DECOMMISSIONING COST ANALYSIS
for the
SAN ONOFRE NUCLEAR GENERATION STATION UNIT 1

prepared for

SOUTHERN CALIFORNIA EDISON

prepared by

TLG Services, Inc.

Bridgewater, Connecticut

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TABLE OF CONTENTS

SECTION - PAGE

TABLE OF CONTENTS
(continued)

SECTION-PAGE

TABLES

FIGURES

APPENDICES

REVISION LOG

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EXECUTIVE SUMMARY

A site-specific cost analysis was prepared for decommissioning the San Onofre Nuclear Generating Station Unit 1 (SONGS-1) for Southern California Edison (SCE) by TLG Services, Inc. This study includes a comprehensive cost and schedule estimate for completing the decommissioning based upon a detailed accounting of the plant inventory. The requirements for component disposition and the associated time to complete were combined to produce the proposed project schedule. The resulting cost to decommission (decontaminate and dismantle) SONGS-1 is estimated at approximately $458.8 million, in 1998 dollars. The major cost contributors are associated with oversight staffing, radioactive waste management (high and low-level), labor, site remediation, low-level radioactive waste disposal, as well as ancillary expenses such as licensing fees, insurance premiums, etc. The costs are based on several key assumptions in areas of regulatory requirements, financing, component characterization, high-level radioactive waste management, the availability for disposal of low-level radioactive waste, performance uncertainties (contingency) and site restoration requirements. A complete discussion of the assumptions relied upon in this analysis is provided in Section 3.

The major cost contributors to the cost to decommissioning SONGS-1 are discussed in Section 6. A copy of the summary information provided in Table 6.1 is reproduced at the end of this summary for completeness. A schedule of annual expenditures is provided at the end of Section 3, with the associated schedule of significant project activities provided in Section 4. A detailed reporting of the information used to generate the summary tables contained within this document can be found in Appendix C.

Alternatives and Regulations

The Nuclear Regulatory Commission (NRC) provided general decommissioning guidance in a rule adopted on June 27, 1988[1], setting forth technical and financial criteria for decommissioning licensed nuclear facilities. The regulations addressed planning needs, timing, funding methods, and environmental review requirements for decommissioning. The rule also defined three decommissioning alternatives - DECON, SAFSTOR and ENTOMB. Because SONGS-1 will have radionuclides in concentrations exceeding the limits for unrestricted use even after 100 years, the ENTOMB option will not be viable. The NRC also recognized that some combination of the first two alternatives would also be appropriate in some instances.

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[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.

DECON was defined by the rule 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]

Methodology

The methodology used to develop the decommissioning cost estimate for SONGS-1 follows the basic approach originally presented in a document developed for the Atomic Industrial Forum (now the Nuclear Energy Institute), entitled "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates[5]." This reference describes a unit cost factor method for estimating decontamination and dismantling activity costs. The unit cost factors used in this study reflect site-specific costs, as well as the latest available information on worker productivity, waste handling and material disposition in decommissioning a nuclear facility. The data obtained from the Shippingport Station Decommissioning Project, completed in 1989, as well as from TLG's involvement in the decommissioning planning and engineering for the Shoreham, Yankee Rowe, Trojan, Rancho Seco, Pathfinder, and Cintichem reactor facilities, are reflected within this estimate.

An activity duration critical path is used to determine the total decommissioning program schedule required for calculating the carrying costs which include program management, administration, field engineering, equipment rental, quality assurance, and security. This systematic approach for assembling decommissioning estimates

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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.

ensures a high degree of confidence in the reliability of the resulting costs.

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 estimate, does not account for price escalation and inflation in the cost of decommissioning over the period of performance.

Contingency is not used as a safety factor within decommissioning estimates. Safety factors provide additional security and address situations that may never occur. Application of contingency on a line-item basis 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 waste, although not all of the material is suitable for "shallow-land" disposal. With the passage of the "Low-Level Radioactive Waste Disposal Act" in 1980[7], and its Amendments of 1985, the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders. California is a member of the Southwest Compact, which is currently in the process of developing such a facility in Ward Valley, California. In 1993, the State of California issued a license to US Ecology to operate a low level radioactive waste facility, however transfer of federal lands to the State of California has been halted while more studies on the environmental impact of the site are being undertaken. The schedule for the actual opening of this facility is still uncertain, however for the purposes of this study, this site is assumed to be operational to support decommissioning operations.

With the high cost of disposal at Ward Valley ($957.61 per cubic foot for the years

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

7 "Low-Level Radioactive Waste Policy Amendments Act of 1985," Public Law 99-240,1/15/86.

2000 – 2006), a large portion of the contaminated material generated during decommissioning will be processed for volume reduction by the most cost effective means, either on site or routed through commercial waste recovery vendor(s). Reduction in the volume of material requiring controlled disposal was assumed to be accomplished through a variety of methods including surveying (for non-verified clean material), incineration, compaction and metal-melt. Costs for waste conditioning and associated recovery fractions were based upon representative market prices and performance data from vendors providing these types of services.

High-Level Waste

Congress passed the "Nuclear Waste Policy Act" in 1982, assigning the responsibility for disposal of spent nuclear fuel created by the commercial nuclear generating plants to the Department of Energy (DOE). This legislation also created a Nuclear Waste Fund to cover the cost of the program, which is funded by the sale of electricity from SONGS-1 (and an estimated equivalent for assemblies irradiated prior to April, 1983). The target date for startup of the federal Waste Management System was originally 1998.

The backlog of spent fuel in the national inventory, delays in site characterization, and intermittent progress in the development of a waste transportation system make it necessary to reflect spent fuel storage in the cost and schedule of commercial reactor decommissioning. After several delays, DOE now estimates that the geologic repository will be operational sometime between the years 2010 and 2015. For the basis of this cost analysis, it is assumed that the high-level waste repository or some interim storage facility will be operational by 2010. Interim storage of the fuel until DOE has completed the transfer will be in an independent facility to be constructed at the SONGS-1 site. This will allow SCE to proceed with decommissioning of the generating facility and the termination of its operating license in the shortest time possible.

Site Restoration

The efficient removal of the contaminated materials at the site and verification that residual radionuclide concentrations are below the NRC limits 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. Prompt demolition is clearly the most appropriate and cost-effective option, as well as a requirement under SCE's current lease agreement for the property.

Currently SCE is planning to construct the ISFSI adjacent to the SONGS-1 power block. Having spent fuel so close to the facility has an effect on the demolition of these remaining structures. For the purposes of the estimate it is assumed that the remaining structures are removed by controlled demolition down to existing grade. After all spent fuel is shipped from the site the remaining foundations will be removed and the site returned to it original condition pursuant to its current lease agreement.

Recommendations

SONGS-1 is currently in a SAFSTOR mode. This cost estimate reflects the current situation. Although the Decommissioning Plan states that dormancy will continue until the shutdown of Units 2 and 3 (approximately 2013), this estimate reflects a more timely solution to the removal of radioactive material from the site.

TLG believes that SCE should, with all deliberate speed, plan for the removal of all contamination from the Unit 1 portion of the site. This will reduce the uncertainties in increases in future costs, changes in plant conditions, and eliminate additional cost increases from mandated regulatory changes for decommissioning.

SUMMARY OF MAJOR CONTRIBUTORS to the COST OF DECOMMISSIONING

Work Activity or Cost Category	Cost (Thousands, 98$)[1,2]	Percent of Total Cost[1]
Staffing	131,333	28.63
Removal – License Termination	82,830	18.05
LLW Burial	71,052	15.49
ISFSI Siting, Construction and Licensing	38,913	8.48
Non-radiological Demolition (Clean Removal)	38,113	8.31
Remaining Costs[3]	18,200	3.97
Security Services	15,313	3.34
Waste Conditioning/Recycling	12,101	2.64
Decontamination	11,025	2.40
Insurance	7,884	1.72
NRC & EP Fees	5,474	1.19
Mixed and Hazardous Wastes	5,435	1.18
Transportation	4,625	1.01
Packaging	4,256	0.93
Site Characterization	3,814	0.83
Soil Remediation	3,037	0.66
License Termination Survey	2,434	0.53
Plant Energy Budget	1,996	0.44
NRC ISFSI Fees	937	0.20
Total	**$458,772**	**100.00**

Notes:

1. Columns may not add due to rounding.
2. All costs include contingency
3. Remaining costs include, building modifications, temporary services and support equipment.

1. INTRODUCTION

This decommissioning cost analysis is designed to provide Southern California Edison (SCE) 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 cost estimate prepared in advance of the detailed engineering preparations required to carry out the decommissioning of Unit 1 of the San Onofre Nuclear Generating Station (SONGS-1). This analysis is also intended to support the production of required licensing documentation, i.e. the Post-Shutdown Decommissioning Activities Report (PSDAR).

1.1 OBJECTIVE OF STUDY

The objective of the study is to prepare a comprehensive estimate of the cost, a detailed schedule of the associated activities, and the resulting volume of low-level radioactive waste generated in decommissioning SONGS-1.

SONGS-1 was permanently shut down in November of 1992 after approximately 25 years of operation. Currently the plant is in a dormancy period until Units 2 and 3 are shut down in 2013 when all three units will be decommissioned simultaneously. SCE is currently exploring options to accelerate the decommissioning of SONGS-1. This study assumes such a scenario, commencing with decommissioning planning in 1998.

1.2 SITE DESCRIPTION

SONGS-1 is located on the coast of southern California in San Diego County, approximately 62 miles southeast of Los Angeles and 51 miles northwest of San Diego. The site is located entirely within the boundaries of the United States Marine Corps Base, Camp Pendleton, near the northwest end of the 18 mile shoreline. The property upon which the station is built is being leased from the United States Government. SCE is the primary owner and holds the license for the station's operation.

