

# Report on Nuclear Decommissioning

## Appendix A

### Background and Terminology

The nuclear industry is replete with special terms and acronyms. The Panel has selected several of those terms that it thinks merit special attention for further discussion and explanation in this appendix. The definitions provided in this appendix are those that the Panel used in this report. In addition, this appendix provides further background information on selected topics that the Panel believes may increase the understanding of the reports topics.

#### Terms

**Waste:** The term waste generally applies to any material that is present on the nuclear power plant site that the owner removes during decommissioning. The disposition of the waste can take one of several forms. First, some market might exist for the sale and use of an item (such as for pumps and other small parts). Second, the waste can be recycled for another purpose. This is commonly performed for clean metal. Third, the waste, if hazardous, radioactively contaminated, or both, can be processed to minimize the affected volume and weight, with the radioactive or hazardous part disposed of at a licensed facility and the clean part released for use, disposal in a landfill, or reuse on site. Fourth, and finally, the waste may be disposed of at a licensed facility without any processing to reduce the weight and volume.

**Low-Level Radioactive Waste:** Radioactive waste is that material that is radiologically contaminated or activated to sufficient levels to preclude unrestricted release of that material from the nuclear license. This process is typically referred to as “free release”. Radioactive waste can be broadly divided into two categories, low-level radioactive waste and high-level radioactive waste (which can include spent nuclear fuel or spent nuclear fuel can be considered a third category). Low-level radioactive waste is further divided into different classes based on criteria contained in 10 CFR 61.55. These classes generally define the risk associated with the waste, and increase in risk from Class A to Class B to Class C to material designated as Greater Than Class C (GTCC) which exceeds the limits for Class C.<sup>1</sup> As discussed elsewhere in this report, there are limited licensed facilities in the U.S. that can accept low-level radioactive waste for disposal.

**High-Level Radioactive Waste:** High-level radioactive waste is that waste resulting from reprocessing of spent fuel, or other highly radioactive material that the NRC determines by rule requires permanent isolation.<sup>2</sup> The Panel understands that the Courts have determined that GTCC waste from commercial utilities is to be treated under the high level waste provisions of the Standard Contract with DOE.

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<sup>1</sup> 10 CFR 50.72.

<sup>2</sup> Ibid.

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**Hazardous Waste:** Hazardous waste includes any other material, such as lead, asbestos, mercury, hydrazine, PCBs, and hydrocarbons, that, by regulation or law requires special handling and must be disposed of in a licensed facility.

**Decommissioning:** Decommissioning, as defined by the NRC, means to remove a facility or site safely from service and reduce residual radioactivity to a level that permits restricted or unrestricted termination of the NRC license. Decommissioning, as defined by the NRC, does not include spent fuel storage or site restoration.<sup>3</sup> When used in this report, the term decommissioning can, and often does, refer to all activities associated with dismantlement of the facility and restoration of the site, including pre and post shutdown activities. When clarity is needed, this report will use the term license termination to refer to those activities included in the NRC definition of decommissioning.

The NRC provides for three methods of decommissioning, of which two are of practical use for commercial reactors.<sup>4</sup> The two practical methods are called DECON and SAFSTOR. DECON involves the prompt dismantlement of the facility, while SAFSTOR involves maintaining and monitoring the facility for some period, after which it is dismantled. There is no clear distinction between these two methods, and may utilities opt for a version of DECON where a short storage period is used. Typically, the SAFSTOR term is used where the storage period is relatively long and where the owner makes modifications to the facility to facilitate the storage period. Anything between DECON and SAFSTOR (such that a short storage period is used) is typically referred to as DELAYED DECON, although this is not an official NRC term.

**License Termination:** License termination is the process by which the NRC license is released. This process can be completed with no future restrictions placed on use of the site, or where some restrictions are placed on future use of the site. There is a formal process for a licensee to terminate its NRC license. This process includes approval of a licensee-submitted termination plan, extensive surveys to verify contamination levels, confirmation surveys by the NRC (or its contractors), and finally, release of the license.

**MARSSIM:** MARSSIM is an acronym standing for Multi-Agency Radiation Survey and Site Investigation Manual. This manual provides guidance to federal agencies, states, site owners, contractors, and other private entities on how to demonstrate that their site is in compliance with a radiation dose or risk-based regulation. MARSSIM was developed by the Departments of Defense and Energy, the Environmental Protection Agency, and the Nuclear Regulatory Commission. MARSSIM

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<sup>3</sup> 10 CFR 50.2, and 10 CFR 50.75. The NRC definition of decommissioning does not include removal of non-radiological hazards such as chemical hazards.

<sup>4</sup> The third method, entombment, involved encasing radioactive contaminants in a structurally long-lived material such as concrete. The entombed structure is maintained and surveillance is continued until the radioactive waste decays to a level permitting termination of the license and release of the property. For a large, commercial reactor, this decay will not happen in the 60 year period normally allotted for decommissioning, and thus this method is not of practical use.

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provides a process for collecting, organizing, and interpreting data and for making decisions about populations of data from samples.

**ALARA:** An acronym standing for “As Low As (is) Reasonable Achievable”. ALARA is defined in 10 CFR 20.1003 to mean making every reasonable effort to maintain radiation exposures as far below the limits as is practical, taking into account the state of technology, economics, and other societal and socioeconomic considerations.

**TEDE:** An acronym standing for “Total Effective Dose Equivalent”. The TEDE is the sum of the effective doses from multiple sources or different nuclides.

### Required Wet Cooling Time

Most dry fuel storage canisters provide tables that can be used to determine the required wet cooling time required for each assembly prior to placing that assembly in dry storage. Figure 1 was extracted from the NUHOMS Final Safety Analysis Report for the cask system used at the SONGS site. This figure provides different rows for the fuel burnup (i.e., how long the fuel assembly was left in the reactor generating power) and columns for the fuel enrichment (i.e., what

**Figure A.1 – PWR Fuel Cooling Times**

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**Table A.2.1-7**  
**PWR Fuel Qualification Table for 1.0 kW per Assembly for the NUHOMS® 24PT4-DSC**  
(Minimum required years of cooling time after reactor core discharge)

| BU<br>(GWd/<br>MTU) | Initial Enrichment |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |
|---------------------|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
|                     | 1.8                | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.8 | 3.9 | 4.0 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 | 4.7 | 4.8 |  |
| 10                  | 5                  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 15                  | 5                  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 20                  | 5                  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 25                  | 5                  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 28                  | 5                  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 30                  | 5                  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 32                  | 5                  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 34                  | 5                  | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 36                  | 6                  | 6   | 6   | 6   | 6   | 6   | 6   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 38                  |                    |     |     |     |     |     |     |     |     |     | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |  |
| 39                  |                    |     |     |     |     |     |     |     |     |     | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |  |
| 40                  |                    |     |     |     |     |     |     |     |     |     | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |  |
| 41                  |                    |     |     |     |     |     |     |     |     |     | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |  |
| 42                  |                    |     |     |     |     |     |     |     |     |     | 7   | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |  |
| 43                  |                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 7   | 7   | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |  |
| 44                  |                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   |  |
| 45                  |                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   |  |
| 48                  |                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |  |
| 51                  |                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   |  |
| 54                  |                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 11  | 11  | 11  | 11  | 11  | 10  | 10  | 10  | 10  | 10  |  |
| 57                  |                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 13  | 13  | 13  | 13  | 12  | 12  | 12  | 12  | 12  | 12  |  |
| 60                  |                    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 15  | 15  | 15  | 15  | 15  | 15  | 14  | 14  | 14  | 14  |  |

**Notes:**

- BU = Assembly average burnup.
- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup are conservatively applied in determination of actual values for these two parameters.
- This table does not apply to reconstituted fuel assemblies with stainless steel rods.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with an initial enrichment either less than 1.8 or greater than 4.85 wt.% U-235 is unacceptable for storage.
- Fuel with a burnup greater than 60 GWd/MTU is unacceptable for storage.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for storage after 5-years cooling.
- Example: An assembly with an initial enrichment of 4.85 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for storage after a six-year cooling time as defined by 4.8 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table.

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This table shows that for a 24 assembly cask that is completely filled uniformly, the required wet cooling time can be as long as 15 years for specific burnup and enrichment combinations.

If specific inventories of different fuel assemblies are maintained in the spent fuel pool, it is possible to reduce the required cooling time to ten years (but that would require that specific assemblies be available for mixing, and that those assemblies could require wet cooling times as long as 20 years). An example of a loading configuration that could be used to reduce wet cooling times is shown in figure 2. This configuration would allow for the loading of eight assemblies cooled for a maximum of 10 years provided that 16 assemblies were available for mixing that were cooled for a maximum of 20 years. Whether this particular mix of assemblies can and will be available 10 years after final shutdown is unknown.

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**Figure A.2 – PWR Fuel Loading Pattern**

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|                                      | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|--------------------------------------|--------|--------|--------|--------|
| Maximum Decay Heat (kWatts / FA)     | 0.9    | NA     | 1.2    | NA     |
| Maximum Decay Heat per Zone (kWatts) | 14.4   | NA     | 9.6    | NA     |

**Figure A.2.1-2**  
24PT4-DSC Heat Load Configurations #2, kW/Assembly

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To determine the required wet cooling time, an owner projects the fuel enrichment and burnup for fuel that will be used in the last several fuel cycles prior to final shutdown, and uses tables like figure 1 based on his specific cask design to estimate the required wet cooling time for the spent fuel.

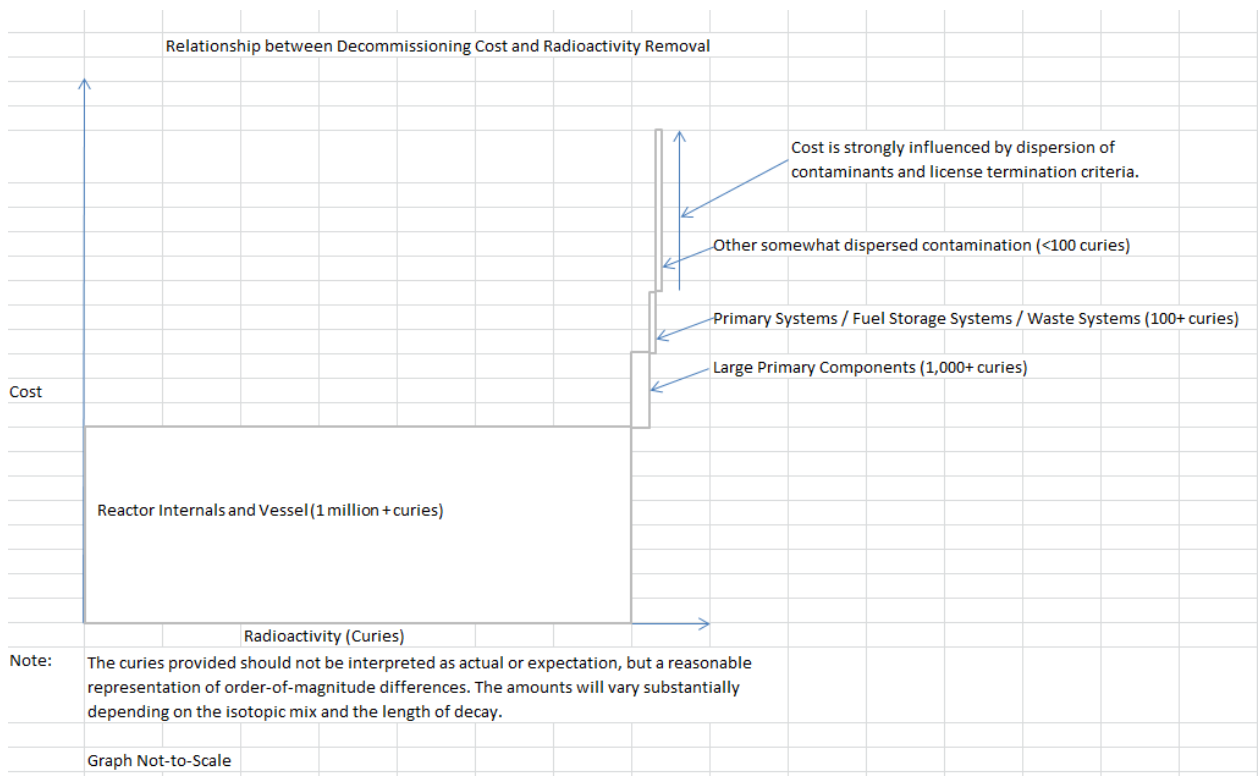
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The Panel interviewed the fuel departments at all three sites, and concludes that the 12 year wet cooling time estimate for DC and SONGS 2&3 is reasonable.

### Cost of removing radioactive material and concentration or dispersion of contamination

During the course of decommissioning a U.S. power reactor, there is a general relationship between the cost of removing radioactive material and the concentration or dispersion of the contamination (measured in curies<sup>5</sup>). The graph shown below depicts this general relationship. The reader is reminded this graph is provided for example only and is not intended to represent actual cost or contamination levels.

**Figure A.3 – Relationship Between Cost and Concentration of Radioactivity**



One could consider that there are four major sources of radioactive activation or contamination associated with decommissioning a U.S. power reactor. The first three sources can be reasonably identified since these sources are directly related to the design and operation of the reactor, are expected to contain high concentrations of radioactive material, and are expected to contain the radioactivity within metal components. The fourth source is more difficult to identify with certainty

<sup>5</sup> A curie is simply a measure of radioactive decays per unit time. One curie is defined as 37 billion radioactive decays per second. One curie is approximately the amount of radioactivity from one gram of the radium 226 isotope.

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because the radioactivity is more widely dispersed, will contain low or very low concentrations of radioactive material and, depending on the concentration (measured in pico Curies per gram, or pCi/gm), may not require removal or disposal as part of the decommissioning project. A detailed statistical analysis (MARSSIM) together with approved site release criteria are used to establish acceptable remaining concentration levels. These acceptable remaining concentration levels are used to determine how much of the dispersed radioactivity must be removed.

Each of the first three sources of radioactivity will be a significant cost driver. The fourth source of radioactivity may or may not be a significant cost driver depending on the concentration and the acceptable remaining concentration levels.

- Reactor Internals and Vessel – These components, the principal source of non-fuel radioactivity (curies) during decommissioning become activated and contaminated during the course of operations. These components contain the vast majority of curies present in a shutdown nuclear station (generally exceeding 99 percent), and, are generally so activated that some of the material is considered Greater-Than-Class-C waste (and requires permanent isolation). These levels of radioactivity require extraordinary measures to control worker radiation dose and contamination (including performing work underwater, using special filter systems and waste packages, etc.). As a result of the levels of radioactivity, the cost of dispositioning these components (including removal, segmentation, packaging, shipping, and disposal) is large, as the number of curies removed is also large.
- Large Primary Components – these components (steam generators and pressurizer) become contaminated during the course of operations, are very large in size (hundreds of tons), and contain concentrated source of radioactivity (contained within the components). Due to both the size and radioactivity contained within the components, the cost of disposition is also substantial.
- Primary, Fuel Storage, and Waste Systems – these systems are designed to become contaminated during the course of operations, are physically smaller than the reactor and large primary components, and are located throughout the station (per the plant design). These systems may also contain levels of contamination similar to the large components, but due to their smaller size are generally easier to package and transport. These systems may contain a substantial amount of curies because they circulate primary system coolant or other similarly contaminated water, and for some systems, are designed to filter (capture curies) from these fluids.
- Other Somewhat Dispersed Contamination – this contamination is expected to be found at very low concentration levels, and dispersed in potentially large volumes of material, such as soil or concrete. Generally, the cost of dispositioning this type of material is influenced by the quantity of affected materials and by the acceptable remaining concentration levels (site release criteria). The lower the acceptable remaining concentration levels, and the more widely dispersed the radioactive material is, the greater the potential decommissioning cost.

The net result is that the cost per curie changes as the source of contamination changes. Highly radioactive primary components are significant cost drivers because they are large, costly to handle, and

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contain concentrated sources of radioactivity. Dispersed contamination may also be a significant cost driver, not because it requires removing a highly concentrated hazard (radioactivity), but because it requires removing, shipping, and disposing (at a licensed facility) a large quantity of material. The quantity of material is strongly influenced by site-specific dispersion and acceptable remaining concentration levels.

### Restricted Access to Class B and C Waste Disposal Facilities

Class B and C waste types, specifically the requirements for near-surface land disposal, are defined in 10 CFR 61, Licensing Requirements for Land Disposal of Radioactive Waste," Sub-Part 61.55. Both long and short-lived radionuclides determine these classifications. San Onofre and Diablo Canyon are located in the Southwest Low-Level Radioactive Waste Compact, which currently does not have access to a Class B and C waste disposal facility. There are two U.S. waste disposal sites licensed to accept Class B and C waste from commercial (non-government) waste generators. Until recently Barnwell accepted waste from all U.S. generators; however, as of July 1, 2008, Barnwell discontinued accepting low-level waste from generators outside the Atlantic Compact (comprised of the states of Connecticut, New Jersey and South Carolina). The 2<sup>nd</sup> facility, Hanford (Washington state), has, since 1993, only accepted waste from the Northwest and Rocky Mountain Compact generators. Since San Onofre and Diablo Canyon are in the Southwest Compact, they do not have access to the only licensed Class B and C waste disposal facilities.

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## **Appendix B**

### **U.S. Decommissioning Experience**

This Appendix contains a summary of information for the six U.S. Pressurized Water Reactors that have essentially completed the physical decommissioning (“radiological remediation” and “demolition” activities). The appendix is organized into a series of tables, with each table providing a summary of costs and other information that may be useful in understanding each decommissioning project (Tables B-1 through B-6). A copy of the cost “source” information (typically extracted from a License Termination Plan or similar document) is provided on the second page of each table to permit the reader to understand how and to what detail cost information is publically disseminated. In addition the appendix provides information relating to estimates of decommissioning costs prior to decommissioning performance (Table B-7), and information relating to current NRC license status (Table B-8)

This appendix contains the following tables:

B.1 Maine Yankee

B.2 Connecticut Yankee

B.3 Rancho Seco

B.4 SONGS 1

B.5 Trojan

B.6 Yankee Rowe

B.7 Extract from NRC NUREG-1628, “Frequently Asked Questions About Reactor Decommissioning”

B.8 NRC Press Releases Related to Release of Site

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**Table B.1**  
**Maine Yankee**

