equipment/Material Costs:	$79.05
Total Craft Labor Man-Hours Required Per Unit:	93.68

APPENDIX B
(continued)

5. NOTES AND REFERENCES

- Work difficulty factors were developed in conjunction with the AIF (now NEI) program to standardize nuclear decommissioning cost estimates and are delineated in Volume 1, Chapter 5 of the “Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986.

- References for equipment & consumables costs:

    1. The Wachs Companies, Quote dated 8/2008
    2. McMaster-Carr website on-line catalog
    3. R.S. Means (2008) Division 015 Section 602-0200 pg 17

- Material and consumable costs were adjusted using the regional indices for Eureka, California.

APPENDIX C

UNIT COST FACTOR LISTING
(Representative)

APPENDIX C

UNIT COST FACTOR LISTING
(Representative)

Unit Cost Factor	Cost/Unit($)
Removal of clean instrument and sampling tubing, $/linear foot	0.55
Removal of clean pipe 0.25 to 2 inches diameter, $/linear foot	5.94
Removal of clean pipe >2 to 4 inches diameter, $/linear foot	8.40
Removal of clean pipe >4 to 8 inches diameter, $/linear foot	16.16
Removal of clean pipe >8 to 14 inches diameter, $/linear foot	22.74
Removal of clean pipe >14 to 20 inches diameter, $/linear foot	32.51
Removal of clean pipe >20 to 36 inches diameter, $/linear foot	51.34
Removal of clean pipe >36 inches diameter, $/linear foot	62.64
Removal of clean valve >2 to 4 inches	107.37
Removal of clean valve >4 to 8 inches	161.59
Removal of clean valve >8 to 14 inches	227.42
Removal of clean valve >14 to 20 inches	325.10
Removal of clean valve >20 to 36 inches	513.38
Removal of clean valve >36 inches	626.43
Removal of clean pipe hanger for small bore piping	35.52
Removal of clean pipe hanger for large bore piping	130.45
Removal of clean pump, <300 pound	270.78
Removal of clean pump, 300-1000 pound	747.95
Removal of clean pump, 1000-10,000 pound	2,975.45
Removal of clean pump, >10,000 pound	5,748.35
Removal of clean pump motor, 300-1000 pound	314.65
Removal of clean pump motor, 1000-10,000 pound	1,239.21
Removal of clean pump motor, >10,000 pound	2,788.21
Removal of clean heat exchanger <3000 pound	1,594.28
Removal of clean heat exchanger >3000 pound	4,004.79

APPENDIX C
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of clean feedwater heater/deaerator	10,067.99
Removal of clean moisture separator/reheater	20,206.49
Removal of clean tank, <300 gallons	348.54
Removal of clean tank, 300-3000 gallon	1,102.38
Removal of clean tank, >3000 gallons, $/square foot surface area	9.15
Removal of clean electrical equipment, <300 pound	148.42
Removal of clean electrical equipment, 300-1000 pound	512.28
Removal of clean electrical equipment, 1000-10,000 pound	1,024.54
Removal of clean electrical equipment, >10,000 pound	2,425.15
Removal of clean electrical transformer < 30 tons	1,684.24
Removal of clean electrical transformer > 30 tons	4,850.31
Removal of clean standby diesel generator, <100 kW	1,720.30
Removal of clean standby diesel generator, 100 kW to 1 MW	3,839.83
Removal of clean standby diesel generator, >1 MW	7,949.23
Removal of clean electrical cable tray, $/linear foot	13.83
Removal of clean electrical conduit, $/linear foot	6.04
Removal of clean mechanical equipment, <300 pound	148.42
Removal of clean mechanical equipment, 300-1000 pound	512.28
Removal of clean mechanical equipment, 1000-10,000 pound	1,024.54
Removal of clean mechanical equipment, >10,000 pound	2,425.15
Removal of clean HVAC equipment, <300 pound	148.42
Removal of clean HVAC equipment, 300-1000 pound	512.28
Removal of clean HVAC equipment, 1000-10,000 pound	1,024.54
Removal of clean HVAC equipment, >10,000 pound	2,425.15
Removal of clean HVAC ductwork, $/pound	0.58
Removal of contaminated instrument and sampling tubing, $/linear foot	1.74
Removal of contaminated pipe 0.25 to 2 inches diameter, $/linear foot	35.75
Removal of contaminated pipe >2 to 4 inches diameter, $/linear foot	46.84
Removal of contaminated pipe >4 to 8 inches diameter, $/linear foot	99.14
Removal of contaminated pipe >8 to 14 inches diameter, $/linear foot	164.71

APPENDIX C
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated pipe >14 to 20 inches diameter, $/linear foot	239.48
Removal of contaminated pipe >20 to 36 inches diameter, $/linear foot	473.70
Removal of contaminated pipe >36 inches diameter, $/linear foot	820.49
Removal of contaminated valve >2 to 4 inches	566.35
Removal of contaminated valve >4 to 8 inches	932.37
Removal of contaminated valve >8 to 14 inches	1,601.39
Removal of contaminated valve >14 to 20 inches	2,441.90
Removal of contaminated valve >20 to 36 inches	4,691.29
Removal of contaminated valve >36 inches	8,310.16
Removal of contaminated pipe hanger for small bore piping	136.43
Removal of contaminated pipe hanger for large bore piping	444.12
Removal of contaminated pump, <300 pound	1,292.55
Removal of contaminated pump, 300-1000 pound	2,817.30
Removal of contaminated pump, 1000-10,000 pound	10,813.41
Removal of contaminated pump, >10,000 pound	26,570.44
Removal of contaminated pump motor, 300-1000 pound	1,073.11
Removal of contaminated pump motor, 1000-10,000 pound	3,315.52
Removal of contaminated pump motor, >10,000 pound	7,479.31
Removal of contaminated heat exchanger <3000 pound	5,410.95
Removal of contaminated heat exchanger >3000 pound	17,054.39
Removal of contaminated feedwater heater/deaerator	40,490.70
Removal of contaminated moisture separator/reheater	85,839.84
Removal of contaminated tank, <300 gallons	1,892.52
Removal of contaminated tank, >300 gallons, $/square foot	49.04
Removal of contaminated electrical equipment, <300 pound	863.36
Removal of contaminated electrical equipment, 300-1000 pound	2,080.09
Removal of contaminated electrical equipment, 1000-10,000 pound	4,000.50
Removal of contaminated electrical equipment, >10,000 pound	7,573.91
Removal of contaminated electrical cable tray, $/linear foot	41.74
Removal of contaminated electrical conduit, $/linear foot	18.66

APPENDIX C
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated mechanical equipment, <300 pound	932.10
Removal of contaminated mechanical equipment, 300-1000 pound	2,229.58
Removal of contaminated mechanical equipment, 1000-10,000 pound	4,293.69
Removal of contaminated mechanical equipment, >10,000 pound	7,573.91
Removal of contaminated HVAC equipment, <300 pound	932.10
Removal of contaminated HVAC equipment, 300-1000 pound	2,229.58
Removal of contaminated HVAC equipment, 1000-10,000 pound	4,293.69
Removal of contaminated HVAC equipment, >10,000 pound	7,573.91
Removal of contaminated HVAC ductwork, $/pound	2.50
Removal/plasma arc cut of contaminated thin metal components, $/linear in.	4.49
Additional decontamination of surface by washing, $/square foot	9.29
Additional decontamination of surfaces by hydrolasing, $/square foot	39.31
Decontamination rig hook up and flush, $/ 250 foot length	7,886.42
Chemical flush of components/systems, $/gallon	17.10
Removal of clean standard reinforced concrete, $/cubic yard	79.69
Removal of grade slab concrete, $/cubic yard	90.60
Removal of clean concrete floors, $/cubic yard	929.62
Removal of sections of clean concrete floors, $/cubic yard	3,031.35
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	114.96
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	2,447.26
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	155.74
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	3,237.70
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	1,242.24
Removal of below-grade suspended floors, $/cubic yard	218.31
Removal of clean monolithic concrete structures, $/cubic yard	2,447.78
Removal of contaminated monolithic concrete structures, $/cubic yard	2,446.51
Removal of clean foundation concrete, $/cubic yard	2,125.41
Removal of contaminated foundation concrete, $/cubic yard	2,276.31
Explosive demolition of bulk concrete, $/cubic yard	89.89
Removal of clean hollow masonry block wall, $/cubic yard	393.67