The entire San Onofre Nuclear Generating Station is comprised of three nuclear generating units with supporting facilities. Unit 1 occupies the northern end of the SCE site. Designed by Bechtel, the unit contains a Westinghouse pressurized water reactor and a Westinghouse turbine-generator set with a gross electrical capacity of 410 Megawatt electric. Units 2 and 3 are located south and immediately adjacent to SONGS-1. Units 2 and 3 are not included in the scope of this study.

The Nuclear Steam Supply System (NSSS) for SONGS-1 consists of a pressurized water reactor and a three-loop Reactor Coolant System (RCS). This system was supplied by Westinghouse. The reactor core power output was 1347 Megawatts thermal.

The RCS is comprised of the reactor vessel and three heat transfer loops, each containing a steam generator and a reactor coolant pump. In addition, the system includes an electrically-heated pressurizer, a pressurizer relief tank and interconnected piping. The system is housed within a "containment sphere," a seismic Category 1 steel sphere enclosure, with a concrete basemat. Enclosing the sphere is a concrete biological shield.

Heat produced in the reactor was converted to electrical energy by the Turbine Generator Systems. A turbine-generator system converted the thermal energy of the steam produced in the steam generators into mechanical shaft power and then into electrical energy. The Unit 1 turbine-generator is a three-cycle tandem compound, quadruple exhaust, condensed 1800 revolutions per minute unit. The high-pressure turbine and two low-pressure turbines are coupled in tandem to drive the generator. The turbines were operated in a closed feedwater cycle which condensed the steam; the heated feedwater was returned to the steam generators. Heat rejected in the main condensers was removed by the Circulating Water System.

The Circulating Water System provided the heat sink required for removal of waste heat in the power plant's thermal cycle. The system had the principal function of removing heat by absorbing this energy in the main condenser. The circulating water pumps took suction from the intake structures and pumped the seawater through the main condensers. The cooling water was returned from the main condensers to the ocean. Reinforced concrete conduits placed below the ocean floor provide for intake and discharge of the sea water.

1.3 REGULATORY GUIDANCE

The NRC provided decommissioning guidance in the rule "General Requirements for Decommissioning Nuclear Facilities," (Ref. 1) published and adopted on June 27, 1988. This rule amended NRC regulations to set forth technical and financial criteria for decommissioning licensed nuclear 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 licensee 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," (Ref. 2) which provided guidance to the licensees of nuclear facilities on 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 amendments.

The rule defined three decommissioning alternatives: DECON, SAFSTOR and ENTOMB. Because SONGS-1 will have radionuclides in concentrations exceeding the limits for unrestricted use even after 100 years the ENTOMB option will not be viable.

> DECON was defined by the rule 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."
>
> 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."
>
> 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."

The rule 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. Consequently, with the new restrictions, the SAFSTOR and ENTOMB options are no longer decommissioning alternatives in themselves, as neither terminates the license for the site. 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 definition of unrestricted release and license termination. Further, the NRC does not believe that ENTOMB is generally a viable option for a power reactor due to the long-lived nature of the radionuclides involved.

In 1996 the NRC published revisions to the general requirements for decommissioning nuclear power plants (Ref. 3). When the decommissioning regulations were adopted in 1988, it was assumed that the majority of licensees would decommission at the end of the operating license life. Since that time, several licensees had permanently and prematurely ceased operations without having submitted a decommissioning plan. In addition, these licensees requested exemptions from certain operating requirements as being unnecessary once the reactor is defueled. Each case has been 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 would submit written certification to the NRC within 30 days after the decision was made to cease operations. Certification would also be required once fuel had been permanently removed from the reactor vessel. Submittal of these notices would entitle the licensee to a fee reduction and eliminate the obligation to follow certain requirements needed only during operation of the reactor. Prior to, or within two years following permanent cessation of operations, the licensee would be required to submit a Post-Shutdown Decommissioning Activities Report (PSDAR) to the NRC. This report would describe the planned decommissioning activities, the associated decommissioning schedule, an estimate of expected costs, and an environmental assessment. Two years prior to terminating the license, the licensee would be required to submit an application to the NRC to terminate the license, along with a license termination plan.

SONGS-1 currently has a Decommissioning Plan for the safe-storage of the plant, which has been accepted as the PSDAR. This document would need to be revised for decommissioning operations.

1.3.1 Nuclear Waste Policy Act

Congress passed the Nuclear Waste Policy Act in 1982 (Ref. 4), reassigning the responsibility for disposal of spent nuclear to the Department of Energy (DOE). Two permanent disposal facilities were envisioned as well as an interim facility. To recover the cost of permanent spent fuel disposal, this legislation created a Nuclear Waste Fund through which money was to be collected from the consumers of the electricity generated by commercial nuclear power plants. The date targeted for startup of the federal Waste Management System was 1998.

After pursuing a national site selection process, the Act was amended in 1987 to designate Yucca Mountain, Nevada, as the only site to be evaluated for geologic disposal of high-level waste. Also in 1987, DOE announced a five-year delay in the opening date for the repository, from 1998 to 2003. Two years later, in 1989, an additional 7-year delay was announced, primarily due to problems in obtaining the required permits from the state of Nevada to perform the required characterization of the site. DOE has projected additional delays as a result of proposed Congressional reductions in appropriations for the program.

Utilities have responded to this impasse by initiating legal action and constructing supplemental storage as a means of maintaining operating margins. The U.S. Court of Appeals for the D.C. Circuit recently confirmed DOE's statutory obligation to provide spent fuel disposal beginning in 1998, regardless of whether the agency has an operating repository. However, since the agency was not in default at the time of the ruling, the court declined to prescribe "remedies" in the likely event DOE fails to uphold its obligation.

For purposes of constructing the decommissioning cost estimate, DOE is assumed to begin receiving spent fuel from the SONGS-1 site in the year 2010. It is estimated that the SONGS-1 spent fuel would be completely transferred to DOE by the end of the year 2024. These schedules and dates are based upon information provided by SCE and DOE's capacity and turnover schedule.

1.3.2 Low-Level Radioactive Waste Policy Amendments Act

Congress passed the "Low-Level Radioactive Disposal Act" in 1980, declaring the states as being ultimately responsible for the disposition of low-level radioactive waste generated within their own borders. The federal law encouraged the formation of regional groups or compacts to implement this objective safely, efficiently and economically, and set a target date of 1986. With little progress, the "Amendments Act" of 1985 (Ref. 5) extended the target, with specific milestones and stiff sanctions for non-compliance. However, more than 10 years later, no new sites have been developed and even the most advanced program is far behind schedule.

California is a member of the Southwest Compact, which is currently in the process of developing such a facility in Ward Valley, California.

In 1993, the State of California issued a license to US Ecology to operate a low level radioactive waste facility, however transfer of federal lands to the State of California has been halted while more studies on the environmental impact of the site are being undertaken. The schedule for the actual opening of this facility is still uncertain, however for the purposes of this study the facility is assumed to be fully operational to accept decommissioning waste.

2. SAFSTOR DECOMMISSIONING ACTIVITIES

The following sections describe the basic 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 the expected scope of work, i.e., engineering and planning at the time of decommissioning.

The operation, shutdown, and safe storage of the nuclear unit are described in detail in the San Onofre Nuclear Generating Station Unit 1 Decommissioning Plan. The activities that have been completed and associated costs expended to date are therefore not included as part of this workscope. This study 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 decommissioning will commence concurrent with the completion of the transfer of all SONGS-1 spent fuel on site to dry storage by August of 2005.

The decommissioning plan prepared by SCE 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 2013. With the requirements enacted through the recently issued regulations, SCE would provide the NRC through an updated PSDAR a description of the decommissioning activities, a schedule for completion of activities, a cost estimate, and an environmental assessment.

The current NRC regulations address decommissioning in three phases. The current plant status (safe-storage) is addressed in Phase II. This phase is applicable to the dormancy phases of the deferred decommissioning alternatives. Phase III pertains to the activities involved in license termination. The submittal of an application to terminate the license, along with a termination plan, marks the commencement of Phase III. The termination plan contains a detailed site characterization, (i.e., location, type and amount of radioactivity), a description of any remaining dismantling activities to be accomplished, plans for site remediation, detailed plans for a final radioation survey, and any planned use of the site. An updated cost to complete termination of the license is required, along with the reporting of any new or altered environmental consequences.

The TLG cost estimating methodology subdivides the decommissioning project into periods, based upon major milestones in the project. Continuing Phase II expenses are not addressed in this study, except where noted. Phase III, addressing the activities associated with decontamination and dismantlement and is subdivided into Periods 3 and 4 in the cost estimate. Period 5 addresses those activities envisioned for site restoration.

2.1 SAFE-STORAGE AND PRE-DECOMMISSIONING

Current site activities include preventive and corrective maintenance on essential systems and site services, area lighting, general building maintenance, heating and ventilation, routine radiological surveys of contaminated structures, maintenance of structural integrity, and a site environmental and radiation monitoring program.

Since the two adjoining units are operational, site resources such as security and office services can be shared, therefore the staff dedicated to Unit 1 is optimized. Consequently, to support decommissioning operations, SCE will have to secure additional resources, internally from the corporate organization or through external sources, e.g., contractors.

The cost to maintain SONGS-1 in its current configuration is not addressed in this study. Costs begin with the preparations of decommissioning in 1998 as described below.

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.

2.2.1 Engineering and Planning

Current 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 must include 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 any associated environmental concerns. The NRC will note the receipt of the plan and make the plan available for public comment and schedule a local hearing. Plan approval will be subject to conditions and limitations as deemed appropriate by the NRC.

