Enclosure 2

TECHNICAL EVALUATION REPORT

HYDROLOGICAL CONSIDERATIONS

(SEP, II-3A, B, B.1, C)

SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1

NRC DOCKET NO. 50-206

NRC TAC NO. 41361, 41350, 41339, 41328

NRC CONTRACT NO. NRC-03-79-118

FRC PROJECT C5257

FRC ASSIGNMENT 16

FRC TASK 423

Prepared by

Franklin Research Center
20th and Race Street
Philadelphia, PA 19103

FRC Group Leader: J. Scherrer

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: G. Staley

September 14, 1982

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

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Prepared by:	Reviewed by:	Approved by:
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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

Mr. J. Scherrer, Ms. S. Roberts, Mr. G. Overbeck, Mr. W. Erickson, Mr. M. Mulvihill, and Mr. J. Turner contributed to the technical preparation of this report through a subcontract with WESTEC Services, Inc.

1. INTRODUCTION

1.1 PURPOSE OF REVIEW

The purpose of this review is to evaluate the U.S. Nuclear Regulatory Commission (NRC) Systematic Evaluation Program (SEP) Topics II-3.A (Hydrologic Description), II-3.B (Flooding Potential and Protection Requirements), II-3.B.1 (Capability of Operating Plants to Cope with Design Basis Flooding Conditions), and II-3.C (Safety-Related Water Supply - Ultimate Heat Sink) for San Onofre Nuclear Generating Station Unit 1. This review includes independent analyses by Franklin Research Center (FRC) as needed to identify various hydrologic conditions. The NRC is reviewing other safety topics within the SEP and intends to coordinate an integrated assessment of plant safety after completion of the review of all applicable safety topics and design basis events (DBEs).

1.2 GENERIC BACKGROUND

The SEP was established to evaluate the safety of 11 of the older nuclear power plants. An important element of the program is the evaluation of the plants against current licensing criteria with respect to 137 selected topics, several of which relate to hydrologic assessments of the site.

In a letter dated January 14, 1981 [1], the NRC agreed to the SEP Owners Group's proposed redirection of the SEP, whereby each licensee would submit evaluations of 60% of the SEP topics in time for a review by the NRC staff to be completed by June 1981. Evaluations of the topics not selected by each licensee were the NRC's responsibility.

1.3 PLANT-SPECIFIC BACKGROUND

This report presents an evaluation of the hydrologic influences at the San Onofre Nuclear Generating Station Unit 1 site and assesses the plant according to criteria currently used by the NRC staff for licensing new facilities. The Licensee will be instructed to inform the NRC of differences between the as-built facility and the licensing basis assumed in this assessment.

2. REVIEW CRITERIA

The reference criteria used for all the hydrology topics were based on the Code of Federal Regulations, Title 10, Part 50 (10CFR50), Appendix A, General Design Criteria, Overall Requirements, Criterion 2, entitled "Design Bases for Protection Against Natural Phenomena." Specific topic review criteria were taken from the following documents:

Standard Review Plan (SRP) [2], Sections:

- 2.4.1 Hydrologic Description
- 2.4.2 Floods
- 2.4.3 Probable Maximum Flood (PMF) on Streams and Rivers
- 2.4.4 Potential Dam Failures
- 2.4.5 Probable Maximum Surge and Seiche Flooding
- 2.4.6 Probable Maximum Tsunami Flooding
- 2.4.7 Ice Effects
- 2.4.8 Cooling Water Canals and Reservoirs
- 2.4.9 Channel Diversions
- 2.4.10 Flooding Protection Requirements
- 2.4.11 Cooling Water Supply
- 2.4.13 Groundwater
- 2.4.14 Technical Specifications and Emergency Operation Requirements

Regulatory Guides

- 1.27 Ultimate Heat Sink for Nuclear Power Plants [3]
- 1.59 Design Basis Floods for Nuclear Power Plants [4]
- 1.102 Flood Protection for Nuclear Power Plants [5]
- 1.127 Inspection of Water Control Structures Associated with Nuclear Power Plants [6]
- 1.135 Normal Water Level and Discharge at Nuclear Power Plants [7]

American National Standards Institute (ANSI) N170-1976 [8]

Standards for Determining Design Basis Flooding at Power Reactor Sites.

3. TECHNICAL EVALUATION

3.1 HYDROLOGIC DESCRIPTION (TOPIC II-3.A)

3.1.1 Topic Background

Information pertaining to the Systematic Evaluation Program (SEP) Topic II-3.A, Hydrologic Description, for the San Onofre Nuclear Generating Station Unit 1 was reviewed. The information was derived from NRC docketed information, NRC staff files, state and local sources, and Licensee responses to a request for additional information [16, 17].

3.1.2 Topic Review Criteria

Criteria for the review of the hydrologic description were taken from the Standard Review Plan (SRP), Section 2.4.1, Hydrologic Description [2], and the American National Standards Institute (ANSI) N170-1976, Hydrologic Description [8].

3.1.3 Evaluation

Site Location

The San Onofre Nuclear Generating Station is situated about 51 miles northwest of San Diego and 62 miles southeast of Los Angeles, in San Diego County near the city of San Clemente, as shown in Figure 1.

San Onofre Unit I covers 83.63 acres and is located at 33°22'10"N latitude and 117°33'30"W longitude. It is bordered on the north and east by Camp Pendleton Marine Corps Base, on the south by San Onofre Units II and III, and on the west by San Onofre State Beach and the Pacific Ocean. The 8-lane Interstate Highway 5 (the San Diego Freeway) and the Atchison, Topeka, and Santa Fe Railway lies within 1000 feet of the plant site, and the nearest privately owned land is 2.5 miles away [9].