APPENDIX C
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated hollow masonry block wall, $/cubic yard	393.67
Removal of clean solid masonry block wall, $/cubic yard	393.67
Removal of contaminated solid masonry block wall, $/cubic yard	393.67
Backfill of below-grade voids, $/cubic yard	45.00
Removal of subterranean tunnels/voids, $/linear foot	407.55
Placement of concrete for below-grade voids, $/cubic yard	201.08
Excavation of clean material, $/cubic yard	8.94
Excavation of contaminated material, $/cubic yard	47.52
Removal of clean concrete rubble (tipping fee included), $/cubic yard	41.60
Removal of contaminated concrete rubble, $/cubic yard	33.26
Removal of building by volume, $/cubic foot	0.93
Removal of clean building metal siding, $/square foot	4.84
Removal of contaminated building metal siding, $/square foot	4.84
Removal of standard asphalt roofing, $/square foot	8.03
Removal of transite panels, $/square foot	7.51
Scarifying contaminated concrete surfaces (drill & spall), $/square foot	17.46
Scabbling contaminated concrete floors, $/square foot	10.37
Scabbling contaminated concrete walls, $/square foot	24.51
Scabbling contaminated ceilings, $/square foot	83.77
Scabbling structural steel, $/square foot	7.82
Removal of clean overhead crane/monorail < 10 ton capacity	2,058.81
Removal of contaminated overhead crane/monorail < 10 ton capacity	2,058.81
Removal of clean overhead crane/monorail >10-50 ton capacity	4,936.36
Removal of contaminated overhead crane/monorail >10-50 ton capacity	4,936.36
Removal of polar crane > 50 ton capacity	18,318.72
Removal of gantry crane > 50 ton capacity	77,245.55
Removal of structural steel, $/pound	0.70
Removal of clean steel floor grating, $/square foot	15.27
Removal of contaminated steel floor grating, $/square foot	15.27
Removal of clean free standing steel liner, $/square foot	37.73

APPENDIX C
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated free standing steel liner, $/square foot	40.80
Removal of clean concrete-anchored steel liner, $/square foot	19.17
Removal of contaminated concrete-anchored steel liner, $/square foot	47.43
Placement of scaffolding in clean areas, $/square foot	29.86
Placement of scaffolding in contaminated areas, $/square foot	31.27
Landscaping with topsoil, $/acre	30,307.60
Cost of CPC B-88 LSA box & preparation for use	2,033.70
Cost of CPC B-25 LSA box & preparation for use	1,800.10
Cost of CPC B-12V 12 gauge LSA box & preparation for use	1,764.38
Cost of CPC B-144 LSA box & preparation for use	10,429.50
Cost of LSA drum & preparation for use	260.39
Cost of cask liner for CNSI 14 195 cask	593.81
Cost of cask liner for CNSI 8 120A cask (resins)	10,974.89
Cost of cask liner for CNSI 8 120A cask (filters)	4,017.47
Decontamination of surfaces with vacuuming, $/square foot	2.15

APPENDIX D

HUMBOLDT BAY POWER PLANT UNIT 3
2010 SAFSTOR
AREA-BY-AREA ESTIMATE

Appendix D
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR Decommissioning Cost Estimate
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 2 - SAFSTOR Dormancy																					
	ISFSI Completed Projects																				
	ISFSI Design & Licensing 1998-2000			-	-	-	-	5,362		5,362		5,362	-	-	-	-	-	-	-	-	-
	ISFSI Design & Licensing 2001			-	-	-	-	398		398		398	-	-	-	-	-	-	-	-	-
	ISFSI Design & Licensing 2002			-	-	-	-	114		114		114	-	-	-	-	-	-	-	-	-
	ISFSI Design & Licensing 2003			-	-	-	-	2,539		2,539		2,539	-	-	-	-	-	-	-	-	-
	ISFSI Design & Licensing 2004			-	-	-	-	1,445		1,445		1,445	-	-	-	-	-	-	-	-	-
	ISFSI Design & Licensing 2005			-	-	-	-	1,672		1,672		1,672	-	-	-	-	-	-	-	-	-
	ISFSI Design & Licensing 2006			-	-	-	-	3,547		3,547		3,547	-	-	-	-	-	-	-	-	-
	ISFSI Design/Licensing/Construction 2007			-	-	-	-	9,509		9,509		9,509	-	-	-	-	-	-	-	-	-
	ISFSI Design/Licensing/Construction 2008			-	-	-	-	29,200		29,200		29,200	-	-	-	-	-	-	-	-	-
	ISFSI Design/Licensing/Construction 2009			-	-	-	-	500		500		500	-	-	-	-	-	-	-	-	-
	HBPP Unit #3 1996 - 2008 Completed Projects																				
	Dismantlement of Ventilation Stack			-	-	-	-	5,740		5,740	5,740	-	-	-	-	-	-	-	-	-	-
	Caisson In-Leakage Repair			-	-	-	-	1,528		1,528	1,528	-	-	-	-	-	-	-	-	-	-
	Suppression Chamber/Remove Baffling & Floor Plates			-	-	-	-	7,931		7,931	7,931	-	-	-	-	-	-	-	-	-	-
	Site Characterization for Dismantlement			-	-	-	-	1,150		1,150	1,150	-	-	-	-	-	-	-	-	-	-
	Miscellaneous Dismantlement Activities			-	-	-	-	300		300	300	-	-	-	-	-	-	-	-	-	-
											-										
	Planning Decommissioning Activity/Misc Dismantlement Activities			-	-	-	-	864		864	864	-	-	-	-	-	-	-	-	-	-
	Remove & Dispose Asbestos			-	-	-	-	800		800	800	-	-	-	-	-	-	-	-	-	-
	Radiological Characterization Plant Systems			-	-	-	-	732		732	732	-	-	-	-	-	-	-	-	-	-
	Irradiated Hardware Spent Fuel Pool Cleanout and Disposal			-	-	-	-	2,676		2,676	2,676	-	-	-	-	-	-	-	-	-	-
	Removal & Disposal Energy Absorber			-	-	-	-	122		122	122	-	-	-	-	-	-	-	-	-	-
	Removal & Disposal Control Rod Drive Hydraulic Pump Equipment			-	-	-	-	201		201	201	-	-	-	-	-	-	-	-	-	-
	Removal & Disposal Service Water Heat Exchanger Equipment			-	-	-	-	66		66	66	-	-	-	-	-	-	-	-	-	-
	Removal & Disposal Reactor Water Cleanup Demineralizer Resin Tank			-	-	-	-	37		37	37	-	-	-	-	-	-	-	-	-	-
	Removal/Disposal Class A Radioactive Waste Material			-	-	-	-	1,045		1,045	1,045	-	-	-	-	-	-	-	-	-	-
	Removal/Disposal Class B & C Materials incl Resin			-	-	-	-	4,822		4,822	4,822	-	-	-	-	-	-	-	-	-	-
PERIOD 2 TOTALS				-	-	-	-	82,301	-	82,301	28,015	54,286	-	-	-	-	-	-	-	-	-
PERIOD 3b - Planning and Preparation																					
Period 3b Additional Costs																					
3b.2.1	*Additional Support Facilities - Radiological Protection*			-	-	-	-	1,385	267	1,652	1,652	-	-	-	-	-	-	-	-	-	-
3b.2.2	Additional Support Facilities - Access, Fencing, Laydown Areas			-	-	-	-	378	73	451	451	-	-	-	-	-	-	-	-	-	-
3b.2.3	Personnel & Material Access RB Access Shaft			-	-	-	-	520	100	620	620	-	-	-	-	-	-	-	-	-	-
3b.2.4	*Cross Contamination Plan*			-	-	-	-	720	180	900	900	-	-	-	-	-	-	-	-	-	-
3b.2.5	*Replacement of Rad Protection Access Software System*			-	-	-	-	480	120	600	600	-	-	-	-	-	-	-	-	-	-
3b.2.6	*Employee Emergency Notification System*			-	-	-	-	320	80	400	400	-	-	-	-	-	-	-	-	-	-
3b.2.7	*Infrastructure for Facility Modifications*			-	-	-	-	720	180	900	900	-	-	-	-	-	-	-	-	-	-
3b.2.8	Mixed Waste Disposal			3	7	-	61	-	21	92	92	-	-	-	126	-	-	-	18,395	-	-
3b.2.9	Rebuild Refueling Building Crane			-	-	-	-	1,418	273	1,691	1,691	-	-	-	-	-	-	-	-	-	-
3b.2.10	Sr-90 Groundwater Program			-	-	-	-	454	87	541	541	-	-	-	-	-	-	-	-	-	-
3b.2.11	*Package Legacy Class B & C Waste*			-	-	-	-	1,535	296	1,831	1,831	-	-	-	-	-	-	-	-	-	-
3b.2.12	Procure Initial Inventory of Tools and Equipment			-	-	-	-	2,100	405	2,505	2,505	-	-	-	-	-	-	-	-	-	-
3b.2	Subtotal Period 3b Additional Costs			3	7	-	61	10,030	2,083	12,183	12,183	-	-	-	126	-	-	-	18,395	-	-
Period 3b Collateral Costs																					
3b.3.1	Decon equipment	954	-	-	-	-	-	-	613	1,568	1,568	-	-	-	-	-	-	-	-	-	-
3b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,436	277	1,713	1,713	-	-	-	-	-	-	-	-	-	-
3b.3.3	Pipe cutting equipment	-	1,000	-	-	-	-	-	321	1,321	1,321	-	-	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	954	1,000	-	-	-	-	1,436	1,211	4,602	4,602	-	-	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.1	Decon supplies	14	-	-	-	-	-	-	5	19	19	-	-	-	-	-	-	-	-	-	-