Much of the information needed in preparing this submittal can be also used to develop the detailed engineering plans and procedures need to support Period 4 activities. This work includes, but is not limited to:

1. Site preparation plans for the proposed decommissioning activities.

2. Detailed procedures and sequences for removal of systems and components.

3. Evaluation of the disposition alternatives for the highly activated reactor vessel and internal components.

4. Options for decontamination of structures and plant systems.

5. Design/procurement and testing of tooling and equipment.

6. Identification/selection of specialty contractors.

7. Procedures for removal and disposition of radioactive materials.

8. Configuration control to minimize conflicts with simultaneous tasks throughout spent fuel pool operation.

2.2.2 <u>Site Preparations</u>

In preparation for the actual decommissioning, the following activities are typically initiated.

1. Preparation of site support and storage facilities, as required.

2. Characterization of the site to determine remediation requirements.

3. Processing of residual liquid and solid waste inventories.

4. Radiation surveys of work areas, major components and structures; sampling of internal piping and primary shield cores.

5. Determination of transportation and disposal container requirements, including shielding, and stabilization for activated materials and/or hazardous material.

6. Procurement of 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, etc.

7. Procedure development for occupational exposure control, control and release of liquid and gaseous effluent, processing of radwaste including DAW, resins, filter media, metallic and non-metallic components generated in decommissioning, site security and emergency programs, and industrial safety.

An Independent Spent Fuel Storage Installation (ISFSI) has been planned for dry storage of the spent fuel which is to be adjacent to the power block of Unit 1 over an area where the Diesel Generator Building currently exists. To avoid delays in decommissioning SONGS-1, plans for this ISFSI must begin. The Diesel Generator Building, and adjacent diesel storage tanks will need to be removed during this phase.

The placement of the ISFSI also puts constraints on the Large Component Removal Project (LCRP). The current planned ISFSI location is the only logical staging area for a crane to remove these large components as well as allowing proper lay-down areas and egress from the site. Preparation work, such as erection of the crane after the Diesel Generator Building removal, as well as removal of the Sphere Enclosure Building roof, and all LCRP planning needs to be completed during this period so as not to affect the schedule.

2.3 PERIOD 4 - DECOMMISSIONING OPERATIONS

Significant decommissioning activities in this phase include:

1. Construction of temporary facilities and modification of existing storage facilities to support the dismantling activities. These may include additional changing rooms and contaminated laundry facilities for increased work force, establishment of laydown areas to facilitate equipment removal and preparation for off-site transfer, upgrading

roads to facilitate hauling and transportation, and modifications to the Containment to facilitate access of large/heavy equipment.

2. Design and fabrication of temporary shielding and contamination control envelopes in support of removal and transportation activities; specify/procure specialty tooling and remotely operated equipment. Modification of the refueling cavity to support segmentation activities and prepare rigging for segmentation and extraction of heavy components

3. Decontamination of components and piping systems as required to control (minimize) worker exposure. Removal, packaging, and disposal of all piping and components that are no longer essential to support decommissioning operations.

4. Removal of control rod drive housings and the head service structure from reactor vessel head and package for controlled disposal.

5. Segmentation of the reactor vessel closure head and vessel flange for shipment in cask liners. Overpack liners loaded into shielded casks or placed in shielded vans for transports.

6. Segmentation of upper internals assembly, including upper support assembly, deep beam weldment, support columns, and upper support plates; package segments in shielded casks. Remote operation of cutting equipment located underwater in the refueling canal. Packaging and disposal of items that meet Title 10 of the Code of Federal Regulations, Section 61 Class "C" requirements or less. (All subsequent references to Title 10 of the Code will be by part number only, i.e. Part 61).

7. Disassembly/segmentation of remaining reactor internals in shielded casks, including core barrel, core baffle/former assembly, thermal shields, lower core plate, and lower core support assembly. Remote under water operation of tools and contamination controls. Packaging and disposal of items that meet Part 61 Class "C" criteria or less.

8. The packaging of Part 61 Greater Than Class "C" (GTCC) components into dry shielded canisters (DSCs) for handling and storage along with the spent fuel assemblies. Transfer of fuel bundle containers to the Fuel Building or suitable storage location.

9. Segmentation/sectioning of the reactor vessel, placing segments into shielded containers. Remote in-air operations using a contamination

control envelope. Placement of sections into containers stored under water (for example in an isolated area of the refueling cavity) using a remote or shielded crane. Transportation of containers using shielded truck casks.

10. Removal of the reactor coolant piping and pumps after the vessel water level drops below the elevation of the reactor vessel inlet and outlet nozzles during vessel segmentation. Sealing of the reactor coolant pumps with steel plate so that the pumps serve as their own containers. Shipment of piping and pumps for controlled disposal.

11. 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.).

12. Removal of activated concrete biological shield and accessible contaminated concrete. Removal of steam generator and pressurizer cubicles by controlled methods for access for component extraction.

13. Removal of steam generators and pressurizer for shipment and controlled disposal. Decontamination of exterior surfaces, as required, and seal-weld openings (nozzles, inspection hatches, and other penetrations). These components can serve as their own burial containers provided that all penetrations are properly sealed and the internal contaminants are immobilized.

14. Routing of material removed in the decontamination and dismantling of the nuclear unit to a central processing area. Material certified to be free of contamination is released for unrestricted disposition, e.g. as scrap, recycle or general disposal. Contaminated material is characterized and segregated for additional off-site processing (disassembly, chemical cleaning, volume reduction, waste treatment, etc.), and/or packaged for controlled disposal at a low-level radioactive waste disposal facility.

15. Removal of contaminated equipment and material from all contaminated areas using radiation and contamination control techniques until radiation surveys indicate that the structures can be released for unrestricted access and demolition.

16. Decontamination of remaining contaminated site buildings and facilities. Packaging and disposal of all remaining low-level radioactive

waste, including soil along with any remaining hazardous and toxic materials.

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

2.4 FINAL RADIATION SURVEY - LICENSE TERMINATION

Incorporated into the License Termination Plan, the Final Radiation Survey Plan details the radiological surveys to be performed once the decontamination activities are completed. Until recently the Final Radiation Survey Plan was developed using the guidance provided in NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination." This is in the process of being replaced by the Multi-Agency Radiation and Site Investigation Manual (MARSSIM), which was issued in December 1997 in final form as NUREG-1575. These documents delineate the statistical approaches to survey design and data interpretation acceptable to the Environmental Protection Agency (EPA), and the NRC. They also identify state-of-the-art, commercially available, instrumentation and procedures for conducting radiological surveys. Use of these guidelines ensure that survey design and implementation are conducted in a manner that provides a high degree of confidence that 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 license if it determines that the remaining dismantlement has been performed in accordance with the terminal radiation survey and associated documentation has been presented to demonstrate that the facility is suitable for release. Once all applicable requirements are satisfied, the NRC can terminate the Part 50 license.

2.4.1 NRC Criteria for Decommissioning

NRC's requirements for decommissioning and license termination are contained in 10 CFR 20 Subpart E (Radiological Criteria for License Termination). However, these regulations do not provide generally applicable radiological criteria for decommissioning as, historically, radiological data unique to specific sites has been utilized for site release determination. The NRC's current (12/96) position on residual contamination criteria, site characterization, and other related decommissioning issues is outlined in a NRC document entitled

"Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites," which was published in the Federal Register on April 6, 1993 (57 FR 13389). Through rulemaking, the NRC has established the decommissioning criteria to be an annual dose of 25 mrem above natural background to the maximally exposed individual from all exposure pathways (i.e. direct radiation, inhalation and ingestion).

2.4.2 Other Regulations and Standards Applicable to Decommissioning

- Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation" - limits radiation doses to members of the public from radioactive materials introduced into the general environment as the result of operations that are part of the nuclear fuel cycle.

- Part 20 "Standards for Protection Against Radiation" - regulates the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual does not exceed the radiation protection standards. According to 10 CFR 20.1001, the total dose to an individual includes doses from licensed and unlicensed radioactive material and from radiation sources other than background radiation. In addition, the requirements of 10 CFR 20.1301 apply to NRC-licensed facilities during decommissioning and when the facility is operational. This regulation prohibits licensees from releasing radioactive materials to an unrestricted area in concentrations that exceed the limits specified in Part 20 or that exceed limits otherwise authorized in an NRC license.

- Part 50 Appendix I - provides numerical guidance for keeping radioactive materials in liquid and gaseous effluents released to unrestricted areas "as low as reasonably achievable" during normal operations of a nuclear power reactor.

2.4.3 NRC Decommissioning Process and Survey Procedures

NRC licensees are required to conduct radiation surveys of the premises where the licensed activities were conducted and submit a report describing the survey results. The survey process follows requirements contained in Part 30.36, Part 40.42, Part 50.82, Part 51.53 which pertain to the decommissioning of a site and termination of a license. This process leads to the unrestricted release of a site.

However, some of these requirements, may not be necessary if an alternate method of release can be demonstrated.

Basically, the current decommissioning process is comprised of the following steps:

1) Site characterization;

2) Development and submission of PSDAR;

3) NRC review of PSDAR;

4) Performance of decommissioning actions described in the PSDAR;

5) Performance of termination survey and submittal of the termination survey report;

6) NRC performance and documentation of confirmatory survey; and

7) NRC termination of license.

Criteria for residual contamination, occupational exposure, and radiation concentration levels are designed to ensure that radioactivity is reduced to a level that permits unrestricted release of the site. The NRC has developed a rule, "Radiological Criteria for Decommissioning," to address release criteria. This rule, along with NUREG-1500, "Working Draft Regulatory Guide on Release Criteria for Decommissioning: NRC Staff's Draft for Comment," would be incorporated into the site release criteria, as appropriate. In addition, any state or federal regulations regarding release criteria (e.g., definitions of "background") would be included in the criteria.