Topographic features of the site include a narrow strip of sand beach below seacliffs which are 60 to 90 ft high and dissected by deep ravines.

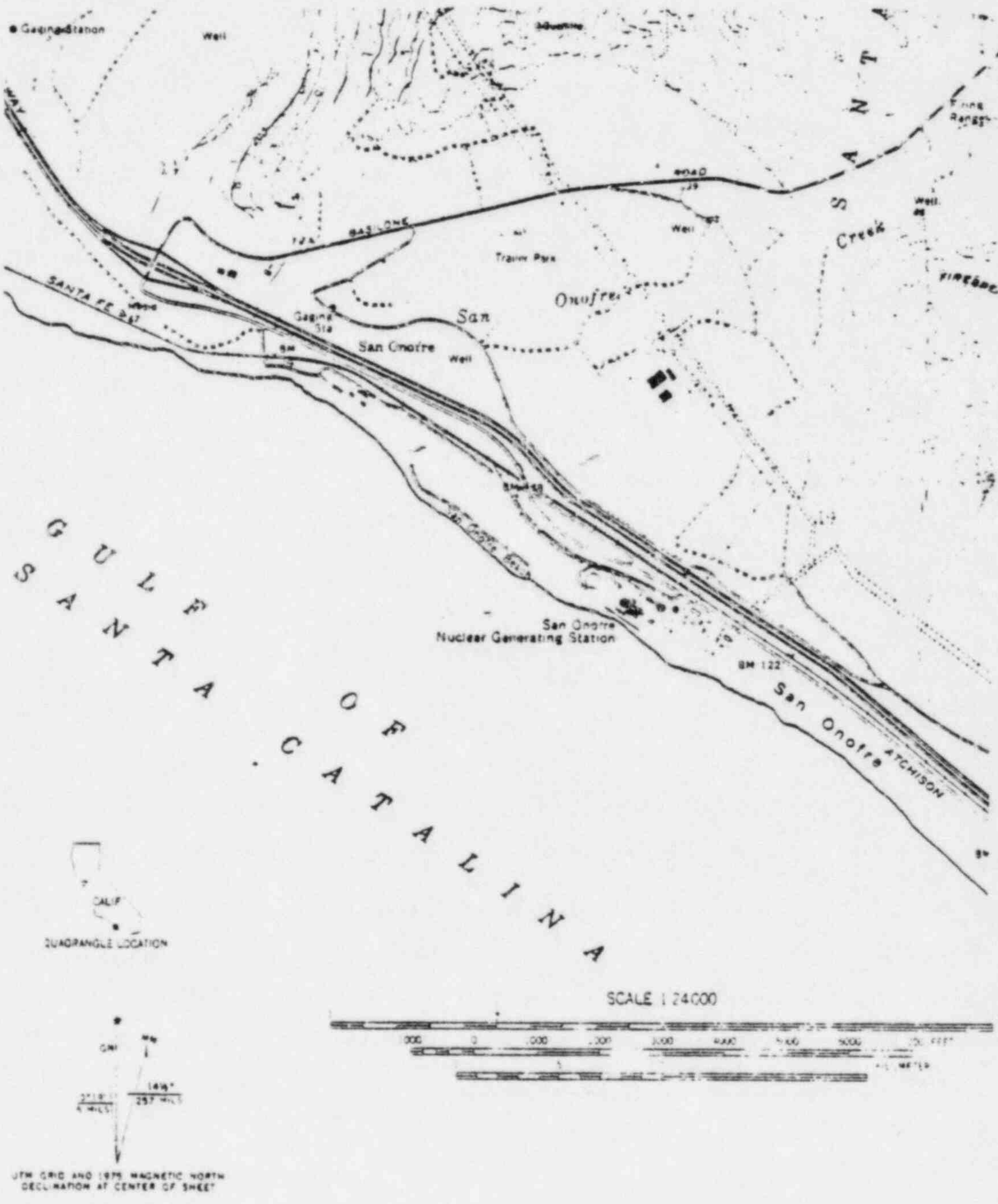

Figure 1. Location Map

Behind the cliffs, a coastal plain extends inland to the foothills of the Santa Margarita Mountain Range, approximately 1.5 miles to the east [10]. Notable hydrologic influences are the Pacific Ocean and a small area of foothills which drains toward the site. The streams and drainageways nearest to the San Onofre Nuclear Generating Station are intermittent. The largest nearby streams are San Mateo Creek, 2 miles to the northwest, and San Onofre Creek, approximately 1 mile to the northwest [11].

Streams and Drainageways

San Onofre Creek drains an area of 43 square miles, approximately 9.7 miles long and 4.7 miles wide. The basin lies entirely in Camp Pendleton. Its highest point is at elevation 3187 ft mean lower low water level (mllw) in the Santa Margarita Mountains, and its mouth is at sea level in the Pacific Ocean. There are no existing or proposed water control structures in the San Onofre Creek basin [11].

There are two U.S. Geological Survey (USGS) stream-gage stations located on San Mateo Creek and two on San Onofre Creek. Measurable flows occur only 4 or 5 months of the year, usually from December through April [11].

Before the construction of San Onofre Nuclear Generating Station, approximately 120 acres of the foothill area east of the plant drained through the plant site. Runoff from this watershed is now intercepted by a drainage system along the northeast side of the San Diego Freeway and carried northwest away from the plant to be discharged into the ocean near Basilone Road.

The earthen channel on the northeast side of the San Diego Freeway has a capacity of 1850 cfs. A pair of concrete culverts that lead under the freeway are maintained by the California State Department of Transportation. The culvert diameters are 42 and 72 in and their capacities are 180 and 520 cfs, respectively [11].

