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STAFF REPORT: REGULAR PERMIT

Application No.:	**9-15-0162**
Applicant:	**Southern California Edison Company**
Location:	San Onofre Nuclear Generating Station, San Diego County.
Project Description:	Install an independent cooling system known as a "Spent Fuel Pool Island" (SFPI) to replace the existing once-through cooling system at SONGS Units 2 and 3.
Staff Recommendation:	Approval with conditions.

SUMMARY OF STAFF RECOMMENDATION

Southern California Edison Company (SCE) proposes to install an independent cooling system to serve the existing spent fuel pools at Units 2 and 3 of the San Onofre Nuclear Generating Station (SONGS), on Camp Pendleton, in San Diego County (**Exhibit 1**). The proposed "spent fuel pool island" (SFPI) system is a stand-alone cooling system that would use air-cooled industrial chillers to dissipate the heat generated by spent nuclear fuel submerged in large pools inside the SONGS spent fuel handling buildings. The SFPI system would circulate warm water between the existing spent fuel pools and a set of heat exchangers, which would transfer the heat, but not the liquid, to secondary water loops connected to four air-cooled chillers. The SFPI system would allow the spent fuel pools to be isolated from the existing once-through cooling system, which depends on the intake of seawater from the Pacific Ocean. The proposed project represents a preliminary step in the decommissioning of SONGS Units 2 and 3, and would

provide an alternate system for spent fuel cooling while eliminating the plant's use of ocean cooling water, consistent with the State of California's Once-Through Cooling Water Policy.[1]

The SFPI system is proposed to be installed beginning in late August, 2015, and would be operated until all remaining spent fuel has been transferred to dry cask storage, currently estimated to be through December 31, 2020. Once the SFPI is no longer in operation the equipment would be removed as part of plant decommissioning.

Under normal operating conditions, the SFPI system would not require the discharge of any fluids or contaminants to coastal waters, and would not affect marine organisms or ecosystems. In order to minimize the potential for accidental leaks and spills from the system, SCE would continuously monitor key system parameters, and plans to implement a maintenance and inspection program. SCE would also implement the existing SONGS Spill Prevention, Control and Countermeasures Plan in order to prevent and contain any leaks and spills from the system. Construction and minor grading activities during the installation of the SFPI system would comply with existing water quality, storm water management and spill prevention plans, including the SONGS Storm Water Management Plan, and their associated best management practices, designed to control runoff and prevent sediment, debris, and contaminants from entering the storm drain system and reaching the ocean.

SCE has conducted probabilistic seismic hazard analyses to estimate the likelihood of a major earthquake near the SONGS site, and the intensity of ground-shaking that could occur during such an event. The SFPI system has been designed to withstand the ground-shaking associated with a major earthquake consistent with the requirements of the California Building Code. However, the ability of the SFPI system to perform according to its seismic design basis depends, at least in part, on the appropriate maintenance of system components. SCE has indicated that it is developing an inspection and system maintenance procedure following manufacturer recommendations. However, because no specific plan is currently available, Commission staff recommends **Special Condition 1**, which would require SCE to submit, for the Executive Director's review and approval, an Inspection and Maintenance Plan detailing the type and frequency of system inspections and the procedures that would be followed to assure that SFPI system remains in good working condition and will continue to meet its initial seismic safety design throughout the project life. The project site is not expected to be threatened by tsunami inundation or coastal erosion during the life of the project.

The project would occur entirely within the previously developed SONGS site, and would not have adverse effects on sensitive species and habitats, coastal access and recreation, or visual resources.

The staff recommends the Commission find that, as conditioned, the project would be consistent with Sections 30230, 30231, 30232, 30251 and 30253 of the Coastal Act, and, therefore recommends that the Commission **APPROVE** coastal development permit application 9-15-0162, as conditioned.

[1] Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling, effective Oct. 1, 2010. http://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/policy.shtml

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I. MOTION AND RESOLUTION

Motion:

*I move that the Commission **approve** Coastal Development Permit 9-15-0162 subject to conditions set forth in the staff recommendation specified below.*

Staff recommends a **YES** vote on the foregoing motion. Passage of this motion will result in approval of the permit as conditioned and adoption of the following resolution and findings. The motion passes only by affirmative vote of a majority of Commissioners present.

Resolution:

The Commission hereby approves the Coastal Development Permit for the proposed project and adopts the findings set forth below on grounds that the development as conditioned will be in conformity with the policies of Chapter 3 of the Coastal Act. Approval of the permit complies with the California Environmental Quality Act because either 1) feasible mitigation measures and/or alternatives have been incorporated to substantially lessen any significant adverse effects of the development on the environment, or 2) there are no further feasible mitigation measures or alternatives that would substantially lessen any significant adverse impacts of the development on the environment.

II. STANDARD CONDITIONS

This permit is granted subject to the following standard conditions:

1. **Notice of Receipt and Acknowledgment**. The permit is not valid and development shall not commence until a copy of the permit, signed by the applicant or authorized agent, acknowledging receipt of the permit and acceptance of the terms and conditions, is returned to the Commission office.

2. **Expiration**. If development has not commenced, the permit will expire two years from the date on which the Commission voted on the application. Development shall be pursued in a diligent manner and completed in a reasonable period of time. Application for extension of the permit must be made prior to the expiration date.

3. **Interpretation**. Any questions of intent of interpretation of any condition will be resolved by the Executive Director or the Commission.

4. **Assignment**. The permit may be assigned to any qualified person, provided assignee files with the Commission an affidavit accepting all terms and conditions of the permit.

5. **Terms and Conditions Run with the Land**. These terms and conditions shall be perpetual, and it is the intention of the Commission and applicant to bind all future owners and possessors of the subject property to the terms and conditions.

III. SPECIAL CONDITIONS

This permit is granted subject to the following special conditions:

1. **System Inspection and Maintenance Plan.** PRIOR TO THE COMMENCEMENT OF OPERATION of the Spent Fuel Pool Island Cooling System, SCE shall submit, for the Executive Director's review and approval, an Inspection and Maintenance Plan for the SFPI system. At a minimum, the Plan shall describe the procedures for inspecting and maintaining each major SFPI system component, including the chillers, heat exchangers, all piping and plumbing on both the primary and secondary cooling loops, and all newly installed pumps. The Plan shall also indicate the frequency at which inspections will be carried out for each set of components. SCE shall not begin operation of the SFPI system without the Executive Director's written approval of the above-submitted information.

2. **Liability for Costs and Attorneys Fees:** SCE shall reimburse the Coastal Commission in full for all Coastal Commission costs and attorneys fees -- including (1) those charged by the Office of the Attorney General, and (2) any court costs and attorneys fees that the Coastal Commission may be required by a court to pay – that the Coastal Commission incurs in connection with the defense of any action brought by a party other than SCE against the Coastal Commission, its officers, employees, agents, successors and assigns challenging the approval or issuance of this permit, the interpretation and/or enforcement of permit conditions, or any other matter related to this permit. The Coastal Commission retains complete authority to conduct and direct the defense of any such action against the Coastal Commission.

IV. FINDINGS AND DECLARATIONS

A. BACKGROUND AND PROJECT DESCRIPTION

Background

SCE permanently ceased operation of SONGS Units 2 and 3 in June 2013 and has begun the process of plant decommissioning. Future planned decommissioning projects include the decontamination and dismantling of major structures, including the generating units and containment buildings, spent fuel pools and buildings, cooling water intake and discharge conduits, and other minor structures over the next 20 years. In the past year, SCE has sought Commission authorization for several preliminary projects that will enable decommissioning to proceed, including the installation of new electrical equipment and a ring-bus system needed to supply the plant with power now that electricity generation at SONGS has ceased (CDP Waiver # 9-14-1550-W), installation of back-up diesel generators (CDP Waivers # 9-14-1550-W and 9-15-0265-W), and replacement of the large ocean water intake pumps serving Units 2 and 3 with smaller pumps better suited to the plant's reduced water needs (CDP Waiver #9-15-0417-W).