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                           |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------------------------|
| <b>Maine Yankee</b>                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                           |
| Inflation Index ('01 - '08)                       | 1.26                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              | CPI Services                              |
| Reactor Type / Thermal Rating (MWt):              | PWR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                                           |
| Thermal Rating                                    | 2,700                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |                                           |
| Location:                                         | Wiscasset, Maine                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |                                           |
| Operating License Issued:                         | 1973                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                           |
| Permanent Cessation of Operations:                | August 1997 (shut down in December 1996)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                           |
| Decommissioning Option Selected:                  | DECON                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |                                           |
| Decommissioning Commenced:                        | Immediately upon cessation of operations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                           |
| License Termination Plan Submitted:               | Yes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                                           |
| Date of License Termination:                      | 2005                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                           |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                           |
|                                                   | <b>U.S. Dollars (thousands)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              | <b>Comments</b>                           |
| <b>Cost Item</b>                                  | <b>('01)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>('08)</b> |                                           |
| Total                                             | 589,329                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 742,555      |                                           |
| License Termination                               | 410,928                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 517,769      | Included LT survey in License Termination |
| Spent Fuel Management                             | 149,379                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 188,218      | Estimate appears to be through year 2022  |
| Site Restoration                                  | 29,022                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 36,568       |                                           |
| Other                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0            |                                           |
| <b>Cost per Megawatt (MWt)</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                           |
| Total                                             | 218                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 275          |                                           |
| License Termination                               | 152                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 192          |                                           |
| Spent Fuel Management                             | 55                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 70           |                                           |
| Site Restoration                                  | 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 14           |                                           |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                           |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                           |
| <b>Notes:</b>                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                           |
| <b>Source of Cost Information</b>                 | License Termination Plan, Revision 3, October 2002 (additional revisions to LTP were issued, but the cost section was not revised).                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                                           |
| <b>Reactor Vessel Disposition</b>                 | Partial internals segmentation to remove Greater-Than-Class-C material and to reduce curie contents to satisfy Barnwell WAC (50,000 Curies package limit). Reactor head transported and disposed of at EnergySolutions (Utah). Reactor vessel placed into a custom waste container and shipped one-piece to Barnwell, SC via intracoastal waterway. Low water level in Savannah River delayed reactor vessel shipment.                                                                                                                                                                                |              |                                           |
| <b>License Termination Criteria</b>               | Criteria was a state standard 10 mrem TEDE (4 mrem/year due to groundwater ingestion) v. NRC-criteria of 25 mrem TEDE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |                                           |
| <b>Steam Generators / Pressurizer Disposition</b> | One-piece removal and shipment to waste processor for volume reduction. Shipped via barge on intracoastal waterway and inland waterways.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                           |
| <b>Building Demolition</b>                        | Major structures including containment and the cooling tower were demolished to 3 feet below grade prior to final status survey (in support of license termination).                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                           |
| <b>Management Approach:</b>                       | Although originally subcontracted to a prime contractor on a turnkey basis, the project was eventually managed by the owner and its subcontractors. The original contractor was forced to declare bankruptcy in the middle of the project (apparently un-related to the Maine Yankee project). The owner elected to assume direct responsibility for managing the work, using many of the same sub-contractors already on site for the larger work scopes, such as vessel segmentation, large component removal, packing, transportation, and disposal, waste transportation, and spent fuel storage. |              |                                           |
| <b>"Clean" concrete disposition</b>               | All demolished concrete was sent off-site. Some concrete sent to EnergySolutions, remaining concrete to a non-hazardous waste landfill in Niagara Falls, NY.                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |                                           |
| <b>Other</b>                                      | Maine Yankee had access to Barnwell (higher activity waste), off-site waste processors, and EnergySolutions low-level waste site in Utah)                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |                                           |
|                                                   | Approximately 72 million pounds of radioactive soil, and 12 million pounds of non-radioactive soil was disposed of.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |                                           |
|                                                   | Plant was shutdown a year before deciding to decommission. Likely that the all of the costs associated with the first year of shutdown were not accrued to decommissioning project                                                                                                                                                                                                                                                                                                                                                                                                                    |              |                                           |
|                                                   | The information presented here is believed to be reasonably accurate, sufficient enough for its intended use in discussing U.S. reactor experiences.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                           |

# Report on Nuclear Decommissioning

**Table B.1 (continued)**  
**Maine Yankee - Source of Cost Information**

MYAPC License Termination Plan  
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**Table 7-1**  
**Maine Yankee Summary of Decommissioning Costs <sup>(1)</sup>**  
**TLG Site Specific Cost Estimate**

|                                             | <u>1997 Dollars</u>                 | <u>2001 Dollars<sup>(6)</sup></u> |
|---------------------------------------------|-------------------------------------|-----------------------------------|
| <b>Plant Radiological Decontamination</b>   |                                     |                                   |
| Staffing                                    | \$91,128                            | \$105,789                         |
| LLW Burial                                  | \$64,816                            | \$75,244                          |
| Equipment Removal                           | \$44,310                            | \$51,439                          |
| LLW Packaging and Shipping                  | \$16,663                            | \$19,344                          |
| Decontamination Activities                  | \$ 6,376                            | \$ 7,402                          |
| Contingency                                 | \$60,265                            | \$69,961                          |
| Other Costs <sup>(2)</sup>                  | \$59,719                            | \$69,327                          |
| <b>Subtotal</b>                             | <b>\$343,279 <sup>(3) (4)</sup></b> | <b>\$398,505 <sup>(5)</sup></b>   |
| <b>Spent Fuel Management</b>                |                                     |                                   |
| Staffing and Security                       | \$33,189                            | \$38,529                          |
| Property Taxes                              | \$25,445                            | \$29,539                          |
| Construction Costs                          | \$52,249                            | \$60,655                          |
| NRC and State Fees                          | \$10,093                            | \$11,717                          |
| Insurance                                   | \$ 3,018                            | \$3,504                           |
| Other Costs <sup>(2)</sup>                  | \$ 4,683                            | \$5,436                           |
| <b>Subtotal</b>                             | <b>\$128,677 <sup>(3) (4)</sup></b> | <b>\$149,379<sup>(5)</sup></b>    |
| <b>Site Restoration (Remediation)</b>       |                                     |                                   |
| Licensing Termination Survey                | \$10,701                            | \$12,423                          |
| Major Component Removal                     | \$10,805                            | \$12,543                          |
| Close-out activities                        | \$ 3,222                            | \$3,740                           |
| Demolition of site buildings                | \$10,973                            | \$12,738                          |
| <b>Subtotal</b>                             | <b>\$35,701 <sup>(3) (4)</sup></b>  | <b>\$41,445 <sup>(5)</sup></b>    |
| <b>Total Decommissioning Costs Estimate</b> | <b>\$508,000 <sup>(3) (4)</sup></b> | <b>\$589,329<sup>(5)</sup></b>    |

Notes:

- (1) Prompt Decommissioning Technique (DECON), costs in thousands of dollars. Components estimated to reflect allocation of cost categories to conform with NRC definition.
- (2) Other costs include insurance, property taxes, energy, NRC and State fees, etc.
- (3) Sums may not be exact due to rounding to nearest thousand.
- (4) Escalation rate of 3.8% used.
- (5) All values derived from the TLG Site Specific Cost Estimate as discussed in LTP Section 7.2.

**Table 7-3**  
**Maine Yankee Comparison Summary of Decommissioning Costs**

|                                           | TLG Site Specific<br>Cost<br>Estimate <sup>(1)(2)</sup> | Maine Yankee<br>Financial Planning<br>Estimate <sup>(3)</sup> |                  |                          |
|-------------------------------------------|---------------------------------------------------------|---------------------------------------------------------------|------------------|--------------------------|
|                                           |                                                         | Expended <sup>(4)(5)</sup>                                    | Projected        | Total                    |
| <b>Plant Radiological Decontamination</b> |                                                         |                                                               |                  |                          |
| Staffing                                  | \$105,789                                               | \$72,433                                                      | \$59,162         | \$131,595 <sup>(7)</sup> |
| LLW Burial                                | \$ 75,244                                               | \$52,463                                                      | \$29,136         | \$ 81,599                |
| Equipment Removal                         | \$ 51,439                                               | \$34,427                                                      | \$ 4,354         | \$ 38,781                |
| LLW Packaging and Shipping                | \$ 19,344                                               | \$20,959                                                      | \$ 5,934         | \$ 26,893                |
| Decontamination Activities                | \$ 7,402                                                | \$21,328                                                      | \$10,606         | \$ 31,934                |
| Contingency                               | \$ 69,961                                               | \$ 135                                                        | \$19,118         | \$ 19,253                |
| Other Costs <sup>(1)</sup>                | \$ 69,327                                               | \$41,318                                                      | \$23,566         | \$ 64,884                |
| <b>Subtotal</b>                           |                                                         | <b>\$243,063</b>                                              | <b>\$151,876</b> |                          |
| <b>Total<sup>(6)</sup></b>                | <b>\$398,505</b>                                        |                                                               |                  | <b>\$394,939</b>         |

Notes:

- (1) Reported in thousands (000's) of 2001 dollars. Allocation of costs based on Maine Yankee's estimate of grouping the cost categories per Reg. Guide 1.179.
- (2) Estimate as shown on Table 7-1.
- (3) Expended through December 2001.
- (4) Until May 2000, Maine Yankee maintained a fixed price contract for Decommissioning Services. Amounts reported as expended include identifiable contract costs, and in some cases, a prorated distribution based on the best information available to Maine Yankee.
- (5) Other Costs include insurance, property taxes, energy, NRC and State fees, etc.
- (6) Amounts are based on activities related to the definition of "Decommissioning" in 10 CFR 50.2 and do not include the cost of removal and disposal of spent fuel or of non-radioactive structures and materials beyond that necessary to terminate the license.
- (7) This value includes License Termination Survey costs of approximately \$7M previously included under Site Restoration in the TLG Site Specific Cost Estimate (Table 7-1). Termination survey (FS5) costs are dominated by staffing expenses. Because of the decision to demolish above grade structures in the industrial area, the final status survey scope has been reduced, and the associated costs are now lower than that determined by TLG in 1997. (See Table 7-1.)

# Report on Nuclear Decommissioning

**Table B.2**  
**Connecticut Yankee**

|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                                                                      |
|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------------------------------|
| <b>Connecticut Yankee</b>                                |                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                                                                      |
| Inflation Index ('03 - '08)                              | 1.18                                                                                                                                                                                                                                                                                                                                                                                                                                         |              | CPI Services                                                                         |
| Reactor Type / Thermal Rating (MWt):                     | PWR                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |                                                                                      |
| Thermal Rating                                           | 1,825                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                                                                                      |
| Location:                                                | Meriden, CT                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                      |
| Operating License Issued:                                | Dec-74                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                                                                      |
| Permanent Cessation of Operations:                       | Dec-96                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                                                                      |
| Decommissioning Option Selected:                         | DECON                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                                                                                      |
| Decommissioning Commenced:                               | 1998                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |                                                                                      |
| License Termination Plan Submitted:                      | Yes                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |                                                                                      |
| Date of License Termination:                             | 2007                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |                                                                                      |
|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                                                                      |
|                                                          | <b>U.S. Dollars (thousands)</b>                                                                                                                                                                                                                                                                                                                                                                                                              |              | <b>Comments</b>                                                                      |
| <b>Cost Item</b>                                         | <b>('03)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>('08)</b> |                                                                                      |
| Total                                                    | 965,685                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1,139,509    |                                                                                      |
| License Termination                                      | 547,985                                                                                                                                                                                                                                                                                                                                                                                                                                      | 646,623      |                                                                                      |
| 1997 - 2002 Dismantlement and Decontamination (\$326.9M) | 362,385                                                                                                                                                                                                                                                                                                                                                                                                                                      |              | Assume costs are in year 2000 dollars, escalated to 2003 dollars using CPI, Services |
| 2003 and beyond License Termination                      | 185,600                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |                                                                                      |
| Spent Fuel Management                                    | 317,900                                                                                                                                                                                                                                                                                                                                                                                                                                      | 375,122      |                                                                                      |
| Site Restoration                                         | 99,800                                                                                                                                                                                                                                                                                                                                                                                                                                       | 117,764      |                                                                                      |
| <b>Cost per Megawatt (MWt)</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                                                                      |
| Total                                                    | 529                                                                                                                                                                                                                                                                                                                                                                                                                                          | 624          |                                                                                      |
| License Termination                                      | 300                                                                                                                                                                                                                                                                                                                                                                                                                                          | 354          |                                                                                      |
| Spent Fuel Management                                    | 174                                                                                                                                                                                                                                                                                                                                                                                                                                          | 206          |                                                                                      |
| Site Restoration                                         | 55                                                                                                                                                                                                                                                                                                                                                                                                                                           | 65           |                                                                                      |
|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                                                                      |
|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                                                                      |
| <b>Notes:</b>                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                                                                                      |
| <b>Source of Cost Information</b>                        | Haddam Neck License Termination Plan, Rev. 2, August 2004.                                                                                                                                                                                                                                                                                                                                                                                   |              |                                                                                      |
| <b>Reactor Vessel Disposition</b>                        | Segment Internals, reactor vessel shell ship in one-piece.                                                                                                                                                                                                                                                                                                                                                                                   |              |                                                                                      |
| <b>License Termination Criteria</b>                      | Multiple License Termination Criteria, State of CT in general was most restrictive. A TEDE of 19 mrem / year was the CT criteria.                                                                                                                                                                                                                                                                                                            |              |                                                                                      |
| <b>Steam Generators / Pressurizer Disposition</b>        | Steam generator domes removed and transported (by truck and then rail) to off-site processor. Lower steam generator assemblies were packaged and barged (then rail) to Barnwell, SC. Pressurizer transported to EnergySolutions facility in Utah.                                                                                                                                                                                            |              |                                                                                      |
| <b>Building Demolition</b>                               | Buildings demolished. All concrete resulting from the demolition was taken off site.                                                                                                                                                                                                                                                                                                                                                         |              |                                                                                      |
| <b>Management Approach:</b>                              | Initially the owner contracted with a contractor to deliver essentially a turnkey decommissioning. Substantial problems arose, until the owner terminated the contract, and managed the decommissioning with its own staff (and staff augmentation and subcontractors for specialty work). There was substantial litigation associated with the terminated contract, including contamination incidents that occurred during decommissioning. |              |                                                                                      |
| <b>"Clean" concrete disposition</b>                      | All removed concrete was disposed of off-site. Material with low radionuclide concentrations was disposed of at controlled landfills.                                                                                                                                                                                                                                                                                                        |              |                                                                                      |
| <b>Other</b>                                             | Concrete processing done on site to reduce costs for disposal. (rebar removed, size reduced). It was noted there was price competition due to the large volumes of waste generated.                                                                                                                                                                                                                                                          |              |                                                                                      |
|                                                          | The information presented here is believed to be reasonably accurate, sufficient enough for its intended use in discussing U.S. reactor experiences.                                                                                                                                                                                                                                                                                         |              |                                                                                      |

# Report on Nuclear Decommissioning

**Table B.2 (continued)**  
**Connecticut Yankee - Source of Cost Information**

Haddam Neck Plant License Termination Plan

**Table 7-1**  
**Actual and Project Decommissioning Expenditures**  
**(\$ Millions)**

| Cost Categories                                                             | Total                  |
|-----------------------------------------------------------------------------|------------------------|
| <i>1997 - 2002 Dismantlement and Decontamination</i>                        | <i>\$ 326.9</i>        |
| <i>2003 "To-go" Decommissioning Cost Estimate: 2003 - 2023</i>              |                        |
| <b>Cost Elements [A]:</b>                                                   |                        |
| (1) Dismantlement and Decontamination                                       | \$ 106.2               |
| (2) Radioactive Waste Costs                                                 | <u>\$ 64.5</u>         |
| Subtotal Dismantlement and Decontamination and Waste (1+2)                  | \$ 170.7               |
| (3) Long Term SNF Storage                                                   | \$ 317.9               |
| (4) Site Restoration                                                        | <u>\$ 99.8</u>         |
| (5) Final Status Survey (FSS)                                               | \$ 14.9                |
| Subtotal SNF Storage, Site Restoration and FSS (3+4+5)                      | \$ 432.6               |
| <b>Total 2003 "To-go" Decommissioning Cost Estimate 2003 - 2023</b>         | <b>\$ 603.3</b>        |
| <b>Total Decommissioning Cost Including Incurred and Estimated Cost [B]</b> | <b><u>\$ 930.2</u></b> |

[A] 2003 "To-go" cost estimate is stated in year 2003 dollars.

[B] Cost total excludes the FERC approved consolidation of the pre-1983 spent fuel fee obligation of \$152.7M (principal & interest as of December, 2003) which was deposited into the decommissioning trust fund. The liability increases according to the spent fuel obligation interest rate requirements and the spent fuel obligation asset accretion assumptions are within the decommissioning funding model.

## Report on Nuclear Decommissioning

**Table B.3**  
**Rancho Seco**

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                                                                                 |
|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Rancho Seco</b>                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                                                                                 |
| Inflation Index ('05 - '08)                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.11         | CPI Services                                                                                                                                    |
| Reactor Type / Thermal Rating (MWt):              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | PWR          |                                                                                                                                                 |
| Thermal Rating                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2,772        |                                                                                                                                                 |
| Location:                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Herald, CA   |                                                                                                                                                 |
| Operating License Issued:                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Aug-74       |                                                                                                                                                 |
| Permanent Cessation of Operations:                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Jun-89       |                                                                                                                                                 |
| Decommissioning Option Selected:                  | SAFSTOR then DECON                                                                                                                                                                                                                                                                                                                                                                                                                                                               |              |                                                                                                                                                 |
| Decommissioning Commenced:                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Feb-97       |                                                                                                                                                 |
| License Termination Plan Submitted:               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Yes          |                                                                                                                                                 |
| Date of License Termination:                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Oct-09       |                                                                                                                                                 |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                                                                                 |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                                                                                 |
|                                                   | <b>U.S. Dollars (thousands)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              | <b>Comments</b>                                                                                                                                 |
| <b>Cost Item</b>                                  | <b>('05)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>('08)</b> |                                                                                                                                                 |
| Total                                             | 534,185                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 592,945      | Estimate includes costs through 2008 plus cost identified in license termination below                                                          |
| License Termination                               | 442,627                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 491,316      | Includes costs associated with disposition of GTCC in 2027, and oversight of Class B and C wastes in storage until 2028                         |
| Spent Fuel Management                             | 91,558                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 101,629      | \$78.6 million in spent fuel damage claims through 31Dec2003; \$2.6 million / year dry storage facility operating costs between '03 through '08 |
| Site Restoration                                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 0            | Buildings / Structures still in place.                                                                                                          |
| <b>Cost per Megawatt (MWt)</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                                                                                 |
| Total                                             | 193                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 214          |                                                                                                                                                 |
| License Termination                               | 160                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 177          |                                                                                                                                                 |
| Spent Fuel Management                             | 33                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 37           |                                                                                                                                                 |
| Site Restoration                                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 0            |                                                                                                                                                 |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                                                                                 |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                                                                                 |
| <b>Notes:</b>                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |                                                                                                                                                 |
| <b>Source of Cost Information</b>                 | RSNGS License Termination Plan, Rev 0, April 2006 (total costs). Spent fuel costs extracted from U.S. Court of Federal Claims, No. 98-488C, Filed: March 31, 2006.                                                                                                                                                                                                                                                                                                               |              |                                                                                                                                                 |
| <b>Reactor Vessel Disposition</b>                 | Reactor Head was segmented on site using a diamond wire saw. Internals were segmented by a contractor. Reactor vessel was segmented on site by the owner with purchased equipment. Reactor waste sent to EnergySolutions site. Class B and C wastes, although eligible (at the time) to be shipped to Barnwell, are stored on site (understanding is that plant had never shipped waste to Barnwell and did not want to establish a potential liability by sending waste there). |              |                                                                                                                                                 |
| <b>License Termination Criteria</b>               | Criteria was NRC-criteria of 25 mrem TEDE.                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |                                                                                                                                                 |
| <b>Steam Generators / Pressurizer Disposition</b> | Steam generator cut in half (on-site) to facilitate transport. Halves were packaged and transported via railway for disposal at EnergySolutions. The design of the steam generators at this facility is substantially different than the design at Diablo Canyon, San Onofre, and Palo Verde. Pressurizer shipped in one-piece via railway to EnergySolutions.                                                                                                                   |              |                                                                                                                                                 |
| <b>Building Demolition</b>                        | Major building / structures remain in place. Owner stated in License Termination Plan no plan to demolish or reuse these buildings in near future.                                                                                                                                                                                                                                                                                                                               |              |                                                                                                                                                 |
| <b>Management Approach:</b>                       | Initial plan was to utilize SAFSTOR strategy. This evolved into incremental decommissioning (dismantlement at a relatively slow pace). This later evolved into full-scale decommissioning. The owner typically was hands-on in the dismantling, including segmenting the reactor vessel with their staff and purchased equipment.                                                                                                                                                |              |                                                                                                                                                 |
| <b>"Clean" concrete disposition</b>               | Major buildings / structures have not been demolished.                                                                                                                                                                                                                                                                                                                                                                                                                           |              |                                                                                                                                                 |
| <b>Other</b>                                      | There were radiological releases outside the confines of the buildings                                                                                                                                                                                                                                                                                                                                                                                                           |              |                                                                                                                                                 |
|                                                   | The information presented here is believed to be reasonably accurate, sufficient enough for its intended use in discussing U.S. reactor experiences.                                                                                                                                                                                                                                                                                                                             |              |                                                                                                                                                 |

# Report on Nuclear Decommissioning

**Table B.3 (continued)**  
**Rancho Seco - Source of Cost Information**

RSNGS License Termination Plan

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activities necessary for termination of the Part 50 license and release of the site for unrestricted use. Additionally, the Cost Estimate includes costs for fuel storage through 2008, coinciding with the scheduled completion of phase one of License Termination. The Cost Estimate does not include costs associated with the disposal of non-radiological materials or structures beyond that necessary to terminate the Part 50 license.