Surface runoff on the San Onofre Creek basin is used by the Camp Pendleton Marine Corps Base to recharge the base well system. There are no other surface-water users in the watershed [11].

Coastal Region

The plant grade elevation varies from 11 to 20 ft mllw. The beach in front of the site is artificial, because of the subsequent construction of Units II and III [12].

San Diego Bay is the site of the tidal reference station nearest to San Onofre plant. The differing locations of the tidal reference station and the San Onofre plant (on a bay and on an open coast, respectively) necessitate application of an amplitude ratio of 0.92 to the San Diego data. The highest tide observed was on December 20, 1968, and the lowest on December 17, 1933. The water levels of these tidal extremes adjusted to San Onofre are +7.18 ft and -2.66 ft mllw, respectively [11].

Wind speed and direction have been measured and recorded at the San Onofre plant site. Long-term wind records have been compiled at the Camp Pendleton Surf and Weather Station and the CAA Intermediate Airport near Oceanside, both about 15 miles southeast of the San Onofre site; at Lindberg Field, North Island; and at Ream Field, in the vicinity of San Diego. Between March and September, the prevailing wind is from the west, while in the colder months, the wind is predominantly from the east [9]. During most of the year, a breeze blows over the San Onofre plant from the sea during the afternoon, followed by variable breezes or calm in the evening [13].

The prevailing regional ocean current, called the California Current, is about 600 miles wide and meanders slowly southward along the coast. From late October or early November until February or March, it is replaced by the northwest-flowing Davidson Current. The two currents determine the physical and chemical properties of the water near the San Onofre shore. Frequently, a meander or eddy from one of the two regional currents induces a current at the San Onofre site, which may dominate tidal and wind currents for up to two weeks [13].

Tsunamis have occurred on the Pacific Ocean at an average rate of one in four years. Some have been observed in California but have produced little or no damage. Seiche measured near San Onofre has had a maximum effect of 0.7 cm on sea surface elevation, and monthly deviations from mean sea level have varied between +8 cm and -9 cm [11].

Site Surface Drainage

The San Onofre Unit 1 site was once a beach terrace deeply dissected by steep ravines. The top surface was at an elevation of between 80 and 90 ft mllw and sloped gently up away from the shore. One of the ravines was a drainage way that extended to the highway. During construction, several feet of sand were removed and the underlying San Mateo formation was used for foundation [11]. Present plant grade varies from 11 to 20 ft mllw. The site is shown in Figure 2.

The watershed contributing runoff to the San Onofre Unit 1 plant site covers an area of about 48 acres and is partially covered with buildings, asphalt roads, concrete-lined channels, and railroad grades which have altered the natural drainage characteristerics. Beneath portions of the watershed is a system of catch basins and interconnected drain pipes that collect surface runoff and convey it to the ocean for discharge.

Northeast of the San Onofre Unit 1 buildings is an 8-ft-high concrete security wall [15]. It is connected on its north and south ends to steel grating security walls. Between these walls and the seawall, the plant yard is graded to drain away from building and concrete walls and into storm drains. Northwest of the plant buildings is a concrete flood wall with top elevation varying from 24.8 to 27.6 ft mllw, running northeast to southwest. Directly northwest of and parallel to this wall is an open concrete drainage ditch, sloping down toward the seawall.

Outflow from the north drainage channel is through four conduits; two conduits perforate the seawall, while two other pipes flow beneath the yard area of San Onofre Unit 1 and discharge to the sea via the cold water intake structure.

The two pipes perforating the seawall consist of a 30-in-diameter corrugated metal pipe (CMP) that is above and parallel to a 42-in-diameter reinforced concrete pipe (RCP). Both of these conduits have top-hinged steel flapgates at their outlets to prevent ocean flooding of the plant site. In addition to the flapgates, both pipes are fitted with steel grating at their inlets.