SCE has stated that the proposed Spent Fuel Pool Island (SFPI) cooling system would facilitate plant decommissioning because it is smaller, simpler and more localized (to the spent fuel areas) than the existing once-through cooling system, and would enable the eventual decommissioning of the Units 2 and 3 seawater intake structures. SFPI systems, using a variety of different

technologies for dissipating the heat generated within the spent fuel pools, have been installed at a number of other U.S. plants in various stages of decommissioning. While no other plant is currently using a system configuration identical to that proposed at SONGS, information provided by SCE indicates that SFPI systems at three other plants use (or have in the past used) chillers to dissipate heat from spent fuel pools, while four others use a similar island cooling design concept, but with evaporative cooling units. SCE states that it selected the chiller-based design instead of a system depending on evaporative cooling in order to avoid the high water usage and highly-visible vapor plumes associated with evaporative cooling units.

In the present "defueled" state of Units 2 and 3, the heat load in the spent fuel pools is significantly lower than if freshly offloaded fuel was still being added to the pools. The SFPI system would have a cooling capacity roughly twice that needed to dissipate the current heat load, and thus can provide an interim system for spent fuel cooling until the fuel can be transferred to dry cask storage. An independent spent fuel storage installation (ISFSI), approved by the Coastal Commission in 2001 (CDP #E-00-014), exists on the SONGS site. SCE is separately applying for a CDP (Application #9-15-0228) for a new ISFSI to accommodate all the nuclear fuel currently stored in the spent fuel pools.

Project Description

The proposed SFPI cooling systems (one for each of the two spent fuel pools) would each be composed of two separate water loops designed to transfer heat from the spent fuel pool to the atmosphere. The primary loop, which includes the spent fuel pools themselves, would continue to operate as it does at present. Water would be circulated from the spent fuel pools to the primary side of a heat exchanger and then back to the pool. The only proposed changes affecting the primary loop are the installation of a new heat exchanger and the addition of new piping and water circulation pumps; no alterations would be made to the existing spent fuel pools themselves.

The secondary loop of the proposed system would replace the existing seawater cooling system. Water would be circulated in a closed loop from the heat exchanger to a set of 200-ton electric chillers which would dissipate the transferred heat to the atmosphere. Schematic diagrams of the existing and proposed spent fuel pool cooling systems are shown in **Exhibit 2**.

In combination, the proposed SFPI systems for Units 2 and 3 include the following major components:

- Four 200-ton industrial electric chillers (19 ft L x 8 ft W x 8.5 ft H) (Trane, 2.4 million BTU/hour capacity per unit);
- Two plate frame heat exchangers (Alfa Laval, 3.0 million BTU/hr capacity per unit);
- Two shipping containers (20 ft L x 8 ft W x 8.5 ft H) housing four new water pumps and piping necessary to circulate water through the system;
- Approximately 100 feet of pre-fabricated stainless steel piping to connect the spent fuel pools to the chillers (50% to be installed within the existing spent fuel buildings);
- Water purification filters, added as a side-branch to the primary loop;
- New instrumentation to monitor temperature, pressure, and flow within the SFPI systems and allow for the detection of leaks.

The new equipment would be installed in and around the existing spent fuel pool buildings within the SONGS protected area (**Exhibit 1**). The chillers and shipping containers would be placed immediately behind the spent fuel buildings, as shown in **Exhibit 3**. Diagrams, specifications and photos of key system components are provided in **Exhibit 4**.

Under normal operations, four chillers (two chillers for each spent fuel pool) would serve the SFPI system. However, the current combined heat load of the spent fuel pools requires that only three chillers be operational at any given time, decreasing to two chillers in approximately a year as the heat load from the spent fuel continues to decline. The four installed chillers would be cross-tied to take advantage of this extra capacity, allowing for operational flexibility and back-up capability in the event that one chiller (and later, two chillers) needs to be taken offline for repairs. The chillers would be secured on reinforced concrete pads, the installation of which may require a minor amount of excavation in order to create a stable foundation. Excavated material would be repurposed onsite or disposed of at an offsite location.

Water used in the spent fuel pools and primary cooling loops would continue to be supplied from the plant's existing demineralized water system. Evaporation from the spent fuel pools currently requires the addition of approximately 900 gallons of water per week to the primary loop. The new secondary cooling loops would recirculate fresh water (treated with a corrosion inhibitor) provided by the local municipal water system. The secondary loops would require initial system fills of approximately 1000 gallons each, and would be replenished only if needed during maintenance.

The SFPI system is proposed to be installed beginning in late August, 2015, and would be operated until all remaining spent fuel has been transferred to dry cask storage. Under SCE's current decommissioning schedule, summarized in the *SONGS Units 2 and 3 Post-Shutdown Decommissioning Report* (PSDAR) submitted to the Nuclear Regulatory Commission, the transfer of spent fuel to dry storage is to be completed by June 1, 2019. However, in order to allow for contingencies, the SFPI system is proposed to be operated through December 31, 2020. If future circumstances, such as changes in the fuel transfer schedule, require that the SFPI system be retained and operated beyond this date, SCE would seek further authorization from the Commission. Once the SFPI is no longer in operation the equipment would be removed as part of plant decommissioning.

Federal pre-emption

The construction and operation of new facilities at SONGS are subject to the approval and oversight of the federal Nuclear Regulatory Commission (NRC) pursuant to NRC regulations. The NRC has exclusive jurisdiction over radiological aspects of the proposed project. The state is preempted from imposing upon operators of nuclear facilities any regulatory requirements concerning radiation hazards and nuclear safety. The state may, however, impose requirements related to other issues. The U.S. Supreme Court, in *Pacific Gas and Electric Company v. State Energy Commission, 461 U.S. 190, 103 S.Ct. 1713 (1983)*, held that the federal government has preempted the entire field of "radiological safety aspects involved in the construction and operation of a nuclear plant, but that the states retain their traditional responsibility in the field of regulating electrical utilities for determining questions of need, reliability, costs, and other related state concerns." The Coastal Commission findings herein address only those state

concerns related to conformity to applicable policies of the Coastal Act, and do not evaluate or condition the proposed project with respect to nuclear safety or radiological issues.

B. OTHER AGENCY APPROVALS

U. S. Nuclear Regulatory Commission

The proposed SFPI project is subject to oversight and review by the U. S. Nuclear Regulatory Commission (NRC) under Title 10 of the Code of Federal Regulation, Part 50, Section 50.59 (10 CFR 50.59), applying to design changes, tests and experiments carried out licensed nuclear facilities. NRC staff has communicated to Coastal Commission staff that the project is being reviewed under Section 50.59 screening criteria, and that the NRC would conduct an inspection of the facility after project completion.

C. MARINE RESOURCES & WATER QUALITY

Section 30230 of the Coastal Act states:

> *Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.*

Section 30231 of the Coastal Act states:

> *The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.*

Section 30232 of the Coastal Act states:

> *Protection against the spillage of crude oil, gas, petroleum products or hazardous substances shall be provided in relation to any development or transportation of such materials. Effective containment and cleanup facilities and procedures shall be provided for accidental spills that do occur.*

These Coastal Act policies generally require that development protect coastal waters and not result in adverse effects to those waters and their associated biological resources. They also require protection against spills of hazardous substances and effective management of spills should they occur. Normal operation of the SFPI system would not result in the discharge of pollutants to coastal waters or otherwise affect marine resources. . However, because the SONGS site is immediately adjacent to the Pacific Ocean, leaks, spills or other incidents associated with the proposed project have the potential to affect water quality and marine

organisms in nearby coastal waters, even when excluding the potential leaks or spills of radiological materials, which are not within the Commission's jurisdiction. In addition, grading and ground disturbance during the construction of concrete foundations for the four chillers could mobilize soil and sediment which, if washed into the ocean, could adversely impact marine resources.

Operational Discharges

All waste discharges to the ocean from SONGS occur through existing offshore conduits serving Units 2 and 3. Discharges are governed by existing National Pollutant Discharge Elimination System (NPDES) Permits, issued by the San Diego Regional Water Quality Control Board, which set discharge limitations for a variety of pollutants and chemical constituents. Because no waste discharges are necessary in order to operate the proposed SFPI cooling system, the proposed project would not result in new operational discharges of pollutants to the ocean, nor require revisions to the existing NPDES permits. However, there is some potential for unintentional discharges from the SFPI system as a result of spills or system leaks.