**Table 7-1**  
**Summary of Remaining Decommissioning Costs**  
**In Year 2005 Dollars (thousands of dollars)**

| Work Category                     | Cost in 2005\$<br>(2006 & beyond) | Remaining<br>Costs |
|-----------------------------------|-----------------------------------|--------------------|
| Decontamination                   | 2,663                             | 1.6%               |
| Large Components, RB Concrete     | 28,429                            | 17.4%              |
| Transportation                    | 2,768                             | 1.7%               |
| Waste Disposal                    | 7,126                             | 4.4%               |
| Characterization/Remediation      | 14,961                            | 9.2%               |
| Final Status Survey               | 13,434                            | 8.2%               |
| Project Staffing                  | 52,730                            | 32.3%              |
| Materials and Equipment           | 3,278                             | 2.0%               |
| Insurance                         | 1,156                             | 0.7%               |
| Other Undistributed Costs         | 12,811                            | 7.9%               |
| Contract & Material Surcharges    | 823                               | 0.5%               |
| Stored Waste Oversight            | 1,994                             | 1.2%               |
| Class B, C, & GTCC Disposal Costs | 20,552                            | 12.6%              |
|                                   |                                   |                    |
| Total                             | 163,088                           | 100.0%             |
|                                   |                                   |                    |
| Expended thru 2005                | 371,097                           |                    |
|                                   |                                   |                    |
| Grand Total                       | 534,185                           |                    |

## 7.3 Decommissioning Funding Plan

The District had maintained an internal decommissioning fund since the early 1980's. In 1991, the District transferred \$90 million from the internal fund into an "external sinking decommissioning trust fund" and submitted its Financial Assurance Plan to the NRC describing the use of the external sinking fund. There have been no significant modifications to the external sinking fund since the initial submittal.

The District plans to accumulate funds in the external trust fund, at the rate of \$27 million per year, through 2008. Based on the current decommissioning cost estimate and funding rate, collecting funds through 2008 will provide sufficient funds to complete decommissioning Rancho Seco and terminate the 10 CFR Part 50 license.

The external trust fund is currently maintained by Wells Fargo Bank. The balance is reviewed on an annual basis to ensure the adequacy of the annual contribution to assure funds will be available to complete decommissioning and terminate the 10CFR Part 50 license.

# Report on Nuclear Decommissioning

**Table B.4**  
**San Onofre Unit 1**

| <b>San Onofre Unit 1</b>                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                                             |
|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------|
| Inflation Index ('08 - '08)                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1               | Costs in 2008 dollars were provided by owner                |
| Reactor Type / Thermal Rating (MWt):              | PWR                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                                             |
| Thermal Rating                                    | 1,347                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |                                                             |
| Location:                                         | San Clemente, CA                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                                                             |
| Operating License Issued:                         | Mar-67                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                                                             |
| Permanent Cessation of Operations:                | Nov-92                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                                                             |
| Decommissioning Option Selected:                  | DECON                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 | Plant was placed in Safe-Storage after shutdown, until 1999 |
| Decommissioning Commenced:                        | 1999                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                 |                                                             |
| License Termination Plan Submitted:               | No                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                                             |
| Date of License Termination:                      | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                                             |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                                             |
| <b>U.S. Dollars (thousands)</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Comments</b> |                                                             |
| <b>Cost Item</b>                                  | <b>('01, '04, '08)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>('08)</b>    |                                                             |
| Total                                             | 780,400                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 843,000         | Cost escalation provided by SCE                             |
| CPUC D.03-10-015 ('01 \$\$)                       | 91,000                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                                                             |
| CPUC D.07-01-003 ('04 \$\$)                       | 298,000                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                                                             |
| CPUC D.10-07-047 ('08 \$\$)                       | 207,000                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                                                             |
| CPUC D.10-07-047 ('08 \$\$) - Remaining Costs     | 184,400                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                                                             |
| <b>Cost per Megawatt (MWt)</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                                             |
| Total                                             | 579                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 626             |                                                             |
| License Termination                               | 67.56                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |                                                             |
| Spent Fuel Management                             | 221                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                                             |
| Site Restoration                                  | 137                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                                             |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                                             |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                                             |
| <b>Notes:</b>                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                                             |
| <b>Source of Cost Information</b>                 | Reasonable decommissioning costs as determined in the CPUC decisions (Decision number identified in "Cost Item")                                                                                                                                                                                                                                                                                                                                                   |                 |                                                             |
| <b>Reactor Vessel Disposition</b>                 | Internals segmented to remove GTCC material and meet the waste acceptance criteria for the Barnwell waste disposal site.<br>Reactor Pressure Vessel (including remaining internals) packaged into a steel canister designed to be transported in one-piece. Reactor Pressure Vessel remains on site in storage.<br>Segmentation and disposal of the package should take place concurrently with the segmentation and disposal of the SONGS 2 and 3 reactor vessels |                 |                                                             |
| <b>License Termination Criteria</b>               | Not yet established - to be developed in coordination with decommissioning Units 2 and 3.                                                                                                                                                                                                                                                                                                                                                                          |                 |                                                             |
| <b>Steam Generators / Pressurizer Disposition</b> | One-piece removal and shipment to EnergySolutions in Utah                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                                                             |
| <b>Building Demolition</b>                        | Essentially all buildings demolished including foundations down to at least 6 feet below grade. (In Phase 1 of the project)                                                                                                                                                                                                                                                                                                                                        |                 |                                                             |
| <b>Management Approach:</b>                       | Initial plan was to place unit in safe-storage and decommission with Units 2 and 3. This plan was modified and in 1999 the unit went into an active decommissioning mode. Overall project managed by owner, with specialty contractors employed where appropriate.                                                                                                                                                                                                 |                 |                                                             |
| <b>"Clean" concrete disposition</b>               | Removed from the station.                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                                                             |
| <b>Other</b>                                      | The remaining costs include \$100 million for the segmentation, re-packaging, shipping, and disposal of the reactor vessel package.                                                                                                                                                                                                                                                                                                                                |                 |                                                             |
|                                                   | The information presented here is believed to be reasonably accurate, sufficient enough for its intended use in discussing U.S. reactor experiences.                                                                                                                                                                                                                                                                                                               |                 |                                                             |

# Report on Nuclear Decommissioning

**Table B.4 (continued)**  
**San Onofre Unit 1 - Source of Cost Information**

The SONGS 1 decommissioning costs incurred from project inception through December 31, 2008, were found reasonable by the CPUC in the following decisions:

|                                                                                 |
|---------------------------------------------------------------------------------|
| 91 million \$ 2001 (D.03-10-015 p. 38 Ordering Paragraph #6)                    |
| 298 million \$ 2004 (D.07-01-003 p. 2 § II A(1) and p. 31 Conclusion of Law #6) |
| 207 million \$ 2008 (D.10-07-047 p. 55 Conclusion of Law #5)                    |

The estimated cost for SONGS 1 Remaining Decommissioning Work of \$184.4 M (2008 \$, 100% Level) was also found reasonable in D.10-07-047 p.54 Conclusion of Law #4.

# Report on Nuclear Decommissioning

**Table B.5**  
**Trojan**

|                                                   |                                                                                                                                                                                                                                                                                                                     |              |                                          |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------|
| <b>Trojan</b>                                     |                                                                                                                                                                                                                                                                                                                     |              |                                          |
| Inflation Index ('97 - '08)                       | 1.42                                                                                                                                                                                                                                                                                                                |              | CPI Services                             |
| Reactor Type / Thermal Rating (MWt):              | PWR                                                                                                                                                                                                                                                                                                                 |              |                                          |
| Thermal Rating                                    | 3,411                                                                                                                                                                                                                                                                                                               |              |                                          |
| Location:                                         | Rainier, Oregon                                                                                                                                                                                                                                                                                                     |              |                                          |
| Operating License Issued:                         | 1975                                                                                                                                                                                                                                                                                                                |              |                                          |
| Permanent Cessation of Operations:                | 11/9/1992                                                                                                                                                                                                                                                                                                           |              |                                          |
| Decommissioning Option Selected:                  | DECON                                                                                                                                                                                                                                                                                                               |              |                                          |
| Decommissioning Commenced:                        | Immediately upon cessation of operations                                                                                                                                                                                                                                                                            |              |                                          |
| License Termination Plan Submitted:               | Yes                                                                                                                                                                                                                                                                                                                 |              |                                          |
| Date of License Termination:                      | 2005 (excluding on-site dry fuel storage facility)                                                                                                                                                                                                                                                                  |              |                                          |
|                                                   |                                                                                                                                                                                                                                                                                                                     |              |                                          |
|                                                   |                                                                                                                                                                                                                                                                                                                     |              |                                          |
|                                                   | <b>U.S. Dollars (thousands)</b>                                                                                                                                                                                                                                                                                     |              | <b>Comments</b>                          |
| <b>Cost Item</b>                                  | <b>('97)</b>                                                                                                                                                                                                                                                                                                        | <b>('08)</b> |                                          |
| Total                                             | 429,700                                                                                                                                                                                                                                                                                                             | 610,174      |                                          |
| License Termination                               | 211,700                                                                                                                                                                                                                                                                                                             | 300,614      |                                          |
| Spent Fuel Management                             | 142,100                                                                                                                                                                                                                                                                                                             | 201,782      |                                          |
| ISFSI Const./Fuel Load                            | 82,000                                                                                                                                                                                                                                                                                                              | 116,440      |                                          |
| ISFSI Long Term Ops                               | 60,100                                                                                                                                                                                                                                                                                                              | 85,342       | Estimate appears to be through year 2018 |
| Site Restoration                                  | 40,200                                                                                                                                                                                                                                                                                                              | 57,084       |                                          |
| Other - Project Reserve                           | 35,700                                                                                                                                                                                                                                                                                                              | 50,694       | Added to total                           |
| <b>Cost per Megawatt (MWt)</b>                    |                                                                                                                                                                                                                                                                                                                     |              |                                          |
| Total                                             | 126                                                                                                                                                                                                                                                                                                                 | 179          |                                          |
| License Termination                               | 62                                                                                                                                                                                                                                                                                                                  | 88           |                                          |
| Spent Fuel Management                             | 42                                                                                                                                                                                                                                                                                                                  | 59           |                                          |
| Site Restoration                                  | 12                                                                                                                                                                                                                                                                                                                  | 17           |                                          |
|                                                   |                                                                                                                                                                                                                                                                                                                     |              |                                          |
|                                                   |                                                                                                                                                                                                                                                                                                                     |              |                                          |
| <b>Notes:</b>                                     |                                                                                                                                                                                                                                                                                                                     |              |                                          |
| <b>Source of Cost Information</b>                 | PGE presentation to Oregon Public Utilities Commission - March 2005                                                                                                                                                                                                                                                 |              |                                          |
| <b>Reactor Vessel Disposition</b>                 | One-piece removal with internals intact. Barge shipment on Columbia River to waste disposal site located on Columbia River (considered very successful project - international award)                                                                                                                               |              |                                          |
| <b>License Termination Criteria</b>               | LTP references 10CFR20.1402 (25 mrem TEDE), structures largely intact at time of final survey.                                                                                                                                                                                                                      |              |                                          |
| <b>Steam Generators / Pressurizer Disposition</b> | One-piece removal. Barge shipment on Columbia River to waste disposal site located on Columbia River                                                                                                                                                                                                                |              |                                          |
| <b>Building Demolition</b>                        | Major structures including containment and the cooling tower were not demolished until after the license was terminated, minimal owner involvement in demolition projects.                                                                                                                                          |              |                                          |
| <b>Management Approach:</b>                       | Owner integrated numerous specialty contractors. Owner very engaged in project, minimized complex "turnkey" projects. For example, for the steam generator / pressurizer project the owner contracted with heavy-lift contractor, construction company, engineering company, marine architect (barge modifications) |              |                                          |
| <b>"Clean" concrete disposition</b>               | Concrete left on site after demolition                                                                                                                                                                                                                                                                              |              |                                          |
| <b>Other</b>                                      | Essentially direct access to waste disposal site via inland waterway to a waste disposal site. This is a unique circumstance in the U.S.                                                                                                                                                                            |              |                                          |
|                                                   | The ISFSI site was surveyed prior to ISFSI construction. Results of that survey are documented in PGE-1074, "Trojan Final Survey Report for the ISFSI Site" (Reference 4-4).                                                                                                                                        |              |                                          |
|                                                   | Environmental contamination not a substantial issue                                                                                                                                                                                                                                                                 |              |                                          |
|                                                   | There were substantial problems with dry fuel storage canisters (relatively early U.S. dry storage project).                                                                                                                                                                                                        |              |                                          |
|                                                   | The information presented here is believed to be reasonably accurate, sufficient enough for its intended use in discussing U.S. reactor experiences.                                                                                                                                                                |              |                                          |

## Report on Nuclear Decommissioning

**Table B.5 (continued)**  
**Trojan - Source of Cost Information**

The following were slides extracted from a PGE presentation to the OPUC on March 8, 2005 (labeled as draft)

### **Decommissioning Cost Estimate** **as of December 2004 (\$1997)**

| <u>Category</u>        | <u>Actual to Date</u> | <u>To Complete</u> | <u>TDF Update</u> |
|------------------------|-----------------------|--------------------|-------------------|
| DECON                  | 205.3                 | 6.4                | 211.7             |
| Non-Rad Decom          | 3.8                   | 36.4               | 40.2              |
| ISFSI Const./Fuel Load | 74.1                  | 7.9                | 82.0              |
| ISFSI Long Term Ops    | 7.0                   | 53.1               | 60.1              |
| Financing              | 0.0                   | 0.0                | 0.0               |
| Subtotal               | 290.2                 | 103.8              | 394.0             |
| Project Reserve        | 0.0                   | 35.7               | 35.7              |
| Total                  | 290.2                 | 139.5              | 429.7             |

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### **Decom. Cost Estimate Comparison** **(\$1997)**

| <u>Category</u>        | <u>TDF Update</u><br><u>UE-102</u> | <u>TDF Update</u><br><u>Dec 99</u> | <u>TDF Update</u><br><u>Dec. 04</u> |
|------------------------|------------------------------------|------------------------------------|-------------------------------------|
| DECON                  | 236.1                              | 235.4                              | 211.7                               |
| Non-Rad. Decom.        | 53.7                               | 44.8                               | 40.2                                |
| ISFSI Const./Fuel Load | 62.9                               | 66.7                               | 82.0                                |
| ISFSI Long Term Ops    | 70.9                               | 67.0                               | 60.1                                |
| Financing              | 11.6                               | 8.7                                | 0.0                                 |
| Subtotal               | 435.2                              | 422.6                              | 397.8                               |
| Project Reserve        | 0.0                                | 7.1                                | 35.7                                |
| Total                  | 435.2                              | 429.7                              | 429.7                               |

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# Report on Nuclear Decommissioning

**Table B.6**  
**Yankee Rowe**

|                                                          |                                                                                                                                                                                                                                                                                                     |              |                                                                                                                                                             |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yankee Rowe</b>                                       |                                                                                                                                                                                                                                                                                                     |              |                                                                                                                                                             |
| Inflation Index ('03 - '08)                              | 1.18                                                                                                                                                                                                                                                                                                |              | CPI Services                                                                                                                                                |
| Reactor Type / Thermal Rating (MWt):                     | PWR                                                                                                                                                                                                                                                                                                 |              |                                                                                                                                                             |
| Thermal Rating                                           | 600                                                                                                                                                                                                                                                                                                 |              |                                                                                                                                                             |
| Location:                                                | Rowe, MA                                                                                                                                                                                                                                                                                            |              |                                                                                                                                                             |
| Operating License Issued:                                | Dec-63                                                                                                                                                                                                                                                                                              |              |                                                                                                                                                             |
| Permanent Cessation of Operations:                       | Oct-91                                                                                                                                                                                                                                                                                              |              |                                                                                                                                                             |
| Decommissioning Option Selected:                         | DECON                                                                                                                                                                                                                                                                                               |              |                                                                                                                                                             |
| Decommissioning Commenced:                               | Immediately upon cessation of operations                                                                                                                                                                                                                                                            |              |                                                                                                                                                             |
| License Termination Plan Submitted:                      | Yes                                                                                                                                                                                                                                                                                                 |              |                                                                                                                                                             |
| Date of License Termination:                             | 2007                                                                                                                                                                                                                                                                                                |              |                                                                                                                                                             |
|                                                          |                                                                                                                                                                                                                                                                                                     |              |                                                                                                                                                             |
|                                                          |                                                                                                                                                                                                                                                                                                     |              |                                                                                                                                                             |
|                                                          | <b>U.S. Dollars (thousands)</b>                                                                                                                                                                                                                                                                     |              | <b>Comments</b>                                                                                                                                             |
| <b>Cost Item</b>                                         | <b>('03)</b>                                                                                                                                                                                                                                                                                        | <b>('08)</b> |                                                                                                                                                             |
| Total                                                    | 636,303                                                                                                                                                                                                                                                                                             | 750,837      |                                                                                                                                                             |
| License Termination                                      | 506,783                                                                                                                                                                                                                                                                                             | 598,004      |                                                                                                                                                             |
| 1997 - 2002 Dismantlement and Decontamination (\$347.9M) | 385,665                                                                                                                                                                                                                                                                                             |              | Assume costs are in year 2000 dollars, escalated to 2003 dollars using CPI, Services                                                                        |
| 2003 and beyond License Termination                      | 121,118                                                                                                                                                                                                                                                                                             |              | This also likely included some "clean" demolition work. Final Status Survey included in license termination costs. Contingency allocated by remaining costs |
| Spent Fuel Management                                    | 129,220                                                                                                                                                                                                                                                                                             | 152,479      | Includes contingency, allocated by remaining costs.                                                                                                         |
| Site Restoration                                         | 300                                                                                                                                                                                                                                                                                                 | 354          | ISFSI. Includes contingency, allocated by remaining costs. Other site restoration costs were likely included in Dismantlement and Decontamination Costs     |
| <b>Cost per Megawatt (MWt)</b>                           |                                                                                                                                                                                                                                                                                                     |              |                                                                                                                                                             |
| Total                                                    | 1,061                                                                                                                                                                                                                                                                                               | 1,251        |                                                                                                                                                             |
| License Termination                                      | 845                                                                                                                                                                                                                                                                                                 | 997          |                                                                                                                                                             |
| Spent Fuel Management                                    | 215                                                                                                                                                                                                                                                                                                 | 254          |                                                                                                                                                             |
| Site Restoration                                         | 1                                                                                                                                                                                                                                                                                                   | 1            |                                                                                                                                                             |
|                                                          |                                                                                                                                                                                                                                                                                                     |              |                                                                                                                                                             |
|                                                          |                                                                                                                                                                                                                                                                                                     |              |                                                                                                                                                             |
| <b>Notes:</b>                                            |                                                                                                                                                                                                                                                                                                     |              |                                                                                                                                                             |
| <b>Source of Cost Information</b>                        | YNPS License Termination Plan, Revision 1 (November 2004). The "To-Go" costs were part of a FERC settlement.                                                                                                                                                                                        |              |                                                                                                                                                             |
| <b>Reactor Vessel Disposition</b>                        | Internals removed and segmented (GTCC material stored on site). Reactor vessel shipped in one-piece to Barnwell (via railway). There were problems in segmenting internals (contaminated other areas).                                                                                              |              |                                                                                                                                                             |
| <b>License Termination Criteria</b>                      | 25 mrem year NRC TEDE; 10 mrem year MADPH TEDE (did not reference the MADPH TEDE in the NRC LTP)                                                                                                                                                                                                    |              |                                                                                                                                                             |
| <b>Steam Generators / Pressurizer Disposition</b>        | One-piece removal and shipment to Barnwell.                                                                                                                                                                                                                                                         |              |                                                                                                                                                             |
| <b>Building Demolition</b>                               | Essentially all buildings demolished.                                                                                                                                                                                                                                                               |              |                                                                                                                                                             |
| <b>Management Approach:</b>                              | Combination of approaches, but best characterized by self-managed with assistance from Engineer - Construction contractors.                                                                                                                                                                         |              |                                                                                                                                                             |
| <b>"Clean" concrete disposition</b>                      | Clean concrete did remain on site for use as backfill. There was a negotiated protocol with the Massachusetts DEP for establishing what materials could be remain on site (phrase was "Beneficial Use Determination").                                                                              |              |                                                                                                                                                             |
| <b>Other</b>                                             | This reactor was the 1st reactor to be decommissioned using updated NRC requirements, including the use of a Preliminary Shutdown Decommissioning Activities Report, and a MARRSSIM based survey. Some activities were conducted under the operating license, sometimes referred to as 10 CFR 50.59 |              |                                                                                                                                                             |
|                                                          | At the start of decommissioning the EnergySolutions site was not available, and when available had a somewhat restrictive material acceptance criteria. As project progressed, EnergySolutions license was revised, and more material was transported to this site.                                 |              |                                                                                                                                                             |
|                                                          | There were many areas outside the confines of the plant buildings that were impacted by plant operations. This included long-term leaks and material spills.                                                                                                                                        |              |                                                                                                                                                             |
|                                                          | The information presented here is believed to be reasonably accurate, sufficient enough for its intended use in discussing U.S. reactor experiences.                                                                                                                                                |              |                                                                                                                                                             |

# Report on Nuclear Decommissioning

Table B.5 (continued)  
Yankee Rowe - Source of Cost Information

YNPS License Termination Plan

Revision 1

Table 7-1  
Actual and Projected Decommissioning Expenditures  
(\$ Millions)

| <u>Cost Categories</u>                                                                | <u>Total</u>    |
|---------------------------------------------------------------------------------------|-----------------|
| <u>1992 – 2002 Dismantlement and Decontamination [A]</u>                              | <u>\$ 347.9</u> |
| <u>2003 FERC Approved "To-go" Decommissioning Cost Estimate: 2003 – 2022</u>          |                 |
| <u>Cost Elements [B]:</u>                                                             |                 |
| (1) Dismantlement and Decontamination                                                 | \$ 97.1         |
| (2) Radioactive Waste Costs                                                           | \$ 20.0         |
| Subtotal Dismantlement and Decontamination and Waste (1+2)                            | \$ 117.1        |
| (3) Long Term SNF Storage*                                                            | \$ 129.2        |
| (4) Site Restoration*                                                                 | \$ 0.3          |
| (5) Final Status Survey (FSS)                                                         | \$ 4.0          |
| Subtotal SNF Storage, Site Restoration and FSS (3+4+5)                                | \$ 133.5        |
| (6) Contingency                                                                       | \$ 37.9         |
| <u>Total 2003 FERC Approved Decommissioning "To-go" Cost Estimate<br/>2003 – 2022</u> | <u>\$ 288.5</u> |
| <u>Total Decommissioning Cost Including Incurred and Estimated Cost</u>               | <u>\$ 636.4</u> |

[A] 1992 – 2002 are stated in actual/nominal year dollars.