Appendix D
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR Decommissioning Cost Estimate
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 3b Period-Dependent Costs (continued)																					
3b.4.2	Insurance	-	-	-	-	-	-	20	3	23	23	-	-	-	-	-	-	-	-	-	-
3b.4.3	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3b.4.4	Health physics supplies	-	146	-	-	-	-	-	47	192	192	-	-	-	-	-	-	-	-	-	-
3b.4.5	Heavy equipment rental	-	74	-	-	-	-	-	24	97	97	-	-	-	-	-	-	-	-	-	-
3b.4.6	Disposal of DAW generated	-	-	0	0	-	29	-	9	39	39	-	-	-	116	-	-	-	2,318	1	-
3b.4.7	Plant energy budget	-	-	-	-	-	-	45	9	53	53	-	-	-	-	-	-	-	-	-	-
3b.4.8	NRC Fees	-	-	-	-	-	-	61	8	69	69	-	-	-	-	-	-	-	-	-	-
3b.4.9	Emergency Planning Fees	-	-	-	-	-	-	25	3	28	28	-	-	-	-	-	-	-	-	-	-
3b.4.10	Environmental / Engineering Support	-	-	-	-	-	-	999	192	1,191	1,191	-	-	-	-	-	-	-	-	-	-
3b.4.11	ISFSI Operating Costs	-	-	-	-	-	-	21	4	25	25	-	-	-	-	-	-	-	-	-	-
3b.4.12	Security Staff Cost	-	-	-	-	-	-	897	173	1,070	1,070	-	-	-	-	-	-	-	-	-	16,457
3b.4.13	DOC Staff Cost	-	-	-	-	-	-	2,151	415	2,566	2,566	-	-	-	-	-	-	-	-	-	25,113
3b.4.14	Utility Staff Cost	-	-	-	-	-	-	1,246	240	1,486	1,486	-	-	-	-	-	-	-	-	-	19,713
3b.4	Subtotal Period 3b Period-Dependent Costs	14	219	0	0	-	29	5,465	1,131	6,860	6,860	-	-	-	116	-	-	-	2,318	1	61,282
3b.0	TOTAL PERIOD 3b COST	969	1,219	4	7	-	90	16,931	4,425	23,645	23,645	-	-	-	242	-	-	-	20,713	1	61,282
PERIOD 3 TOTALS		969	1,219	4	7	-	90	16,931	4,425	23,645	23,645	-	-	-	242	-	-	-	20,713	1	61,282
PERIOD 4a - Systems Removal																					
Period 4a Direct Decommissioning Activities																					
Removal of Major Equipment																					
4a.1.1	Main Turbine/Generator	-	555	70	102	-	1,469	-	679	2,875	2,875	-	-	-	5,850	-	-	-	488,000	3,392	-
4a.1.2	Main Condensers	-	496	914	41	-	3,047	-	1,264	5,762	5,762	-	-	-	12,135	-	-	-	247,000	1,984	-
4a.1.3	Remove Spent Fuel Racks	55	11	23	21	-	510	-	210	830	830	-	-	-	2,025	-	-	-	34,700	211	-
4a.1.4	Fuel Pool Cleanup	-	-	-	-	-	-	415	80	495	495	-	-	-	-	-	-	-	-	750	-
Disposal of Plant Systems																					
4a.1.5.1	RB2-1	-	119	20	6	-	169	-	96	410	410	-	-	-	868	-	-	-	32,917	2,012	-
4a.1.5.2	RB2-2	-	124	25	7	-	233	-	119	509	509	-	-	-	1,089	-	-	-	41,259	2,071	-
4a.1.5.3	RB2-3	-	205	9	2	-	20	-	74	310	310	-	-	-	322	-	-	-	12,297	3,538	-
4a.1.5.4	RB2-4	-	48	3	1	-	8	-	18	78	78	-	-	-	123	-	-	-	4,686	820	-
4a.1.5.5	RB2-5	-	284	54	10	-	96	-	131	575	575	-	-	-	1,551	-	-	-	59,756	4,801	-
4a.1.5.6	RB2-6	-	367	24	7	-	63	-	143	604	604	-	-	-	1,024	-	-	-	38,844	6,263	-
4a.1.5.7	RB3-1	-	95	14	3	-	64	-	53	229	229	-	-	-	407	-	-	-	15,696	1,654	-
4a.1.5.8	RB4-1	-	148	30	9	-	213	-	121	520	520	-	-	-	1,354	-	-	-	51,348	2,506	-
4a.1.5.9	TB1-1	-	283	122	41	-	1,620	-	635	2,702	2,702	-	-	-	6,430	-	-	-	242,716	4,932	-
4a.1.5.10	TB1-2	-	4	-	-	-	-	-	1	5	5	-	-	-	-	-	-	-	-	68	-
4a.1.5.11	TB1-3	-	16	-	-	-	-	-	5	21	21	-	-	-	-	-	-	-	-	291	-
4a.1.5.12	TB2-1	-	1,149	117	34	-	1,341	-	822	3,462	3,462	-	-	-	5,321	-	-	-	201,577	19,280	-
4a.1.5.13	TB2-2	-	38	-	-	-	-	-	12	51	51	-	-	-	-	-	-	-	-	692	-
4a.1.5.14	TB3-1	-	509	85	23	-	429	-	316	1,361	1,361	-	-	-	3,601	-	-	-	134,937	8,633	-
4a.1.5.15	TB3-2	-	6	-	-	-	-	-	2	8	8	-	-	-	-	-	-	-	-	113	-
4a.1.5.16	TB3-3 clean area	-	10	-	-	-	-	-	3	14	14	-	-	-	-	-	-	-	-	188	-
4a.1.5.17	TB4-1	-	117	20	6	-	167	-	95	404	404	-	-	-	950	-	-	-	35,935	1,857	-
4a.1.5.18	TB4-2	-	697	62	17	-	458	-	382	1,615	1,615	-	-	-	2,602	-	-	-	98,837	11,710	-
4a.1.5.19	TB5-1	-	153	12	3	-	141	-	97	406	406	-	-	-	560	-	-	-	20,574	2,617	-
4a.1.5.20	TB5-2	-	92	13	3	-	107	-	66	280	280	-	-	-	498	-	-	-	18,961	1,543	-
4a.1.5.21	TB6-1	-	109	19	5	-	131	-	80	344	344	-	-	-	742	-	-	-	28,239	1,832	-
4a.1.5.22	TB6-2	-	128	26	7	-	202	-	111	474	474	-	-	-	1,148	-	-	-	43,543	2,166	-
4a.1.5.23	YARD	-	2	-	-	-	-	-	1	2	2	-	-	-	-	-	-	-	-	31	-
4a.1.5.24	YD1-1 clean area	-	15	-	-	-	-	-	5	20	20	-	-	-	-	-	-	-	-	278	-
4a.1.5	Totals	-	4,719	654	182	-	5,462	-	3,390	14,406	14,406	-	-	-	28,591	-	-	-	1,082,122	79,898	-
4a.1.6	Scaffolding in support of decommissioning	-	151	4	0	10	6	-	53	225	225	-	-	173	20	-	-	-	5,967	825	-
4a.1	Subtotal Period 4a Activity Costs	55	5,932	1,664	346	10	10,495	415	5,675	24,593	24,593	-	-	173	48,622	-	-	-	1,857,788	87,060	-