2.5 PERIOD 5 - SITE RESTORATION

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

This cost study presumes that non-essential structures and site facilities will be dismantled as a continuation of the decommissioning activity. This removal is also required under the terms of the existing lease with the U. S. Government. The ISFSI is currently planned to be placed adjacent to the power block of Unit 1. This places restrictions on the demolition of the Unit 1 structures. After license termination, buildings will be removed by controlled demolition to grade so as not to disturb the spent fuel storage. Any below grade voids will be filled and the area paved over. Slab and foundation removal will be performed for all three units after all fuel has been removed from the site since controlled demolition of below grade structures while fuel is on site would be cost prohibitive. The costs for removal of the Unit 1 portion of the below grade structures is included in this study. The Buildings included in this study are:

- Administration/Operations Building
- Containment Sphere and Enclosure
- Control Building
- Diesel Generator Building
- Doghouse
- Equipment Ventilation Building
- Fuel Storage Building
- Health Physics Building
- Unit 1 Intake Structure
- Maintenance Facility
- Reactor Auxiliary Building
- Turbine Building
- Vent Stack
- Miscellaneous small structures on Unit 1 side (including the PASS)

Activities during this period include:

- Demolition of the remaining portions of buildings. Internal floors (and walls, if above grade) are removed from the lower levels upward using controlled demolition techniques. Concrete rubble and clean fill produced by demolition activities will not be used to backfill below-grade voids.

- Rubblization of concrete through a crushing station that is brought on site. All concrete and asphalt debris produced through the demolition process will be processed through this station.

2.6 POST-PERIOD 5 - ISFSI OPERATIONS AND DEMOLITION

Following the transfer of the spent fuel inventory from the Fuel Storage Building, the ISFSI will operate independently of the nuclear unit. Transfer of spent fuel to a DOE or intermediary facility will be exclusively from the ISFSI, once the Fuel Storage Building's pool has been emptied and the structure released for decommissioning. This study assumes that the DOE will be able to complete the transfer of spent fuel generated from Unit 1 by the year 2024.

At the conclusion of the transfer process, the ISFSI will be decommissioned. Long-term exposure of the spent fuel assemblies will have produced low-level neutron activation of the interior surfaces of the dry storage modules to levels exceeding current release limits. Consequently, portions of the modules will be disposed of as low-level radioactive waste.

The Commission will terminate the Part 72 license if it determines that the termination radiation survey is complete, and the 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 concrete dry storage modules are then demolished and disposed of as clean fill, the concrete loading ramps are removed, and the area graded and landscaped to conform with the surrounding environs.

Once all the fuel has been removed from the site all below-grade structures will be removed and the site returned to the conditions specified by the property owner.

3. COST ESTIMATE

A site-specific cost estimate was prepared for decommissioning SONGS-1. The estimate accounts for the unique features of the site, including the NSSS, electric power generating systems, structures, and supporting facilities. The basis of the estimate and its 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 by identifying specific work areas as incremental units. Each accessible area was visually inspected. An inventory and the attributes of each area were documented. Specific consideration included material accessibility and egress, radiological conditions, and physical limitations for staging work crews.

Drawings and other plant 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).

Low-level radioactive waste generated in the decontamination and dismantling of the SONGS-1 is assumed to be destined for the Southwest Compact's future disposal facility in Ward Valley, California. The waste stream is assumed to be conditioned to the maximum extent possible, e.g. through decontamination, volume reduction, incineration, metal-melt, etc., so as to avoid as much of the high cost of direct disposal as possible.

Spent fuel currently located on the SONGS site was assumed to be relocated to an on-site ISFSI by August of 2005. This allows decontamination and dismantling activities to proceed on the spent fuel storage areas without the current constraint to maintain spent fuel storage pool systems and services.

SONGS-1 structures and facilities will be remediated, dismantled, and demonstrated to be free of contamination. Site restoration is the most prudent action considering the destructive nature of decontamination processes and the availability of a mobilized and trained work force.

SCE, as licensee, will oversee the decommissioning operations. The plant staff will be augmented with the necessary resources 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 to ensure proper management of the spent fuel.

3.2 METHODOLOGY

The methodology used to develop this cost estimate follows the basic approach originally advanced by the Atomic Industrial Forum (now Nuclear Energy Institute) in their program to develop a standardized model for decommissioning cost estimates. The results of this program were published as AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," (Ref. 6). This document presents a unit factor method for estimating direct activity costs, thereby simplifying the estimating process. Unit factors for the removal of equipment, concrete, steel, etc., were constructed from the labor cost information provided by SCE. The direct activity, or activity-dependent, cost can then be estimated using the plant inventory developed for each work area.

Appendix A presents the detailed development of a typical site-specific unit cost factor. Wage rates were provided by SCE, while equipment and consumables were estimated from industry cost guides. Appendix B provides the values contained within one set of factors developed for the SONGS-1 analysis.

The unit factors used in this study reflect the latest available data concerning worker productivity during decommissioning, including field experience from the Shippingport Station Decommissioning Project completed in 1989, as well as from TLG's involvement in the decommissioning planning and engineering for the Shoreham, Yankee Rowe, Trojan, Rancho Seco, Pathfinder, and Cintichem reactor facilities.

The unit cost factor method provides a demonstrable basis for establishing reliable cost estimates. The detail available in the unit cost factors for activity time, labor costs (by craft), and equipment and consumable costs provides assurance that cost elements have 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

Work Difficult Factors (WDFs) 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% to 40%
- Respiratory Protection Factor - 0% to 50%
- Radiation/ALARA Factor - 0% to 100%
- Protective Clothing Factor - 0% to 30%
- Work Break Factor - 8.33%

These factors and their associated range of values were developed in conjunction with the Atomic Industrial Forum's Guideline Study. The factors (and their suggested application) are discussed in more detail in this publication. The WDF assigned to each work area as well as guidelines of how these WDFs are applied to each area are discussed in Appendix D.

Scheduling Program Durations

An area-by-area activity duration critical path was used to develop the total decommissioning program schedule. The unit cost factors, adjusted for WDFs as described above, were applied against the inventory of materials to be removed in each defined work area. Each work area was assessed for the maximum number of workers that could be accommodated. These adjusted unit cost factors were applied against the available manpower so that an overall duration for removal of components and piping for each work area could be calculated. Outlines of the major work areas in the power block are shown in Appendix E.

The program schedule is used to determine the period-dependent costs for program management, administration, field engineering, equipment rental, contracted services, etc. The study relies upon regional or site-specific salary and wage rates for the personnel associated with the intended program.

3.3 FINANCIAL COMPONENTS OF THE COST MODEL

TLG's cost model is comprised of a multitude of distinct cost line items, calculated using the unit cost factor methodology described above. Period-dependent and collateral costs are added to produce a comprehensive accounting of the identified expenditures. However, the resulting costs in and of themselves do not comprise the total cost to accomplish the project goal of license termination.

3.3.1 Contingency

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, illness, weather delays, labor stoppages, etc. Contingency fulfills this role in TLG's cost model. 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 monies to cover these types of expenses.

The activity- and period-dependent costs are combined to develop the total decommissioning costs. A contingency is then applied on a line-item basis, using one or more of the contingency types listed in Chapter 13 of the AIF/NESP-036 Guidelines Study. This reference also identifies the types of unforeseeable events that are likely to occur in decommissioning and provides guidelines for the application of contingency.

"Contingencies" are defined in the American Association of Cost Engineers "Project and Cost Engineers' Handbook" (Ref. 7) 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 estimate are based upon ideal conditions and maximum efficiency; therefore, consistent with industry practice, a contingency factor has been applied. It should be noted that contingency, as used in this estimate, does not account for price escalation and inflation in the cost of decommissioning over the program duration.

The use and role of contingency within decommissioning estimates is not a "safety factor issue." Safety factors provide additional security and address situations that may never occur. They also provide assurance that sufficient funding is available to accomplish the intended tasks. Some of the rationale for (and need to incorporate) contingency within any estimate is offered in the following discussion. An estimate without contingency, or from which contingency has been removed, can disrupt the orderly progression of events and jeopardize a successful conclusion to the decommissioning process.

The most technologically challenging task in decommissioning a nuclear generating unit will be the disposition of the reactor vessel and internal components, which have become highly radioactive after a lifetime of exposure to radiation produced in the core. The disposition of these highly radioactive components forms the basis for the critical path (schedule) for decommissioning operations. Cost and schedule are interdependent and any deviation in schedule has a significant impact on cost for performing a specific activity.

Disposition of the reactor vessel internal components involves the underwater cutting of complex components that are highly radioactive. Costs are based upon optimum segmentation, handling, and packaging scenarios. The schedule is primarily dependent upon the turnaround time for the heavily-shielded shipping casks, including preparation, loading and decontamination of the containers for transport. The number of casks required is a function of the pieces generated in the segmentation activity, a value calculated on optimum performance of the tooling employed in cutting the various subassemblies. The risk and uncertainties associated with this task are that the expected optimization may not be achieved, resulting in delays and additional program costs. For this reason, contingency must be included to mitigate the consequences of the expected inefficiencies inherent in this complex activity, along with related concerns associated with specialty tooling modifications and repairs, field changes, discontinuities in the coordination of plant services, system failure, water clarity, lighting, computer-controlled cutting software corrections, etc. Experience in decommissioning other plants in the past has shown that many of these problem areas have occurred during, and in support of, the segmentation process. Contingency dollars are an integral part of the total cost to complete this task. Exclusion of this component puts at risk a successful completion of the intended tasks and, potentially, follow-on related activities.

The following list is a composite of some of the activities, assembled from past decommissioning programs, in which contingency dollars were needed to respond to, compensate for, and/or provide adequate funding of decontamination and dismantling tasks:

Incomplete or Changed Conditions:

- Unavailable/incomplete operational history which led to a recontamination of a work area, because a sealed cubicle (incorrectly identified as being non-contaminated) was breached without controls.

- Surface coatings covering contamination which, due to an incomplete characterization, required additional cost and time to remediate.