[B] "To-go" 2003 cost estimate is stated in year 2003 dollars.

\* Included but not part of NRC required decommissioning activities.

## Report on Nuclear Decommissioning

**Table B.7**  
**Estimated Cost of Decommissioning (Established Prior to Actual Performance)**

The following was extracted from NRC NUREG-1628, Staff Responses to Frequently Asked Questions Concerning Decommissioning of Nuclear Power Reactor, June 2000 (date of publication is indicative that costs shown do not represent "actual" costs)

### **How much does it cost to decommission a nuclear power plant?**

The total cost of decommissioning depends on many factors, including the sequence and timing of the various stages of the program, location of the facility, radioactive waste burial costs, and plans for spent fuel storage. The minimum amounts that are required for reasonable assurance of funds for decommissioning are \$290 million for pressurized-water reactors and \$370 million for boiling-water reactors. These costs are in 1999 dollars and are adjusted annually, as further specified in the regulations. These are minimum amounts to show reasonable assurance, rather than estimates, of what it would cost to decommission a specific nuclear reactor.

Actual site-specific costs incurred and estimated costs of decommissioning give a better indication of what the process costs. The Fort St. Vrain nuclear plant, which was a 330-megawatt-electric (MWe) high-temperature gas-cooled reactor, ceased power operations in 1989 and underwent immediate decontamination and dismantlement. The decommissioning effort was completed in late 1996, and the license was terminated. The total cost of decommissioning was \$189 million.

The cost for decommissioning the Trojan nuclear plant (a 1130-MWe pressurized-water reactor) was estimated to be \$210 million in 1993 dollars, which did not include \$42 million for nonradioactive site remediation or \$110 million for independent spent fuel storage installation and related fuel management. The Trojan plant planned an immediate decontamination and decommissioning from shutdown in 1993 to license termination in 2002.

The estimated cost for decommissioning the Haddam Neck nuclear plant, a 619-MWe pressurized-water reactor, is \$344.4 million in 1996 dollars, not including \$82.3 million in spent fuel storage costs (for a total of \$426.7 million).

The estimated cost for decommissioning Maine Yankee, an 830-MWe pressurized-water reactor, was \$274.9 million in 1997 dollars. This did not include costs for spent fuel management (\$53.4 million) or for site restoration (\$49.2 million), for a total of \$377.6 million.

The estimated cost for decommissioning Big Rock Point, a 67-MWe boiling-water reactor, was \$290 million in 1997 dollars.

The estimated cost for decommissioning Rancho Seco, a 913-MWe pressurized-water reactor was \$441 million in 1995 dollars.

The estimated cost for decommissioning Yankee Rowe, a 175-MWe pressurized-water reactor was \$306.4 million in 1995 dollars.

Decommissioning costs vary based on plant size and design, local labor and radiological waste burial costs, and the specific process that is being used for decommissioning.

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# Report on Nuclear Decommissioning

## Table B.8 NRC Press Releases Related to Release of Site



No. 09-165

October 7, 2009

### NRC RELEASES RANCHO SECO NUCLEAR PLANT FOR UNCONDITIONAL USE

The Nuclear Regulatory Commission has approved the request of the Sacramento Municipal Utility District (SMUD) to release most of the Rancho Seco nuclear power plant site near Herald, Calif., for unrestricted public use.

The contamination level of the land, approximately 80 acres, falls below NRC regulatory requirements that allow a maximum radiation dose of 25 millirem per year from residual contamination. (The average person in the United States receives about 300 millirem a year from background, or natural, radiation.)

Rancho Seco's NRC licenses will still apply to a low-level radioactive waste storage building and a dry-cask storage facility for spent nuclear fuel. The total land remaining under license is about six acres. SMUD remains responsible for the security and protection of this land and the waste storage facilities, and is required to maintain \$100 million in liability insurance coverage until all radioactive material has been removed from the site.

The NRC issued SMUD an operating license for Rancho Seco in August 1974, and the plant began commercial operations in April 1975. It was shut down in June 1989. SMUD submitted its license termination plan in 2006, and the NRC approved the plan in 2007. Recent NRC surveys verified that cleanup met the 25 millirem requirement.

NRC's Safety Evaluation Report of SMUD's request to release the site is available in the agency's ADAMS online document library at <http://www.nrc.gov/reading-rm/adams/web-based.html> by entering ML092520046 in the search field.

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News releases are available through a free Internet subscription at the following Web address: <http://www.nrc.gov/public-involvement/listserver.html>. The NRC homepage at [www.nrc.gov](http://www.nrc.gov) also offers a SUBSCRIBE link. E-mail notifications are sent to subscribers when news releases are posted to NRC's Web site.



No. 05-135

October 3, 2005

### NRC RELEASES MAJORITY OF MAINE YANKEE ATOMIC POWER PLANT SITE FOR UNRESTRICTED PUBLIC USE

The Nuclear Regulatory Commission has amended the operating license of the Maine Yankee Atomic Power Co. to release the majority of land from the old Maine Yankee power plant site for unrestricted public use.

The land, approximately 167 acres, meets NRC regulatory requirements of a maximum radiation dose of 25 millirem per year, as well as the state of Maine's clean-up standards of 10 millirem per year from all pathways and 4 millirem per year from groundwater sources of drinking water. (The average person in the United States receives about 300 millirem from background radiation each year.) Release of this land for unrestricted use poses no threat to public health and safety.

Maine Yankee's amended license will still apply to the site's dry cask storage facility, where the spent nuclear fuel from the plant's 23 years of operation is stored, plus a small parcel of land adjacent to this facility that was used as a loading area for excavated soil awaiting off-site shipment and disposal during the decommissioning of the plant and will be used for future cask-handling operations. The total land remaining under the license is approximately 12 acres. Maine Yankee remains responsible for the security and protection of this land and the dry cask storage facility, and is required to maintain a radiation monitoring program at the site.

Maine Yankee received an operating license on June 29, 1973. The plant ceased production on December 9, 1996, and the company informed the NRC in August 1997 that it intended to decommission the plant. Decommissioning work began in February 2003 and was completed in June 2005. Transfer of the spent fuel from the spent fuel pool to the dry cask storage facility was completed in February 2004.

The NRC's Safety Evaluation of Maine Yankee's license amendment request will be available in the agency's online documents database, ADAMS, at this address: <http://www.nrc.gov/reading-rm/adams/web-based.html>, using accession number ML052380284 in the search field. A notice of the license amendment will be published soon in the *Federal Register*.

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# Report on Nuclear Decommissioning

## Table B.8 (continued) NRC Press Releases Related to Release of Site

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**NRC NEWS**  
U.S. NUCLEAR REGULATORY COMMISSION  
Office of Public Affairs Telephone: 301/415-8200  
Washington, D.C. 20555-0001 E-mail: [opa@nrc.gov](mailto:opa@nrc.gov)  
Web Site: <http://www.nrc.gov/CPA>

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No. 05-082 May 23, 2005

**NRC ENDS LICENSE FOR TROJAN NUCLEAR POWER PLANT,  
RELEASES SITE FOR UNRESTRICTED USE**

The Nuclear Regulatory Commission has granted the request of Portland General Electric (PGE) to terminate its license for the Trojan nuclear power plant, which closed permanently in November 1992, and has released for unrestricted use the area where the plant formerly operated. The facility was located in Columbia County, Ore., about 42 miles north of Portland.

PGE's NRC license to store spent fuel removed from the reactor at an independent installation on another portion of the site will remain in effect and is not affected by this action.

Trojan began commercial operations in May 1976, with a net electrical output rating of 1130 megawatts electric. After PGE decided to cease operation of the reactor permanently, it conducted cleanup and decommissioning activities in accordance with its NRC-approved license termination plan from February 2001 to December 2004. The NRC offered the public an opportunity for a hearing on the plan, but no request was filed. Decommissioning activities included dismantlement of the reactor and decontamination. The reactor vessel, which represented most of the remaining radioactive material, except for the spent fuel, was removed from the site in 1999.

In December 2004, PGE submitted an application for termination of its license, indicating that it has completed radiological decommissioning and that final radiation surveys of the site show that it meets NRC criteria for decommissioning and release for unrestricted use.

NRC conducted a number of on-site inspections of the licensee's actions during the decommissioning process to verify that decommissioning and cleanup were being conducted as described in the license termination plan and to evaluate the quality of this activity. The agency also conducted independent measurements to verify the company's final radiation surveys. NRC has concluded that (1) dismantlement and decontamination activities were performed in accordance with the approved license termination plan; and (2) the final radiation surveys and associated documentation demonstrate the facility and site have met the criteria for decommissioning in Part 20 of the Commission's regulations. Therefore, the license has been terminated.

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**NRC NEWS**  
U.S. NUCLEAR REGULATORY COMMISSION  
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No. 07-158 November 26, 2007

**NRC RELEASES MOST OF HADDAM NECK NUCLEAR PLANT SITE  
FOR UNRESTRICTED PUBLIC USE**

The Nuclear Regulatory Commission has approved Connecticut Yankee Atomic Power Co.'s request to release a majority of the Haddam Neck nuclear power plant site near Meriden, Conn., for unrestricted public use.

Residual contamination on the land (approximately 210 acres) is below NRC regulatory requirements that allow a maximum radiation dose of 25 millirem per year. (The average person in the United States receives about 300 millirem from background radiation each year.) Release of this land for unrestricted use poses no threat to public health and safety.

Connecticut Yankee's license will still apply to the site's dry cask storage facility, where the spent nuclear fuel from the plant's 28 years of operation is stored, plus a parcel of land surrounding this facility. The total land remaining under the license is approximately 5 acres. Connecticut Yankee remains responsible for the security and protection of this land and the dry cask storage facility, and is required to maintain \$100 million in nuclear liability insurance coverage for the facility until the waste has been removed.

Haddam Neck began commercial operations Jan. 1, 1968, and ceased production Dec. 5, 1996. Connecticut Yankee initiated decommissioning shortly thereafter. Dismantlement and decommissioning were completed in July 2007. NRC surveys verified that cleanup met the 25 millirem per year requirement.

The NRC's Safety Evaluation Report of Connecticut Yankee's amendment request will be available in the agency's online documents database, ADAMS, at this address: <http://www.nrc.gov/reading-rm/adams/web-based.html>, using accession number ML073120350 in the search field.

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News releases are available through a free *listserve* subscription at the following Web address: <http://www.nrc.gov/public-involvement/listserve.html>. The NRC homepage at [www.nrc.gov](http://www.nrc.gov) also offers a SUBSCRIBE link. E-mail notifications are sent to subscribers when news releases are posted to NRC's Web site.

# Report on Nuclear Decommissioning

**Table B.8 (continued)**  
**NRC Press Releases Related to Release of Site**



No. 07-105

August 17, 2007

## **NRC RELEASES MOST OF YANKEE NUCLEAR POWER STATION SITE FOR UNRESTRICTED PUBLIC USE**

The Nuclear Regulatory Commission has released a majority of the Yankee Nuclear Power Station site near Rowe, Mass., for unrestricted public use. This action completes the decommissioning of the former nuclear power station portion of the site.

The land, approximately 30 acres, is below NRC safety requirements that allow a maximum radiation dose of 25 millirem per year from residual contamination. (The average person in the United States receives about 300 millirem from background radiation each year.) Release of this land for unrestricted use poses no threat to public health and safety.

Yankee's license still applies to the site's dry cask storage facility, where the spent nuclear fuel from the plant's 30 years of operation is safely stored, plus a small parcel of land surrounding this facility. The total land remaining under license is approximately five acres. The licensee, Yankee Atomic Electric Co., remains responsible for the security and protection of this land and the dry cask storage facility, and is required to maintain \$100 million in nuclear liability insurance coverage for the facility.

Yankee Nuclear Power Station began commercial operations in 1961, and ceased production Oct. 1, 1991. Yankee Atomic Electric Co. initiated decommissioning shortly thereafter. Dismantlement and decommissioning were completed in July 2007. NRC surveys verified that cleanup met the 25 millirem per year requirement.

The NRC's Safety Evaluation Report of Yankee's amendment request will be available in the agency's online documents database, ADAMS, at this address: <http://www.nrc.gov/reading-rm/adams/web-based.html>, using accession number ML071830515 in the search field.

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News releases are available through a free list serve subscription at the following Web address: <http://www.nrc.gov/public-involvement/jspserver.html>. The NRC homepage at [www.nrc.gov](http://www.nrc.gov) also offers a SUBSCRIBE link. E-mail notifications are sent to subscribers when news releases are posted to NRC's Web site.

# **Report on Nuclear Decommissioning**

## **Appendix C**

### **Work Papers**

**for the Comparison of 2008 San Onofre and  
Diablo Canyon Decommissioning Cost Estimates**

## Report on Nuclear Decommissioning

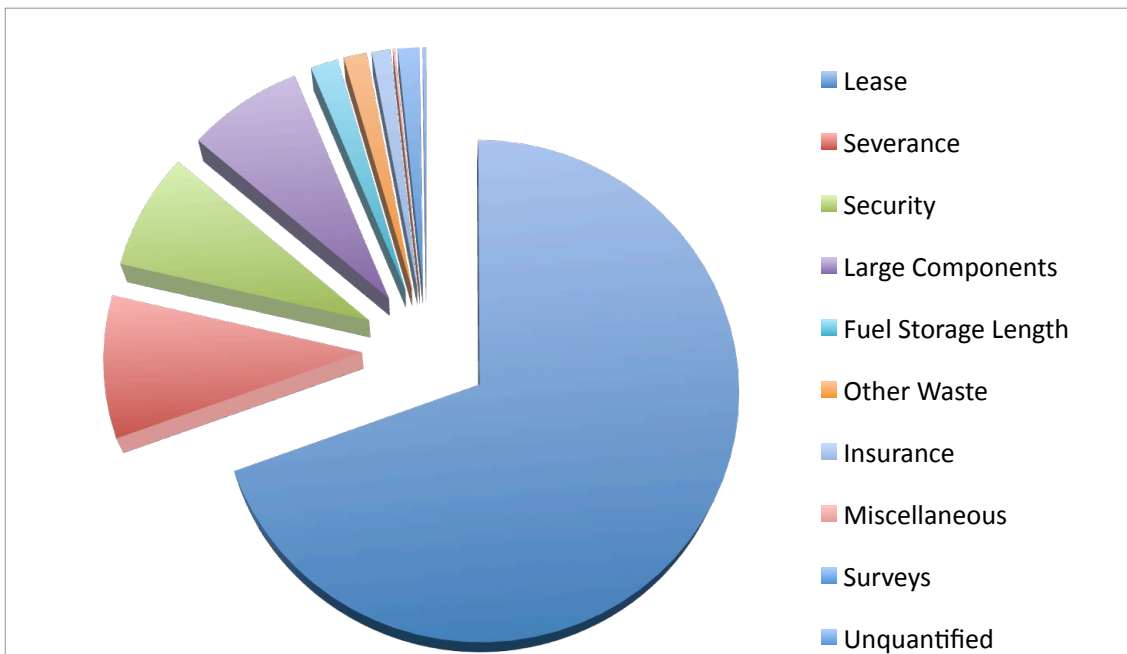
### Decommissioning Comparison (Thousand 2008 \$)

|                                             |                     |
|---------------------------------------------|---------------------|
| <b>San Onofre Units 2 and 3 Estimate</b>    | <b>\$ 3,658,805</b> |
| <b><i>Unit 1 Share of ISFSI O&amp;M</i></b> | <b>\$ 33,586</b>    |

|                                             |                     |
|---------------------------------------------|---------------------|
| <b>Diablo Canyon Units 1 and 2 Estimate</b> | <b>\$ 1,828,346</b> |
|---------------------------------------------|---------------------|

|                   |                     |
|-------------------|---------------------|
| <b>Difference</b> | <b>\$ 1,864,045</b> |
|-------------------|---------------------|

|                                   |                     |
|-----------------------------------|---------------------|
| <b><i>Lease</i></b>               | <b>\$ 1,334,845</b> |
| <b><i>Severance</i></b>           | <b>\$ 177,931</b>   |
| <b><i>Security</i></b>            | <b>\$ 146,518</b>   |
| <b><i>Large Components</i></b>    | <b>\$ 144,195</b>   |
| <b><i>Fuel Storage Length</i></b> | <b>\$ 34,135</b>    |
| <b><i>Other Waste</i></b>         | <b>\$ 28,637</b>    |
| <b><i>Insurance</i></b>           | <b>\$ 22,852</b>    |
| <b><i>Miscellaneous</i></b>       | <b>\$ (2,549)</b>   |
| <b><i>Surveys</i></b>             | <b>\$ (26,649)</b>  |
| <b><i>Unquantified</i></b>        | <b>\$ 4,130</b>     |