Appendix D
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR Decommissioning Cost Estimate
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 4a Additional Costs																					
4a.2.1	Modifications Supporting Access for Equipment Removal		-	-	-	-	-	170	33	203	203	-	-	-	-	-	-	-	-	-	-
4a.2.2	*Activation Analysis of Reactor*	-	-	-	-	-	-	80	20	100	100	-	-	-	-	-	-	-	-	-	-
	Subtotal Period 4a Additional Costs	-	-	-	-	-	-	250	53	303	303	-	-	-	-	-	-	-	-	-	-
Period 4a Collateral Costs																					
4a.3.1	Process liquid waste	15	-	8	34	-	26	-	26	108	108	-	-	-	104	-	-	-	6,251	27	-
4a.3.2	Small tool allowance	-	93	-	-	-	-	-	30	123	123	-	-	-	-	-	-	-	-	-	-
4a.3	Subtotal Period 4a Collateral Costs	15	93	8	34	-	26	-	56	232	232	-	-	-	104	-	-	-	6,251	27	-
Period 4a Period-Dependent Costs																					
4a.4.1	Decon supplies	117	-	-	-	-	-	-	37	154	154	-	-	-	-	-	-	-	-	-	-
4a.4.2	Insurance	-	-	-	-	-	-	162	21	183	183	-	-	-	-	-	-	-	-	-	-
4a.4.3	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4a.4.4	Health physics supplies	-	2,385	-	-	-	-	-	766	3,152	3,152	-	-	-	-	-	-	-	-	-	-
4a.4.5	Heavy equipment rental	-	1,268	-	-	-	-	-	407	1,675	1,675	-	-	-	-	-	-	-	-	-	-
4a.4.6	Disposal of DAW generated	-	-	8	3	-	844	-	273	1,128	1,128	-	-	-	3,349	-	-	-	66,974	22	-
4a.4.7	Plant energy budget	-	-	-	-	-	-	459	89	548	548	-	-	-	-	-	-	-	-	-	-
4a.4.8	NRC Fees	-	-	-	-	-	-	1,316	169	1,485	1,485	-	-	-	-	-	-	-	-	-	-
4a.4.9	Emergency Planning Fees	-	-	-	-	-	-	202	26	228	228	-	-	-	-	-	-	-	-	-	-
4a.4.10	Environmental / Engineering Support	-	-	-	-	-	-	7,273	1,402	8,675	8,675	-	-	-	-	-	-	-	-	-	-
4a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	170	33	203	203	-	-	-	-	-	-	-	-	-	-
4a.4.12	Security Staff Cost	-	-	-	-	-	-	7,182	1,384	8,567	8,567	-	-	-	-	-	-	-	-	-	133,486
4a.4.13	DOC Staff Cost	-	-	-	-	-	-	21,109	4,069	25,177	25,177	-	-	-	-	-	-	-	-	-	251,787
4a.4.14	Utility Staff Cost	-	-	-	-	-	-	12,325	2,376	14,700	14,700	-	-	-	-	-	-	-	-	-	213,619
4a.4	Subtotal Period 4a Period-Dependent Costs	117	3,653	8	3	-	844	50,198	11,052	65,875	65,875	-	-	-	3,349	-	-	-	66,974	22	598,892
4a.0	TOTAL PERIOD 4a COST	187	9,679	1,680	383	10	11,365	50,863	16,835	91,003	91,003	-	-	173	52,075	-	-	-	1,931,014	87,108	598,892
PERIOD 4b - Reactor Vessel Removal																					
Period 4b Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
4b.1.1.1	CRDMs & NIs Removal	4	31	104	20	-	202	-	95	456	456	-	-	-	913	-	-	-	24,050	628	-
4b.1.1.2	Reactor Vessel Internals	13	1,774	1,656	384	-	1,497	119	3,358	8,802	8,802	-	-	-	506	-	470	-	60,589	13,200	660
4b.1.1.3	Reactor Vessel	2	4,098	536	132	-	7,966	119	9,306	22,158	22,158	-	-	-	381	2,699	-	-	298,310	13,200	660
4b.1.1	Totals	20	5,903	2,296	536	-	9,664	238	12,759	31,416	31,416	-	-	-	1,800	2,699	470	-	382,950	27,028	1,320
Disposal of Plant Systems																					
4b.1.2.1	RB2-7	-	306	28	6	-	108	-	138	585	585	-	-	-	904	-	-	-	34,459	5,136	-
4b.1.2.2	RB2-8	115	269	62	21	-	203	-	237	906	906	-	-	-	3,267	-	-	-	123,326	6,053	-
4b.1.2.3	RB2-9	115	267	59	20	-	192	-	233	886	886	-	-	-	3,104	-	-	-	117,173	6,249	-
4b.1.2.4	RW1-1	-	265	27	7	-	283	-	181	764	764	-	-	-	1,124	-	-	-	42,705	4,503	-
4b.1.2.5	RW1-2	-	269	54	16	-	161	-	148	648	648	-	-	-	2,604	-	-	-	92,757	4,611	-
4b.1.2.6	RW1-3	-	5	1	0	-	8	-	4	19	19	-	-	-	34	-	-	-	1,303	87	-
4b.1.2.7	RW1-4	-	122	15	4	-	173	-	98	412	412	-	-	-	741	-	-	-	26,242	2,124	-
4b.1.2.8	RW1-5	-	108	11	3	-	140	-	82	343	343	-	-	-	554	-	-	-	19,650	1,875	-
4b.1.2.9	RW1-6	-	49	14	4	-	44	-	32	144	144	-	-	-	708	-	-	-	26,687	784	-
4b.1.2.10	RW1-7	-	19	5	1	-	11	-	10	47	47	-	-	-	172	-	-	-	6,568	295	-
4b.1.2.11	RW1-8	-	5	1	0	-	2	-	3	11	11	-	-	-	34	-	-	-	1,311	83	-
4b.1.2.12	RW1-9	-	4	0	0	-	1	-	2	7	7	-	-	-	17	-	-	-	626	69	-
4b.1.2.13	RWP	-	178	-	-	-	-	-	57	235	235	-	-	-	-	-	-	-	-	3,080	-
4b.1.2	Totals	230	1,867	277	83	-	1,325	-	1,225	5,006	5,006	-	-	-	13,264	-	-	-	492,806	34,951	-
4b.1.3	Scaffolding in support of decommissioning	-	189	5	0	13	8	-	66	281	281	-	-	217	25	-	-	-	7,458	1,031	-
4b.1	Subtotal Period 4b Activity Costs	249	7,959	2,577	619	13	10,998	238	14,050	36,703	36,703	-	-	217	15,089	2,699	470	-	883,214	63,010	1,320

