SCE Position Paper
Tsunami Hazard Analysis & Protection

I. Summary

The effects of potential tsunamis at San Onofre are bounded by the design capability of the dry storage cask system and seawall protection for the Units 2&3 site (including the Spent Fuel Pools). The site is protected by two seawalls. The dry storage cask system seawall is constructed of continuous steel "sheetpile" members and the seawall for Units 2&3 spent fuel pools are constructed of reinforced concrete. Both seawalls are higher than the maximum water level postulated for a potential tsunami at San Onfore. In addition, the dry cask storage system (canisters and modules), are designed for total submersion during an extreme design basis flood event, postulated to result from natural phenomena such as tsunami. Engineering analyses demonstrate acceptable performance of the storage system for tsunami flood effects.

II. Scope

The purpose of this position paper is to explain how spent nuclear fuel stored at the San Onofre site (at the Independent Spent Fuel Storage Installation and Units 2&3 Spent Fuel Pools) is protected against a potential tsunami hazard. The paper summarizes the results of the site-specific tsunami analyses that have been performed, and how protection is assured for the ISFSI and the Spent Fuel Pools.

III. Analysis

Federal regulations require that spent fuel storage installations as well as nuclear structures, and systems are designed to withstand the effects of natural phenomena such as . . . tsunami [Code of Federal Regulations, Title 10, Part 72 (Sections 92 and 122), and Part 50, Appendix A (Criterion 2)].

<u>Tsunami Characteristics</u>

- A tsunami is generated by rapid large-scale dislocations of the surface or bottom of the sea, or of some equivalent impulse. This large wave action is generally caused by an earthquake.
- Because of its broad shelf topography offshore, the Southern California coast is not sensitive to tsunami waves generated by distant sources on the Pacific Rim, unlike other locations in the world. Because of the moderating effect of Southern California's offshore borderland, the maximum analyzed tsunami wave will be generated by a local offshore fault zone.
- An analysis of the local offshore fault zone, referenced in the Updated Final Analysis Report , results in a maximum tsunami water height for San Onofre site of not greater than 27 feet (for reference, sea level is elevation = 0 feet).

<u>Protection of the Units 2&3 Spent Fuel Pools</u>

- Tsunami protection for the Unit 2&3 site is provided by a reinforced concrete seawall and intake screen well perimeter wall constructed to elevation 30 feet above sea level. The San Onofre Units 2&3 plant grade is also 30 feet above sea level.

- The SONGS 2&3 seawall, intake perimeter wall, and plant grade elevation are above the maximum analyzed tsunami water level and there is no impact to the Units 2&3 Spent Fuel Pools.
- Even if a tsunami would disrupt spent fuel cooling, there is over 99 hours for the station to respond and return cooling to the pool with portable equipment.

Protection of the Independent Spent Fuel Storage Installation (ISFSI)

- Although the Unit 1 site was cleared of most structures for construction of the ISFSI, the 28 foot high seawall remains. It is constructed of continuous steel "sheetpile" members driven into the sandstone bedrock and covered in gunnite (a concrete protective coating).
- Both the dry shielded canister (DSC), which provides confinement of the spent nuclear fuel, and the Advanced Horizontal Storage Modules (AHSMs) are designed for an enveloping design basis flood, postulated to result from natural phenomena such as tsunami. To evaluate design capability from an extreme flood event, a water depth of 50 feet (measured from the bottom of the concrete modules) having a water velocity of 15 feet per second was used.
- The storage modules are located on a reinforced concrete foundation, at elevation 19.75 feet above sea level. As a result, San Onofre's dry cask storage system flooding design capability is 69.75 feet. As determined by computer structural analysis, the strength of the storage cask system exceeds the forces generated during a tsunami flood event. The forces generated for overturning and sliding during a flood (tsunami) event are bounded by seismic design criteria, so the modules will be stable.
- Submersion of the modules does not adversely affect the thermal analysis for the self-cooling dry storage cask system. The dry cask system needs no electric power for cooling since it is a totally passive system. Any blockage would be identified during post-tsunami inspections. The reinforced concrete storage modules are designed to safely withstand tornado-generated missiles traveling at high velocity, including wooden telephone poles, steel pipes, and large deformable objects (e.g., automobiles) traveling at least 185 feet per second (over 100 miles per hour). Any debris moving with the tsunami wave would have a velocity much less than the tornado missiles for which the modules have been analyzed.

IV. Conclusion

The Units 2&3 site is protected from tsunami by a reinforced concrete seawall which is higher than the maximum water level determined for a tsunami at San Onfore. In addition, the SFP structure itself provides significant protection against external flooding, and the San Onofre has over 99 hours to respond to a sustained loss of SFP cooling with portable equipment.

The continuous steel seawall located between the Pacific Ocean and the ISFSI provides protection against inundation of the ISFSI site from ocean hazards. The design capability of the ISFSI is much greater than the potential effects of tsunami at the San Onofre site. The design of the DSC and AHSM exceeds the maximum analyzed tsunami water level, with significant design

margin. Engineering analyses demonstrate acceptable performance of the storage system for tsunami flood effects, including structural capacity, stability, thermal effects during submersion, and missile protection.