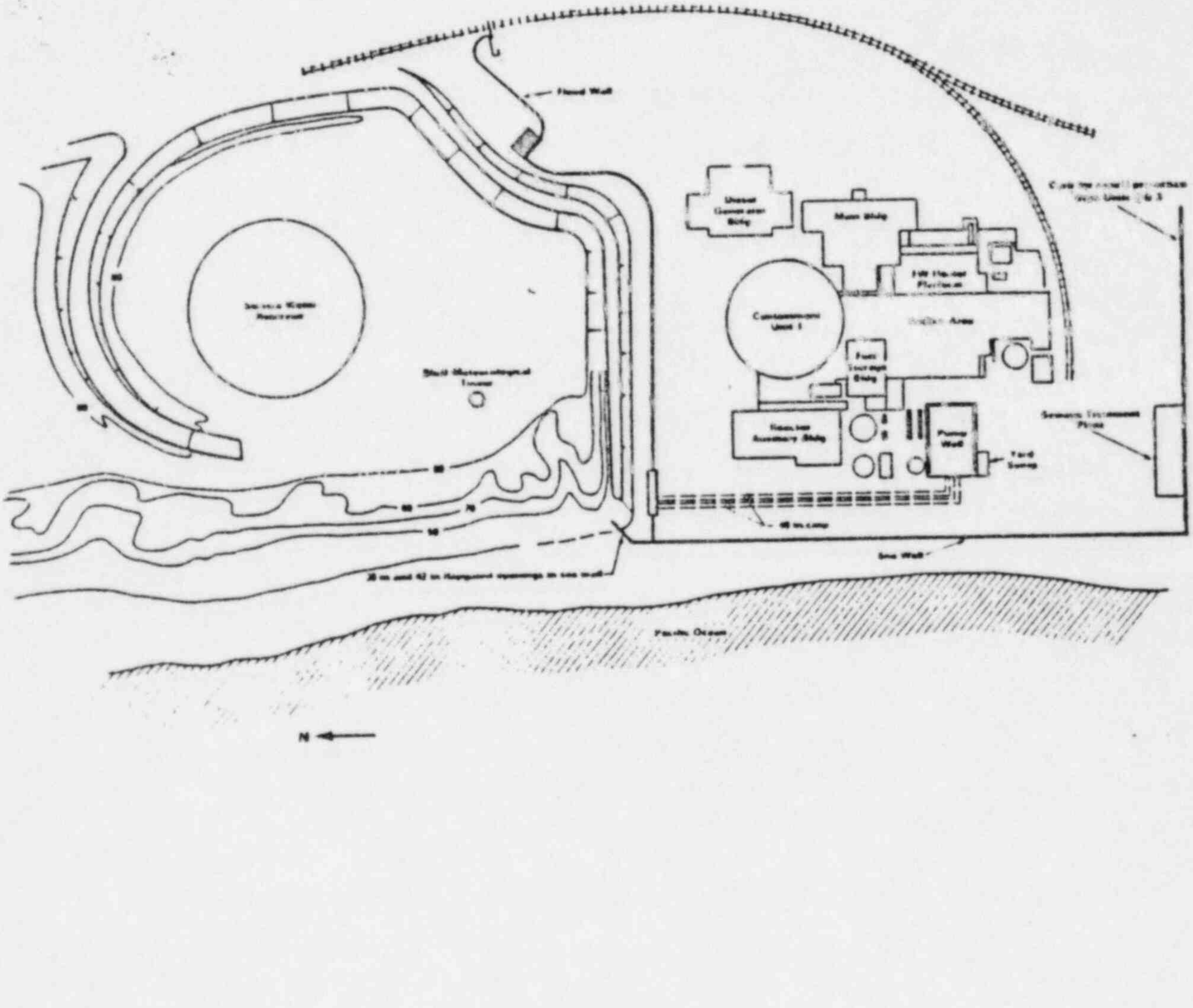

Figure 2. Site Map

The second set of discharge pipes for the north drainage channel consists of a pair of 48-in-diameter culverts that convey floodwater beneath the plant site to the cold water intake structure. This pipe system is the primary discharge conduit for the north drainage channel. Further description of the site drainage characteristics is presented in SEP Topic II-3.B.

On the bluff directly northwest of the concrete drainage ditch is a 3,000,000-gal service water reservoir [10]. Its mean water level is 92.8 ft mllw, and elevation around it varies from 94.4 ft to 101.7 ft mllw. The reservoir is circular, with a diameter of approximately 185 ft, and is surrounded by an asphalt berm [15]. The lining of the reservoir is 4 ft thick [9].

The saltwater cooling pumps are located in a pumpwell at elevation -6 ft mllw. These pumps are not submersible. The chemical and volume control system pumps are in the basement of the auxiliary building at 0 ft mllw. Component cooling water pumps, heat exchangers, and surge tank are located outside on the roof of the auxiliary building at 20 ft mllw. All other equipment needed for safe shutdown is inside plant structures at 14 ft mllw or higher [12].

Tsunani Wall

San Onofre Unit 1 is protected from Pacific Ocean flooding by a sheetpile sea wall fronted by a walkway and bolstered by riprap. The wall is pierced at its north end by three flap-gated pipes which drain storm water. Two of these pipes are 42-inch-diameter RCP with an invert elevation of 9.7 ft mllw at the seaward edge of the wall and 10 ft mllw at the east edge of the wall. The third pipe, directly above one of the concrete pipes, is a CMP with a diameter of 30 inches. Its invert elevation varies from 15 ft mllw on the plant side to 14.7 ft mllw on the seaward side of the wall.

The bottom of the sea wall is at elevation -18 ft mllw, and the top at 28.2 ft mllw. In front of the sea wall is a 15-foot-wide walkway structure built of compacted sand over a berm of riprap and paved with concrete. The walk is fronted by a steel-reinforced-concrete retaining wall with a base at elevation 7 ft mllw and is supported by a berm of riprap with a slope of 2 horizontal to 1 vertical. The riprap base is at elevation 5 ft mllw, its top extends to 15 ft mllw, and the berm is partially covered by beach sand. On the south end, the sea wall joins the wall in front of San Onofre Units 2 and 3 and connects with the curb which separates Unit 1 from Units 2 and 3 [14].

Snow and Ice

Problems from snow and ice blockage or melting are not expected at the San Onofre Plant because of the warm climate.

Groundwater

The San Onofre Nuclear Generating Station is located at the southwestern corner of the San Onofre Valley groundwater basin. The basin covers an area of approximately 43 square miles and extends inland about 13 miles into the Santa Margarita Mountains. It is bounded on the south by the San Onofre Mountains and on the north by a ridge that separates it from the neighboring San Mateo Creek basin. The San Onofre Valley groundwater basin lies completely within the borders of the Camp Pendleton Marine Corps Base [11].

Water-bearing rock strata in the basin are the Capistrano and San Mateo Formations. Lower strata are hardened and are essentially not water-bearing. The major aquifer is unconsolidated alluvium which fills the valleys to an average depth of 70 ft. Production wells in the basin are located only in alluvial areas [11].

The sources of recharge of the San Onofre Valley groundwater basin are stream channels and alluvium high up in the valleys, percolation of recycled sewage effluent, and surface storm runoff. The basin is easily recharged. Groundwater movement is toward and into the ocean. Camp Pendleton is the major source of groundwater withdrawal, and the Marine Corps controls all groundwater use in the basin. Marine Corps policy requires that a seaward gradient be maintained at all times to prevent saline intrusion into the aquifer [11].