Appendix D
Humboldt Bay Power Plant, Unit 3
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(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 4b Additional Costs																					
4b.2.1	Discharge Piping	50	21	9	36	-	144	-	94	354	354	-	-	-	2,361	-	-	-	165,240	811	-
4b.2.2	Asbestos Removal	-	-	-	-	-	-	285	55	340	340	-	-	-	-	-	-	-	-	-	-
4b.2.3	Expand Waste Packaging Laydown Area	-	-	-	-	-	-	136	26	162	162	-	-	-	-	-	-	-	-	-	-
4b.2	Subtotal Period 4b Additional Costs	50	21	9	36	-	144	421	175	856	856	-	-	-	2,361	-	-	-	165,240	811	-
Period 4b Collateral Costs																					
4b.3.1	Process liquid waste	31	-	15	68	-	53	-	52	218	218	-	-	-	210	-	-	-	12,581	55	-
4b.3.2	Small tool allowance	-	73	-	-	-	-	-	23	96	96	-	-	-	-	-	-	-	-	-	-
4b.3	Subtotal Period 4b Collateral Costs	31	73	15	68	-	53	-	75	314	314	-	-	-	210	-	-	-	12,581	55	-
Period 4b Period-Dependent Costs																					
4b.4.1	Decon supplies	475	-	-	-	-	-	-	153	628	628	-	-	-	-	-	-	-	-	-	-
4b.4.2	Insurance	-	-	-	-	-	-	122	16	138	138	-	-	-	-	-	-	-	-	-	-
4b.4.3	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4b.4.4	Health physics supplies	-	1,822	-	-	-	-	-	585	2,407	2,407	-	-	-	-	-	-	-	-	-	-
4b.4.5	Heavy equipment rental	-	2,261	-	-	-	-	-	726	2,988	2,988	-	-	-	-	-	-	-	-	-	-
4b.4.6	Disposal of DAW generated	-	-	6	3	-	652	-	211	872	872	-	-	-	2,587	-	-	-	51,732	17	-
4b.4.7	Plant energy budget	-	-	-	-	-	-	273	53	325	325	-	-	-	-	-	-	-	-	-	-
4b.4.8	NRC Fees	-	-	-	-	-	-	990	127	1,117	1,117	-	-	-	-	-	-	-	-	-	-
4b.4.9	Emergency Planning Fees	-	-	-	-	-	-	152	20	171	171	-	-	-	-	-	-	-	-	-	-
4b.4.10	Environmental / Engineering Support	-	-	-	-	-	-	4,225	814	5,039	5,039	-	-	-	-	-	-	-	-	-	-
4b.4.11	Radwaste Processing Equipment/Services	-	-	-	-	-	-	564	109	673	673	-	-	-	-	-	-	-	-	-	-
4b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	128	25	152	152	-	-	-	-	-	-	-	-	-	-
4b.4.13	Security Staff Cost	-	-	-	-	-	-	5,387	1,038	6,425	6,425	-	-	-	-	-	-	-	-	-	100,389
4b.4.14	DOC Staff Cost	-	-	-	-	-	-	14,641	2,822	17,463	17,463	-	-	-	-	-	-	-	-	-	177,845
4b.4.15	Utility Staff Cost	-	-	-	-	-	-	9,835	1,896	11,731	11,731	-	-	-	-	-	-	-	-	-	168,370
4b.4	Subtotal Period 4b Period-Dependent Costs	475	4,083	6	3	-	652	36,316	8,594	50,129	50,129	-	-	-	2,587	-	-	-	51,732	17	446,604
4b.0	TOTAL PERIOD 4b COST	806	12,136	2,608	725	13	11,847	36,975	22,894	88,003	88,003	-	-	217	20,246	2,699	470	-	1,112,768	63,892	447,924
PERIOD 4c - Prepare Buildings for Demolition																					
Period 4c Direct Decommissioning Activities																					
Disposal of Plant Systems																					
4c.1.1.1	HMS1-1	-	36	8	3	-	34	-	24	105	105	-	-	-	419	-	-	-	15,816	601	-
4c.1.1.2	HMS1-2	-	5	3	1	-	9	-	5	24	24	-	-	-	152	-	-	-	5,726	96	-
4c.1.1.3	HMSP	-	6	1	0	-	2	-	3	12	12	-	-	-	34	-	-	-	1,275	99	-
4c.1.1.4	OTS-1	-	6	-	-	-	-	-	2	7	7	-	-	-	-	-	-	-	-	101	-
4c.1.1.5	OTS-2	-	6	-	-	-	-	-	2	8	8	-	-	-	-	-	-	-	-	102	-
4c.1.1.6	OTS-3	-	7	-	-	-	-	-	2	10	10	-	-	-	-	-	-	-	-	132	-
4c.1.1.7	OTS-4	-	6	-	-	-	-	-	2	8	8	-	-	-	-	-	-	-	-	103	-
4c.1.1.8	OTS-5	-	25	3	1	-	21	-	15	65	65	-	-	-	84	-	-	-	3,217	418	-
4c.1.1.9	OTS-6	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	13	-
4c.1.1.10	RB1-1	-	88	8	2	-	91	-	59	248	248	-	-	-	361	-	-	-	13,723	1,508	-
4c.1.1.11	RB1-2	-	32	3	1	-	29	-	20	85	85	-	-	-	116	-	-	-	4,417	544	-
4c.1.1.12	RB1-3	-	21	2	1	-	7	-	9	40	40	-	-	-	106	-	-	-	4,001	368	-
4c.1.1.13	RB1-4	-	116	14	4	-	50	-	56	239	239	-	-	-	611	-	-	-	23,199	1,990	-
4c.1.1.14	RB1-5	-	127	16	4	-	44	-	58	249	249	-	-	-	711	-	-	-	26,146	2,170	-
4c.1.1.15	RB1-6	52	211	20	6	-	228	-	178	695	695	-	-	-	907	-	-	-	34,362	4,245	-
4c.1.1.16	RB3-2	-	15	3	1	-	22	-	12	53	53	-	-	-	93	-	-	-	3,566	265	-
4c.1.1.17	RB4-2	-	62	7	2	-	76	-	46	193	193	-	-	-	325	-	-	-	11,592	1,082	-
4c.1.1.18	RB5-1	-	23	3	1	-	9	-	11	47	47	-	-	-	148	-	-	-	5,513	381	-
4c.1.1.19	RB5-1 (HVAC Scope)	-	22	9	3	-	29	-	18	80	80	-	-	-	467	-	-	-	17,640	319	-
4c.1.1.20	RBP	23	199	2	2	-	8	-	82	315	315	-	-	-	135	-	-	-	9,465	2,710	-
4c.1.1.21	TB7-1	-	59	-	-	-	-	-	19	78	78	-	-	-	-	-	-	-	-	1,067	-
4c.1.1.22	TB7-2	-	9	-	-	-	-	-	3	13	13	-	-	-	-	-	-	-	-	171	-
4c.1.1.23	TB7-3	-	11	4	1	-	13	-	9	38	38	-	-	-	209	-	-	-	7,906	161	-
4c.1.1.24	TB7-4	-	13	1	0	-	3	-	5	21	21	-	-	-	28	-	-	-	1,040	227	-
4c.1.1.25	TB7-5	-	27	8	2	-	11	-	13	61	61	-	-	-	348	-	-	-	13,169	427	-
4c.1.1.26	TB7-6	-	39	10	3	-	100	-	47	199	199	-	-	-	514	-	-	-	19,435	587	-

Appendix D
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR Decommissioning Cost Estimate
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (continued)																					
4c.1.1.27	TB7-7	-	13	-	-	-	-	-	4	18	18	-	-	-	-	-	-	-	-	240	-
4c.1.1.28	TBP	-	1,000	-	-	-	-	-	321	1,322	1,322	-	-	-	-	-	-	-	-	17,317	-
4c.1.1.29	YD1-2	-	7	2	1	-	31	-	13	55	55	-	-	-	124	-	-	-	4,692	104	-
4c.1.1.30	YD1-5	-	9	2	1	-	7	-	6	25	25	-	-	-	114	-	-	-	4,272	138	-
4c.1.1.31	YD2-1	-	56	4	1	-	14	-	23	98	98	-	-	-	168	-	-	-	6,375	947	-
4c.1.1.32	YD2-2	-	19	3	1	-	8	-	9	40	40	-	-	-	133	-	-	-	5,024	302	-
4c.1.1.33	YD2-3	-	8	2	1	-	9	-	6	26	26	-	-	-	111	-	-	-	4,197	125	-
4c.1.1.34	YD2-4	-	116	30	8	-	351	-	156	661	661	-	-	-	1,394	-	-	-	49,592	1,994	-
4c.1.1.35	YD2-5	-	253	46	15	-	585	-	278	1,176	1,176	-	-	-	2,320	-	-	-	87,642	4,102	-
4c.1.1.36	YD2-6	-	185	28	9	-	350	-	177	750	750	-	-	-	1,390	-	-	-	52,552	2,693	-
4c.1.1.37	YDP	-	178	17	5	-	54	-	78	331	331				864	-	-	-	31,068	1,875	-
4c.1.1	Totals	76	3,016	258	78	-	2,195	-	1,771	7,393	7,393	-	-	-	12,387	-	-	-	466,620	49,727	-
4c.1.2	Scaffolding in support of decommissioning	-	38	1	0	3	2	-	13	56	56	-	-	43	5	-	-	-	1,492	206	-
Decontamination of Site Buildings																					
4c.1.3.1	HMS	-	57	6	4	-	18	-	25	110	110	-	-	-	281	-	-	-	19,674	821	-
4c.1.3.2	Hot Machine Shop & Calibration	-	3	1	0	-	9	-	4	18	18	-	-	-	48	-	-	-	2,015	55	-
4c.1.3.3	RB1	91	1,748	542	180	-	3,807	-	1,948	8,317	8,317	-	-	-	18,660	-	-	-	989,526	29,415	-
4c.1.3.4	RB2	-	3,120	207	49	-	1,693	-	1,582	6,651	6,651	-	-	-	6,249	-	-	-	280,809	54,462	-
4c.1.3.5	RB3	-	99	7	3	-	54	-	51	214	214	-	-	-	328	-	-	-	17,949	1,484	-
4c.1.3.6	RB4	-	81	7	3	-	54	-	45	191	191	-	-	-	336	-	-	-	18,543	1,206	-
4c.1.3.7	RB5-1 (Refuel Bldg Roof)	-	19	4	3	-	12	-	11	47	47	-	-	-	190	-	-	-	13,290	254	-
4c.1.3.8	RW1	-	534	166	44	-	1,289	-	616	2,649	2,649	-	-	-	5,192	-	-	-	247,927	7,988	-
4c.1.3.9	Refueling	-	3	4	1	-	46	-	16	70	70	-	-	-	190	-	-	-	5,487	53	-
4c.1.3.10	TB1	-	93	8	5	-	46	-	47	198	198	-	-	-	417	-	-	-	26,269	1,356	-
4c.1.3.11	TB2	-	122	11	7	-	47	-	57	244	244	-	-	-	538	-	-	-	35,623	1,775	-
4c.1.3.12	TB3	-	30	6	4	-	25	-	19	84	84	-	-	-	293	-	-	-	19,550	423	-
4c.1.3.13	TB4	-	203	11	6	-	73	-	91	385	385	-	-	-	565	-	-	-	33,971	3,005	-
4c.1.3.14	TB5	-	87	4	3	-	13	-	33	140	140	-	-	-	209	-	-	-	14,628	1,270	-
4c.1.3.15	TB6	-	76	4	3	-	12	-	29	124	124	-	-	-	196	-	-	-	13,698	1,106	-
4c.1.3.16	TB7	-	31	6	4	-	20	-	18	79	79	-	-	-	313	-	-	-	21,936	423	-
4c.1.3.17	Turbine	-	4	4	1	-	54	-	20	83	83	-	-	-	223	-	-	-	6,442	76	-
4c.1.3.18	YD1	-	24	3	2	-	8	-	11	47	47	-	-	-	129	-	-	-	9,054	343	-
4c.1.3.19	YD2	-	98	12	8	-	36	-	46	200	200	-	-	-	582	-	-	-	40,746	1,403	-
4c.1.3	Totals	91	6,434	1,012	330	-	7,315	-	4,669	19,851	19,851	-	-	-	34,940	-	-	-	1,817,136	106,919	-
4c.1 Activity Costs		166	9,487	1,271	409	3	9,511	-	6,453	27,300	27,300	-	-	43	47,332	-	-	-	2,285,247	156,852	-
Period 4c Additional Costs																					
4c.2.1	Contaminated Soil Removal	-	211	663	2,567	-	14,035	-	5,157	22,633	22,633	-	-	-	169,154				11,840,787	2,684	-
4c.2.2	Replacement of Drains and Catch Basins	-	75	-	-	-	-	-	24	99	99	-	-	-	-	-	-	-	-	687	-
4c.2.3	Caisson Mixed Waste Removal	-	159	10	40	-	1,175	-	438	1,822	1,822	-	-	-	2,433	-	-	-	170,284	2,117	-
4c.2.4	Site work supporting spent fuel pool removal	-	-	-	-	-	-	990	191	1,180	1,180	-	-	-	-	-	-	-	-	507	-
4c.2.5	Removal of 3 spent fuel pool walls	-	704	68	418	-	3,479	-	1,433	6,101	6,101	-	-	-	24,120	-	-	-	2,210,400	49,551	-
4c.2.6	Removal of Yard Pipe Tunnel	-	647	14	205	-	2,561	-	1,072	4,498	4,498	-	-	-	10,162	-	-	-	1,219,420	24,962	-
4c.2.7	Contaminated Soil & Concrete Storage Facility	-	-	-	-	-	-	436	84	520	520	-	-	-	-	-	-	-	-	476	-
4c.2	Total	-	1,796	754	3,230	-	21,250	1,425	8,398	36,854	36,854	-	-	-	205,869	-	-	-	15,440,890	80,983	-
Period 4c Collateral Costs																					
4c.3.1	Process liquid waste	28	-	14	61	-	48	-	47	197	197	-	-	-	189	-	-	-	11,354	49	-
4c.3.2	Small tool allowance	-	179	-	-	-	-	-	58	237	237	-	-	-	-	-	-	-	-	-	-
4c.3.3	Decommissioning Equipment Disposition	-	-	206	7	540	335	-	240	1,328	1,328	-	-	9,000	1,058	-	-	-	309,936	123	-
4c.3	Subtotal Period 4c Collateral Costs	28	179	220	68	540	383	-	344	1,762	1,762	-	-	9,000	1,247	-	-	-	321,290	173	-
Period 4c Period-Dependent Costs																					
4c.4.1	Decon supplies	58	-	-	-	-	-	-	19	77	77	-	-	-	-	-	-	-	-	-	-
4c.4.2	Insurance	-	-	-	-	-	-	72	9	81	81	-	-	-	-	-	-	-	-	-	-
4c.4.3	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4c.4.4	Health physics supplies	-	624	-	-	-	-	-	200	824	824	-	-	-	-	-	-	-	-	-	-
4c.4.5	Heavy equipment rental	-	1,503	-	-	-	-	-	290	1,793	1,793	-	-	-	-	-	-	-	-	-	-