- Additional decontamination, controlled removal, and disposition of previously undetected (although at some sites, suspected) contamination due to access gained to formerly inaccessible areas and components.

- Unrecorded construction modifications, facility upgrades, maintenance, enhancements, etc., which precipitated scheduling delays, more costly removal scenarios, additional costs (e.g., for re-engineering, shoring, structural modifications), and compromised worker safety.

Adverse Working Conditions:

- Lower than expected productivity due to high temperature environments, resulting in a change in the working hours (shifting to cooler periods of the day) and additional manpower.

- Confined space, low-oxygen environments where supplied air was necessary and additional safety precautions prolonged the time required to perform required tasks.

Maintenance, Repairs and Modifications

- Facility refurbishment required to support site operations, including those needed to provide new site services, as well as to maintain the integrity of existing structures.

- Damage control, repair, and maintenance from birds' nesting and fouling of equipment and controls.

- Building modification, i.e., re-supporting of floors to enhance loading capacity for heavily shielded casks.

- Roadway upgrades on site to handle heavier and wider loads; roadway rerouting, excavation, and reconstruction.

- Requests to analyze accident scenarios beyond those defined by the removal scenarios (requested by the NRC to comply with "total scope of regulation").

- Additional collection of site runoff and processing of such due to disturbance of natural site contours and drainage.

- Concrete coring for removal of embedments and internal conduit, piping, and other potentially contaminated material not originally identified as being contaminated.

- Modifications required to respond to higher than expected worker exposure, water clarity, water disassociation, and hydrogen generation from high temperature cutting operations.

- Additional waste containers needed to accommodate cutting particulates (fines), inefficient waste geometries and excess material.

Labor

- Turnover of personnel, e.g., craft and health physics. Replacement of labor is costly, involving additional training, badging, medical exams, and associated processing procedures. Recruitment costs are incurred for more experienced personnel and can include relocation and living expense compensation.

- Additional personnel required to comply with NRC mandates and requests.

- Replacement of personnel due to non-qualification and/or incomplete certification (e.g., welders).

Schedule

- Schedule slippage due to a conflict in required resources, i.e., the licensee was forced into a delay until prior (non-licensee) commitments of outside resources were resolved.

- Rejection of material by NRC inspectors, requiring refabrication and causing program delays in activities required to be completed prior to decommissioning operations.

Weather

- Weather-related delays in the construction of facilities required to support site operations (with compensation for delayed mobilization made to vendor).

- Destruction of an exterior asbestos containment enclosure due to violent winds.

This estimate incorporates considerations for items such as those described above, generating contingency dollars (at varying percentages of total line-item cost) with every activity.

3.3.2 Financial Risk

In addition to the routine uncertainties that contingency addresses, another cost element that is necessary to consider when answering the question of decommissioning cost relates to other types and levels of uncertainties. These consist of changes in work scope, pricing, job performance and other variations that could conceivably, but not necessarily, occur. Consideration of such items may be necessary to address the question concerning how costly the decommissioning project could become, within a range of probabilities. TLG considers these types of costs under the broad term "financial risk." These costs are addressed by SCE by placing an averaged 40% contingency value on the total cost of the estimate. Financial risk is typically addressed through a probability analysis using a Monte Carlo-type simulation program. The output of such a simulation typically includes a curve and range of probabilities for various cost estimates.

Included within the category of financial risk are:

- Delays in approval of the decommissioning (or license termination) plan due to intervention, public participation in local community meetings, legal challenges, state and local hearings, etc.

- 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, e.g., affecting worker health and safety, site release criteria, waste transportation, and disposal.

- Policy decisions altering federal and state commitments, e.g., in the ability to accommodate certain waste forms for disposition, or in the timetable for such.

- Pricing changes for basic inputs, such as labor, energy, materials, and burial.

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 much higher probability. This is mostly due to the pricing uncertainty for 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).

3.4 SITE-SPECIFIC CONSIDERATIONS

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

3.4.1 Spent Fuel Disposition

Currently there are 207 spent fuel bundles residing in the Unit 1 spent fuel pool, and an additional 188 fuel assemblies also stored on site. This decommissioning estimate assumes that the inventory stored in the Unit 1 fuel pool will be transferred to an ISFSI so that decommissioning operations may proceed on the nuclear unit. It is also assumed that the construction and licensing of the ISFSI will be completed in sufficient time to allow the transfer of the fuel currently stored on the site to this facility by August 2005. This will allow decontamination and dismantling of the facility to proceed without being significantly constrained by spent fuel caretaking activities. This estimate contains the costs of the Unit 1 portion of the ISFSI structure, including the capital costs required to construct and license the facility as well as to monitor the fuel in dry storage. The transfer of the fuel assemblies to DOE is not expected to be completed until the year 2024.

3.4.2 Reactor Vessel and Internal Components

The reactor pressure vessel and reactor internal components are segmented for disposal in shielded transportation casks. Segmentation and packaging of the reactor internal components are performed in the refueling cavity where a turntable and remote cutter will be installed. The vessel is segmented in place, using a mast-mounted cutter. Transportation cask specifications and Department of Transportation (DOT) regulations will dictate segmentation and packaging methodology.

The dismantling of reactor internal components at SONGS-1 will generate radioactive waste generally unsuitable for shallow land disposal. This waste is generally referred to as "Greater-than-Class-C" (GTCC). Although the material is not classified as high-level waste, DOE has indicated it will accept title to this waste for disposal at the future high-level waste repository (Ref. 8). However, the DOE has not yet established an acceptance criteria or a 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 waste has been packaged and disposed of as high-level waste, at a cost equivalent to that envisioned for the spent fuel.

3.4.3 Steam Generators and Other Primary Coolant System Components

The steam generators' size, weight and configuration and the limited access in Containment itself, place constraints on the intact removal of these components. Modifications to Containment are necessary for component extraction, due to the fact that there is no large component access to the building.

Determination of the removal strategy requires several different considerations. These include the extraction process, the availability of site area for removal, modifications to the Containment dome and the Sphere Enclosure Building for removal of the generators from the structure, and the component preparations needed to transport the generators to a disposal site.

A potential method for removal (and the one used for the basis in this estimate) is to remove the roof of the Sphere Enclosure Building. Holes would then be cut into the Containment dome large enough for extraction of each generator and pressurizer. A heavy-duty ringer crane would then be erected for the component removal. Removal of sections of the steam generator cubicle walls, adjoining floor slabs, and floor grating will also have to be accomplished to allow for the generators to be maneuvered to the opening

The Sphere Enclosure Building roof would be removed using a diamond wire saw to section the concrete into large blocks that can be safely handled by cranes. Once the building is opened, grating within the work area will be decontaminated and removed. A 15-foot section of the cubicle wall surrounding the steam generators will be dismantled, which is the minimum portion of the cubicle wall requiring removal to allow the maneuvering of the generators within the building. Large sections of the wall will be lifted out of the Containment using the ringer crane. Once these sections are removed they will be decontaminated and transported to a separate area for processing. Because an ISFSI structure is planned in the only area of the site which allows for the access for the large component extraction and lay down, this work must be completed in a timely fashion as not to delay the schedule in constructing the ISFSI facility.

The generators will be rigged for removal, disconnected from the surrounding piping and supports, and maneuvered and picked vertically from containment. Once the steam generator has been lowered to the horizontal position, nozzles and other openings will be welded closed. When this stage has been completed, the generator will be lifted onto a multi-wheeled transporter and moved to an on-site storage facility. The remaining two generators and pressurizer will be removed using the same technique. Once the components have been removed, the openings to the containment dome will be sealed.

Once at the storage area, each generator will have a two-inch thick carbon steel membrane welded to its outside surface as required for shielding during transport. The generators will then be loaded onto a multi-wheeled transporter and moved to an on-site rail head where they will be shipped to Ward Valley. If required by the facility the steam generators will be filled with low-density cellular concrete.

3.4.4 Main Turbine and Condenser

The main turbine is dismantled using conventional maintenance procedures. The turbine rotors and shafts are removed to a laydown area. The lower turbine casings are removed from their anchors by controlled demolition. The main condensers are also disassembled and moved to a laydown area. Material that is considered potentially contaminated will be surveyed and designated for either decontamination or volume reduction, conventional disposal or controlled disposal. Components are packaged and readied for transport in accordance with the intended disposition.

3.4.5 Transportation Methods

For the purposes of the cost estimate, it was assumed that the low-level radioactive waste produced and destined for controlled disposal will be moved overland by truck or shielded van to a licensed burial facility. The destination selected as the basis for the estimate of transportation costs was Ward Valley, California. Transportation of the waste to a recycling center was assumed to be Oak Ridge, Tennessee for estimating purposes.

3.4.6 Low-Level Radioactive Waste Disposal and Recycle

The burial cost for disposal at the future regional radioactive waste disposal facility in Ward Valley California was based upon projections available from US Ecology, the site developer and intended operator. An average cost of disposal of $957.61 per cubic foot (supplied by SCE) was used in this estimate. The rate is indicative of the unit cost projected for the years 2000 – 2006 (in 1998 dollars) and contains contingency.

To the greatest extent practical, non-compactable low-level radioactive waste is conditioned to reduce the volume of material requiring controlled disposal. Material from which the contamination is removed can be released as scrap, requiring no further cost consideration. The remaining material is processed for volume reduction and packaged for controlled disposal as radioactive waste. Material/waste recovery and recycling will be performed by the most cost effective manner, either on site, or off site at a licensed processing center. Processing costs for metallic waste are reported in the cost estimate as “Other” costs for Plant Systems and Structures. Unit costs for processing metallic components ranged from $1 to $3 per pound, depending upon the handling and pretreatment involved and the required conditioning anticipated.