## Report on Nuclear Decommissioning

### Comparison of San Onofre and Diabie Canyon Decommissioning Estimates (all costs in Thousand 2008 \$)

|                                                       |           | Unit 2            | Unit 3              | Total               | Total w/ cont       | Notes                                                                                                                    |
|-------------------------------------------------------|-----------|-------------------|---------------------|---------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------|
| <b>San Onofre</b>                                     |           |                   |                     |                     |                     |                                                                                                                          |
| Sub-Total                                             | \$        | 1,438,349         | \$ 1,498,890        | \$ 2,937,239        |                     | Unit 2 S/D in 2/22, Unit 3 in 11/22                                                                                      |
| Contingency                                           | \$        | 352,558           | \$ 369,008          | \$ 721,566          |                     |                                                                                                                          |
| <b>Total</b>                                          | <b>\$</b> | <b>1,790,907</b>  | <b>\$ 1,867,898</b> | <b>\$ 3,658,805</b> |                     |                                                                                                                          |
| <b>Diablo Canyon</b>                                  |           |                   |                     |                     |                     |                                                                                                                          |
|                                                       |           | Unit 1            | Unit 2              |                     |                     |                                                                                                                          |
| Sub-Total                                             | \$        | 616,870           | \$ 845,719          | \$ 1,462,588        |                     | Unit 1 S/D in 11/24, unit 2 in 8/25                                                                                      |
| Contingency                                           | \$        | 154,278           | \$ 211,479          | \$ 365,758          |                     |                                                                                                                          |
| <b>Total</b>                                          | <b>\$</b> | <b>771,148</b>    | <b>\$ 1,057,198</b> | <b>\$ 1,828,346</b> |                     |                                                                                                                          |
| <b>Difference</b>                                     | <b>\$</b> | <b>1,019,759</b>  | <b>\$ 810,700</b>   | <b>\$ 1,830,459</b> |                     |                                                                                                                          |
| <b>Unit 1 Share</b>                                   | <b>\$</b> | <b>(14,090)</b>   | <b>\$ (12,779)</b>  | <b>\$ (26,869)</b>  | <b>\$ (33,586)</b>  | U1 share of ISFSI O&M                                                                                                    |
| <b>Lease</b>                                          | <b>\$</b> | <b>542,563</b>    | <b>\$ 525,313</b>   | <b>\$ 1,067,876</b> | <b>\$ 1,334,845</b> |                                                                                                                          |
| Clean Direct Cost in Estimate                         | \$        | 73,288            | \$ 134,022          | \$ 207,309          |                     |                                                                                                                          |
| Contaminated Direct Cost in Estimate                  | \$        | 85,880            | \$ 82,941           | \$ 168,820          |                     |                                                                                                                          |
| Total Waste Direct Cost in Estimate                   | \$        | 159,167           | \$ 216,962          | \$ 376,129          |                     |                                                                                                                          |
| Clean associated with lease requirements              |           | 73%               | 55%                 | 61%                 |                     | Proportion of Clean Concrete Total above DC Total                                                                        |
| Contaminated waste associated with lease requirements |           | 67%               | 67%                 | 67%                 |                     | Proportion of Contaminated Concrete Total above DC Total                                                                 |
| Waste not associated with lease requirements          |           | 30%               | 39%                 | 36%                 |                     |                                                                                                                          |
| Lease Direct Clean Cost                               | \$        | 53,640            | \$ 73,654           | \$ 127,294          |                     |                                                                                                                          |
| Lease Direct Contaminated Cost                        | \$        | 57,737            | \$ 55,386           | \$ 113,122          |                     |                                                                                                                          |
| TOTAL Lease Direct Cost                               | \$        | 111,376           | \$ 129,039          | \$ 240,416          |                     |                                                                                                                          |
| Additional Disposal Cost                              | \$        | 68,608            | \$ 86,862           | \$ 155,470          |                     | Disposal of material that absent the lease could have been left on site                                                  |
| Indirect costs of removing additional material        | \$        | 362,579           | \$ 309,411          | \$ 671,990          |                     | Removal costs not associated with change in scope                                                                        |
| <b>Severence</b>                                      | <b>\$</b> | <b>76,500</b>     | <b>\$ 65,845</b>    | <b>\$ 142,345</b>   | <b>\$ 177,931</b>   |                                                                                                                          |
| <b>Security</b>                                       | <b>\$</b> | <b>113,922</b>    | <b>\$ 3,292</b>     | <b>\$ 117,214</b>   | <b>\$ 146,518</b>   | DC values from Period Dependent Spreadsheet                                                                              |
| <b>Large Component Removal</b>                        | <b>\$</b> | <b>56,473</b>     | <b>\$ 58,883</b>    | <b>\$ 115,356</b>   | <b>\$ 144,195</b>   | S/G, PZR, RV, and RVI. Includes DC old S/G. Normalized DC contingency to 25%. Includes containment penetration for SONGS |
| <b>Other Waste</b>                                    | <b>\$</b> | <b>13,994</b>     | <b>\$ 8,916</b>     | <b>\$ 22,910</b>    | <b>\$ 28,637</b>    | Hazardous and on-site at shutdown and GTCC treatment (packed volume versus actual volume), DC GTCC costs from RPVO-U1    |
| <b>Insurance</b>                                      | <b>\$</b> | <b>8,814</b>      | <b>\$ 9,468</b>     | <b>\$ 18,282</b>    | <b>\$ 22,852</b>    | Asbestos Ins substantial contributor to difference                                                                       |
| <b>Fuel Storage Length</b>                            | <b>\$</b> | <b>15,154</b>     | <b>\$ 12,154</b>    | <b>\$ 27,308</b>    | <b>\$ 34,135</b>    | 2.75 added years for U2 and 2.5 added years for U3 (only non-security costs and non-insurance costs)                     |
| <b>Misc Fees</b>                                      | <b>\$</b> | <b>(5,432)</b>    | <b>\$ 3,393</b>     | <b>\$ (2,039)</b>   | <b>\$ (2,549)</b>   | NRC Fees, HP Supplies, Emergency Planning Fees                                                                           |
| <b>Survey Costs</b>                                   | <b>\$</b> | <b>(8,845)</b>    | <b>\$ (12,475)</b>  | <b>\$ (21,319)</b>  | <b>\$ (26,649)</b>  |                                                                                                                          |
| <b>Contingency on above items</b>                     |           | <b>199,763.40</b> | <b>165,502.30</b>   | <b>\$ 365,266</b>   |                     | Calculated at 25%                                                                                                        |
| <b>Sum of Differences</b>                             |           | <b>998,817.02</b> | <b>827,511.50</b>   | <b>\$ 1,826,329</b> | <b>\$ 1,826,329</b> |                                                                                                                          |

## Report on Nuclear Decommissioning

### Metrics

|                                    | SONGS |               | DC | Ratio       |      |
|------------------------------------|-------|---------------|----|-------------|------|
| Estimated Cost (Thousands 2008 \$) | \$    | 3,658,805     | \$ | 1,828,346   | 2.00 |
| LABOR                              |       |               |    |             |      |
| Craft Labor Hours                  |       | 4,442,944     |    | 2,599,059   | 1.71 |
| PM & Support Hours (non-security)  |       | 9,749,208     |    | 5,201,814   | 1.87 |
| Active Work Periods (years)        |       | 28.9          |    | 13.3        | 2.17 |
| PM&Support Hours/Craft Labor Hours |       | 2.19          |    | 2.00        | 1.10 |
| Labor FTE per year                 |       | 77            |    | 98          | 0.79 |
| Labor per Ton of Waste             |       | 3.21          |    | 5.02        | 0.64 |
| WASTE                              |       |               |    |             |      |
| Contaminated Waste (lbs)           |       | 181,482,738   |    | 59,873,939  | 3.03 |
| Clean Waste (lbs)                  |       | 2,584,140,031 |    | 974,760,273 | 2.65 |
| Dollars per pound of waste handled | \$    | 1.32          | \$ | 1.77        | 0.75 |
| Pounds waste per year              |       | 95,619,936    |    | 77,731,033  | 1.23 |
| ENERGY                             |       |               |    |             |      |
| Total Energy Usage (MW-hrs)        |       | 1,101,979.2   |    | 303,684.5   | 3.63 |
| Energy/pound of waste handled      |       | 398           |    | 294         | 1.36 |
| FUEL STORAGE                       |       |               |    |             |      |
| Wet Storage (years)                |       | 24.0          |    | 24.0        |      |
| Dry Storage (years)                |       | 37.9          |    | 30.6        |      |

## Report on Nuclear Decommissioning

### Waste Summary

#### Diablo Canyon Estimate

|                            | Unit 1 Value       | Units      | Unit 2 Value       | Units      | Notes | Combined             | Units      |
|----------------------------|--------------------|------------|--------------------|------------|-------|----------------------|------------|
| <b>Contaminated Wastes</b> |                    |            |                    |            |       |                      |            |
| Class A Waste              | 12,029,047         | lbs        | 12,657,732         | lbs        |       | 24,686,779           | lbs        |
| Included Concrete          | 1,858,838          | lbs        | 2,131,006          | lbs        |       | <b>3,989,844</b>     | <b>lbs</b> |
| Class B Waste              | 684,759            | lbs        | 686,747            | lbs        |       | 1,371,506            | lbs        |
| Class C Waste              | 69,650             | lbs        | 69,650             | lbs        |       | 139,300              | lbs        |
| GTCC Waste                 | 85,510             | lbs        | 85,510             | lbs        |       | 171,020              | lbs        |
| Processed off-site         | 15,636,010         | lbs        | 13,879,480         | lbs        |       | 29,515,490           | lbs        |
| <b>Total A/B/C Waste</b>   | <b>30,363,814</b>  | <b>lbs</b> | <b>29,510,125</b>  | <b>lbs</b> |       | <b>59,873,939</b>    | <b>lbs</b> |
| <b>Clean Wastes</b>        |                    |            |                    |            |       |                      |            |
| Metal                      | 95,983,842         | lbs        | 153,210,831        | lbs        |       | 249,194,673          | lbs        |
| Rubblized "Clean" Concrete | 182,221,650        | lbs        | 543,343,950        | lbs        | 2,3   | 725,565,600          | lbs        |
| <b>Total Clean Waste</b>   | <b>278,205,492</b> | <b>lbs</b> | <b>696,554,781</b> | <b>lbs</b> |       | <b>974,760,273</b>   | <b>lbs</b> |
| <b>DC Total Waste</b>      | <b>308,569,306</b> | <b>lbs</b> | <b>726,064,906</b> | <b>lbs</b> |       | <b>1,034,634,212</b> | <b>lbs</b> |

#### San Onofre Estimate

|                            | Unit 2 Value         | Units      | Unit 3 Value         | Units      | Notes |                      |            |
|----------------------------|----------------------|------------|----------------------|------------|-------|----------------------|------------|
| <b>Contaminated Wastes</b> |                      |            |                      |            |       |                      |            |
| Class A Waste              | 760,529              | cu ft      | 748,271              | cu ft      | 4     | 1,508,800            | cu ft      |
| Included Concrete          | 68,775,425           | lbs        | 67,565,042           | lbs        |       | <b>136,340,467</b>   | <b>lbs</b> |
| Class B Waste              | 2,708                | cu ft      | 2,708                | cu ft      | 4     | 5,416                | cu ft      |
| Class C Waste              | 476                  | cu ft      | 476                  | cu ft      | 4     | 952                  | cu ft      |
| GTCC Waste                 | 1,200                | cu ft      | 1,500                | cu ft      | 4     | 2,700                | cu ft      |
| <b>Total A/B/C Waste</b>   | <b>92,656,872</b>    | <b>lbs</b> | <b>88,825,865</b>    | <b>lbs</b> | 4     | <b>181,482,738</b>   | <b>lbs</b> |
| <b>Clean Wastes</b>        |                      |            |                      |            |       |                      |            |
| Metal                      | 99,237,542           | lbs        | 104,820,519          | lbs        |       | 204,058,061          | lbs        |
| Concrete                   | 932,709,360          | lbs        | 1,297,796,479        | lbs        |       | 2,230,505,839        | lbs        |
| <b>Total Clean Waste</b>   | <b>1,037,728,552</b> | <b>lbs</b> | <b>1,546,411,479</b> | <b>lbs</b> |       | <b>2,584,140,031</b> | <b>lbs</b> |
| <b>SONGS Total Waste</b>   | <b>1,130,385,425</b> | <b>lbs</b> | <b>1,635,237,345</b> | <b>lbs</b> |       | <b>2,765,622,769</b> | <b>lbs</b> |

## Report on Nuclear Decommissioning

### Schedule Comparison

#### Diablo Canyon Estimate

|                                                        | Unit 1<br>Weeks        | Unit 1 Craft<br>Man-Hours |                                                     | Unit 2<br>Weeks        | Unit 2 Craft<br>Man-Hours | Combined<br>Craft Man-<br>Hours |                 |
|--------------------------------------------------------|------------------------|---------------------------|-----------------------------------------------------|------------------------|---------------------------|---------------------------------|-----------------|
| Period 1a - Shutdown Through Transition                | 52                     | 22                        |                                                     |                        |                           | 22                              |                 |
| Period 1b - Decommissioning Preparations               | 26                     | 26,626                    | Period 1a - Shutdown Through Transition             | 52                     | 21                        | 26,647                          |                 |
| Period 2a - Large Component Removal                    | 83                     | 280,557                   | Period 1b - Decommissioning Preparations            | 26                     | 12,319                    | 292,876                         |                 |
| Period 2b - Site Decontamination                       | 100                    | 332,989                   | Period 2a - Large Component Removal                 | 81                     | 297,917                   | 630,906                         |                 |
| Period 2c - Wet Fuel Storage                           | 24                     | 29                        | Period 2b - Site Decontamination                    | 101                    | 365,696                   | 365,725                         |                 |
| Period 2d - Decommissioning Following Wet Fuel Storage | 416                    | 57,221                    | Period 2c - Wet Fuel Storage                        | 24                     | 36                        | 57,257                          |                 |
| Period 2e - License Termination                        | 39                     | 142,841                   | Period 2d - Decommissioning Following Wet Fuel Stor | 374                    | 53,865                    | 196,706                         |                 |
| Period 3a - Site Restoration Delay                     | -                      | -                         | Period 2e - License Termination                     | 39                     | 209,470                   | 209,470                         |                 |
|                                                        |                        |                           | Period 3a - Site Restoration Delay                  | -                      | -                         | -                               |                 |
| Period 3b - Site Restoration                           | 107                    | 162,590                   | Period 3b - Site Restoration                        | 107                    | 619,256                   | 781,846                         |                 |
| Period 3c - Fuel Storage Operations/Shipping           | 568                    | -                         | Period 3c - Fuel Storage Operations/Shipping        | 568                    | -                         | -                               |                 |
| Period 3d - GTCC Shipping                              | 2                      | -                         | Period 3d - GTCC Shipping                           | 2                      | -                         | -                               |                 |
| Period 3e - ISFSI Decontamination                      | 17                     | 15,356                    | Period 3e - ISFSI Decontamination                   | 17                     | 15,356                    | 30,712                          |                 |
| Period 3f - ISFSI Site Restoration                     | 9                      | 3,446                     | Period 3f - ISFSI Site Restoration                  | 9                      | 3,446                     | 6,892                           |                 |
| Total Schedule and Craft Man-Hours                     | 28 years               | 1,021,677                 |                                                     | 27 years               | 1,577,382                 | 2,599,059                       | 1,300 man-years |
| Diablo Canyon Active Work Periods                      | 346 Weeks<br>6.7 years | 934,333                   |                                                     | 346 Weeks<br>6.7 years | 1,507,695                 | 2,442,028<br>91.73 FTE/year     |                 |

#### San Onofre Estimate

|                                           | Unit 2<br>Weeks | Unit 2<br>Laborers | Unit 2 Craft<br>Man-Hours |                           | Unit 3<br>Weeks | Unit 3<br>Laborers | Unit 3 Craft<br>Man-Hours | Combined<br>Craft Man-<br>Hours |                  |
|-------------------------------------------|-----------------|--------------------|---------------------------|---------------------------|-----------------|--------------------|---------------------------|---------------------------------|------------------|
| WBS 0 Pre-Shutdown Preps                  | 104             | -                  | -                         | WBS 0 Pre-Shutdown Preps  | 104             | -                  | -                         | -                               |                  |
| WBS 1 Wet Storage/Preps                   | 104             | 25                 | 103,584                   | WBS 1 Wet Storage/Preps   | 104             | 25                 | 103,584                   | 207,168                         |                  |
| WBS 2 Wet Storage/RAD D&D                 | 522             | 71                 | 1,482,480                 | WBS 2 Wet Storage/RAD D&D | 522             | 77                 | 1,616,112                 | 3,098,592                       |                  |
| WBS 3 Dry Storage/RAD D&D                 | 152             | 55                 | 332,576                   | WBS 3 Dry Storage/RAD D&D | 152             | 85                 | 519,232                   | 851,808                         |                  |
| WBS 4 Dry Storage/Fuel                    | 741             | -                  | -                         | WBS 4 Dry Storage/Fuel    | 780             | -                  | -                         | -                               |                  |
| WBS 5 Site Restoration                    | 104             | 37                 | 152,256                   | WBS 5 Site Restoration    | 52              | 64                 | 133,120                   | 285,376                         |                  |
| <b>Total Schedule and Craft Man-Hours</b> | <b>33</b>       | <b>years</b>       | <b>2,070,896</b>          | <b>33</b>                 | <b>years</b>    | <b>2,372,048</b>   | <b>4,442,944</b>          | <b>2,221</b>                    | <b>man-years</b> |
| <b>SONGS Active Work Periods</b>          | <b>778</b>      | <b>Weeks</b>       | <b>1,967,312</b>          | <b>726</b>                | <b>Weeks</b>    | <b>2,268,464</b>   | <b>4,235,776</b>          | <b>73.22</b>                    | <b>FTE/year</b>  |
|                                           | <b>15.0</b>     | <b>years</b>       |                           | <b>14.0</b>               | <b>years</b>    |                    |                           |                                 |                  |

# Report on Nuclear Decommissioning

## Staffing Comparison

### Diablo Canyon Estimate

|                                                        | Unit 1<br>Period<br>Duration<br>(Weeks) | Unit 1 Staff<br>(Non-<br>Security)<br>FTE | Unit 1 Staff (Non-<br>Security)<br>Man-Years | Unit 1<br>Security<br>FTE | Unit 1<br>Security<br>Man-Years | Unit 1<br>Security Cost<br>(no cont) |                                              | Unit 2<br>Period<br>Duration<br>(Weeks) | Unit 2 Staff<br>(Non-<br>Security)<br>FTE | Combined<br>Staff (FTE) | Unit 2 Staff<br>(Non-<br>Security)<br>Man-Years | Unit 2<br>Security<br>FTE | Unit 2<br>Security Man-<br>Years | Unit 2<br>Security Cost<br>(no cont) | Combined<br>Security | Combined<br>Non-Security<br>Man-Years | Combined-<br>Security Man-<br>years | Combined<br>Security Cost<br>(no cont) |
|--------------------------------------------------------|-----------------------------------------|-------------------------------------------|----------------------------------------------|---------------------------|---------------------------------|--------------------------------------|----------------------------------------------|-----------------------------------------|-------------------------------------------|-------------------------|-------------------------------------------------|---------------------------|----------------------------------|--------------------------------------|----------------------|---------------------------------------|-------------------------------------|----------------------------------------|
| Period 1a - Shutdown Through Transition                | 52                                      | 203                                       | 204                                          | 6                         | 6                               | \$ 775                               | Period 1a - Shutdown Through Transition      | 52                                      | 166                                       | 203                     | 166                                             | 76                        | 76                               | #####                                | 6                    | 204                                   | 6                                   | 775                                    |
| Period 1b - Decommissioning Preparations               | 26                                      | 265                                       | 132                                          | 6                         | 3                               | \$ 385                               | Period 1b - Decommissioning Preparations     | 26                                      | 211                                       | 426                     | 107                                             | 76                        | 38                               | \$5,158                              | 82                   | 298                                   | 79                                  | \$ 10,616                              |
| Period 2a - Large Component Removal                    | 83                                      | 215                                       | 342                                          | 6                         | 9                               | \$1,151                              | Period 2a - Decommissioning Preparations     | 81                                      | 218                                       | 372                     | 339                                             | 63                        | 99                               | #####                                | 81                   | 449                                   | 47                                  | \$ 6,309                               |
| Period 2b - Site Decontamination                       | 100                                     | 155                                       | 298                                          | 6                         | 11                              | \$1,394                              | Period 2a - Large Component Removal          | 100                                     | 209                                       | 372                     | 407                                             | 63                        | 123                              | #####                                | 69                   | 636                                   | 109                                 | \$ 14,776                              |
| Period 2c - Wet Fuel Storage                           | 24                                      | 97                                        | 45                                           | 3                         | 1                               | \$ 182                               | Period 2b - Site Decontamination             | 101                                     | 209                                       | 306                     | 407                                             | 63                        | 123                              | #####                                | 66                   | 451                                   | 125                                 | \$ 16,939                              |
| Period 2d - Decommissioning Following Wet Fuel Storage | 416                                     | 7                                         | 57                                           | -                         | -                               | \$ -                                 | Period 2c - Wet Fuel Storage                 | 24                                      | 146                                       | 153                     | 67                                              | 33                        | 15                               | \$2,143                              | 33                   | 124                                   | 15                                  | \$ 2,143                               |
| Period 2e - License Termination                        | 39                                      | 48                                        | 36                                           | 3                         | 2                               | \$ 298                               | Period 2d - Decommissioning Following Wet Fu | 374                                     | 40                                        | 88                      | 284                                             | 53                        | 383                              | #####                                | 36                   | 320                                   | 385                                 | \$ 52,621                              |
| Period 3a - Site Restoration Delay                     | -                                       | -                                         | -                                            | -                         | -                               | \$ -                                 | Period 2e - License Termination              | 39                                      | 88                                        | 88                      | 66                                              | 33                        | 25                               | \$3,433                              | 53                   | 66                                    | 25                                  | \$ 3,433                               |
| Period 3b - Site Restoration                           | 107                                     | 26                                        | 52                                           | 1                         | 3                               | \$ 338                               | Period 3a - Site Restoration Delay           | -                                       | -                                         | 26                      | -                                               | -                         | \$ -                             | -                                    | -                    | -                                     | \$ -                                |                                        |
| Period 3c - Fuel Storage Operations/Shipping           | 568                                     | 3                                         | 37                                           | 14                        | 147                             | #####                                | Period 3b - Site Restoration                 | 107                                     | 61                                        | 65                      | 126                                             | 33                        | 67                               | \$9,337                              | 34                   | 178                                   | 69                                  | \$ 9,675                               |
| Period 3d - GTCC Shipping                              | 2                                       | 3                                         | 0                                            | 14                        | 1                               | \$ 73                                | Period 3c - Fuel Storage Operations/Shipping | 568                                     | 3                                         | 7                       | 37                                              | 14                        | 147                              | #####                                | 27                   | 74                                    | 295                                 | \$ 41,703                              |
| Period 3e - ISFSI Decontamination                      | 17                                      | 3                                         | 1                                            | 4                         | 1                               | \$ 172                               | Period 3d - GTCC Shipping                    | 2                                       | 3                                         | 6                       | 0                                               | 14                        | 1                                | \$ 73                                | 27                   | 0                                     | 1                                   | \$ 147                                 |
| Period 3f - ISFSI Site Restoration                     | 9                                       | 2                                         | 0                                            | 4                         | 1                               | \$ 86                                | Period 3e - ISFSI Decontamination            | 17                                      | 3                                         | 5                       | 1                                               | 4                         | 1                                | \$ 172                               | 7                    | 2                                     | 2                                   | \$ 343                                 |
|                                                        |                                         |                                           |                                              |                           |                                 |                                      | Period 3f - ISFSI Site Restoration           | 9                                       | 2                                         | 2                       | 0                                               | 4                         | 1                                | \$ 86                                | 7                    | 1                                     | 1                                   | \$ 173                                 |
| Total Staffing and Security Man-Years                  | 28                                      |                                           | #####                                        |                           | 184                             | #####                                |                                              | 27                                      |                                           | #####                   | #                                               |                           | 975                              | #####                                |                      | 2,601                                 | 1,154                               | #####                                  |