Appendix D
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR Decommissioning Cost Estimate
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 4c Period-Dependent Costs (continued)																					
4c.4.6	Disposal of DAW generated	-	-	1	1	-	134	-	43	179	179	-	-	-	533	-	-	-	10,651	3	-
4c.4.7	Plant energy budget	-	-	-	-	-	-	97	19	115	115	-	-	-	-	-	-	-	-	-	-
4c.4.8	NRC Fees	-	-	-	-	-	-	658	85	743	743	-	-	-	-	-	-	-	-	-	-
4c.4.9	Emergency Planning Fees	-	-	-	-	-	-	101	13	114	114	-	-	-	-	-	-	-	-	-	-
4c.4.10	Environmental / Engineering Support	-	-	-	-	-	-	2,648	510	3,159	3,159	-	-	-	-	-	-	-	-	-	-
4c.4.11	Radwaste Processing Equipment/Services	-	-	-	-	-	-	375	72	447	447	-	-	-	-	-	-	-	-	-	-
4c.4.12	ISFSI Operating Costs	-	-	-	-	-	-	85	16	101	101	-	-	-	-	-	-	-	-	-	-
4c.4.13	Security Staff Cost	-	-	-	-	-	-	3,591	692	4,283	4,283	-	-	-	-	-	-	-	-	-	66,743
4c.4.14	DOC Staff Cost	-	-	-	-	-	-	9,559	1,843	11,402	11,402	-	-	-	-	-	-	-	-	-	119,282
4c.4.15	Utility Staff Cost	-	-	-	-	-	-	6,662	1,284	7,946	7,946	-	-	-	-	-	-	-	-	-	115,757
4c.4	Subtotal Period 4c Period-Dependent Costs	58	2,127	1	1	-	134	23,848	5,096	31,265	31,265	-	-	-	533	-	-	-	10,651	3	301,782
4c.0	TOTAL PERIOD 4c COST	252	13,590	2,247	3,707	543	31,279	25,274	20,290	97,181	97,181	-	-	9,043	254,980	-	-	-	18,058,079	238,011	301,782
PERIOD 4d - Building Demolition, Yard Work, Soil Remediation																					
Demolition of Site Buildings																					
4d.1.1	Contaminated Equipment Storage	-	7	10	42	-	174	-	44	278	278	-	-	-	2,842	-	-	-	198,936	90	-
4d.1.2	Gas Stack	-	33	82	331	-	1,381	-	347	2,175	2,175	-	-	-	22,563	-	-	-	1,579,419	184	-
4d.1.3	Hot Machine Shop & Calibration	-	20	24	95	-	394	-	101	634	634	-	-	-	6,445	-	-	-	451,120	252	-
4d.1.4	New Off Gas Vault	-	80	189	759	-	3,163	-	796	4,987	4,987	-	-	-	51,687	-	-	-	3,618,076	460	-
4d.1.5	Radwaste Treatment	-	145	149	597	-	2,490	-	642	4,023	4,023	-	-	-	40,680	-	-	-	2,847,575	1,322	-
4d.1.6	Refueling	-	1,099	310	1,247	-	5,196	-	1,494	9,346	9,346	-	-	-	84,907	-	-	-	5,943,511	3,112	-
4d.1.7	Solid Waste Vault	-	4	6	23	-	96	-	24	153	153	-	-	-	1,572	-	-	-	110,067	30	-
4d.1.8	Turbine	-	243	389	1,565	-	6,522	-	1,656	10,375	10,375	-	-	-	106,576	-	-	-	7,460,292	1,674	-
4d.1.9	Yard Structures	-	57	36	143	-	598	-	158	992	992	-	-	-	9,765	-	-	-	683,540	647	-
4d.1	Totals	-	1,687	1,195	4,803	-	20,015	-	5,262	32,962	32,962	-	-	-	327,036	-	-	-	22,892,536	7,770	-
Period 4d Additional Costs																					
4d.2.1	Backfill of Structures and Site	-	1,460	-	-	-	-	-	281	1,741	-	-	1,741	-	-	-	-	-	-	-	-
4d.2	Subtotal Period 4c Additional Costs	-	1,460	-	-	-	-	-	281	1,741	-	-	1,741	-	-	-	-	-	-	-	-
Period 4d Collateral Costs																					
4d.3.1	Small Tool Allowance	-	9	-	-	-	-	-	2	11	11										
	Subtotal Period 4d Collateral Costs	-	9	-	-	-	-	-	2	11	11	-	-	-	-	-	-	-	-	-	-
Period 4d Period-Dependent Costs																					
4d.4.1	Insurance	-	-	-	-	-	-	138	18	155	155	-	-	-	-	-	-	-	-	-	-
4d.4.2	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4d.4.3	Health physics supplies	-	441	-	-	-	-	-	142	582	582	-	-	-	-	-	-	-	-	-	-
4d.4.4	Heavy equipment rental	-	925	-	-	-	-	-	178	1,104	1,104	-	-	-	-	-	-	-	-	-	-
4d.4.5	Disposal of DAW generated	-	-	1	0	-	98	-	32	131	131	-	-	-	390	-	-	-	7,793	3	-
4d.4.6	Plant energy budget	-	-	-	-	-	-	150	29	179	179	-	-	-	-	-	-	-	-	-	-
4d.4.7	NRC Fees	-	-	-	-	-	-	350	45	395	395	-	-	-	-	-	-	-	-	-	-
4d.4.8	Emergency Planning Fees	-	-	-	-	-	-	194	25	218	218	-	-	-	-	-	-	-	-	-	-
4d.4.9	Environmental / Engineering Support	-	-	-	-	-	-	3,137	605	3,742	3,742	-	-	-	-	-	-	-	-	-	-
4d.4.10	Radwaste Processing Equipment/Services	-	-	-	-	-	-	719	139	858	858	-	-	-	-	-	-	-	-	-	-
4d.4.11	ISFSI Operating Costs	-	-	-	-	-	-	163	31	194	194	-	-	-	-	-	-	-	-	-	-
4d.4.12	Security Staff Cost	-	-	-	-	-	-	6,079	1,172	7,251	7,251	-	-	-	-	-	-	-	-	-	116,520
4d.4.13	DOC Staff Cost	-	-	-	-	-	-	14,518	2,798	17,316	17,316	-	-	-	-	-	-	-	-	-	194,800
4d.4.14	Utility Staff Cost	-	-	-	-	-	-	10,603	2,044	12,647	12,647	-	-	-	-	-	-	-	-	-	176,920
	Subtotal Period 4d Period-Dependent Costs	-	1,366	1	0	-	98	36,051	7,257	44,773	44,773	-	-	-	390	-	-	-	7,793	3	488,240
4d.0	TOTAL PERIOD 4d COST	-	4,522	1,196	4,803	-	20,113	36,051	12,802	79,486	77,745	-	1,741	-	327,426	-	-	-	22,900,330	7,773	488,240