Accidental leaks or spills from the SFPI system, other than leaks and spills of substances exclusively regulated by the NRC, could occur as follows: (1) Leakage of fresh water treated with rust inhibitors from secondary loop components connecting the heat exchangers with the chillers, either within or outside the Fuel Handling Buildings; and (2) spills during the handling of chemicals used to treat either of the SFPI loops. Runoff from the SONGS complex does not enter the ocean directly, but is captured in either interior or exterior drain systems prior to active dilution and discharged through the offshore conduits. Nevertheless, these materials would eventually end up in the ocean, just diluted with other discharges from the SONGS facility.

SCE has indicated that it would continuously monitor SFPI system parameters (e.g., temperature, pressure, flow rates) and conduct daily inspections of critical system components. If a damaged or malfunctioning component were identified, or if a leak were detected, the affected components or systems would be removed from service and repaired or replaced. SCE has further stated that it is developing an inspection and maintenance procedure for the SFPI system based on manufacturer recommendations.

In the event of a leak or spill from the SFPI system, SCE would seek to shut off the leak and implement spill response measures (including damming and diverting strategies and the use of spill clean-up kits kept near each Fuel Handling Building) designed to contain the spill and prevent fluids from entering the drain systems. SCE has prepared a draft *Spent Fuel Pool Off-Normal Actions* procedure outlining the immediate actions to be taken in the event of a leak, spill or other emergency affecting the SFPI system, while the existing SONGS *Spill Prevention, Control and Countermeasures* (SPCC) plan describes the procedures and equipment availability needed to prevent and control spills of hazardous materials on site, and prevent such spills from reaching the drain systems. Both plans have been provided to and reviewed by Commission staff. Implementation of these plans will minimize the potential that a leak or spill of fluids or hazardous materials during operation of the SFPI system would reach coastal waters.

In the worst case, a leak or spill from the secondary loop (containing fresh water treated with anti-corrosion agents) could enter the SONGS drain system and be discharged to the ocean

through the offshore outfalls. While the environmental effects of such a discharge have the potential to be adverse, they would not be significant, for several reasons. First, the only potential non-radiological contaminant in the SFPI system will be the anti-corrosion agents, and the volume of rust inhibitor additive used in the secondary loop water would be small (approximately 1 gallon of rust inhibitor per 1000 gallons of water). Second, the combined volume of water (2000 gallons) circulating through the two secondary loops is very small relative to both the current and future volumes of water being discharged through the outfalls, with which any fluid leaked from the SFPI systems would be mixed prior to reaching the ocean. As a result, even the largest potential leak or spill would be massively diluted prior to discharge to the ocean.[2] Further, a large spill of this sort would be an isolated event rather than a chronic discharge, and thus any measurable effects on the marine environment would be temporary. In summary, a leak or spill from the secondary loop which reached the SONGS drain system and was discharged to the ocean would not significantly degrade nearshore water quality or populations of marine organisms.

Construction-related discharges

Construction activities and grading during the installation of the SFPI cooling system would comply with existing water quality, storm water management, and spill prevention plans and their associated best management practices (BMPs). Because the project construction activities – minor excavation, pouring of concrete, use of heavy equipment, etc. – are similar to those already occurring at SONGS, the existing plans and BMPs provide appropriate controls to avoid and minimize potential adverse water quality effects. The facility's Storm Water Management Plan (SWMP) includes procedures regarding dust control and debris cleanup that apply to the types of equipment to be used and activities to be conducted during the project, and use of this procedure during construction will control dust and loose soil, minimize storm water runoff, and prevent soil and sediment from entering the ocean. Similarly, the risk of spills of oil or fuel from construction equipment would be minimized by implementation of the existing SPCC Plan. SCE will stage all project-related construction machinery and heavy equipment in paved, developed areas inside the SONGS perimeter where the necessary spill prevention controls are already in place, and will refuel vehicles within already authorized areas.

Reduced Seawater Intake

At present, the daily intake of ocean water at SONGS is approximately 98 MGD, or about 4% of the full operational flow when the plant was operational. Even at this reduced level of intake, the plant remains a major user of once-through cooling water, and results in the mortality of large numbers of marine organisms, both through entrainment in the intake stream and through impingement against the intake screens. Installation of the SFPI system, along with a previously-approved retrofit of the plant HVAC system and installation of smaller intake pumps (CDP waiver 9-15-0417-W), would eliminate the need for once-through cooling water and halve

[2] At present, SONGS takes in and discharges approximately 98 million gallons per day (MGD) of ocean water through the offshore conduits, primarily for the purpose of cooling various plant systems, including the spent fuel pools, but this water also serves to dilute plant waste streams prior to discharge. In the worst case, the complete leakage of both secondary loops, with a spill volume of 2000 gallons, would represent a tiny fraction (0.002%) of the current daily discharge from the plant. With the anticipated completion of the SFPI system and a previously-approved project to downsize the Units 2 and 3 intake pumps and replace the plant HVAC system (CDP# 9-15-0417-W), the intake of ocean cooling water would be eliminated. However, the plant would still take in and discharge approximately 48 MGD of seawater for the purpose of diluting SONGS waste streams. Thus, in the future, the maximum combined spill volume from the secondary loops would still only amount to 0.004% of the daily discharge volume.

the plant's rate of ocean water intake, to approximately 48 MGD.[3] This reduction in ocean water intake would result in commensurate reductions in entrainment and impingement impacts on marine organisms, and will thus improve biological productivity and enhance marine resources in nearby coastal waters, compared to existing conditions.

Conclusion

For the reasons described above, the Commission finds that the proposed project will be carried out in a manner that maintains and enhances marine resources, sustains the biological productivity and quality of coastal waters and will prevent or respond to potential spills, and is therefore consistent with Coastal Act Sections 30230, 30231 and 30232.

D. GEOLOGIC HAZARDS

Section 30253 of the Coastal Act states, in relevant part:

> *New development shall do all of the following:*
>
> *(a) Minimize risk to life and property in areas of high geologic, flood, and fire hazard.*
>
> *(b) Assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area or in any way require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs.*

The SONGS site lies in the Peninsular Ranges geomorphic province of southern California. Bedrock at the site is the San Mateo Formation, a dense, well-lithified sandstone of Pliocene to Pleistocene age, and, south of the Cristianitos Fault, the Monterey Formation, consisting of shale susceptible to landslides. These bedrock units are overlain by a series of marine and non-marine terrace deposits, approximately 50 feet thick, of late Pleistocene age. Units 2 and 3, including the site of the proposed SFPI project, were constructed on San Mateo Formation bedrock after the removal of overlying terrace deposits. The following geologic issues must be considered to determine whether the proposed development will minimize risk to life and property, and to assure stability and structural integrity at the site: Seismic safety (including ground shaking, fault rupture, and liquefaction), and coastal hazards (including tsunami inundation and bluff erosion).

Seismic Hazards

Like most of coastal California, the SONGS site lies in an area subject to earthquakes. SONGS is approximately 8 km from the Newport-Inglewood-Rose Canyon fault system, 38 km from the Elsinore Fault, 73 km from the San Jacinto Fault, and 93 km from the San Andreas Fault, all of which have been designated "active" (evidence of movement in the past 11,700 years) by the California Geological Survey (Jennings and Bryant 2010). Several relatively nearby offshore faults, including the Coronado Bank Fault Zone, the San Diego Trough Fault Zone, the Thirty-Mile Bank Fault, and the Oceanside Thrust also may have been active during Quaternary time. Nevertheless, seismicity here has historically been relatively quiet compared to much of the rest

[3] Continued ocean water intake through the end of decommissioning is needed to provide a means of diluting on-going plant waste streams and complying with state and federal discharge requirements (i.e., NPDES permits, ODCM limits).

of southern California, probably because of the relatively great distance from the San Andreas Fault, which accommodates most of the plate motion in the area, and the relatively low slip rates of the nearer faults (Peterson et al., 1996). A magnitude (M_L) 5.4 earthquake, associated with an unusually large swarm of aftershocks, occurred near the offshore San Diego Trough Fault Zone in 1986, but no other moderate or large (>M 5.0) earthquake has occurred within 50 km in historic time.