Average groundwater level at the site is +5 ft mllw, and the groundwater gradient ranges below 0.3%. Wells located on the San Onofre site do show a response to tidal fluctuations, with a time lag of about one hour. Wells closer to the shore are more responsive and those farther from the shore less responsive to tides. The ratio of observation well level to tidal water level is from 0.1 to 0.3 between the shore and the containment structures. The San Mateo Formation lies under the site to a depth of approximately 900 ft. Its average horizontal permeability is 0.025 ft/min, and its minimum vertical permeability is 0.005 ft/min [11].

Design Bases

Surge

The original design basis for high ocean water levels was a tsunami. A high tide to elevation 7.0 ft mllw, a storm surge of 1.0 ft, and a tsunami 6.0 ft high (of which one-half the height, or 3.0 ft, is the rise, and the other half is the subsequent drawdown) adds up to a surge of 11.0 ft above mllw as shown in Table 1. Wind waves were not considered critical. Runup was assumed to reach an elevation of 13.0 ft mllw. A seawall was provided to a height of 28.0 ft mllw [9].

In 1980, construction was planned of a walkway on the seaward side of the sheetpile tsunami wall. The walkway was to incorporate several features designed to increase protection against tsunami to a height of 15.6 ft mllw with coincident storm waves 7 ft high. The design wave runup was to elevation 28.2 ft mllw [17]. This is the current design basis for protection of San Onofre Unit 1 from high water.

Low Water

The design bases for low water are not known.

Local Precipitation

The original design basis for surface runoff from local precipitation at San Onofre Unit 1 was a 100-year frequency storm. Local rainfall was expected to run off through onsite and uphill storm drainage networks with no ponding

Table 1. Design Bases

Event	Design Bases: Original (1965)	Present (1982)	NRC (1982)
Surge			
Tsunami	11 ft mllw [9]	15.6 ft mllw [16]	15.6 ft mllw [11]
Runup	13 ft mllw [9]	26.6 ft mllw [17]	27.5 ft mllw [11]
Low Water			
SWL	Unknown	Unknown	-2.63 ft mllw [11]
Tsunami	Unknown	Unknown	-12.3 ft mllw [11]
Local Precipitation	100-yr rainfall [9]	Unknown	PMP 7.0 in 1 hr [19] 12.0 in 6 hr [19]
Rooftop Ponding	Unknown	Unknown [16]	PMP 7.0 in 1 hr [19] 12.0 in 6 hr [19]
Groundwater			
Normal High	Unknown	5.0 ft mllw [22]	10.0 ft mllw
Extreme High	Unknown	5.0 ft mllw [22]	Plant grade

in the plant area [9]. Currently, the design basis is for no ponding above 14.0 ft mllw, with no ponding at all in the area of the intake [16]. Table 2 gives the elevation of protection of plant structures:

Table 2. Elevation of Protection [16]

Structure	Lowest Opening Elevation (mllw)
Reactor Auxiliary Building	20'-0"
Administration and Control Building	14'-2"
Diesel Generator Building	20'-6"
Fuel Storage Building	14'-2"
Turbine West Heater Platform	14'-0"
Turbine East Heater Platform	14'-0"
Turbine South Extension	20'-0"
Turbine North Extension	14'-0"
Sampling Station Building	20'-0"
Ventilation Building	20'-0"
Intake Structure	-6'-6"

Rooftop Flooding

The design basis for rooftop ponding varies between structures. The control building, reactor auxiliary building, sphere enclosure building, and post-accident sampling building were designed for direct runoff from the roofs. Figure 3 shows these plant structures. The diesel generator building was designed to withstand water ponded to the top of the parapet, 1.0 ft above the low points of the roof. The fuel storage and ventilation buildings were designed to withstand less live loading than would be exerted by water ponded to the tops of the parapets, 1 ft 2 in and 1 ft 3 in, respectively, above the low points of the roofs. The buildings were equipped with 2 in x 8 in scuppers above the roof drains to facilitate runoff [16]. The turbine building, with its north and south extensions and east and west heater platforms, has no parapets and is not subject to ponding.

Groundwater

Groundwater loading was not considered in the original design of San Onofre Unit 1 structures. The Licensee's current design basis for groundwater is 5.0 ft mllw.