Appendix D
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR Decommissioning Cost Estimate
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 4e - License Termination																					
Period 4e Direct Decommissioning Activities																					
4e.1.1	ORISE confirmatory survey	-	-	-	-	-	-	151	29	180	180	-	-	-	-	-	-	-	-	-	-
4e.1.2	Terminate license	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4e.1	Subtotal Period 4e Activity Costs	-	-	-	-	-	-	151	29	180	180	-	-	-	-	-	-	-	-	-	-
Period 4e Additional Costs																					
4e.2.1	License Termination Survey (sample analysis & equipment)		-	-	-	-	-	725	279	1,004	1,004	-	-	-	-	-	-	-	-	-	-
4e.2	Subtotal Period 4e Additional Costs		-	-	-	-	-	725	279	1,004	1,004	-	-	-	-	-	-	-	-	-	-
Period 4e Collateral Costs																					
4e.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,436	277	1,713	1,713	-	-	-	-	-	-	-	-	-	-
4e.3	Subtotal Period 4e Collateral Costs	-	-	-	-	-	-	1,436	277	1,713	1,713	-	-	-	-	-	-	-	-	-	-
Period 4e Period-Dependent Costs																					
4e.4.1	Insurance	-	-	-	-	-	-	24	3	27	27	-	-	-	-	-	-	-	-	-	-
4e.4.2	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4e.4.3	Health physics supplies	-	192	-	-	-	-	-	62	254	254	-	-	-	-	-	-	-	-	-	-
4e.4.4	Disposal of DAW generated	-	-	0	0	-	38	-	12	51	51	-	-	-	152	-	-	-	3,036	1	-
4e.4.5	Plant energy budget	-	-	-	-	-	-	16	3	19	19	-	-	-	-	-	-	-	-	-	-
4e.4.6	NRC Fees	-	-	-	-	-	-	236	30	266	266	-	-	-	-	-	-	-	-	-	-
4e.4.7	Emergency Planning Fees	-	-	-	-	-	-	34	4	38	38	-	-	-	-	-	-	-	-	-	-
4e.4.8	Environmental / Engineering Support	-	-	-	-	-	-	443	85	528	528	-	1	-	-	-	-	-	-	-	-
4e.4.9	ISFSI Operating Costs	-	-	-	-	-	-	28	5	34	34	-	-	-	-	-	-	-	-	-	-
4e.4.10	Security Staff Cost	-	-	-	-	-	-	948	183	1,131	1,131	-	-	-	-	-	-	-	-	-	18,126
4e.4.11	DOC Staff Cost	-	-	-	-	-	-	2,128	410	2,538	2,538	-	-	-	-	-	-	-	-	-	28,757
4e.4.12	Utility Staff Cost	-	-	-	-	-	-	1,457	281	1,737	1,737	-	-	-	-	-	-	-	-	-	22,831
4e.4	Subtotal Period 4e Period-Dependent Costs	-	192	0	0	-	38	5,314	1,080	6,624	6,624	-	-	-	152	-	-	-	3,036	1	69,714
4e.0	TOTAL PERIOD 4e COST	-	192	0	0	-	38	7,626	1,665	9,522	9,522	-	-	-	152	-	-	-	3,036	1	69,714
PERIOD 4 TOTALS		1,246	40,119	7,731	9,618	566	74,641	156,788	74,487	365,195	363,454	-	1,741	9,433	654,879	2,699	470	-	44,005,225	396,785	1,906,552
PERIOD 5b - Site Restoration																					
Period 5b Direct Decommissioning Activities																					
Site Closeout Activities																					
5b.1.1	Grade & landscape site	-	41	-	-	-	-	-	13	55	-	-	55	-	-	-	-	-	-	105	-
5b.1.2	Final report to NRC	-	-	-	-	-	-	195	38	233	233	-	-	-	-	-	-	-	-	-	1,560
5b.1	Subtotal Period 5b Activity Costs	-	41	-	-	-	-	195	51	287	233	-	55	-	-	-	-	-	-	105	1,560
Period 5b Additional Costs																					
5b.2.1	Disposal of Asphalt Roadways	-	-	-	-	-	-	63	12	75			75								
5b.2.2	Disposal of Legacy Class B & C Waste	-	-	-	148	-	1,400	-	478	2,026	2,026	-	-	-	-	384	96	-	14,050	-	-
5b.2.3	*Disposal of Intermodal Containers*	-	-	-	-	-	-	975	188	1,163	1,163	-	-								
5b.2	Subtotal Period 5b Additional Costs	-	-	-	148	-	1,400	1,038	678	3,264	3,189	-	75	-	-	384	96	-	14,050	-	-
Period 5b Collateral Costs																					
5b.3.1	Small tool allowance	-	0	-	-	-	-	-	0	0	0	-	0	-	-	-	-	-	-	-	-
5b.3	Subtotal Period 5b Collateral Costs	-	0	-	-	-	-	-	0	0	0	-	0	-	-	-	-	-	-	-	-
Period 5b Period-Dependent Costs																					
5b.4.1	Insurance	-	-	-	-	-	-	36	5	40		40		-	-	-	-	-	-	-	-
5b.4.2	Property taxes	-	-	-	-	-	-	-	-	-		-		-	-	-	-	-	-	-	-
5b.4.3	Plant energy budget	-	-	-	-	-	-	12	2	14		14	-	-	-	-	-	-	-	-	-
5b.4.4	NRC ISFSI Fees	-	-	-	-	-	-	98	13	111		111	-	-	-	-	-	-	-	-	-
5b.4.5	Emergency Planning Fees	-	-	-	-	-	-	50	6	57		57	-	-	-	-	-	-	-	-	-
5b.4.6	ISFSI Operating Costs	-	-	-	-	-	-	42	8	50		50	-	-	-	-	-	-	-	-	-
5b.4.7	Security Staff Cost	-	-	-	-	-	-	1,422	274	1,696		1,696	-	-	-	-	-	-	-	-	27,040
5b.4.8	DOC Staff Cost	-	-	-	-	-	-	127	24	152		152	-	-	-	-	-	-	-	-	1,300