SONGS Units 2 and 3 are located on firm San Mateo Formation bedrock, which is not prone to liquefaction. Although the Cristianitos Fault crosses a portion of the SONGS site, this fault is not considered active, with no evidence for displacement during Quaternary time (within the last 1.6 million years) (Jennings and Bryant 2010). Thus, the primary seismic hazard at the project site is presented by ground shaking during a large earthquake centered off-site.[4]

The California Geological Survey's (CGS) Earthquake Shaking Potential for California (Branum et al., 2008) portrays the San Onofre area as a region of relatively low seismic shaking potential, with the Big Sur coast being the only other part of coastal California having a comparably low ground shaking potential according to this assessment. A comparable, quantitative assessment is provided by the U.S. Geological Survey's (USGS) Seismic-Hazard Map for the Coterminous United States, 2014 (Peterson et al. 2015), which characterizes the ground-shaking risk in firm bedrock areas along the San Onofre coast as a 10% chance of exceeding a peak ground acceleration (PGA) of approximately 0.25 g in 50 years. Probabilistic peak ground accelerations and spectral accelerations for the San Onofre area, assuming firm bedrock conditions, can also be estimated using on-line tools provided by both the USGS and CGS:

	10% in 50 yr (475-yr return period) (USGS)[5]	**10% in 50 yr** (475-yr return period) **(CGS)**[6]	**2% in 50 yr** (2475-yr return period) **(USGS)**[4]	**2% in 50 yr** (2475-yr return period) **(CGS)**[5]
PGA	0.20 – 0.25 g	0.245 g	0.40 – 0.50 g	0.505 g
0.2 sec SA	0.50 – 0.60 g	0.564 g	1.0 – 1.2 g	1.113 g
1.0 sec SA	0.15 – 0.20 g	0.200 g	0.30 – 0.40 g	0.377 g

These assessments, however, are based only on current understanding of the likelihood of earthquakes of varying intensities on nearby faults.

Studies undertaken at the time of the licensing permit application for SONGS Units 2 and 3 (U.S. Nuclear Regulatory Commission, 1981) identified an earthquake on the Newport-Inglewood-Rose

[4] Seismic hazards are often discussed in terms of the strength or intensity of ground shaking rather than earthquake magnitude. Measures of ground-shaking account for the attenuation of seismic waves due to distance from a rupture and amplification or damping due to substrate types (e.g., soft sediments vs. hard rock) and thus provide a better estimate of the amount of damage that may occur at a given site. Ground shaking is often expressed as the *acceleration* experienced by an object during an earthquake. The *spectral acceleration* occurs at different oscillation frequencies, which can be plotted to form a ground shaking *response spectrum*. The *peak ground acceleration* (PGA) is a measure of is the maximum force (expressed as a % of the acceleration of gravity, *g*) experienced by a small mass located at the surface of the ground during an earthquake. PGA is often used in seismic design as a hazard index for short, stiff structures.

[5] U. S. Geological Survey, Seismic Hazards Science Center, Custom Hazard Maps tool, http://geohazards.usgs.gov/hazards/apps/cmaps/, and/or Peterson et al. (2015).

[6] California Geological Survey, Probabilistic Seismic Hazards Ground Motion Interpolator (2008), http://www.quake.ca.gov/gmaps/PSHA/psha_interpolator.html.

Canyon fault system, centered on the portion of the fault nearest to SONGS, to be the seismic event with the greatest potential ground shaking for the SONGS site. Modeling of this "design basis earthquake" (M_S = 7.0, at 8 km from the site), yielded response spectra with a peak ground acceleration of 0.31 g. After comparison with empirical models, and in order to build in conservatism for inaccuracies in the model, the NRC approved the calculated spectra multiplied by a factor of about 2, resulting in a design basis peak ground acceleration of 0.67 g. In 2010, as an update to the older studies, SCE commissioned a new study (*Probabilistic Seismic Hazard Analysis Report*, GeoPentech, 2010) to assess the seismic hazard presented by both previously-recognized strike-slip faulting near SONGS and several more recently postulated – and still scientifically controversial -- offshore blind thrust faults (e.g., Oceanside and Thirty-Mile Bank thrust faults), which several studies suggest could generate significant earthquakes (M 7.1 – 7.6) (e.g., Rivero et al. 2000; Rivero and Shaw 2011).[7] Probabilistic peak ground accelerations and spectral accelerations for the SONGS site as determined in the 2010 PSHA study were similar to the USGS and CGS estimates:

	10% in 50 yr (475-yr return period) (GeoPentech 2010)	**2% in 50 yr** (2475-yr return period) (GeoPentech 2010)
PGA	0.227 g	0.477 g
0.2 sec SA	0.530 g	1.111 g
1.0 sec SA	0.261 g	0.501 g

The analyses summarized above indicate that the proposed project could experience strong ground shaking during a large earthquake, potentially causing damage to the new SFPI system components which could result in the disruption or complete shutdown of the spent fuel pool cooling system. The consequences of such a shutdown, in terms of radiological safety, are outside the jurisdiction of the Commission, and are not considered here. However, the Coastal Act imposes an independent requirement that all new development assure stability and structural integrity, and minimize risks to life and property, in areas of high geologic hazards. The proposed SFPI system must conform to these policies irrespective of its role in cooling the spent fuel pools.

SCE has stated that all new SFPI equipment, piping and support infrastructure have been designed to meet the seismic requirements of the California Building Code (CBC), and that a supply of replacement parts would be kept on site to facilitate any needed repairs if the system were damaged in a major earthquake. In addition, in the event that one of the chillers was damaged, the cross-tied configuration of the SFPI system would allow the remaining three chillers to serve both spent fuel pools while the damaged chiller was offline.

The 2013 CBC requires that non-structural components (including architectural, mechanical, electrical and plumbing equipment) and their supports and attachments that are permanently attached to a structure be designed and constructed to resist the effects of earthquake motions in accordance with design loads and other requirements contained in the American Society of Civil

[7] Other studies dispute the existence of blind thrust faults offshore of Orange and San Diego counties, and suggest that the observational data (seismic reflection profiling, earthquake clustering patterns, etc.) used by Rivero et al. to infer thrust faulting can be interpreted within a framework of step-overs and trend changes along known north-to-northwest oriented strike-slip fault systems (Ryan et al. 2012; Malloney et al., *in press*).

Engineers *Minimum Design Loads and Requirements for Buildings and other Structures* (ASCE 7-10, 2013). CBC Section 1613 and ASCE 7 lay out specific procedures for determining seismic design criteria for different site classes (determined by soil properties) and structure/component risk categories based on probabilistic analysis of seismic loading (i.e., ground acceleration) for a specific location. The CBC mandates the use of USGS Maximum Considered Earthquake Ground Motion Response Acceleration maps for seismic design analysis. The USGS also provides an on-line, georeferenced Risk Targeted Ground Motion Calculator[8] for the purposes of calculating ground motion parameter values in accordance with ASCE 7 standards for building and non-structural design.

SCE has conducted seismic design analysis for the SFPI system following the procedures and requirements of ASCE 7, generating a set of horizontal and vertical ground-shaking intensities (spectral accelerations) defining the design seismic loads for the proposed system. The design seismic response spectrum encompasses ground-shaking intensities of 0.820 g at a 0.2 second period (0.2 sec SA) and 0.471 g at a 1.0 second period (1.0 sec SA), corresponding to a PGA of approximately 0.35 g – 0.45 g. These ground-shaking intensities correspond to an average return period of approximately 1,500 – 2,000 years, or a 2.5 – 5% chance of exceedance in 50 years. The SFPI system, including mechanical, electrical, piping and support components, will be designed and installed to withstand this level of ground-shaking, without collapsing or resulting in damage to adjacent equipment.

The ability of the proposed system to perform according to its design basis during an earthquake will depend at least in part on the appropriate maintenance of system components. In order to assure that the proposed system will continue meet its initial seismic safety design throughout the project life, the Commission finds that **Special Condition 1** is necessary; this condition would require that SCE submit an Inspection and Maintenance Plan detailing the type and frequency of system inspections and the procedures that will be followed to maintain the SFPI system in good working condition.