### San Onofre Estimate

|                                              | Unit 2<br>Period<br>Duration<br>(Weeks) | Unit 2 Staff<br>(Non-<br>Security)<br>FTE | Unit 2 Staff (Non-<br>Security)<br>Man-Years | Unit 2<br>Security<br>FTE | Unit 2<br>Security<br>Man-Years |                           | Unit 3<br>Period<br>Duration<br>(Weeks) | Unit 3 Staff<br>(Non-<br>Security)<br>FTE | Combined<br>Staff (FTE) | Unit 3 Staff<br>(Non-<br>Security)<br>Man-Years | Unit 3<br>Security<br>FTE | Unit 3<br>Security Man-<br>Years | Combined<br>Security | Combined<br>Non-Security<br>Man-Years | Combined-<br>Security Man-<br>years |
|----------------------------------------------|-----------------------------------------|-------------------------------------------|----------------------------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------------------|-------------------------------------------|-------------------------|-------------------------------------------------|---------------------------|----------------------------------|----------------------|---------------------------------------|-------------------------------------|
| WBS 0 Pre-Shutdown Preps                     | 104                                     | 12                                        | 24                                           | -                         | -                               | WBS 0 Pre-Shutdown Preps  | 104                                     | 4                                         | 16                      | 8                                               | -                         | -                                | -                    | 8                                     | -                                   |
| WBS 1 Wet Storage/Preps                      | 104                                     | 301                                       | 602                                          | 68                        | 136.00                          | WBS 1 Wet Storage/Preps   | 104                                     | 266                                       | 567                     | 532                                             | 68                        | 136                              | 136                  | 668                                   | 272                                 |
| WBS 2 Wet Storage/RAD D&D                    | 522                                     | 238                                       | 2,389                                        | 68                        | 682.62                          | WBS 2 Wet Storage/RAD D&D | 522                                     | 238                                       | 476                     | 2,389                                           | 68                        | 683                              | 136                  | 3,072                                 | 1,365                               |
| WBS 3 Dry Storage/RAD D&D                    | 152                                     | 94                                        | 274                                          | 31                        | 91.78                           | WBS 3 Dry Storage/RAD D&D | 152                                     | 94                                        | 187                     | 274                                             | 31                        | 92                               | 63                   | 365                                   | 184                                 |
| WBS 4 Dry Storage/Fuel                       | 741                                     | 18                                        | 251                                          | 31                        | 447.45                          | WBS 4 Dry Storage/Fuel    | 780                                     | 18                                        | 35                      | 264                                             | 31                        | 471                              | 63                   | 711                                   | 918                                 |
| WBS 5 Site Restoration                       | 104                                     | 37                                        | 74                                           | -                         | -                               | WBS 5 Site Restoration    | 52                                      | 50                                        | 87                      | 50                                              | -                         | -                                | -                    | 50                                    | -                                   |
| <b>Total Staffing and Security Man-Years</b> | <b>33</b>                               |                                           | <b>3,614</b>                                 |                           | <b>1,358</b>                    |                           | <b>33</b>                               |                                           | <b>3,517</b>            |                                                 | <b>1,381</b>              |                                  | <b>4,875</b>         | <b>2,739</b>                          |                                     |

## Report on Nuclear Decommissioning

### Energy Comparion

#### Diablo Canyon Estimate (2008 \$)

|                                                        | Unit 1<br>Weeks | Energy Load<br>(MW) | MW-Hrs         |                                                        | Unit 2<br>Weeks | Energy Load<br>(MW) | MW-Hrs         |                             |
|--------------------------------------------------------|-----------------|---------------------|----------------|--------------------------------------------------------|-----------------|---------------------|----------------|-----------------------------|
| Period 1a - Shutdown Through Transition                | 52              | 2.20                | 19,272         | Period 1a - Shutdown Through Transition                | 52              | 2.2                 | 19,272         |                             |
| Period 1b - Decommissioning Preparations               | 26              | 4.40                | 19,114         | Period 1b - Decommissioning Preparations               | 26              | 4.4                 | 19,430         |                             |
| Period 2a - Large Component Removal                    | 83              | 2.09                | 29,043         | Period 2a - Large Component Removal                    | 81              | 2.09                | 28,441         |                             |
| Period 2b - Site Decontamination                       | 100             | 1.65                | 27,760         | Period 2b - Site Decontamination                       | 101             | 1.65                | 28,116         |                             |
| Period 2c - Wet Fuel Storage                           | 24              | 0.88                | 3,548          | Period 2c - Wet Fuel Storage                           | 24              | 0.88                | 3,548          |                             |
| Period 2d - Decommissioning Following Wet Fuel Storage | 416             | 0.42                | 29,243         | Period 2d - Decommissioning Following Wet Fuel Storage | 374             | 0.44                | 27,646         |                             |
| Period 2e - License Termination                        | 39              | 0.44                | 2,904          | Period 2e - License Termination                        | 39              | 0.44                | 2,904          |                             |
| Period 3a - Site Restoration Delay                     | -               | -                   | -              | Period 3a - Site Restoration Delay                     | -               | -                   | -              |                             |
| Period 3b - Site Restoration                           | 107             | 0.22                | 3,949          | Period 3b - Site Restoration                           | 107             | 2.2                 | 39,494         |                             |
| Period 3c - Fuel Storage Operations/Shipping           | 568             | -                   | -              | Period 3c - Fuel Storage Operations/Shipping           | 568             | -                   | -              |                             |
| Period 3d - GTCC Shipping                              | 2               | -                   | -              | Period 3d - GTCC Shipping                              | 2               | -                   | -              |                             |
| Period 3e - ISFSI Decontamination                      | 17              | -                   | -              | Period 3e - ISFSI Decontamination                      | 17              | -                   | -              |                             |
| Period 3f - ISFSI Site Restoration                     | 9               | -                   | -              | Period 3f - ISFSI Site Restoration                     | 9               | -                   | -              |                             |
| <b>Total Schedule and Energy Usage</b>                 | <b>28</b>       | <b>years</b>        | <b>134,833</b> |                                                        | <b>27</b>       | <b>years</b>        | <b>168,852</b> | <b>303,684 Total MW-Hrs</b> |

#### San Onofre Estimate (2008 \$)

|                                        | Unit 2<br>Weeks | Energy Load<br>(MW) | MW-Hrs         |                           | Unit 3<br>Weeks | Energy Load<br>(MW) | MW-Hrs         |                               |
|----------------------------------------|-----------------|---------------------|----------------|---------------------------|-----------------|---------------------|----------------|-------------------------------|
| WBS 0 Pre-Shutdown Preps               | 104             | -                   | -              | WBS 0 Pre-Shutdown Preps  | 104             | -                   | -              |                               |
| WBS 1 Wet Storage/Preps                | 104             | 4.00                | 69,888         | WBS 1 Wet Storage/Preps   | 104             | 4.00                | 69,888         |                               |
| WBS 2 Wet Storage/RAD D&D              | 522             | 4.00                | 350,784        | WBS 2 Wet Storage/RAD D&D | 522             | 4.00                | 350,784        |                               |
| WBS 3 Dry Storage/RAD D&D              | 152             | 4.00                | 102,144        | WBS 3 Dry Storage/RAD D&D | 152             | 4.00                | 102,144        |                               |
| WBS 4 Dry Storage/Fuel                 | 741             | 0.20                | 24,898         | WBS 4 Dry Storage/Fuel    | 780             | 0.20                | 26,208         |                               |
| WBS 5 Site Restoration                 | 104             | 0.20                | 3,494          | WBS 5 Site Restoration    | 52              | 0.20                | 1,747          |                               |
| <b>Total Schedule and Energy Usage</b> | <b>33</b>       | <b>years</b>        | <b>551,208</b> |                           | <b>33</b>       | <b>years</b>        | <b>550,771</b> | <b>1,101,979 Total MW-Hrs</b> |

# Report on Nuclear Decommissioning

## Concrete Volumes of Selected Buildings

Assumed average scabbling depth 0.5 inch

### Diablo Canyon Estimate

|                   | Unit 1 Value | Units | Unit 2 Value | Units | Combined<br>(cu yd) | Notes                              | Unit 1<br>Contaminated<br>(cu yd) | Unit 2<br>Contaminated<br>(cu yd) |
|-------------------|--------------|-------|--------------|-------|---------------------|------------------------------------|-----------------------------------|-----------------------------------|
| Reactor Building  | 19,843       | cu yd | 19,860       | cu yd | 39,703              |                                    | 428                               | 428                               |
| Fuel Building     | 8,062        | cu yd | 8,062        | cu yd | 16,124              |                                    | 19                                | 19                                |
| Turbine Building  | 14,356       | cu yd | 19,889       | cu yd | 34,245              | Includes pedestal                  |                                   |                                   |
| Aux Building      |              |       | 24,659       | cu yd | 24,659              |                                    |                                   | 50                                |
| Intake Structure  |              |       | 20,186       | cu yd | 20,186              |                                    |                                   |                                   |
| Radwaste Building |              |       | 7,824        | cu yd | 7,824               |                                    |                                   | 5                                 |
| Penetration Area  | 3,507        | cu yd | 3,508        | cu yd | 7,015               |                                    | 12                                | 12                                |
|                   |              |       |              |       | <b>149,756</b>      | <b>cu yd above (-3), including</b> | <b>973</b>                        | <b>cu yds contaminated</b>        |

### San Onofre Estimate

|                          | Unit 2 Value | Units | Unit 3 Value | Units | Combined<br>Above Grade<br>(cu yd) | Notes                               |               |                            |
|--------------------------|--------------|-------|--------------|-------|------------------------------------|-------------------------------------|---------------|----------------------------|
| Containment              | 1,287        | cu yd | 1,287        | cu yd | 42,658                             | 2                                   |               |                            |
| Fuel Building            | 499          | cu yd | 499          | cu yd | 26,960                             |                                     |               |                            |
| Turbine Building         | 1,571        | cu yd | 1,571        | cu yd | 12,498                             |                                     |               |                            |
| Safety Equip Building    | 402          | cu yd | 383          | cu yd | 18,343                             |                                     |               |                            |
| Intake Structure         | 1,668        | cu yd | 1,668        | cu yd | -                                  |                                     |               |                            |
| Radwaste Building        | 795          | cu yd | 795          | cu yd | 25,008                             |                                     |               |                            |
| Penetration Area         | 103          | cu yd | 103          | cu yd | 4,679                              |                                     |               |                            |
|                          |              |       |              |       | <b>130,146</b>                     | <b>cu yd above grade, including</b> | <b>27,225</b> | <b>cu yds contaminated</b> |
|                          |              |       |              |       | <b>210,874</b>                     | <b>cu yd below grade</b>            |               |                            |
| <b>Above Grade Clean</b> |              |       |              |       |                                    |                                     |               |                            |
| Containment              | 16,019       | cu yd | 16,019       | cu yd |                                    |                                     |               |                            |
| Fuel Building            | 12,908       | cu yd | 12,908       | cu yd |                                    |                                     |               |                            |
| Turbine Building         | 6,249        | cu yd | 6,249        | cu yd |                                    |                                     |               |                            |
| Safety Equip Building    | 4,111        | cu yd | 3,636        | cu yd |                                    |                                     |               |                            |
| Intake Structure         |              |       |              |       |                                    |                                     |               |                            |
| Radwaste Building        | 11,460       | cu yd | 11,460       | cu yd |                                    |                                     |               |                            |
| Penetration Area         | 951          | cu yd | 951          | cu yd |                                    |                                     |               |                            |
| <b>Contaminated</b>      |              |       |              |       |                                    |                                     |               |                            |
| Containment              | 5,310        | cu yd | 5,310        | cu yd |                                    |                                     |               |                            |
| Fuel Building            | 572          | cu yd | 572          | cu yd |                                    |                                     |               |                            |
| Turbine Building         |              |       |              |       |                                    |                                     |               |                            |
| Safety Equip Building    | 5,424        | cu yd | 5,172        | cu yd |                                    |                                     |               |                            |
| Intake Structure         |              |       |              |       |                                    |                                     |               |                            |
| Radwaste Building        | 1,044        | cu yd | 1,044        | cu yd |                                    |                                     |               |                            |
| Penetration Area         | 1,389        | cu yd | 1,389        | cu yd |                                    |                                     |               |                            |
| <b>Below Grade Clean</b> |              |       |              |       |                                    |                                     |               |                            |
| Containment              | 13,408       | cu yd | 13,408       | cu yd |                                    |                                     |               |                            |
| Fuel Building            |              |       |              |       |                                    |                                     |               |                            |
| Turbine Building         | 36,166       | cu yd | 36,166       | cu yd |                                    |                                     |               |                            |
| Safety Equip Building    | 1,313        | cu yd | 1,536        | cu yd |                                    |                                     |               |                            |
| Intake Structure         | 45,035       | cu yd | 45,035       | cu yd |                                    |                                     |               |                            |
| Radwaste Building        | 8,966        | cu yd | 8,966        | cu yd |                                    |                                     |               |                            |
| Penetration Area         | 438          | cu yd | 438          | cu yd |                                    |                                     |               |                            |

## Report on Nuclear Decommissioning

### Notes

- 1 Costs for LLRW are based on packaged volumes. Volumes displayed in the DC study include packing efficiencies. Volumes displayed in the SONGS study do not include packing efficiencies
- 2 Concrete volumes are expressed in cu yds in the study and have been converted to lbs using 150 lbs/cu ft
- 3 Concrete was assumed to be rubblelized and used as fill onsite
- 4 Waste volumes are only provided in cubic feet in the study, and are not packed volumes. Disposal costs consider packing efficiency in addition to these volumes

# Report on Nuclear Decommissioning

## Appendix D

### Data for Comparison of U.S. Nuclear Decommissioning Cost Estimates

The data used in the comparison of US nuclear decommissioning cost estimates was taken from the current decommissioning cost estimate available for each plant/site as follows:

1. Diablo Canyon – Decommissioning Cost Analysis for the Diablo Canyon Power Plant, TLG Services, Inc., March 2009, Document P01-1604-003, Rev. 0.

| Unit | Cash Flows | Waste Burial | Labor    |
|------|------------|--------------|----------|
| 1    | Table 3.1a | Table C1     | Table C1 |
| 2    | Table 3.1b | Table C2     | Table C2 |

2. Indian Point2 – Preliminary Decommissioning Cost Analysis for the Indian Point Energy Center, Unit 2, TLG Services, Inc., October 2008, Document E11-1583-003.

| Unit | Cash Flows | Waste Burial | Labor   |
|------|------------|--------------|---------|
| 2    | Table 3    | Table A      | Table A |

3. Palo Verde – 2007 Decommissioning Cost Study for the Palo Verde Nuclear Generating Station, TLG Services, Inc., March 2008, Document A04-1563-002, Rev. 0.

| Facility                                              | Cash Flows | Waste Burial | Labor     |
|-------------------------------------------------------|------------|--------------|-----------|
| Unit 1                                                | Table B-1  | Table C-1    | Table C-1 |
| Unit 2                                                | Table B-2  | Table C-2    | Table C-2 |
| Unit 3                                                | Table B-3  | Table C-3    | Table C-3 |
| Stored Steam Generators & Storage Facility            | Table B-4  | Table G      | Table G   |
| Water Reclamation Facility                            | Table B-5  | Table H      | Table H   |
| Water Reclamation Supply System Pipeline & Structures | Table B-6  | Table I      | Table I   |
| Evaporation Ponds                                     | Table B-7  | Table J      | Table J   |
| Make-up Water Reservoirs                              | Table B-8  | Table K      | Table K   |
| Decon, ISFSI                                          | Table B-9  | Table L      | Table L   |
| Stored Reactor Closure Heads & Storage Facility       | Table B-10 | Table M      | Table M   |

4. San Onofre – San Onofre Nuclear Generating Station Units 2 and 3 (SONGS 2/3) Decommissioning Cost Estimate, ABZ, Inc., February 2009. Separate estimates for Unit 2 and Unit 3 combined into one report.

| Unit | Cash Flows    | Waste Burial   | Craft Labor    | Utility/Contractor Labor |
|------|---------------|----------------|----------------|--------------------------|
| 2    | App B, Page 1 | App B, Page 11 | App G, page 25 | Decas Results - Staffing |
| 3    | App B, Page 1 | App B, Page 11 | App G, page 25 | Decas Results - Staffing |

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5. St. Lucie – Decommissioning Cost Analysis for the St. Lucie Nuclear Plant, Units 1 and 2, TLG Services, Inc., October 2005, Document F02-1512-002, Rev. 0.

| Unit | Cash Flows | Waste Burial | Labor     |
|------|------------|--------------|-----------|
| 1    | Table 3.1  | Table C-1    | Table C-1 |
| 2    | Table 3.2  | Table C-2    | Table C-2 |

6. STP – Decommissioning Cost Analysis for the South Texas Project Electric Generating Station, TLG Services, Inc., March 2008, S30-1564-002, Rev. 0.

| Unit | Cash Flows | Waste Burial | Labor     |
|------|------------|--------------|-----------|
| 1    | Table 3.1  | Table C-1    | Table C-1 |
| 2    | Table 3.2  | Table C-2    | Table C-2 |

7. Vogtle – Decommissioning Cost Study for the Vogtle Electric Generating Plant, TLG Service, Inc., December 2009, Document S18-1615-003, Rev. 0.

| Unit | Cash Flows | Waste Burial | Labor     |
|------|------------|--------------|-----------|
| 1    | Table 3.1a | Table C-1    | Table C-1 |
| 2    | Table 3.1b | Table C-2    | Table C-2 |

### Consolidation of cash flow information

Consolidated cash flow information for each site was developed by combining the separate cash flows for each unit and in the case of PV, additional facilities were included, and then the total converted into 2008 dollars using an annual inflation rate of 3 percent. The site totals for IP 2 and PV 1, 2&3 were adjusted as describe in section 5 to produce a “two unit site” equivalent cash flow.