Appendix D
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR Decommissioning Cost Estimate
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 5b Period-Dependent Costs (continued)																					
5b.4.9	Utility Staff Cost	-	-	-	-	-	-	428	83	511		511	-	-	-	-	-	-	-	-	7,540
5b.4	Subtotal Period 5b Period-Dependent Costs	-	-	-	-	-	-	2,215	415	2,631	-	2,631	-	-	-	-	-	-	-	-	35,880
5b.0	TOTAL PERIOD 5b COST	-	41	-	148	-	1,400	3,448	1,144	6,182	3,421	2,631	130	-	-	384	96	-	14,050	105	37,440
PERIOD 5c - Fuel Storage Operations																					
Period 5c Period-Dependent Costs																					
5c.4.1	Insurance	-	-	-	-	-	-	251	32	284		284	-	-	-	-	-	-	-	-	-
5c.4.2	Property taxes	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
5c.4.3	Plant energy budget	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
5c.4.4	NRC ISFSI Fees	-	-	-	-	-	-	709	91	801		801	-	-	-	-	-	-	-	-	-
5c.4.5	Emergency Planning Fees	-	-	-	-	-	-	354	45	399		399	-	-	-	-	-	-	-	-	-
5c.4.6	ISFSI Operating Costs	-	-	-	-	-	-	297	57	355		355	-	-	-	-	-	-	-	-	-
5c.4.7	Security Staff Cost	-	-	-	-	-	-	9,998	1,927	11,925		11,925	-	-	-	-	-	-	-	-	190,023
5c.4.8	DOC Staff Cost	-	-	-	-	-	-	198	38	236		236	-	-	-	-	-	-	-	-	1,827
5c.4.9	Utility Staff Cost	-	-	-	-	-	-	1,087	210	1,297		1,297	-	-	-	-	-	-	-	-	14,617
												-	-								
5c.4	Subtotal Period 5c Period-Dependent Costs	-	-	-	-	-	-	12,896	2,401	15,297		15,297	-	-	-	-	-	-	-	-	206,467
5c.0	TOTAL PERIOD 5c COST	-	-	-	-	-	-	12,896	2,401	15,297	-	15,297	-	-	-	-	-	-	-	-	206,467
PERIOD 5d - Spent Fuel and GTCC shipping																					
Period 5d Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
5d.1.1.1	Vessel & Internals GTCC Disposal	-	-	95	-	-	346	-	79	519	519	-	-	-	-	-	-	17	3,228	-	-
5d.1	Subtotal Period 5d Activity Costs	-	-	95	-	-	346	-	79	519	519	-	-	-	-	-	-	17	3,228	-	-
Period 5d Collateral Costs																					
5d.3.1	Transfer Spent Fuel to DOE	-	-	-	-	-	-	462	89	551	-	551	-	-	-	-	-	-	-	-	-
5d.3.1	Subtotal Period 5d Collateral Costs	-	-	-	-	-	-	462	89	551	-	551	-	-	-	-	-	-	-	-	-
Period 5d Period-Dependent Costs																					
5d.4.1	Insurance	-	-	-	-	-	-	36	7	43	43	-	-	-	-	-	-	-	-	-	-
5d.4.2	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5d.4.3	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5d.4.4	NRC ISFSI Fees	-	-	-	-	-	-	99	13	111	111	-	-	-	-	-	-	-	-	-	-
5d.4.5	Emergency Planning Fees	-	-	-	-	-	-	51	7	57	57	-	-	-	-	-	-	-	-	-	-
5d.4.6	ISFSI Operating Costs	-	-	-	-	-	-	43	8	51	51	-	-	-	-	-	-	-	-	-	-
5d.4.7	Security Staff Cost	-	-	-	-	-	-	1,430	276	1,705	1,705	-	-	-	-	-	-	-	-	-	-
5d.4.8	DOC Staff Cost	-	-	-	-	-	-	28	5	34	34	-	-	-	-	-	-	-	-	-	-
5d.4.9	Utility Staff Cost	-	-	-	-	-	-	156	30	186	186	-	-	-	-	-	-	-	-	-	2,091
5d.4.	Subtotal Period 5d Period-Dependent Costs	-	-	-	-	-	-	1,841	345	2,187	2,187	-	-	-	-	-	-	-	-	-	2,091
5d.0	TOTAL PERIOD 5d COST	-	-	95	-	-	346	2,303	513	3,257	2,706	551	-	-	-	-	-	17	3,228	-	2,091
PERIOD 5e - ISFSI Decontamination																					
Period 5e Additional Costs																					
5e.2.1	ISFSI Decontamination	-	5	0	2	-	10	1,169	231	1,417	-	1,417	-	-	116	-	-	-	10,376	1,270	2,560
5e.2	Subtotal Period 5e Additional Costs	-	5	0	2	-	10	1,169	231	1,417	-	1,417	-	-	116	-	-	-	10,376	1,270	2,560
Period 5e Collateral Costs																					
5e.3.1	Small tool allowance	-	0	-	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-
5e.3	Subtotal Period 5e Collateral Costs	-	0	-	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-

Appendix D
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR Decommissioning Cost Estimate
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 5e Period-Dependent Costs																					
5e.4.1	Insurance	-	-	-	-	-	-	23	3	26	-	26	-	-	-	-	-	-	-	-	-
5e.4.2	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5e.4.3	Heavy equipment rental	-	118	-	-	-	-	-	23	141	-	141	-	-	-	-	-	-	-	-	-
5e.4.4	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5e.4.5	Security Staff Cost	-	-	-	-	-	-	877	169	1,046	-	1,046	-	-	-	-	-	-	-	-	17,680
5e.4.6	DOC Staff Cost	-	-	-	-	-	-	17	3	21	-	21	-	-	-	-	-	-	-	-	170
5e.4.7	Utility Staff Cost	-	-	-	-	-	-	95	18	114	-	114	-	-	-	-	-	-	-	-	1,360
5e.4.	Subtotal Period 5e Period-Dependent Costs	-	118	-	-	-	-	1,013	216	1,347	-	1,347	-	-	-	-	-	-	-	-	19,210
5e.0	TOTAL PERIOD 5e COST	-	124	0	2	-	10	2,181	447	2,764	-	2,764	-	-	116	-	-	-	10,376	1,270	21,770
PERIOD 5f - ISFSI Site Restoration																					
Period 5f Additional Costs																					
5f.2.1	ISFSI Demolition	-	270	-	-	-	-	48	61	380	-	380	-	-	-	-	-	-	-	2,643	160
5f.2	Subtotal Period 5f Additional Costs	-	270	-	-	-	-	48	61	380	-	380	-	-	-	-	-	-	-	2,643	160
Period 5f Collateral Costs																					
5f.3.1	Small tool allowance	-	3	-	-	-	-	-	1	3	-	3	-	-	-	-	-	-	-	-	-
5f.3	Subtotal Period 5f Collateral Costs	-	3	-	-	-	-	-	1	3	-	3	-	-	-	-	-	-	-	-	-
Period 5f Period-Dependent Costs																					
5f.4.1	Insurance	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
5f.4.2	Property taxes	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
5f.4.3	Heavy equipment rental	-	61	-	-	-	-	-	12	73		73	-	-	-	-	-	-	-	-	-
5f.4.4	Plant energy budget	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
5f.4.5	Security Staff Cost	-	-	-	-	-	-	492	95	587		587	-	-	-	-	-	-	-	-	9,360
5f.4.6	DOC Staff Cost	-	-	-	-	-	-	10	2	12		12	-	-	-	-	-	-	-	-	90
5f.4.7	Utility Staff Cost	-	-	-	-	-	-	54	10	64		64	-	-	-	-	-	-	-	-	720
5f.4	Subtotal Period 5f Period-Dependent Costs	-	61	-	-	-	-	555	119	735	-	735	-	-	-	-	-	-	-	-	10,170
5f.0	TOTAL PERIOD 5f COST	-	334	-	-	-	-	604	181	1,119	-	1,119	-	-	-	-	-	-	-	2,643	10,330
PERIOD 5 TOTALS		-	499	95	149	-	1,756	21,432	4,686	28,618	6,127	22,361	130	-	116	384	96	17	27,654	4,019	278,099
TOTAL COST TO DECOMMISSION		2,214	41,837	7,830	9,774	566	76,487	277,452	83,598	499,759	421,241	76,647	1,871	9,433	655,237	3,083	566	17	44,053,592	400,805	2,245,933

TOTAL COST TO DECOMMISSION WITH 25% CONTINGENCY:	**499,759**	**thousands of 2008 dollars**
TOTAL NRC LICENSE TERMINATION COST IS 84.3% OR	**421,241**	**thousands of 2008 dollars**
SPENT FUEL MANAGEMENT COST IS 15.3% OR:	**76,647**	**thousands of 2008 dollars**
NON-NUCLEAR DEMOLITION COST IS 0.4% OR:	**1,871**	**thousands of 2008 dollars**
TOTAL Class A RADWASTE VOLUME BURIED:	**655,237**	**Cubic Feet**
TOTAL Class B & C RADWASTE VOLUME BURIED:	**3,648**	**Cubic Feet**
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	**17**	**Cubic Feet**
TOTAL CRAFT LABOR REQUIREMENTS:	**400,805**	**Man-hours**

End Notes:
n/a - indicates that this activity not charged as decommissioning expense.
a - indicates that this activity performed by decommissioning staff.
0 - indicates that this value is less than 0.5 but is non-zero.
a cell containing " - " indicates a zero value

APPENDIX E

HUMBOLDT BAY POWER PLANT UNIT 3
2010 SAFSTOR
CPUC COST DISALLOWANCES

Appendix E
Humboldt Bay Power Plant, Unit 3
2010 SAFSTOR CPUC COST DISALLOWANCES
(Thousands of 2008 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems																					
1.1	Clean Seismic Modifications		17						3	20			20							310	
1.2	Contaminated Seismic Modifications		85	17	3		117		61	284	284				465				17,984	1,419	
1	Totals		102	17	3		117		64	304	284		20		465				17,984	1,729	
Period 4 Collateral & Period-Dependent Costs																					
1	Small tool allowance		2						1	3	3										
2	Disposal of DAW generated			2			11		3	16	16				43				864	4	
Subtotal of Collateral & Period-Dependent Costs			2	2			11		4	19	19				43				864	4	
Demolition of Site Buildings																					
2.1	Seismic Modifications		54						9	63			63							672	
2	Totals		54						9	63			63							672	
TOTAL COST TO DECOMMISSION			158	19	3		128		77	386	302		83		508				18,848	2,405	

CPUC COST DISALLOWANCES	25.0% CONTINGENCY	385,520
NRC LICENSE TERMINATION COST IS	78% OR	302,326
NON-NUCLEAR DEMOLITION COST IS	22% OR	83,194
TOTAL RADWASTE VOLUME BURIED		508 Cubic Feet
TOTAL CRAFT LABOR REQUIREMENTS		2,405 Man-hours

APPENDIX F

HUMBOLDT BAY 2010 SAFSTOR DECOMMISSIONING SCHEDULE

HUMBOLDT BAY 2010 SAFSTOR DECOMMISSIONING SCHEDULE