In summary, the SFPI system would be designed and constructed in accordance with applicable state (the CBC) and national (ASCE 7) standards for seismic safety, and, with the adoption of **Special Condition 1**, would be inspected and maintained to assure the integrity of system components. The Commission finds that compliance with these standards and this condition would minimize geologic hazards and assure structural stability.

Coastal Hazards

The new equipment proposed as part of the SFPI system would be located approximately 475 feet inland of the existing SONGS Units 2 and 3 seawall, at an elevation of 31 feet above mean lower low water (MLLW), and as a result is not expected to be exposed to coastal hazards, including tsunami flooding and bluff erosion, during the life of the project.

Several previous studies have estimated the potential run-up and inundation that would occur on the SONGS Site during a tsunami event. The most recent site-specific analysis was conducted as part of SCE's 2013 *Calculations for a Probable Maximum Tsunami* report (Kirby 2013), which considered both local- and distant-sourced tsunami events. Models of far field tsunami sources

[8] U.S. Geological Survey Risk Targeted Ground Motion Calculator, http://earthquake.usgs.gov/hazards/designmaps/rtgm.php

associated with large subduction-zone earthquakes (M 9.0 – 9.5) from around the Pacific Rim (e.g., Aleutians, Kuril Islands, Japan Islands, Chile) yielded tsunami wave run-up elevations ranging from 8.5 to 22 feet MLLW, with the largest tsunamis produced by earthquakes in the eastern Aleutian Islands.[9] Models of locally-sourced tsunamis, including those resulting from a M7.5 earthquake along a theorized offshore blind thrust fault and from submarine landslides, yielded maximum run-up elevations ranging from 10 to 21.5 feet MLLW. A recent, independent evaluation of potential tsunami inundation at the SONGS site is provided by the *Tsunami Inundation Map for Emergency Planning* (San Onofre Bluff quadrangle), prepared by the State of California in 2009. The purpose of this series of maps was to identify a "credible upper bound" of potential inundation at any location along the coast, based on a combination of potential tsunami source events, including both local and fair field sources. At SONGS, the map suggests a credible upper bound to potential inundation of 20 to 23 feet MLLW, similar to the projections contained in the SCE study.

Short-duration high water levels, such as those occurring during extreme high tides ("king tides") and/or winter storms, could be expected to increase tsunami inundation levels by up to several feet. Sea level rise associated with global warming, which can be expected to exacerbate tsunami inundation at SONGS in future decades, would make only a slight contribution (if any), to increased water levels during the life of the project (through December 2020).[10] Even taking into account these additional factors, the elevation of the project site at 31 feet MLLW would remain above the maximum credible tsunami run-up expected for this location during the project life.[11]

Similarly, the project site would not be threatened by shoreline erosion during the project life. In their natural state, coastal bluffs at the SONGS Units 2 and 3 site are composed of highly-erodible terrace deposits underlain by the more resistant San Mateo Formation sandstone. During plant construction, the bluff was extensively graded, the terrace deposits were largely removed, and the plant foundations were set in San Mateo Formation bedrock. SCE also installed a shoreline protection system, consisting of a rock revetment and a concrete seawall/bulkhead rising to an elevation of approximately 30 feet MLLW, in front of Units 2 and 3 at the time of construction. As a result, there has been no measurable bluff retreat at Units 2 and 3 over the past 35 years, and future erosion is expected to be negligible so long as the shoreline protection remains in place. Previous studies of coastal bluffs to the north and south of SONGS have estimated long-term bluff retreat rates in the range of 6 – 20 inches per year at the base of unprotected slopes within the San Mateo Formation (Hapke and Reed 2007; Hapke et al. 2007).[12] Discounting the presence of shoreline armoring, a maximum bluff retreat rates of 20

[9] For comparison, actual tsunami run-up heights observed along the Southern California coast following large historical earthquakes on the Pacific Rim, including the M9.5 1960 Chilean earthquake, M9.2 1964 Alaskan earthquake, and M8.8 2010 Chilean earthquake, ranged from 4.9 to 12.5 feet above MLLW. (California Geologic Survey, *Historic Tsunamis in California*, http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Pages/About_Tsunamis.aspx#historic)

[10] Based on sea level rise curves derived from projections contained in the National Research Council's *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future* (2012) report, sea level along the Southern California Shoreline could rise 1-7 inches by 2021.

[11] This analysis does not take into account the existing seawall in front of Units 2 and 3, which provides additional protection against a tsunami and is expected to remain in place during the life of the project.

[12] Shoreline erosion processes are highly episodic, and bluff retreat rates can vary greatly over time and over short distances in response to wave action, storm events, and differences in bluff substrate.

inches per year over the 5-year life of the project would equate to a total bluff retreat of just 8 feet, far short of the approximately 475-foot setback of the SFPI system. Thus, even in the absence of the existing shoreline protection, the proposed project would not be at risk from coastal erosion.

Conclusion

For the reasons described above, the Commission finds that the proposed project, as modified by **Special Condition 1**, would minimize risks to life and property from seismic, flooding, and erosion hazards and assure stability and structural integrity without requiring shoreline protection, and is therefore consistent with Coastal Act Sections 30253(a) and (b).

E. VISUAL RESOURCES

Section 30251 of the Coastal Act states:

> *The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance. Permitted development shall be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural land forms, to be visually compatible with the character of surrounding areas, and, where feasible, to restore and enhance visual quality in visually degraded areas. New development in highly scenic areas such as those designated in the California Coastline Preservation and Recreation Plan prepared by the Department of Parks and Recreation and by local government shall be subordinate to the character of its setting.*

The proposed project involves the installation of new structures and equipment inside or adjacent to larger existing buildings on the heavily industrialized SONGS site. The largest new structures, the two shipping containers and four chillers (each approximately 20 ft L x 8 ft W x 8.5 ft H), would be placed at ground level behind the 110-ft tall Auxiliary Building, between the two 120-ft tall Units 2 and 3 Fuel Handling Buildings (*see* **Exhibit 3**), and would not be visible from the public walkway seaward of SONGS or other publically-accessible shoreline areas. The project site is situated at an elevation (31 feet above MLLW) well below that of the public roads inland of SONGS (i.e., Old Pacific Coast Highway, Interstate 5), and would not be visible to drivers along these corridors. Thus, the project would not block views to or along the coast or alter the predominantly industrial visual character of the SONGS site. Although a minor amount of excavation will be necessary in order to construct foundations for the four chillers, the entire SONGS site was heavily graded during plant construction, and the present project would not alter natural landforms.

For these reasons, the Commission finds that the proposed project will not result in substantial visual effects and is consistent with Section 30251 of the Coastal Act.

F. ATTORNEYS' FEES AND COSTS

Coastal Act section 30620(c)(1) authorizes the Commission to require applicants to reimburse the Commission for expenses incurred in processing CDP applications. *See also* 14 C.C.R. § 13055(e). Thus, the Commission is authorized to require reimbursement for expenses incurred in defending its action on the pending CDP application. Therefore, consistent with Section 30620(c), the Commission imposes **Special Condition 2**, requiring reimbursement of any costs

and attorneys fees the Commission incurs "in connection with the defense of any action brought by a party other than the Applicant/Permittee … challenging the approval or issuance of this permit."

G. CALIFORNIA ENVIRONMENTAL QUALITY ACT

Section 13096 of the Commission's administrative regulations requires Commission approval of coastal development permit applications to be supported by a finding showing the application, as modified by any conditions of approval, to be consistent with any applicable requirements of the California Environmental Quality Act ("CEQA"). Section 21080.5(d)(2)(A) of CEQA prohibits approval of a proposed development if there are feasible alternatives or feasible mitigation measures available that would substantially lessen any significant impacts that the activity may have on the environment. The project as proposed is not expected to have any significant adverse impacts to the environment. The project has been conditioned to ensure that it is consistent with all applicable Coastal Act policies. Therefore, the proposed project is consistent with CEQA.

Appendix A – Substantive File Documents

Branum, D., S. Harmsen, E. Kalkan, M. Petersen and C. Wills (2008). *Earthquake Shaking Potential for California,* Map Sheet 48 (Revised), California Geological Survey, Sacramento, California, 2008.

California Coastal Commission, *Coastal Development Permit Application #9-15-0228*, submitted by Southern California Edision for the construction of an independent spent fuel storage installation (ISFSI) in the SONGS North Industrial Area, February 20, 2015.