The “two unit site” cash flows were then combined into parallel cash flows where “year one” corresponded to the final shutdown of the second unit at each site (the year of shutdown for IP 2). The resulting cash flows for each site used in section 5 are listed in Table D.1.

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**Table D.1**  
**Site cash flows organized by year major decommissioning begins**  
**(Thousand 2008 dollars)**

| Year  | DC        | IP 2 (x2)* | PV (x2/3) | St. Lucie | SONGS 2&3 | STP       | Vogtle    |
|-------|-----------|------------|-----------|-----------|-----------|-----------|-----------|
| -7    |           | *7,577     |           |           |           |           |           |
| -6    |           | 7,556      |           | 39,310    |           |           |           |
| -5    |           | 7,556      | 218       | 54,613    |           | 43,028    |           |
| -4    |           | 7,556      | 373       | 19,223    |           | 8,179     |           |
| -3    |           | 7,577      | 373       | 19,223    |           | 8,219     |           |
| -2    |           | 7,556      | 2,031     | 19,275    |           | 8,179     |           |
| -1    |           | 7,556      | 3,210     | 16,275    | 2,789     | 8,179     | 76,217    |
| 0     | 11,783    | 7,556      | 20,283    | 10,402    | 3,835     | 33,923    | 98,397    |
| 1     | 105,482   | 51,282     | 140,923   | 48,893    | 152,831   | 95,961    | 166,448   |
| 2     | 223,490   | 116,139    | 175,070   | 128,632   | 273,256   | 196,494   | 151,018   |
| 3     | 286,439   | 352,128    | 218,298   | 171,004   | 240,804   | 229,475   | 174,167   |
| 4     | 211,100   | 155,122    | 171,145   | 177,964   | 223,746   | 203,222   | 118,796   |
| 5     | 159,258   | 54,893     | 165,950   | 109,754   | 223,746   | 154,500   | 87,958    |
| 6     | 85,336    | 52,590     | 132,362   | 102,343   | 223,746   | 128,682   | 72,971    |
| 7     | 37,469    | 52,590     | 91,685    | 67,891    | 223,746   | 80,136    | 60,389    |
| 8     | 40,580    | 52,590     | 65,496    | 51,364    | 223,746   | 59,144    | 54,792    |
| 9     | 40,469    | 53,080     | 57,729    | 46,396    | 223,746   | 67,251    | 54,643    |
| 10    | 40,469    | 54,559     | 54,891    | 5,307     | 223,746   | 70,222    | 21,109    |
| 11    | 40,469    |            | 51,358    | 5,293     | 223,746   | 6,728     | 5,684     |
| 12    | 40,580    |            | 58,612    | 5,293     | 223,746   | 5,486     | 5,700     |
| 13    | 56,384    |            |           | 5,293     | 184,346   | 5,501     | 5,684     |
| 14    | 96,324    |            |           | 5,307     | 158,104   | 5,486     | 5,684     |
| 15    | 98,732    |            |           | 5,293     | 157,848   | 5,486     | 5,684     |
| 16    | 99,446    |            |           | 5,293     | 75,526    | 5,486     | 5,700     |
| 17    | 17,043    |            |           | 5,293     | 18,526    | 5,501     | 5,684     |
| 18    | 10,219    |            |           | 33,361    | 18,526    | 5,486     | 32,100    |
| 19    | 10,219    |            |           | 9,508     | 18,526    | 5,486     | 4,634     |
| 20    | 10,247    |            |           |           | 18,526    | 5,486     |           |
| 21    | 10,219    |            |           |           | 18,526    | 5,501     |           |
| 22    | 10,219    |            |           |           | 18,526    | 5,486     |           |
| 23    | 10,219    |            |           |           | 18,526    | 5,486     |           |
| 24    | 10,247    |            |           |           | 18,526    | 5,486     |           |
| 25    | 10,219    |            |           |           | 18,526    | 5,501     |           |
| 26    | 10,219    |            |           |           | 18,526    | 5,486     |           |
| 27    | 32,547    |            |           |           | 18,526    | 42,631    |           |
| 28    | 9,907     |            |           |           | 18,526    |           |           |
| 29    |           |            |           |           | 18,526    |           |           |
| 30    |           |            |           |           | 24,586    |           |           |
| 31    |           |            |           |           | 81,196    |           |           |
| 32    |           |            |           |           | 49,121    |           |           |
| 33    |           |            |           |           |           |           |           |
| Total | 1,825,334 | 1,063,018  | 1,410,008 | 1,167,803 | 3,658,794 | 1,526,502 | 1,213,461 |

\*Indian Point-2 is mothballed for SAFSTOR 50 years before major decommissioning begins.

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### Waste Burial Volumes

The waste burial volumes used in section 5, extracted from the sources indicated above are listed in Table D.2.

**Table D.2**

### LLRW Class A Volume for Direct Burial and Processing/Conditioning

(Cu. Ft.)

|           | DC      | IP 2      | PV        | St. Lucie | SONGS 2&3 | STP     | Vogtle  |
|-----------|---------|-----------|-----------|-----------|-----------|---------|---------|
| Burial    | 283,869 | 1,240,332 | 378,883   | 236,278   | 1,508,800 | 289,984 | 209,238 |
| processed | 761,125 | 762,124   | 1,104,569 | 263,274   |           | 765,191 | 676,803 |

### Staffing

The craft and utility/contractor staffing values used in section 5, extracted from the sources indicated above, are listed in Table D.3.

**Table D.3**

### Craft and Utility/Contractor Staffing During Decommissioning

(man-hours)

|                         | DC        | IP 2       | PV        | St. Lucie | SONGS 2&3  | STP       | Vogtle    |
|-------------------------|-----------|------------|-----------|-----------|------------|-----------|-----------|
| Craft                   | 2,599,059 | 2,037,670  | 4,029,048 | 2,162,311 | 4,493,658  | 3,308,042 | 3,291,854 |
| Utility /<br>contractor | 8,492,015 | 11,685,141 | 6,474,618 | 7,209,341 | 20,553,645 | 8,281,598 | 7,393,478 |

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### Appendix E

#### Common Format

The Panel offers the following table as a suggested format for the Common Summary Format. The Owners are encouraged to improve upon this.

|                                                                                             | DCPP | SONGS 2&3 |
|---------------------------------------------------------------------------------------------|------|-----------|
| <b>Assumptions</b>                                                                          |      |           |
| DOE performance (common)                                                                    |      |           |
| State severance requirements (common)                                                       |      |           |
| State site restoration requirements (common)                                                |      |           |
| Alternatives and pricing for LLRW burial (common)                                           |      |           |
| Extent of site and building contamination                                                   |      |           |
| LLRW and hazardous waste on site at beginning of decommissioning including large components |      |           |
| <b>Results</b>                                                                              |      |           |
| Craft and non-craft labor hours, total, and by period                                       |      |           |
| Security labor hours, total and by period (non-safeguards)                                  |      |           |
| Average craft, non-craft and security labor rates                                           |      |           |
| LLRW handled, and removed from site                                                         |      |           |
| Clean waste handled, and all waste removed from site                                        |      |           |
| Major "activity" and "period" costs that are comparable between the estimates               |      |           |

# **Report on Nuclear Decommissioning**

## **Appendix F**

### **References**

The following “outside” references were used in the preparation of this report. Information extracted from NDCTP proceedings is cited within the report text.

#### **U.S. Decommissioning Cost Estimates**

1. Decommissioning Cost Analysis for the St. Lucie Nuclear Plant, Units 1 and 2, Document F02-1512-002, Rev. 0, October 2005, TLG Services, Inc.
3. Decommissioning Cost Analysis for the South Texas Project Electric Generating Station, Document S30-1564-002, Rev. 0, March 2008, TLG Services, Inc.
4. Preliminary Decommissioning Cost Analysis for the Indian Point Energy Center, Unit 2, Document E11-1583-003, October 2008, TLG Services, Inc. (document is an enclosure to Entergy letter NL-08-144 to the U.S. NRC, dated October 27, 2008).
6. San Onofre Nuclear Generating Station Units 2 AND 3 (SONGS 2/3) Decommissioning Cost Estimate, February 2009 (Unit 2), ABZ, Incorporated.
7. San Onofre Nuclear Generating Station Units 2 AND 3 (SONGS 2/3) Decommissioning Cost Estimate, February 2009 (Unit 3), ABZ, Incorporated.
5. Decommissioning Cost Analysis for the Diablo Canyon Power Plant, Document P01-1604-003, Rev. 0, March 2009, TLG Services, Inc.
2. Decommissioning Cost Study for the Vogtle Electric Generating Plant, Document S18-1615-003, Rev. 0, December 2009, TLG Services, Inc.

#### **EPRI Reports**

1. Maine Yankee Decommissioning - Experience Report, Detailed Experiences 1997-2004, EPRI Report 1011734, Final Report, May 2005.
2. Connecticut Yankee Decommissioning – Experience Report, Detailed Experiences 1996-2006, EPRI Report 1013511, Final Report, November 2006.
3. Rancho Seco Nuclear Generating Station Decommissioning - Experience Report, Detailed Experiences 1989-2007, EPRI Report 1015121, Final Report, December 2007.

#### **License Termination Plans (extracts from the plans)**

1. Maine Yankee License Termination Plan, Rev. 3, October 2002.
2. Haddam Neck License Termination Plan, Rev. 2, August 2004.
3. Yankee Nuclear Plant Station License Termination Plan, Rev. 1, November 2004.
4. Rancho Seco License Termination Plan, Rev. 0, April 2006.

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5. PGE-1061, Trojan Nuclear Plant Decommissioning Plan and License Termination Plan (PGE-1078), Revision 16, March 2003.

### **NRC Published Materials (extracts from these materials) (excludes information cited from the Code of Federal Regulations)**

1. NRC NUREG – 1628, Staff Responses to Frequently Asked Questions Concerning Decommissioning of Nuclear Power Reactor, June 2000.
2. NRC NUREG – 1307, Rev. 14, Report on Waste Burial Charges Changes in Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities, October 2010.
3. NRC Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste, June 2009, Revision 2, at 15.

### **Other**

1. Trojan Decommissioning Status, PGE Presentation, OPUC Meeting March 8, 2005 (draft).
2. Paper presented at WM'06 Conference, February 26-March 2, 2006, Tucson AZ, TWO APPROACHES TO REACTOR DECOMMISSIONING: 10 CFR PART 50, LICENSE TERMINATION AND LICENSE AMENDMENT, LESSONS LEARNED FROM THE REGULATORY PERSPECTIVE, Bruce A. Watson, John T. Buckley, and Claudia M. Craig, US Nuclear Regulatory Commission, Office of Nuclear Materials Safety and Safeguards, Decommissioning Directorate (T7E18) Washington, D.C. 20555.
3. Bureau of Labor Statistics Consumer Price Index - All Urban Consumers, CUUR0000SAS.
4. EPA discussion on tritium at <http://www.epa.gov/radiation/radionuclides/tritium.html>, last updated on February 9, 2009.
5. "Cost Estimating Guide for Program and Project Management, US Department of Energy, DOE G-430.1-1X, April 2004 at 38.
6. United States of America, Federal Energy Regulatory Commission, Order Accepting for Filing and Suspending Proposed Revisions to Wholesale Power Contract and Establishing Hearing and Settlement Judge Procedures, Docket No. ER06-249-000, Issues January 21, 2006.

# **Report on Nuclear Decommissioning**

## **Appendix G**

### **Comments to January 25, 2011 Staff Briefing in order received**

#### **Eric Greene / CPUC, received Thursday, January 27, 2011**

Part of the CPUC's mission is to reduce costs to ratepayers in an efficient and effective manner.

#### **CPUC Comment 1:**

You indicated that a large part of the SONGS 2&3 decommissioning expenditures are related to its existing lease with the Navy. Perhaps in your recommendations you could include that SCE should make every attempt possible to renegotiate the lease or inform the Navy that the existing lease, and the need to remove everything 3-feet below grade level results in additional \$ millions. Perhaps SCE could do a cost-benefit analysis to show that the costs exceed the benefits of having to remove everything, both on-shore and offshore. The CPUC would certainly be agreeable to assist SCE in their discussions with the Navy in an attempt to reduce the high decommissioning costs for SONGS 2&3.

#### **Response:**

Section 4 of the Report, together with Appendix C, provide the Panel's estimated cost for complying with the Navy Lease based on the 2008 study. The Report also addresses tritium contamination in Section 6. Additional discussion regarding renegotiation of the Navy lease is included in the response to TURN Comment 1.

#### **CPUC Comment 2:**

You also mentioned that DCP and SONGS 2&3 are using a 12-year period for spent fuel storage in a wet pool before transfer to an ISFSI, rather than a 5-year period that is more the industry norm. PG&E and SCE base this on having longer fuel cycles or higher burnups. Perhaps you could recommend that PG&E and SCE revisit this 12-year spent fuel storage period to see if more effective spent fuel management or any other factors could reduce this storage period, which would help lower the decommissioning costs. We would certainly support, on a technical side, using higher fuel enrichment, higher burnup, or longer fuel cycles, if feasible, allowed, and practicable, which would lower the fuel costs. However, these all contribute to longer spent fuel storage and higher decommissioning costs, so there needs to be some balance.

#### **Response:**

The Report explains how fuel cooling times are determined, and evaluates the needed cooling times based on the casks selected by PG&E and SCE with the estimated fuel characteristics at shutdown. There is a trade off between actions that reduce fuel cooling times and actions that minimize fuel operating costs. This trade off can be estimated and is likely to show greater benefit for minimizing fuel operating cost vs. reducing fuel cooling time. As discussed in the Report section on comparison of US plants, there is merit in keeping the annual expenses as low as possible during the wet fuel storage

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period. Additional information on required wet cooling times is provided in Appendix A, and in the response to CPUC Comment 14.

### CPUC Comment 3:

In the final report, can you also address the effect of 20-year license extensions for DCP, SONGS 2&3, and PVNGS? In all likelihood, the license extension applications will be approved for DCP and PVNGS by the NRC, and SCE will also apply perhaps about the time of the next NDCTP, so it would not be too early to factor in the longer plant life in future decommissioning cost studies.

### Response:

Based on this comment, Section 7 of the Report now includes a discussion of the effect on the cost estimate of a 20-year license renewal for these plants.

In general there are three principal cost drivers impacted by license renewal. These include:

1. Timing of decommissioning (costs are deferred approximately 20 years, assuming that the same decommissioning strategy is selected)
2. Increased activation levels in the reactor and reactor internals (which would be expected to modestly increase reactor disposition cost)
3. Spent fuel storage (these costs could increase or decrease depending on expected DOE performance)

The principal impact on funding is driven by forward-looking economic projections, including inflation rates and earnings on trust fund balances. Assuming that after-tax earnings on trust fund balances measurably exceed inflation rates it is reasonable to assume that a 20-year license renewal would result in a lower net present value decommissioning cost.

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### **Judge Darling / CPUC, received Thursday, January 27, 2011**

#### **CPUC Comment 4:**

The Phase 1 decision asked the Commission to send a letter to the U.S. Navy about the restoration requirements, although I don't have high hopes that the Navy has any reason to respond at this point in time. It seems to me that a cost-benefit analysis is premature to determine the actual costs 20+ years from now as facts of storage & disposal will change.

#### **Response:**

As the comment suggests, the Navy may take its time in deciding if, when, and how to respond to a request to consider renegotiation of the lease. Also as noted, key facts regarding decommissioning may materially change over time. A cost benefit analysis may have an important role as a subset of a larger strategy involved in renegotiating the Navy Lease with timing determined by the larger strategy. Additional discussion regarding the Navy Lease is included in the response to TURN Comment 1.

#### **CPUC Comment 5:**

The Phase 1 decision also asked the utilities to give an overall estimate based on re-licensing in the next NDCTP.

#### **Response:**

A cost estimate for the California plants based on a relicensing scenario is feasible for the next NDCTP. Assumptions for the estimate would be discussed with the utilities as part of development of any such estimate and would be along the lines of those discussed in the Report.

#### **CPUC Comment 6:**

I'm interested in some specific recommendations of ways the utilities can get early warning of contamination and improve operational practices. Your presentation alluded to testing concrete when available and perhaps that could be a requirement. What do they do with the soil & groundwater testing they do? Are the results available to the estimating experts? Is there anything we should order them to do? For example, should they provide contamination information annually by Advice Letter? or with the NDCTP?

I'm looking for specific safety related operational recommendations, if reasonably supported, that could impact decom costs, e.g., sealing up to three feet above floor level in certain areas. Any possibilities?

#### **Response:**

The Report discusses and makes recommendations regarding the use of data to reduce the uncertainty in estimated costs, including soil and groundwater testing. The Report also makes recommendations related to more fully documenting and explaining the basis for decommissioning contamination assumptions. The Report also discusses the role of minimizing operational contamination, related existing regulatory guidance and decommissioning experience lessons learned.

## **Report on Nuclear Decommissioning**

### **Lindsey How-Downing / PG&E, received Friday, January 28, 2011**

#### **PG&E Comment 1:**

The Presentation contains a recommendation that the facility owners consider sharing actual cost data. This recommendation should recognize that any such cost sharing must take into account restrictions on disclosure of confidential and commercially sensitive materials.

#### **Response:**

The Report now clarifies that the Panel is not recommending the public disclosure of confidential and commercially sensitive materials.

#### **PG&E Comment 2:**

The Presentation recommends that plant security personnel be involved with development of the security assumptions for the decommissioning cost estimate. The report should acknowledge that no Security Safeguards Information (information or material that provides insight to defensive design, construction and materials of the physical plant, armaments, tactics, staffing and schedules) can be discussed.

#### **Response:**

The Report now clarifies that the Panel is not suggesting that Security Safeguards information be provided to the estimator, or disclosed to the public in a decommissioning cost estimate report. The point of the Presentation was that security personnel need to be involved in preparation or review of the security assumptions such that all security cost requirements are addressed in the estimate.

#### **PG&E Comment 3:**

The Presentation includes recommendations that common license termination and site termination criteria be developed. PG&E requests clarification of the intent of these provisions given the differences between Diablo Canyon Power Plant's situation and the requirements imposed on SONGS 2&3 associated with its site leases.

#### **Response:**

The intent of the recommendation was to recognize that there may be multiple layers of criteria necessary to complete the decommissioning process and that for two stations both located in California they would likely be subject to many of the same criteria.

The NRC's and EPA requirements could be considered the first "common" layer. Typically this is interpreted as achieving no more than 25 mrem / year TEDE (Total Effective Dose Equivalent) considering ALARA, managing the spent fuel until transfer to the DOE, and complying with the EPA groundwater standard. It is generally recognized that if most (but not all) of the radioactive material produced as a result of plant operation is removed, the NRC's and the EPA's release requirements can be satisfied.

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The second layer would be the State of California and its agency's requirements. These could be considered state requirements associated with site restoration. These requirements, specifically an interpretation of specific "acceptance" criteria, are less obvious to the estimator, and may require substantial judgment in defining the criteria decades before decommissioning. It is these criteria which may have substantial commonality between the two California stations.

The third layer (also related to site restoration) would be other decommissioning requirements / desired actions included within the decommissioning funding basis. These requirements would be expected to be unique to each station. For the circumstance of SCE this could include the activities and costs necessary to terminate the lease.

### PG&E Comment 4:

PG&E requests that the draft report expand upon the Presentation's suggestion for potential cost-mitigation actions related to expectations concerning low level waste price escalation and waste disposal alternatives.

### Response:

The topic is now expanded upon in the Report. The Panel is not proposing to provide specific suggestions for potential cost-mitigation actions, but is identifying the need to consider the relationship between escalation assumptions and decommissioning methodology.

The basic premise of the suggestion is to consider if the methods selected for decommissioning are consistent with a relatively large low level waste price escalation rate that extends for many years. Simply stated, if low level waste escalates at a rate approximately twice the rate of labor or general inflation for multiple decades, there would be an increased incentive (benefit) to use additional labor and equipment to minimize the amount of waste produced.