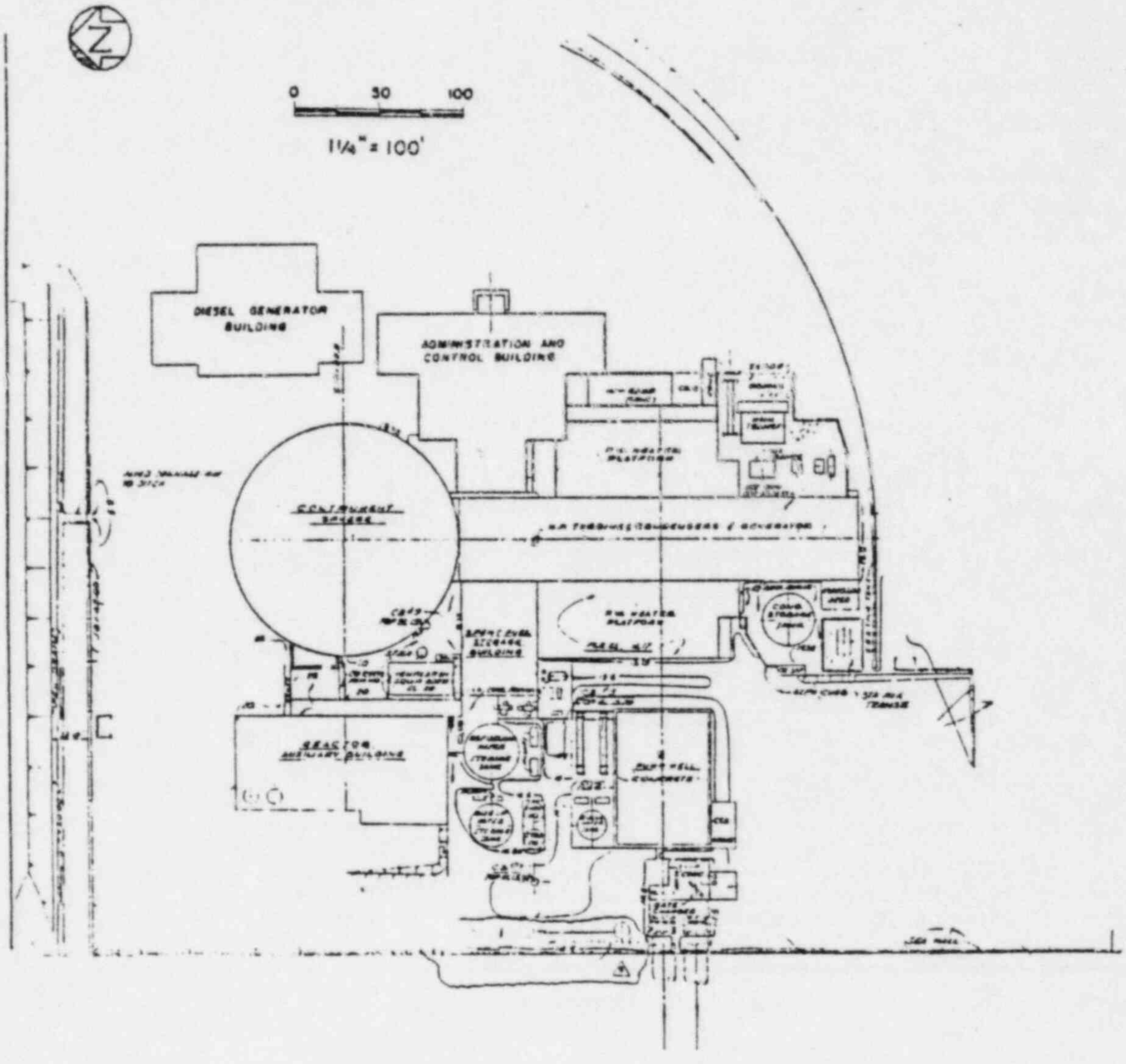

Figure 3. Plant Structures

3.1.4 Conclusion

The design bases for low water and rooftop ponding are not adequately described. Measurements of groundwater elevation at San Onofre Unit 1 are not sufficient to allow an accurate identification of probable maximum groundwater level. On other subjects, the hydrologic environment is adequately described.

3.2 FLOODING POTENTIAL AND PROTECTION REQUIREMENTS (TOPIC II-3.B)

3.2.1 Topic Background

Information pertaining to the SEP Topic II-3.B, "Flooding Potential and Protection Requirements," for San Onofre Unit 1 was reviewed. The findings presented in this section were derived from NRC docketed information, NRC staff files, drawings provided by the Licensee, and state and local sources.

The purpose of this topic is to identify, under current licensing criteria, the design basis flood level resulting from all potential flood sources external to the plant and site. It includes the evaluation of submitted documentation and the determination of significant differences between the values of parameters used for design and construction of the plant in 1965 and those derived in accordance with current licensing criteria. The evaluation addresses the effects of flood and other changes in hydrostatic and hydrodynamic loads on safety-related structures, systems, and equipment, and the adequacy of existing or proposed flood protection measures such as revetments, flood walls and doors, and emergency and administrative procedures.

In particular, this evaluation focuses on the following subjects:

- tsunami
- local flooding and site drainage
- roof drainage
- groundwater.

Regulatory Guides 1.59 [11] and 1.102 [12] were specifically cited by the NRC's Regulatory Requirements Review Committee for consideration in the backfitting of operating reactors. These guides are used to determine whether the facility design either complies with current criteria or presents equivalent alternatives. Deviations identified in this evaluation and the need for further action will be judged at a later time during an integrated assessment review.

3.2.2 Topic Review Criteria

Criteria for the review of flooding potential and protection requirements were taken from the following sources:

Standard Review Plan (SRP) [2], Sections:

- 2.4.2 Floods
- 2.4.3 Probable Maximum Flood (PMF) on Streams and Rivers
- 2.4.5 Probable Maximum Surge and Seiche Flooding
- 2.4.6 Probable Maximum Tsunami Flooding
- 2.4.10 Flooding Protection Requirements
- 2.4.13 Groundwater

NRC Regulatory Guides

- 1.59 Design Basis Floods for Nuclear Power Plants [4]
- 1.102 Flood Protection for Nuclear Power Plants [5]
- 1.135 Normal Water Level and Discharge at Nuclear Power Plants [7]

American National Standards Institute (ANSI) N170-1976 [8]

Standards for Determining Design Basis Flooding at Power Reactor Sites.

3.2.3 Evaluation

3.2.3.1 Flood History

There is no history of flooding from any event at the site of San Onofre Unit 1 which would affect normal plant operation.

Tsunamis of significant size have never occurred at or near the San Onofre site. Large local earthquakes have only caused small tsunamis, and tsunamis of remote origin have not raised waves higher than the astronomical tides [9].