California Coastal Commission, *Coastal Development Permit #E-00-014*, issued to Southern California Edison for construction of an ISFSI, consisting of up to 104 steel-reinforced concrete fuel storage modules, to provide temporary dry storage for SONGS 2&3 spent fuel, July 11, 2001.

California Coastal Commission, *Coastal Development Permit De Minimis Waiver #9-14-1550-W*, issued to Southern California Edison for the removal of existing switchyard controls and installation of a new 12kV power source and back-up diesel generators at SONGS, September 10, 2014.

California Coastal Commission, *Coastal Development Permit De Minimis Waiver #9-14-0265-W*, issued to Southern California Edison for the on-site relocation of a back-up diesel generator at SONGS, April 17, 2015.

California Coastal Commission, *Coastal Development Permit De Minimis Waiver #9-14-0417-W*, issued to Southern California Edison for the replacement of the SONGS Units 2 and 3 cooling water pumps with smaller dilution pumps, and retrofitting of plant HVAC system, May 14, 2015.

California Emergency Management Agency, California Geological Survey, and University of Southern California (2009). *Tsunami Inundation Map for Emergency Planning, San Onofre Bluff Quadrangle*, June 1, 2009.

GeoPentech (2010). *San Onofre Nuclear Generating Station Seismic Hazard Assessment Program 2010 Probabilistic Seismic Hazard Analysis Report*, prepared for Southern California Edison, Dec 2010.

Hapke, C.J. and D. Reid (2007). *National Assessment of Shoreline Change, Part 4: Historical Coastal Cliff Retreat along the California Coast.* U.S. Geological Survey Open-File Report 2007-1133.

Hapke, C.J., D. Reid and B. Richmond (2007). Rates and trends of coastal change in California and the regional behavior of the beach and cliff system. *Journal of Coastal Research* 25: 603-615.

Jennings, C.W., and W.A. Bryant (2010). *Fault activity map of California.* California Geological Survey, Sacramento, California, 2010.

Kirby, J.T. (2013). *SONGS Calculations for Probable Maximum Tsunami*, prepared for Southern California Edison Company.

Malloney, J., N. Driscoll, G. Kent, S. Duke, T. Freeman, and J. Bormann (in press). Segmentation and step-overs along strike-slip fault systems in the inner California Borderlands: Implications for fault architecture and basin formation. *Applied Geology in California*.

National Research Council, *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*, 2012.

Petersen, M.D., Byrant, W.A., Cramer, C.H., Cao, T., Reichle, M.S., Frankel, A.D., Leinkaemper, J.J., McCrory, P.A., and Schwarta, D.P. (1996). *Probabilistic seismic hazard assessment for the state of California*, California Division of Mines and Geology, Sacramento, California, 1996.

Petersen, M.D., M.P. Moschetti, P.M. Powers, C.S. Mueller, K.M. Haller, A.D. Frankel, Y. Zeng, S. Rezaeian, S.C. Harmsen, O.S. Boyd, E.H. Field, R. Chen, N. Luco, R.L. Wheeler, R. A. Williams, A.H. Olsen and K.S. Rukstales (2015). *Seismic-hazard maps for the conterminous United States, 2014*. U.S. Geological Survey Scientific Investigations Map 3325, http://dx.doi.org/10.3133/sim3325.

Rivero, C. and J.H. Shaw (2011). Active folding and blind thrust faulting induces by basin inversion processes, inner California borderlands. In: Shaw, J.H., and J. Suppe, eds., *Thrust Fault Related Folding*, AAPG Memoir Vol. 94, pp. 187-214.

Rivero, C., J.H. Shaw and K. Mueller (2000). Oceanside and Thirtymile Bank blind thrusts: Implications for earthquake hazards in coastal southern California. *Geology* 28(10): 891-894.

Ryan, H.F., J.E. Conrad, C.K. Paull and M. McGann (2012) Slip rate on the San Diego Trough fault zone, inner California borderland, and the 1986 Oceanside earthquake swarm revisited. *Bulletin of the Seismological Society of America* 102(6): 2300-2312.

San Diego Regional Water Quality Control Board, *National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements, San Onofre Nuclear Generating Station, Unit 2* (NPDES No. CA0108073; Order No. R9-2005-0005).

San Diego Regional Water Quality Control Board, *National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements, San Onofre Nuclear Generating Station, Unit 3* (NPDES No. CA0108181; Order No. R9-2005-0006).

Southern California Edison, *San Onofre Nuclear Generating Station Units 2 and 3 Post-Shutdown Decommissioning Activities Report*, submitted to the U.S. Nuclear Regulatory Commission on September 23, 2014 (NRC Docket Nos. 50-361 and 50-362).

Southern California Edison, *SONGS Units 1, 2 and 3 Spill Prevention, Control and Countermeasures (SPCC) Plan*, Revision 11 (SO123-XV-16).

Southern California Edison, *SONGS Units 1, 2 and 3 Storm Water Management Plan (SWMP)*, Revision 9 (SO123-XV-32).

Southern California Edison, *SONGS Spent Fuel Pool Cooling Island Operation*, Draft Procedure, Revision 0 (SO23-3-2.11.2).

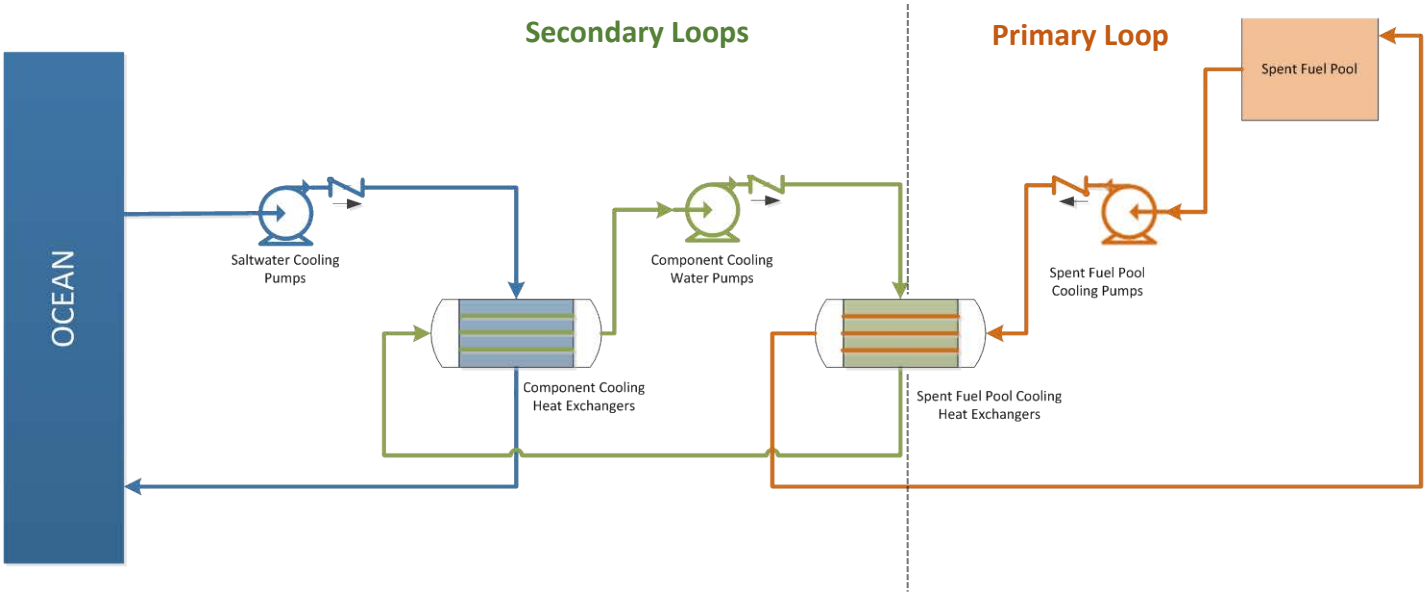
Southern California Edison, *SONGS Spent Fuel Pool Cooling Island Off-Normal Actions*, Draft Procedure, Revision 0 (SO23-3-2.11.3).