The Panel believes an example of this would be the nuclear industry's response to historical increases in low-level waste costs at rates greater than general inflation. The Panel believes that there were greater efforts made by the industry to minimize the production of low-level waste to manage the overall low-level waste disposal cost, as noted by the NRC in NUREG-1307, Vol 14, Section A.3.

"...Waste management costs at nuclear power plants are being reduced through the use of waste vendors and the Clive, Utah disposal facility. Also, closer attention to LLW management by power plant licensees has resulted in dramatic reductions of LLW being disposed of at the commercial LLW burial sites. Since publication of NUREG/CR-0130 and NUREG/CR-0672, the average annual LLW volume disposed of by nuclear power plants has decreased by an order of magnitude. This volume reduction has been achieved through a combination of increased efforts to minimize the volume of LLW generated to begin with and increased use of waste vendors to reduce the volume of disposed LLW. The trend of utilizing waste vendors and the Clive, Utah disposal facility by licensees of operating nuclear power plants is also now being observed at nuclear power plants being decommissioned."

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Similarly the industry (via EPRI), in response to increased costs and / or lack of available disposal facilities, has taken the initiative to consider the means of reducing Class B and C waste, i.e., EPRI Report – “Waste Class B/C Reduction Guide”, Report 1015115, November 2007.

### P&E Comment 5:

In the report’s discussion of the material on slide 5 of the presentation, in light of the DOE disposal requirements on greater than Class C waste, PG&E suggests that greater than Class C waste be identified as high-level rather than low-level waste.

### Response:

The NRC has defined low-level radioactive waste that exceeds the radionuclide concentration limits provided in 10 CFR 61.55 as “Greater than Class C waste,” or GTCC. This definition occurs several places, including 10 CFR 72.3. The Panel understands that the Court of Federal Claims has determined that the Owner’s contract with the Department of Energy (DOE) for spent fuel requires the Government to accept GTCC radioactive waste concurrently with spent fuel and other high level waste.<sup>6</sup> For the purposes of the Report, the Panel is using the NRC definition for GTCC waste.

### PG&E Comment 6:

For clarification, PG&E suggests that the terminology on spent fuel management (slide 6) include a reference to Interim Spent Fuel Storage Installation (“ISFSI”), which term is frequently used in utility nuclear proceedings. Similarly, PG&E suggests the use of “Decommissioning Operations Contractor” or “DOC” for contractor managed, but not owned, decommissioning.

### Response:

The Report includes clarification of these terms.

### PG&E Comment 7:

In the report’s discussion of regulatory requirements (slide 7), local regulatory requirements should be included.

### Response:

The Report includes this change.

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<sup>6</sup> United States Court of Appeals for the Federal Circuit, 2007-5025, -5031, *Yankee Atomic Electric Company v. United States*, 2007-0526, -0532, *Maine Yankee Atomic Power Company v. United States*, and 2007-0527, -0533, *Connecticut Yankee Atomic Power Company v. United States*, at 13.

## **Report on Nuclear Decommissioning**

### **Administrator / SCE, received January 28, 2011**

#### **SCE Comment 1:**

At page 9, the briefing presentation lists the last decommissioning cost estimates published for each of the referenced commercial nuclear facilities before decommissioning commenced at each facility. Of the three such decommissioning projects that have been completed, the estimates ranged from 38% to 82% below the recorded costs. On page 23, the briefing shows several out-of-state cost estimates for facilities whose owners have no decommissioning experience as industry data points for comparison to the SONGS 2&3, Diablo, and Palo Verde estimates. Given the significant under-estimation of most recently completed decommissioning projects, does the panel have confidence that these estimates are not also inordinately low? If so, on what basis?

#### **Response:**

This Panel, as indicated in the discussion in the Report, appreciates the historical U.S. decommissioning experience as indicated in Presentation slide 9. The Panel, as indicated in the discussion in the Report, also appreciates the care that must be exercised in comparing estimates. The out-of-state cost estimates for facilities noted in Presentation slide 23 were all developed based on industry experience available when the estimates were done, and were accepted as reasonable by the appropriate rate regulators. California decommissioning experience is combined with other experience to provide the basis for updates to decommissioning cost estimates both in and outside the state of California. The out-of-state cost estimates are used for comparison purposes, particularly focusing on any areas where the estimates show differences between different sites and different phases of decommissioning.

#### **SCE Comment 2:**

Has the panel compared the recorded quantities of materials that required direct burial and reprocessing from each of the three completed decommissioning projects shown on page 9 versus the quantities projected in their corresponding referenced cost estimates? Also, has the panel made a similar comparison between the 1998 SONGS 1 decommissioning cost estimate and the recorded material quantities that required direct burial in Phase I?

#### **Response:**

The Panel did not obtain or review the recorded quantities of materials, but does believe that the estimated quantities were substantially below the reported quantities. The reported quantities will be summarized in the Panel's report. The Panel does believe there is a correlation between the selected decommissioning end-state, cost of waste disposal, and the quantities of waste produced.

## **Report on Nuclear Decommissioning**

### SCE Comment 3:

Is there more that could be done by decommissioning cost estimating professionals to reflect recent industry experience in their cost estimating models?

#### Response:

As more information is gained concerning decommissioning and site restoration, the Panel anticipates that such information should and will be reflected in estimates. To the extent that each owner obtains better characterizations of its site, the Panel would also expect this information to be reflected in the study.

### SCE Comment 4:

How would the panel propose to address the latent tension that exists between facility owner-operator reliance upon cost estimator experience and expertise versus facility owner-operator assumptions that may be inconsistent with the estimator's experience and expertise, or otherwise not be supportable in the estimator's professional opinion? How far should an estimator go to make recommendations regarding decommissioning assumptions to a facility owner-operator for consideration in updates to the decommissioning cost estimates? Conversely, how much deference should an estimator give to an owner-operator for assumptions the estimator strongly disagrees with?

#### Response:

The Panel did not evaluate as part of its assigned work these assertions or questions. However, based on brief discussion, the Panel offers these general observations:

- In general, the owner relies on the estimator to make numerous assumptions based on industry experience and standard estimating practices
- Assumptions subject to dispute are best resolved by open and candid discussion between the estimator and the owner during the course of developing the estimate.
- Where the owner and the estimator may continue to prefer different assumptions on a particular issue, an available approach is to document in the estimate the basis for the assumption(s) in question and the party responsible for the assumption(s).

### SCE Comment 5:

Although it is acknowledged that the implementation plans for decommissioning projects will likely be different from the plans used to develop the estimates, is there more that can be done in developing the estimates to attempt to more closely reflect the manner, cost, and schedule, in which a decommissioning project will likely be implemented?

## **Report on Nuclear Decommissioning**

### Response:

The Panel believes on a practical level the answer is no. From a historical perspective, the variability in approaches used for similar PWR reactors recently decommissioned demonstrates that even decommissioning projects taking place in the same time frame were completed using a wide-range of implementation techniques. To further make the point of the situational nature of decommissioning experience to-date, the most recent large PWR to begin decommissioning (Zion Station) is expected to use a process substantially different than the previous techniques.

While any decommissioning cost estimate assumes certain planning and execution sequences, fundamental understanding of the decommissioning cost challenge needs to stay focused on identifying and estimating major cost drivers, i.e., labor, waste disposal, end-state criteria, spent fuel management, DOE performance, and schedule.

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Matthew Freedman / TURN, received Wednesday, February 2, 2011

### **SONGS 2&3 Navy Lease issues**

#### TURN Comment 1:

(1) How can the state most effectively work with the U.S. Navy to obtain a guarantee regarding less expensive site release criteria?

#### Response:

The Panel did not evaluate as part of its assigned work these assertions or questions. However, based on brief discussion, Panel members offer these general observations:

- The State needs to establish the basis for its interests, and the reasonableness and merits of less expensive site release criteria
- The discussion will need to recognize up front that any decision involves costs to California rate payers today vs. potential reuse for yet to be specified purposes by the Navy in the future or other Navy concerns.
- it may be of value to identify any precedents established by the Navy, and to present the risks and benefits consistent with those precedents.
- There are established mechanisms for making decisions like this; examples include Environmental Assessments/Environmental Impact Statement processes.
- The strategy for approaching the Navy needs to consider the length of time likely to be involved and that all parties need to be prepared to respond to situations that may arise, unplanned, (like nuclear plant decommissioning) that will affect the outcome.

#### TURN Comment 2:

(2) Is the updated decommissioning estimate for SONGS 2/3 likely to show the impact of the Navy lease to be larger or smaller than the last ABZ study?

#### Response:

The Panel does not have an opinion at this time as to whether a future estimate may show the Navy Lease impact as being larger or smaller than the estimate provide in the Report. The 2008 ABZ study did not specifically study the cost impact of the Navy Lease. The lease impact estimate provided in this Report is based on an extraction and analysis of selected cost estimate data. The Panel is recommending that the Navy and State Lands Lease impacts be looked at in the next SONGS 2&3 cost estimate. The detailed costs will depend on the detailed assumptions used for that estimate, and will include the effect of any experience gained by SCE and others since the last estimate.

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### TURN Comment 3:

(3) Can SCE provide a range of release criteria scenarios in its next decommissioning estimate? If so, what are reasonable scenarios to use?

#### Response:

There are many scenarios that can be envisioned, however, there is considerable uncertainty as to which scenarios are most reasonable to consider and worth the expenditure of time and money for their investigation. The Panel's recommendation, as noted above in response to TURN Comment 2, is to focus on the Navy and State Lands Leases. Absent the Navy and State Lands Lease requirements, there is still uncertainty between and within NRC and EPA requirements. In addition, the estimate includes costs for activities that will not be performed for approximately 40 years (potentially longer with license renewal). To the extent that the Commission desires multiple scenarios, the Panel suggests this be a future discussion between the Commission and SCE.

### **SCE adjustments to PV cost study**

#### TURN Comment 4:

(1) The presentation only identified the "dismantling adjustment" (page 20). Are the other adjustments (Large component removal, contingency, ISFSI/SNF) reasonable? Should they be allowed in the future?

#### Response:

The Panel is open to future adjustments related to large component removal, contingency, and ISFSI/SNF. Any adjustments should be reasonably defended each time they are used as the circumstances and experience that justify such adjustments may change over time.

#### TURN Comment 5:

(2) Can the panel provide more detail on the history of these adjustments?

#### Response:

The Panel has looked briefly at the regulatory history of the SCE adjustments to the Palo Verde estimates, and is providing a very short summary in the Report. A more detailed and comprehensive history is beyond the scope of the Panel and deserves its own separate effort.

#### TURN Comment 6:

(3) Are there any precedents for the use of such adjustments by other utilities across the U.S.?

#### Response:

The Panel believes there are, in limited instances, circumstances where different owners have established their own funding basis for a nuclear station, or different rate commissions have authorized

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differing fund collections based on the same estimate. The Panel did not investigate the details of this belief.

### **Contamination issues**

#### TURN Comment 7:

(1) How will different levels of contamination impact the cost estimates?

#### Response:

In a simplistic sense, higher levels of contamination generally imply larger costs when the extent of contamination increases or the level of contamination increases sufficiently to increase burial costs or the volume removed, or to change the removal method. There can be exceptions to this general rule where efficiency is gained by removal of the whole item or a large part as compared to more surgical removal.

#### TURN Comment 8:

(2) How do the levels of expected contamination differ between SONGS 2&3, PV, and Diablo? How do these compare to a "normal" level of contamination expected for a typical facility?

#### Response:

The Panel believes there are no significant differences in the expected contamination between SONGS 2&3, PV and DCP. The Panel believes there are no significant differences compared to a "normal" level of contamination for a typical facility. This belief is based on limited observations during the plant tours and panel members' experience, not on any quantitative analysis.

#### TURN Comment 9:

(3) Is there enough data on actual contamination at each facility to provide meaningful guidance for future decommissioning studies?

#### Response:

In the context that the studies are used for long-term financial planning and funding, the Panel believes that there is sufficient information to make reasonable assumptions for future decommissioning studies. The Panel is recommending that volumetric contamination and activation information obtained from materials removed for maintenance or modifications be considered in future estimates.

#### TURN Comment 10:

(4) Can the panel reach any conclusions about the extent to which current and future radiological contamination is due to actions taken by facility owners? In other words, should some portion of the

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expected contamination be understood to be avoidable? If not, what further work would be required to make useful conclusions?

### Response:

The Panel's current assumption, as indicated in response to TURN Comment 8, is that DCP, SONGS 2&3 and PV are at a "normal" level of contamination for a typical facility which would not be considered to include any "avoidable" contamination. Any further discussion of "normal" or "avoidable" levels of contamination should be after additional information is available as suggested in the response to TURN Comment 9.

### TURN Comment 11:

(5) What operational practices should the utilities adopt to minimize future contamination?

### Response:

Please see the Panel's response to CPUC Comment 6.

## **Waste burial cost escalation**

### TURN Comment 12:

(1) How can the Commission consider the uncertainties inherent in these assumptions during the next NDCTP?

### Response:

The Panel believes the Commission could consider the sensitivity of waste burial cost escalation on funding requirements by requesting multiple escalation analyses. These analyses could consider both different assumed values for waste burial escalation as well as the actions that may be taken by a utility to mitigate the increase in waste burial costs above general inflation. One way to consider mitigating actions (without performing different decommissioning cost estimates) is to use a waste burial escalation rate that lies between the assumed waste burial escalation rate and the rate of general inflation. For example, a utility could perform different funding analyses looking at the approved escalation rates as well as reduced escalation rates that would inherently assume some mitigation had occurred.

There is professional disagreement about whether waste burial costs can continue to escalate at rates above general inflation for extended periods of time. While the utilities have taken actions to reduce waste burial volumes, the waste disposal sites have also taken counter actions to reduce the effectiveness of the utility actions.<sup>7</sup> In addition, there is still no licensed site for disposal of some of the

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<sup>7</sup> For example, in the mid 1990s, the utilities became very effective in packaging waste to minimize the waste volume (with a smaller reduction in waste weight). In response, one of the waste disposal sites revised its burial rates to charge by weight instead of by volume.

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radioactive wastes that will be generated during decommissioning, so any projection of the disposal costs for this waste will remain speculative.

### **License extension**

#### TURN Comment 13:

(1) What impact will license extension have on the expected decommissioning costs for all three sites?

#### Response:

This issue is discussed in the Panel's response to CPUC Comment 3. As discussed in that response, license renewal can result in higher or lower costs depending on multiple factors, notably DOE performance. In addition, funding requirements can be higher or lower for a license renewal scenario as compared to a non-license renewal scenario depending on escalation, trust fund rates of return, and decommissioning approach.

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### **Administrator/ SCE, received February 8, 2011**

#### **SCE Comment 6:**

The current easement granted by the CA State Lands Commission requires the excavation and disposal of the SONGS 2 & 3 offshore circulating water conduits. Given that the estimated cost is approximately \$100 M (in addition to the cost to fulfill the current site restoration requirements of the site lease from the Navy Department), SCE requests that the Panel explicitly address the impact of this easement in its report.

#### **Response:**

The Panel has included the \$50 million from the cost estimate in the Report.

#### **SCE Comment 7:**

SCE currently projects that the only incremental decommissioning scope increase that would arise from SONGS 2 & 3 license renewal would be the incremental increase in the size of the ISFSI that would result during the twenty-year period of extended operations.

#### **Response:**

The Panel is considering this information in the Report.

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## **Appendix H**

### **Comments to February 14, Draft Report in order received**

#### **Eric Greene / CPUC, received Monday and Tuesday, February 15 and 16, 2011**

##### **CPUC Comment 7:**

Page ii, first para ... where you mention the five other non-California sites. Would be helpful to state where these plants are located, for example Indian Point (New York), Palo Verde (Arizona), St. Lucie (Florida), South Texas Project (Texas), Vogtle (Georgia). I think elsewhere in the report you refer to Trojan, Yankee Rowe, and some other Yankee plants, et., al. You might also want to provide the location, if not obvious.

##### **Response:**

The locations by state have been added. Location by state is also provided in Table 5.1.

##### **CPUC Comment 8:**

Page 4, first para., discussing the U.S. reactors undergoing decommissioning. Can you include their names in the paragraph? Five of the reactors ... Connecticut Yankee, Maine Yankee, Ranch Seco

(Sacramento CA), Trojan, Yankee Rowe (Massachusetts) ... The sixth reactor (SONGS Unit 1) was co-located on a station with two additional operating reactors..... In addition, there is also one BWR (Humboldt Bay Power Plant Unit 3) located in northern California ....

##### **Response:**

The names and locations of the reactors have been added. Names and locations are also provided in Tables 3.1 and 3.2.

##### **CPUC Comment 9:**

Delete footnote 2 on page 4, which is repeated on page 5. Add Barnwell's location, i.e., Barnwell (South Carolina).

##### **Response:**

The duplicated footnote has been deleted and the location of Barnwell has been added to the remaining footnote.

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### CPUC Comment 10:

Page 6, third bullet - identify the two owners ... Two of the owners (Connecticut Yankee and Maine Yankee) attempted a near turn-key contracting approach ....

#### Response:

The names of the two power plants and reference to their owners have been added.

### CPUC Comment 11:

Page 11, first sentence .... suggested revision ... Nuclear power plants are typically licensed for a 40-year full power operating period, which can be extended for an additional 20 years, to form an effective total of 60 years of full power operation.

#### Response:

The wording has been clarified.

### CPUC Comment 12:

Page 11, Footnote 4 ... add ...Some states, such as Vermont, have prevented power plants located in their states from pursuing license extension without State approval, which was not granted.

... add to footnote 8 that the City of Riverside owns about 2% of SONGS Units 2 and 3.

#### Response:

Information about license renewal, including Vermont Yankee, and the ownership interest of the City of Riverside in SONGS 2&3 has been added.

### CPUC Comment 13:

Page 20 ... middle of page ... There are four bullets. Then you state that a fourth area, schedule, was identified ... Did you mean fifth?

At the bottom of the page you discuss Indian Point 2 and mention IP3. I'm not positive, but I vaguely recall that IP2 and IP3 have different owners. If so, and this contributes to your not being able to obtain the decommissioning cost estimates for IP3, you might want to add this information. I also think that IP1 is in Oswego NY, a different location. You might want to add this for completeness, in case someone wonders about IP1.

#### Response:

The wording regarding the fifth bullet has been corrected.

## **Report on Nuclear Decommissioning**

The paragraph regarding IP 1 and IP 3 has been revised with additional information.

### CPUC Comment 14:

Page 26 ... You state DCP and SONGS assume wet fuel storage periods after shutdown of 12 years. The 12-year period applies at all times, even during operation, before transfer to a dry fuel storage facility such as an ISFSI. You then continue stating that the other sites assume five years. You might want to add here that the longer wet storage time is due to higher uranium fuel enrichments, higher fuel burnups, and longer fuel cycles. SONGS is considering going to 24-month fuel cycles, rather than the 18-month fuel cycles at DCP, or annual fuel cycles at other nuclear plants.

### Response:

The required time that fuel must cool before being placed in a storage cask is a function of the licensing analysis performed for that specific cask. Generally, two factors are responsible for the required wet cooling time. These factors are the radiation dose resulting from the fuel, and the decay heat generated by the fuel. Generally, the longer a fuel bundle is used in the reactor, the larger the decay heat generated by that fuel bundle.

Some cask designs allow multiple configurations where hotter fuel can be combined with less hot fuel in specific arrangements to allow shorter cooling times. These configurations require that specific combinations of fuel be maintained in the spent fuel pool until needed for cask loading.

For decommissioning, the required wet storage period is determined by the fuel discharged from the reactor during the last few cycles of operation. Thus, what is important is not how the reactor is operated today, but how it will be operated in the last several years before shutdown.

It is the Panel's judgment that the projected operating strategy of the DCP and SONGS 2&3 units are not different from the rest of the industry, and that, as more people approach decommissioning, the assumed wet storage periods will increase to reflect the requirements of the cask licenses. Additional information on the cask licenses and fuel cooling is provided in Appendix A.

### **Admininstrator/SCE, served on February 18, 2011**

Marked up copy of the Panel's February 14, 2011 draft report, primarily editorial in nature.

### Response:

The editorial comments and corrections of punctuation, etc were largely incorporated. Substantive comments were reviewed by the Panel and some changes have been made in the Report

# **Report on Nuclear Decommissioning**

## **Appendix I**

### **Comments to February 22, Public Workshop in order received**

There were no additional comments received subsequent to the Public Workshop.