The largest seiche recorded in the area of San Onofre affected sea surface elevation by only 0.7 cm [11].

The highest tide recorded at San Diego since 1906, when accurate tidal records began, and adjusted to the San Onofre Plant is 7.18 ft mllw. It occurred in 1968 [11].

3.2.3.2 Local Flooding

Local PMP Definition

The most severe hydrometeorological condition with respect to site drainage is the probable maximum flood (PMF) resulting from rainfall equivalent to the probable maximum precipitation (PMP). The PMP is generally defined as the theoretically greatest depth of precipitation for a given duration that is physically possible over a drainage basin at a particular time of year [19].

The depth and duration of the 1-square-mile local PMP at the San Onofre Nuclear Generating Station was determined by the standardized procedure outlined in Reference 19.

The local storm PMP for San Onofre has the following temporal distribution:

Duration (hours)	Cumulative Rainfall Depth (inches)
0.08	1.50
0.25	3.01
1	7.00
2	8.96
3	10.15
6	12.04
12	15.67
24	19.11

Local Drainage

Watershed Boundaries and Hydraulic Connections

The watershed contributing runoff to the San Onofre Unit 1 plant site covers an area of about 48 acres and is partially covered with buildings, asphalt roads, concrete-lined channels, and railroad grades which have altered the natural drainage characteristics. Beneath portions of the watershed is a system of catch basins and interconnected drain pipes that collect surface runoff and convey it to the ocean for discharge.

For added computational precision of the HEC-1 watershed model [20], the San Onofre Unit 1 watershed was subdivided into units defined on Figure 4. For the purposes of this study, drainage area C, seen on Figure 4, was called the onsite drainage area; the remaining sub-basins were collectively called the offsite drainage area.

San Onofre Unit 1 is located within an 11.2-acre compound surrounded by a combined security wall and seawall. This combined wall, although not continuous throughout its length, acts as a watershed divide for the onsite drainage area. The yard area, within this basin, is graded into shallow depressions for collecting surface runoff. Each low area drains to a concrete catch basin having an open grate top. All of these catch basins are interconnected to form a system that ultimately discharges through the cold water intake structure to the sea. Figure 5 contains an onsite drainage map showing representative surface runoff flowlines converging in the vicinity of the yard sump.

During all rainfall conditions, drainage areas D1 and D2 will discharge their stormwater runoff southeast along the unlined ditch that runs parallel to the Atchison, Topeka, and Santa Fe Railroad. Similarly, drainage area G is a closed basin with no outlet and does not contribute runoff to the offsite drainage.

The remaining portion of the offsite drainage area, comprised of sub-basins A, B, E, and F, discharge their stormwater runoff through the north drainage channel, identified in Figure 4. At the mouth of this channel is a seawall with a top elevation of 28.2 ft mllw. This wall prevents direct discharge to the Pacific Ocean. Outflow from the north drainage channel is through four conduits; two conduits perforate the seawall, while two other pipes flow beneath the yard area of San Onofre Unit 1 and discharge to the sea via the cold water intake structure.

The two pipes perforating the seawall consist of a 30-in-diameter CMP that is above and parallel to a 42-in RCP. Both of these conduits have