Compactable Dry Active Waste (DAW), such as booties, glove liners, respirator filter cartridges, shipping containers, radiological controls survey materials, etc. will be assumed to be drummed and compacted to 10% of their original volume.

3.4.7 Site Conditions Following Decommissioning

It is assumed that all SONGS-1 structures and site facilities will be dismantled following their decontamination. The ISFSI is currently planned to be placed adjacent to the power block of Unit 1. This places restrictions on the demolition of Unit 1 structures that must be taken into account in the demolition process. After license termination the Unit 1 structures will be removed to grade by controlled demolition so as not to disturb the ISFSI. Any below grade voids will be filled. Subgrade structure removal will be performed once all spent fuel is removed from the site. The site will be returned to pre-construction conditions pursuant to the current lease agreement.

3.5 ASSUMPTIONS

The following assumptions were used in developing the decommissioning cost estimate for the SONGS-1.

Estimating Basis

1. The estimate is performed in accordance with the methodology described in the Atomic Industrial Forum - National Environmental Studies Project report AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates."

2. Decommissioning costs are reported in the year of projected expenditure; however, the values are provided in 1998 dollars for the current estimate. Costs are not inflated or escalated over the period of performance.

3. Plant drawings, equipment and structural specifications, including construction details, were provided by SCE. The inventory of plant equipment was performed on site by SCE and TLG personnel.

Labor Costs

1. The craft labor required to decontaminate and dismantle the nuclear unit will be acquired through standard site contracting practices. The current cost of labor at the site is used as an estimating basis.

2. Utility staffing requirements will vary with the level of effort associated with the various phases of the project. Once the decommissioning program commences, only those staff positions necessary to support the decommissioning program are included in this estimate.

3. SCE, as licensee, will oversee the decommissioning operations. Site security, radiological controls and overall site administration during decommissioning and dismantling will be provided by SCE. This organization will be supplemented with the expertise necessary to ensure that the intended program is completed safely and successfully.

4. Costs for site administration, operations, construction and maintenance personnel are based upon current SCE salary information, supplied by SCE.

Design Conditions

1. Any fuel cladding failure that occurred during the lifetime of the plant is assumed to have released fission products at sufficiently low levels that the buildup of quantities of long-lived isotopes (e.g. cesium-137, strontium-90, or transuranics) 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 Part 61.

2. The estimated curie content of the vessel and internal components at final shutdown was derived from an activation analysis specifically performed to support the decommissioning planning for SONGS-1. The results of this activation analysis appear in TLG document number S03-1230-003 "The San Onofre Nuclear Generating Station Unit 1 Reactor Vessel, Internals, and Primary Shield Wall Radionuclide Inventory" (Ref. 9).

3. Segmentation of the reactor vessel internal components will produce a limited quantity of activated material in which radionuclide inventories will exceed Class C quantities, as defined by Part 61. The GTCC material is generally not suitable for shallow land disposal and will

most likely be disposed of as high-level waste in the DOE's geological repository (unless an alternative solution is approved by the NRC). The cost of disposal, unlike that for the spent fuel, is not addressed by DOE's 1 mill/kWhr surcharge. As such, the disposal cost for GTCC presumes the packaging of this material in canisters similar to those used for spent fuel and disposed of at an equivalent cost.

Transportation

1. Contaminated piping, components, and structural material other than the highly activated reactor vessel and internal components will qualify as LSA-I, II or III or SCO-I or II, as described in Title 49 of the Code of Federal Regulations, Section 173 (Ref. 10). The contaminated material will be packaged in Industrial Packages (IPI, II or III) for transport unless demonstrated to qualify as their own shipping containers. The reactor vessel and internal components are expected to be transported in accordance with Part 71, as Type B. It is conceivable that the reactor, due to its limited specific activity, could qualify as LSA II or III. However, the high radiation levels on the outer surface would require that additional shielding be incorporated with the packaging so as to attenuate the dose to levels acceptable for transport.

2. Material requiring controlled disposal is assumed to be routed to the Ward Valley facility. Contaminated metallic waste will be routed to a recovery/recycling facility for decontamination and volume reduction. Transportation costs to are based upon published tariffs from Tri-State Motor Transit (Ref. 11). Truck transport assumes a maximum normal road weight limit of 80,000 pounds for all shipments with the exception of the overweight shielded casks. Rates for shipping radioactive wastes were provided by Tri-State Motor Transit.

3. Large components such as the steam generators and pressurizer are assumed to be shipped by rail to the Ward Valley facility.

4. Transport of the highly activated metal, produced in the segmentation of the reactor vessel and internal components, will be by shielded truck cask. Cask shipments may exceed 95,000 pounds, including vessel segment(s), supplementary shielding, cask tie-downs and tractor-trailer. The maximum number of curies per shipment assumed permissible is based upon the license limits of available shielded shipping casks. The number and curie content of vessel and internal segments are selected to meet these limits.

5. The number of cask shipments out of Containment is expected to average one per week. Non-cask shipments will be limited to three per week.

Spent Fuel

1. The cost to remove and dispose of the spent fuel from the site is not reflected within the estimate to decommission SONGS-1. Ultimate disposition of the spent fuel is the province of the DOE's Waste Management System, as defined by the Nuclear Waste Policy Act. Any delay in the transfer of spent fuel would increase the on-site management costs.

2. An ISFSI is assumed to be constructed at the site. The spent fuel currently stored on site is assumed to be transferred to the ISFSI by August 2005, so as not to significantly interfere with the decommissioning process. The costs associated with the operation and maintenance of the Unit 1 portion of spent fuel in the ISFSI are reflected within this estimate. Caretaking costs include staffing, insurance, taxes and fees as well as costs associated with final disposition of the facility are also included in the estimate.

3. The ISFSI design will utilize a multi-purpose (storage and transport), dry shielded storage canister with a horizontal, reinforced concrete storage silo. An internal stainless steel liner and portions of the concrete silo are assumed to become activated over the storage period of the fuel. The cost of the disposition of this material, as well as the remainder of the ISFSI facility, is included in the estimate.

4. GTCC material generated in the segmentation of the reactor vessel internal components, is assumed to be stored in the ISFSI to await transfer to the geologic repository.

General

1. The existing plant equipment is considered obsolete and suitable for scrap as deadweight quantities only. No equipment is salvageable as used equipment.

2. Scrap generated during decommissioning is not included as a salvage credit line item in this study for two reasons: (1) the scrap value merely offsets the associated site removal and scrap processing costs, and (2) a

relatively low value of scrap exists in the market. Scrap processing and site removal costs are not included in the estimate.

3. SCE will provide for the on-site electrical power required to demolish the plant. For estimating purposes the plant is assumed to be de-energized. Replacement power costs are used to estimate the cost of consumption during decommissioning.

4. Current plant staffing 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 SCE that will be easily removed without the use of special equipment, at no cost or credit to the project.

5. Existing warehouses will be cleared out of non-essential material and remain for use by SCE and its subcontractors. The warehouses may be dismantled as they become unnecessary to the decommissioning program.

6. Current SCE staffing perform the following activities at no cost or credit to the project during the first six months of the planning period:

   - Fuel oil tanks will be emptied. Tanks will be cleaned by flushing or steam cleaning as required prior to disposal.
   - Acid and caustic tanks will be emptied.
   - Lubricating and transformer oils will be drained and removed from site by a waste disposal vendor.

7. The decommissioning activities will be performed in accordance with current regulations assumed to still be in effect at the time of decommissioning.

8. Material and equipment costs for conventional demolition and/or construction activities were taken from R.S. Mean Construction Cost Data (Ref. 12).

9. The study follows the principles of ALARA through the use of work duration adjustment factors, which incorporate such items as radiological protection instruction, mock-up training, the use of respiratory protection and personnel protective clothing. These items lengthen a task's duration, which increases the costs and lengthens the overall schedule. ALARA planning is considered in the costs for engineering and planning, and in the development of activity

specifications and detailed procedures. Changes to Part 20 worker exposure limits may impact the decommissioning cost and projects schedule.

10. Nuclear liability insurance provides coverage for damage or injuries due to radiation exposure from equipment, material, etc. used during decommissioning. Nuclear liability insurance is phased out upon final decontamination of the site. Current nuclear liability and property insurance premiums are adjusted to reflect the increased activity during the decommissioning program.

11. Nuclear property insurance for the site will continue throughout the decommissioning period. Nuclear property insurance will cease upon termination of the Part 72 license.

12. The perimeter fence and in-plant security barriers will be moved as appropriate to conform with the Site Security Plan in force at the various stages in the project.

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

14. The intake and discharge conduits located beneath the ocean floor will be uncovered and removed using a barge-mounted clamshell bucket or other dredging equipment. The dredged material will be disposed of adjacent to the removal area; this will require permits which were not covered as part of this study. The conduit will be removed in sections as it was originally placed; the conduit concrete sections will be placed on shore and recycled with the rest of the concrete,

15. All site vestiges are assumed to be removed by controlled methods to grade, where all sub-grade structures will remain until all spent fuel is removed from the site. After all fuel has been removed building foundations will be removed and the adjacent terrain restored to the local grade level.

16. Contaminated metallic waste will be sent off site to a waste recovery/recycling vendor.

17. The disposition of all hazardous waste currently stored on site is included in this estimate. SCE supplied the quantities of this waste, including quantities of asbestos.

18. Clean asbestos is disposed of in a licensed local landfill authorized to accept asbestos. Contaminated asbestos is buried as radioactive waste.

3.6 COST ESTIMATE SUMMARY

A summary of the decommissioning costs and annual expenditures is provided in Table 3.1. Table 6.1 provides a breakdown of those same costs into the components of decontamination, removal, packaging, transportation, waste disposal, project management (staffing), and other. The costs were extracted from the detailed report in Appendix C, which provides a detailed listing of activities and associated costs for the decommissioning scenario. The following should be considered when reviewing this table:

- "Decon," as used in the headings of these tables, refers to decontamination activities as opposed to the NRC term DECON, which refers to the prompt removal decommissioning scenario.