U.S. Nuclear Regulatory Commission (1981). *Safety evaluation report related to the operation of San Onofre Nuclear Generating Station, Units 2 and 3, Docket numbers 50-361 and 50-362, Southern California Edison Company, et al.*, U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C., 1981.

(a) Regional map of Southern California with San Onofre Nuclear Generating Station (SONGS) designated as a red star

(b) Project Location: Aerial photograph of SONGS identifying Units 2 and 3 (yellow box) and the general location of the SFPI project (red box)

(A) Schematic of Existing Ocean Water Once-Through Cooling System



(B) Schematic of Proposed Spent Fuel Pool Island Cooling System

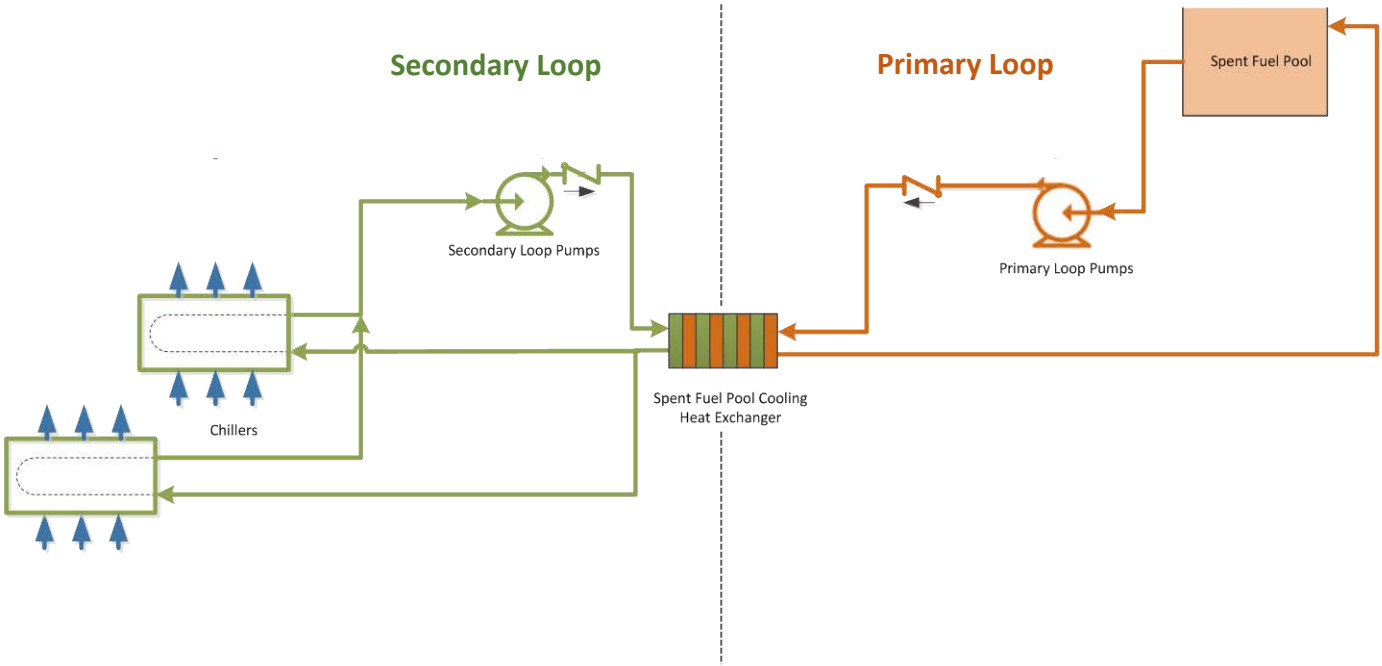
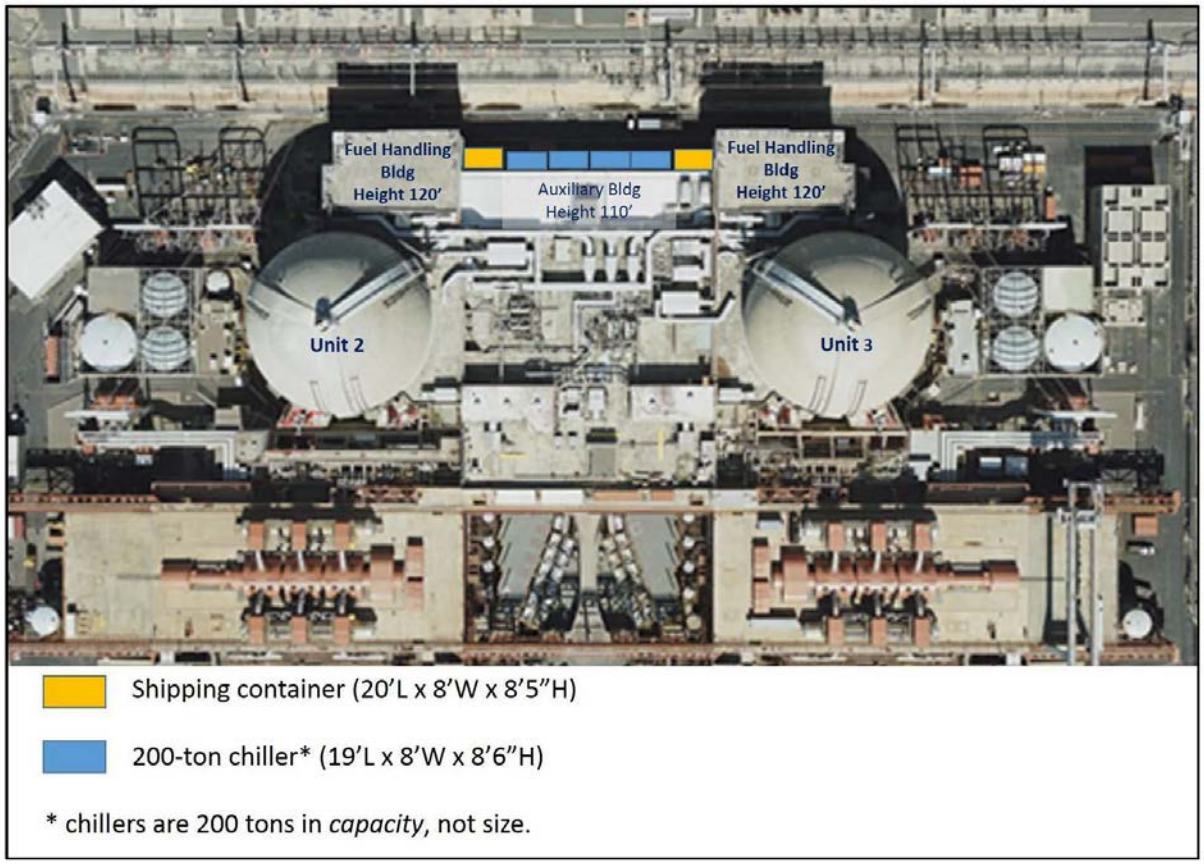


Exhibit 2
Application No. 9-15-0162
Southern California Edison
Cooling System Schematic Diagrams



Above: Configuration of the shipping containers and chillers between the Units 2 and 3 fuel handling buildings (Note: shipping container and chiller representations not to scale; the area that will be occupied is less than half the space shown in this figure)