- "Total," as used in the headings of these tables, is the sum of Decon, Remove, Pack, Ship, Bury, and Contingency, as well as other Miscellaneous items not listed (such as engineering and preparations).

- The subtotal for the aforementioned major cost categories does not include contingency, which is reported in a separate column.

- "Other" includes different types of costs which vary by the associated line item and do not readily fall into one of the other categories. For instance, in systems removal and structures decontamination, the "Other" cost consists of the off-site recycling costs for low-level radioactive waste. The "Other" cost is strictly in most of the engineering preparatory activities. However, "Other" also includes the utility staffing, taxes, insurance, plant energy budgets, and regulatory fees.

TABLE 3.1

SCHEDULE OF DECOMMISSIONING EXPENDITURES
(Thousands of 1998 Dollars)

Year	Period 3 Preparations	Period 4 Decommissioning	Period 5 Site Restoration	Post Period 5 Dry Fuel Storage	Totals
1998	1,985				1,985
1999	7,000				7,000
2000		51,499			51,499
2001		68,206			68,206
2002		68,020			68,020
2003		70,438			70,438
2004		70,904			70,904
2005		32,926	11,669		44,596
2006			21,713		21,713
2007			13,431	230	13,661
2008				600	600
2009				601	601
2010				600	600
2011				600	600
2012				600	600
2013				601	601
2014				600	600
2015				600	600
2016				600	600
2017				601	601
2018				600	600
2019				600	600
2020				600	600
2021				601	601
2022				600	600
2023				600	600
2024				600	600
2025				0	0
2026				0	0
2027				0	0
2028				0	0
2029				0	0
2030				0	0
2031				0	0
2032				0	0
2033				0	0
2034				0	0
2035				0	0
2036				0	0
2037				0	0
2038				0	0
2039				0	0
2040				0	0
2041				0	0
2042				0	0
2043				0	0
2044				0	0
2045				0	0
2046				0	0
2047				0	0
2048				0	0
2049				0	0
2050				30,552	30,552
	8,985	361,992	46,813	40,982	458,772

APPENDIX D

WORK DIFFICULTY FACTOR ADJUSTMENTS

GUIDELINES FOR APPLYING WORK DURATION ADJUSTMENT FACTORS

TLG has historically applied work duration adjustment factors in determining Unit Cost Factors to account for working in a radiologically controlled environment. In performing an area-by-area decommissioning cost/schedule estimate the work duration factors are applied on an "area" basis, based on the nominal area conditions. Where practical, areas are established based on similar working conditions.

The WDF's fall into five categories: access, respiratory protection, ALARA, protective clothing (PC), and work breaks. Guidelines on how these factors are assessed for each area is described below. Table D-1 outlines the WDF's for each area.

1) Access Factor:

Controlling Variables:

- Height of the component above the working floor
- Difficulty in working around the component (restricted access)

Source of Variable Information:

- Estimators observation or judgment
- Plant drawings

Range of Access Factor Adjustments:

0% - Components are accessible and located near a working level floor or platform

10% - Scaffolding (component less than <12 feet above floor) is required to access the majority of the components *or* the area around the components is congested.

20% - Scaffolding (component less than <12 feet above floor) is required to access the majority of the components *and* the area around the components is congested.

30% - Scaffolding (component between 12 - 20 feet above floor) is required to access the majority of the components *or* the area around the components are extremely congested.

40% - Scaffolding (component between 20 - 45 feet above floor) is required to access the majority of the components).

50% - Scaffolding (component greater than 45 feet above floor) is required to access the majority of the components).

2) Respiratory Protection Factor:

Controlling Variables:
- Component surface contamination levels (internal or external)
- Type of work (potential to create an airborne problem)
- General area surface contamination levels
- Site specific requirements for maintaining respirator qualifications (initial qualification, requalification, etc.)
- Personal air sampler requirements

Sources of Variable Information:
- Radiation Work Permit Requirements
- Area Survey Maps
- Site Radiation Protection Program Manual

Range of Respiratory Protection Factor Adjustments:
0% - Respiratory protection is not required (clean system or loose surface contamination has been removed).
25% - Respiratory protection is only required during limited segments of the work (i.e. physical cutting)
50% - Respiratory protection is continuously required while working on the component.

3) Radiation/ALARA Factor:

Controlling Variables:
- Component contact dose rate
- General area dose rate
- Site specific requirements for maintaining radiation worker qualification (initial qualification, requalification, etc.)
- Dosimetry requirements

Sources of Variable Information:
- Area Survey Maps
- Site Radiation Protection Program Manual
- Radiation Work Permit Requirements

Range of Radiation/ALARA Factor Adjustments:
(Note surface contamination levels are principally accounted for in protective clothing requirements and respiratory protection requirements)

0% - The component is clean and is not located in a radiologically controlled area

10% - The component is located in a radiologically controlled area (General Area Radiation field < 2 .5 mrem/hr).

20% - The component is located in a radiologically controlled area (General Area Radiation field between 2. 5 to 15 mrem/hr).

40% - The component is located in a radiologically controlled area (General Area Radiation field between 16 and 99 mrem/hr).

100% - The component is located in a radiologically controlled area (General Area Radiation field > 100 mrem/hr).

4) Protective Clothing Factor:

Controlling Variables:

- Component surface contamination levels (internal or external)
- General area surface contamination levels
- Type of activity (wet/dry work, potential to create a surface contamination problem)
- Site specific work schedule arrangements

Sources of Variable Information:

- Radiation Work Permit Requirements
- Area Survey Maps
- Site Radiation Protection Program Manual

Range of Protective Clothing Factor Adjustments (alternate site-specific schedules may dictate alternate adjustments):

0% - The component is clean and is not located in a radiologically controlled area.

30% - The component is clean or contaminated and is located in a surface contamination controlled area . Work is to be completed in accordance with the requirements of an RWP, which specifies a single or double set of "PC's", or "PC's" with plastics.

50% - The components is located in a surface contamination controlled area. Work is to be completed in accordance with the requirements of an RWP, which specifies "plastics" in addition to double PC's for protective clothing.

100% - The component is located in a surface contamination controlled area. Work is to be completed in accordance with the requirements of an RWP, which specifies double "PC's" and double "plastics". (extremely wet or humid working environment).

5) **Work Break Factor:**

Controlling Variables:

- Site specific work schedule arrangements

Sources of Variable Information:

- Typical site work schedule

Range of Work Break Factor Adjustments:

8.33% - Workday schedule outlined in AIF/NESP-036 (alternate site-specific schedules may dictate alternate adjustments).

		Work Difficulty Factors			
Area Ident.	**Main Components**	**Access**	**Respiratory**	**Rad/ ALARA**	**Prot. Clthg.**
AC1-1	Aux Cooler, pump, xfmrs, fire pumps	10%	0%	10%	0%
AC1-2	Area between Circ Pit and Turb Bldg	10%	0%	10%	0%
AD1-1	I & C Addition	0%	0%	0%	0%
AD1-2	Operations/Planning/Chemistry	0%	0%	0%	0%
AD1-3	DC Swgr and Battery Room	0%	0%	0%	0%
AD1-4	Door 16 Count Room	0%	0%	0%	0%
AD1-5	Door 16 Chemistry Lab	0%	25%	10%	30%
AD2-1	I & C Addition	0%	0%	0%	0%
AD2-2	Vent. Room/Instr Shop/Comm	0%	25%	10%	30%
AD2-3	Emerg. Ventilation Room	0%	0%	0%	0%
AD3-1	Control Room	0%	0%	0%	0%
AD3-2	Control Room Viewing/Offices	0%	0%	0%	0%
AD3-3	Office	0%	25%	10%	30%
AD3-4	RadioChem/Chemical Control	20%	25%	10%	50%
ADP	Admin and Control Building	0%	25%	40%	50%
ADX	Admin and Control Building	0%	0%	0%	0%
BSX	Compressed Gas (Bottle) Storage	0%	0%	0%	0%
BW1-1	Northeast Quadrant	30%	0%	10%	30%
BW1-2	Northwest Quadrant	30%	0%	10%	30%
BW1-3	Southeast Quadrant	30%	0%	10%	30%
BW1-4	Southwest Quadrant	30%	0%	10%	30%
BW2-1	Ball to Wall above 42' elevation	50%	0%	10%	30%
CB1-1	RHR Pumps	10%	50%	40%	50%
CB1-2	RHR Hx	10%	50%	40%	50%
CB1-3	Pressurizer2 Relief Tank	30%	50%	40%	50%
CB1-4	RCDT, Excess Letdown	30%	50%	40%	50%
CB1-5	TSP, general area	10%	25%	20%	30%
CB2-1	Steam Gen "A"	30%	50%	40%	30%
CB2-2	RCP "A"	30%	50%	40%	30%
CB2-3	Steam Gen "B"	30%	50%	40%	30%
CB2-4	RCP "B"	30%	50%	40%	30%
CB2-5	Stem Gen "C"	30%	50%	40%	30%
CB2-6	RCP "C"	30%	50%	40%	30%
CB2-7	Pressurizer	30%	50%	40%	30%
CB2-8	Regenerative Hx	30%	50%	100%	50%
CB3-1	Steam Gen "A"	30%	50%	40%	30%

		Work Difficulty Factors			
Area Ident.	Main Components	Access	Respiratory	Rad/ ALARA	Prot. Clthg.
CB3-4	RCP "B"/RCP Motor	30%	25%	40%	30%
CB3-5	Stem Gen "C"	30%	50%	40%	30%
CB3-6	RCP "C"/RCP Motor	30%	25%	40%	30%
CB3-7	Pressurizer	30%	50%	40%	30%
CB4-1	Steam Gen "A"	30%	50%	40%	30%
CB4-2	RCP "A"	30%	50%	40%	30%
CB4-3	Steam Gen "B"	30%	50%	40%	30%
CB4-4	RCP "B"	30%	50%	40%	30%
CB4-5	Stem Gen "C"	30%	50%	40%	30%
CB4-6	RCP "C"	30%	50%	40%	30%
CB4-7	Pressurizer	30%	50%	40%	30%
CB5-1	Area south of "A" Doghouse	30%	50%	20%	30%
CB5-2	RCP "A" access/cavity filters	30%	25%	20%	30%
CB5-4	RCP "B" /incore drivers/fan A4	30%	25%	20%	30%
CB5-6	RCP "C" access	30%	25%	20%	30%
CB5-8	Fans A3-A8ss	30%	25%	20%	30%
CB5-9	Reactor Vessel/Refuel Cavity	30%	50%	100%	100%
CB6-1	Top of"A"Doghouse	30%	50%	40%	30%
CB6-3	Top of "B" Doghouse	30%	50%	40%	30%
CB6-5	Top of "C" Doghouse	30%	50%	40%	30%
CB6-7	Top of "PZR" Doghouse	30%	50%	40%	30%
CB7-1	North o/s bioshield to Ball	40%	25%	10%	30%
CB7-2	East o/s bioshield to Ball	40%	25%	10%	30%
CB7-3	South o/s bioshield to Ball	40%	25%	10%	30%
CB7-4	West o/s bioshield to Ball	40%	25%	10%	30%
CB8-1	Ball interior above 54'	50%	25%	10%	30%
CBP	Containment Bioshield/Refuel Cavity	10%	25%	40%	50%
CC1-1	Component Cooling Pad	10%	50%	20%	30%
CV1-1	CVI skid/Control Panel	20%	25%	20%	30%
CW1-1	Aux SWC Pump/Pit/Tsunami Pits	10%	25%	10%	30%
CW1-2	Circ Water Screens/Gates	0%	0%	0%	0%
CW1-3	Circ Water Pit	0%	0%	10%	0%
CW1-4	Sodium Hypochlorite Tank	0%	0%	0%	0%
CW1-5	Yard Sump	20%	25%	40%	50%
DG1	DG1 Main Room	0%	0%	0%	0%
DG2	DG2 Main Room	0%	0%	0%	0%
DG3	DG1 Fan Room	0%	0%	0%	0%

		Work Difficulty Factors			
Area Ident.	Main Components	Access	Respiratory	Rad/ ALARA	Prot. Clthg.
DG4	DG2 Fan Room	0%	0%	0%	0%
DG5	Diesel Generator Building	0%	0%	0%	0%
DS1-1	Diesel Swithgear Room (Backyard)	10%	0%	10%	0%
FB1-1	Spent Fuel Pool	30%	50%	100%	50%
FB2-1	New Fuel Storage	10%	25%	10%	30%
FBP	Fuel Building/SPF Cavity	0%	25%	40%	50%
HP1-1	Entrance/Exit/Beta booth, etc.	0%	25%	10%	30%
HP1-2	Decon Showers	0%	25%	10%	30%
HP2-1	Locker Rooms	0%	0%	0%	0%
HP2-2	Office Areas	0%	0%	0%	0%
LO1-1	Lube Oil Storage Tanks D-4 A, B	0%	0%	10%	0%
MF1-1	First floor Maint Fac	0%	0%	0%	0%
MF2-1	Second floor Maint. Fac.	0%	0%	0%	0%
MT1-1	Monitor Tanks Area	10%	50%	40%	50%
MT1-2	High Rad Storage/High-High Rad	10%	50%	100%	100%
MU1-1	Primary Make up Water Stor.Tank	0%	25%	10%	30%
MU1-2	AFW Pump "C"	0%	25%	10%	30%
OSY1	Aux Feedwater Storage Tank/Area	30%	0%	0%	0%
OSY2	SouthWest Area	0%	0%	0%	0%
OSY3	NorthWest Area	0%	0%	0%	0%
OSY4	North Fenceline Area	0%	0%	0%	0%
OSY5	NorthEast Area	0%	0%	0%	0%
OSY6	SouthEast Area	0%	0%	0%	0%
PA1-1	Sample Lab	10%	25%	10%	30%
PA1-2	Sample Pit	10%	50%	10%	30%
RM1-1	Mechanical Decon Room	0%	25%	10%	30%
RM1-2	REMS Storage	0%	25%	10%	30%
RM1-3	Control Point/Beta booth	0%	25%	10%	30%
RM1-4	West Pad @ REMS Storage	0%	25%	10%	30%
RM1-5	Pad Area between buildings	0%	25%	10%	30%
RM2-1	Second floor offices	0%	0%	0%	0%
RW1-1	Hold up Tanks C20 A, B, and C	20%	50%	100%	50%
RW1-2	Charging Pumps G-8 A, and B	10%	25%	20%	50%
RW1-3	Waste Gas Decay and Surge Tanks	10%	50%	20%	50%
RW1-4	Gas Stripper/Flash Tank	30%	50%	100%	100%
RW1-5	Spent Resin Storage Tank	30%	50%	100%	100%
RW1-6	Ion Exchangers	50%	50%	100%	100%

		Work Difficulty Factors			
Area Ident.	**Main Components**	**Access**	**Respiratory**	**Rad/ ALARA**	**Prot. Clthg.**
RW1-7	Pumps, Flash tank,gas strip, monitor	10%	50%	20%	50%
RW1-8	Cir Pump G-23/Building Sump	20%	25%	20%	50%
RW1-9	Pipe Tunnel	10%	25%	20%	30%
RW2-1	Boric Acid Tank D-3	10%	25%	10%	30%
RW2-2	Boric Acid Batch Tank	10%	25%	10%	30%
RW2-3	Volume Control Tank C-15	30%	50%	100%	100%
RW2-5	Boron Meas /Reactor Coolant Filter	0%	50%	40%	50%
RW2-6	2 Car Garage	0%	25%	10%	30%
RW2-7	P C Storage/RMC Supply	0%	0%	10%	30%
RW2-8	Outside/Above Radwaste Building	10%	0%	10%	0%
RW3-1	Boric Acid Batch loading	10%	0%	10%	0%
RWP	Liquid Radwaste Building	0%	25%	40%	50%
RWST1	Refueling Water Storage Tank	30%	50%	20%	50%
SD1-1	Lower Sphere Doghouse	20%	50%	20%	50%
SD2-1	Upper Sphere Doghouse	10%	50%	20%	50%
SDP	Storm Drains/Sewers	0%	25%	40%	50%
SEBX	Sphere Enclosure Building	10%	0%	0%	0%
SEBY	Sphere Outside Yard Areas	0%	0%	0%	0%
TB1-1	Main Condenser E-2a (N)	30%	0%	10%	0%
TB1-10	Vacuum Pump X-7a	10%	0%	10%	0%
TB1-11	Vacuum Pump X-7b	10%	0%	10%	0%
TB1-12	Exciter, DC starter, MCC's	10%	0%	10%	0%
TB1-13	Lube Oil Reservoir D-12	0%	0%	10%	0%
TB1-14	Chem Feed Area	10%	25%	10%	30%
TB1-15	4 KV Switchgear	20%	0%	10%	0%
TB1-16	Outside Ramp Area	0%	0%	0%	0%
TB1-17	Air Receivers	0%	0%	10%	0%
TB1-18	Condensate Storage Tank D-2	40%	0%	10%	0%
TB1-19	Sta. Aux Transformers "C"	0%	0%	0%	0%
TB1-2	Main Condenser E-2a (S)	30%	0%	10%	0%
TB1-20	Main Xfmer/Aux a and b xfmrs	0%	0%	0%	0%
TB1-21	Oily Waste Separator	10%	25%	10%	30%
TB1-3	Moisture Sep/Reheaters E-25 c , d	30%	0%	10%	0%
TB1-4	Moisture Sep/Reheaters E-25 a, b	30%	0%	10%	0%
TB1-5	Feedwater Pump G-3a--East	10%	25%	10%	30%
TB1-6	Feedwater Pump G-3b--West	10%	25%	10%	30%
TB1-7	Aux Feedwater Pumps G-10, G-10s	10%	25%	10%	30%

		Work Difficulty Factors			
Area Ident.	**Main Components**	**Access**	**Respiratory**	**Rad/ ALARA**	**Prot. Clthg.**
TB1-8	Air Compressors K-1 a,b and c	10%	0%	10%	0%
TB1-9	East area below FW heater deck	10%	0%	10%	0%
TB2-1	Lube Oil Equip (Mezz.)	20%	25%	20%	30%
TB2-2	Chem Feed (Mezz.)	20%	25%	20%	30%
TB2-3	Gland Steam Condenser E-23 a	10%	0%	10%	0%
TB2-4	Gland Steam Condenser E-23 b	10%	0%	10%	0%
TB3-1	Main Turbines	0%	0%	0%	0%
TB3-2	Operating Deck	20%	25%	10%	30%
TB3-3	East Feedwater Heater Deck	10%	25%	10%	30%
TB3-4	West Feedwater Heater Deck	10%	25%	10%	30%
TC1-1	Turbine Cooling Water Tank D-11	0%	0%	10%	0%
TC1-2	Turbine Plant Coolers/Pumps	0%	0%	10%	0%
TCX	Trash Compactor Area	0%	0%	0%	0%
VA1-1	Valve Alley	10%	25%	20%	50%
VE1-1	Ventilation Equipment Building	10%	25%	10%	30%
VE1-2	Vent Stack/Area	50%	25%	10%	30%
YDP	Yard Piping--Fire Protection System	0%	0%	0%	0%

APPENDIX E

WORK AREA OUTLINES