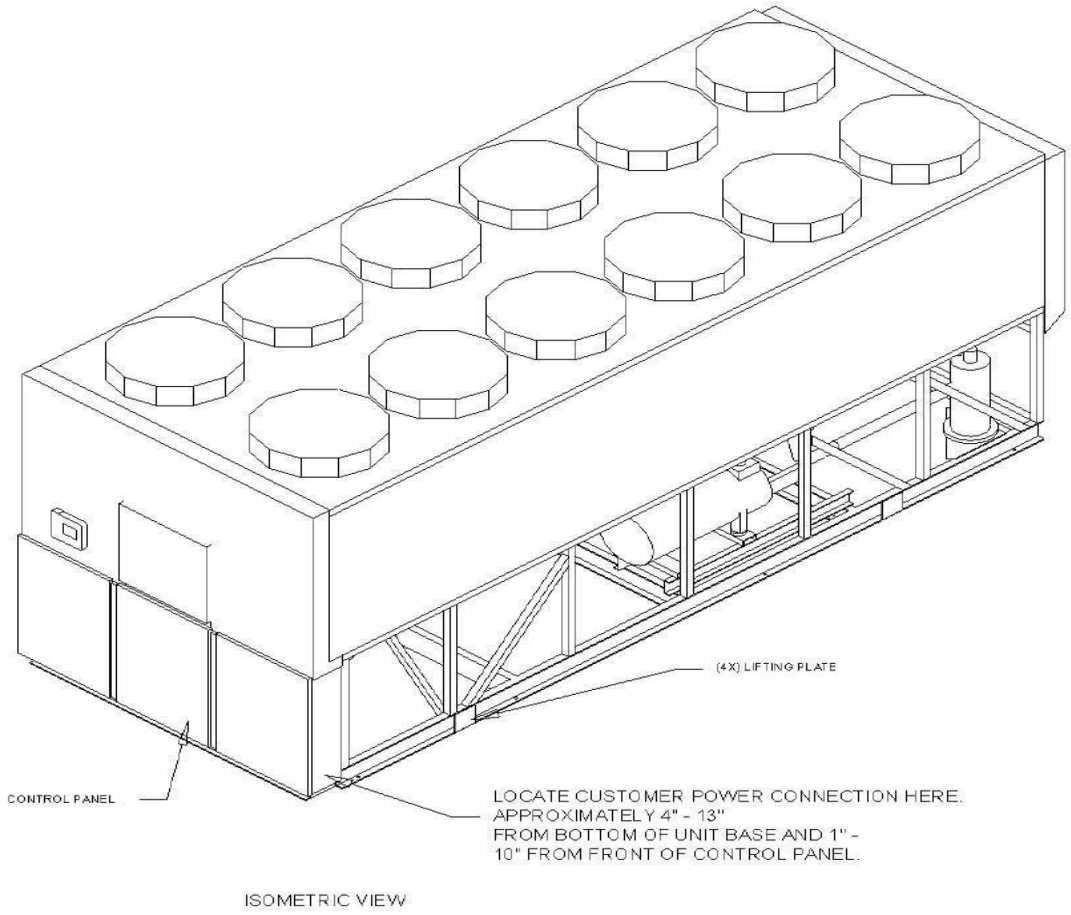
Below: Oblique view of project site with simulated placement of chillers and containers

Exhibit 3
Application No. 9-15-0162
Southern California Edison
Project Configuration

Trane 200 Ton Chiller Unit

Equipment Description:

Two 200-ton capacity air cooled chillers will be used within a closed loop cooling system utilizing potable water on the secondary side of the temporary fuel pool cooling system for SONGS Unit 2 and SONGS Unit 3. The designed criterion is based on information provided by SONGS of a heat load calculation of three million BTU/hr per fuel pool. Each chiller will be a 200-ton unit designed to remove 2.4 MBTU/hr and have the ability to be cross connected so the entire heat load of Units 2 and 3 spent fuel pools can be removed by three chillers. Chillers require 460 VAC power. The chillers will be limited to a return temperature of 100°F due to relief valves on the refrigerant side of the unit, which will lift at 108°F and release Freon into the atmosphere.



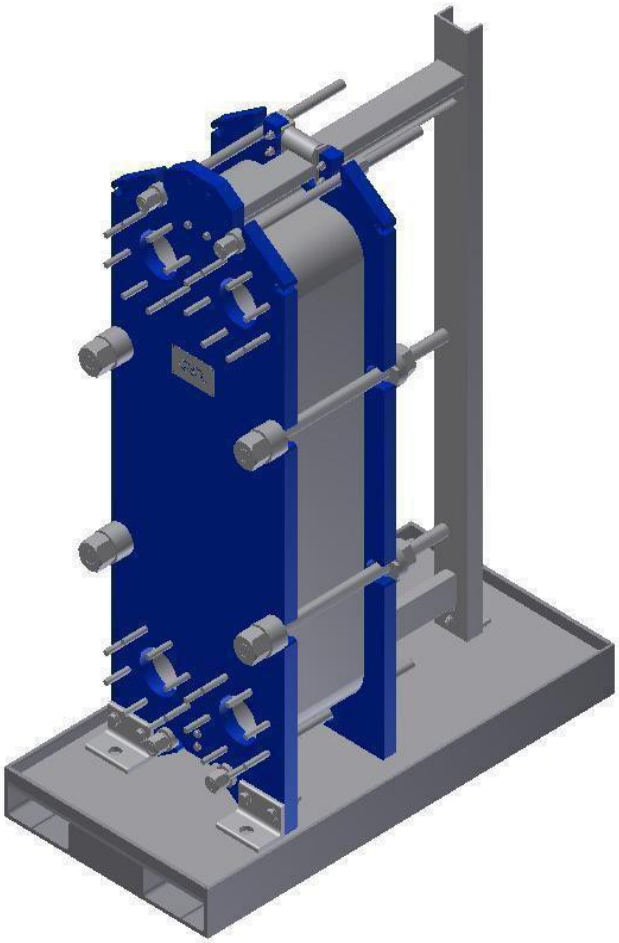
ISOMETRIC VIEW

Manufacturer Performance Data:

Rated capacity (AHRI)	198.90 tons	Rated efficiency (AHRI)	9.7 EER Evap application Std temp
ASHRAE 90.1/CSA compliance All versions IPLV	13.6 EER		
Refrig (HFC-134a) - ckt 1	215.0 lb.	Refrig (HFC-134a) - ckt 2	215.0 lb
Evap fluid type	Water		
Evap entering temp	54.00 F Evap	Evap leaving temp	44.00 F
Evap fluid concentration	0.00 %	Fluid freeze point	32.00 F
Evap flow rate	475.50 gpm		
Max Evap flow rate	883.00 gpm	Min Evap flow rate	241.00 gpm
H2O Evap fouling factor	0.00010 hr-sq ft-deg F/Btu	Press drop max Evap flow	36.80 ft. H2O
Evap configuration	2 pass		
Saturated Evap temp – ckt 1	40.10 F	Saturated Evap temp - ckt 2	40.90 F

Equipment Description Plate Frame Heat Exchanger (HEX)

Equipment Description:
The Plate Frame Heat Exchanger has a 3 million btu/hr. capacity based on the inlet temperature of 100 degrees F on the primary loop side with a secondary side cold water temperature of 76 degrees F. The primary loop will take suction from the fuel pool, discharge heat to the heat exchanger, and return back to the fuel pool. The secondary loop will accept heat from the heat exchanger and return back to the electric chiller units, removing the heat load generated from the primary loop. The picture below is a conceptual drawing not to be used from dimensional information.



HEX Manufacturer Performance Data

		Hot side	Cold side
Fluid		Water	Water
Density	lb/ft³	61.99	62.14
Specific heat capacity	Btu/lb, °F	1.00	1.00
Thermal conductivity	Btu/ft, h, °F	0.360	0.354
Viscosity – inlet	cP	0.683	0.906
Viscosity – outlet	cP	0.783	0.814
Volume flow rate	GPM	500.0	700.0
Inlet temperature	°F	100.0	76.0
Outlet temperature	°F	87.9	84.6
Pressure drop	psi	4.00	7.18
Heat Exchanged	kbtu/h	3000	
L.M.T.D.	°F	13.6	
O.H.T.C clean conditions	Btu/ft²,h,°F	954.4	
O.H.T.C service	Btu/ft²,h,°F	752.2	
Heat transfer area	ft²	293.6	
Duty margin	%	26.9	
Relative directions of fluids		Countercurrent	
Number of plates		46	
Effective plates		44	
Number of passes		1	1
Extension capacity			19
Plate material / thickness		ALLOY 316 / 0.50 mm	
Sealing material		EPDMP CLIP-ON	EPDMP CLIP-ON
Connection material		Stainless steel	Stainless steel
Connection diameter		See drawing	See drawing
Nozzle orientation		S4 -> S3	S1 <- S2
Pressure vessel code		ASME	ASME
Flange rating		150#	150#
Design pressure	psi	150.0	150.0
Test pressure	psi	195.0	195.0
Design temperature	°F	200.0	200.0
Overall length x width x height	in	45 x 26 x 74	
Liquid volume	ft³	2.00	2.08

Example of a standard shipping container

Example of a 200-ton heat capacity chiller