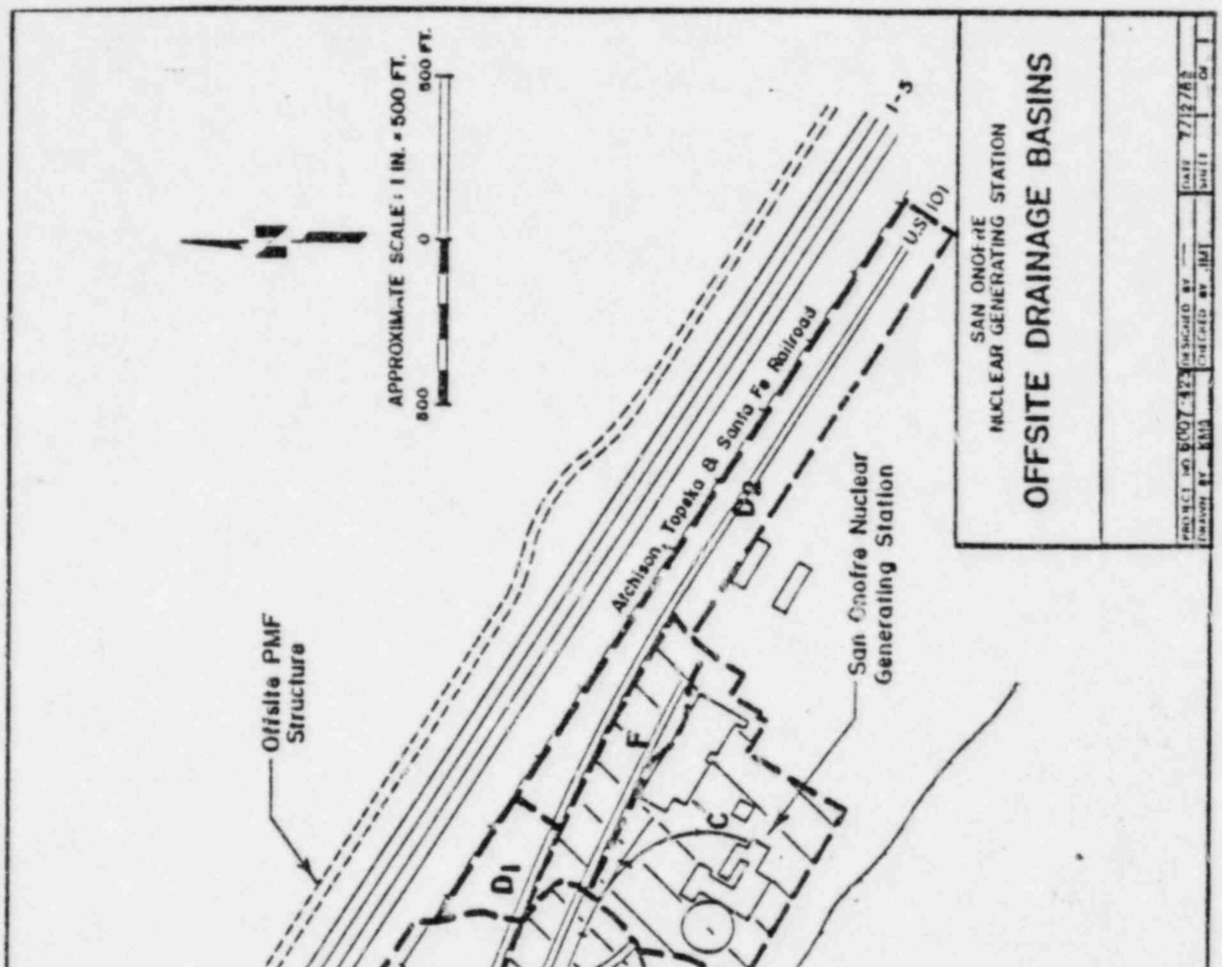

Figure 4. Offsite Drainage Basins

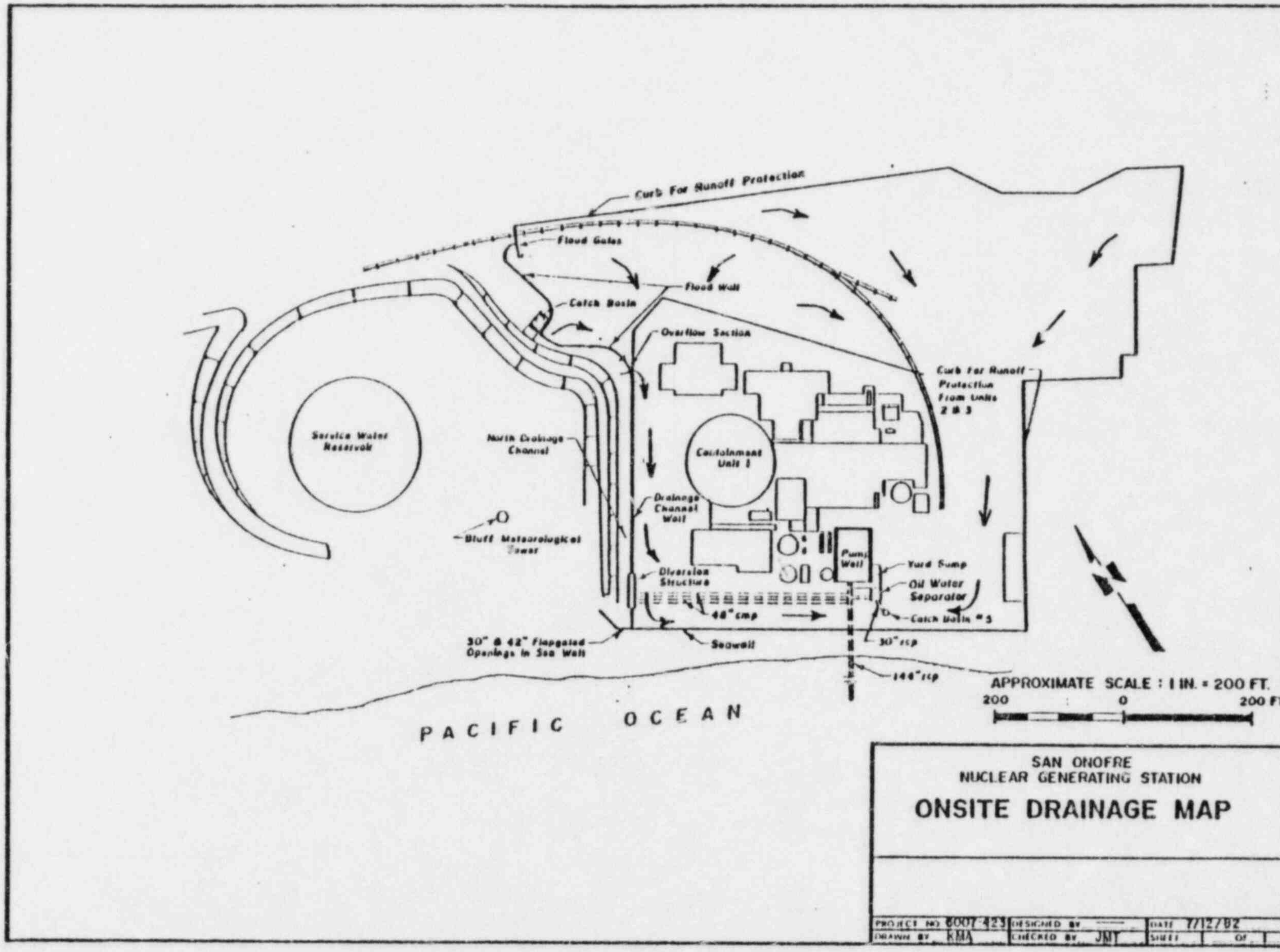

Figure 5. Onsite Drainage Map

top-hinged steel flapgates at their outlets to prevent ocean flooding of the plant site. In addition to the flapgates, both pipes are fitted with steel grating at their inlets.

During the site visit [18], it was observed that the flapgate on the lower 42-in RCP was almost entirely covered with sand; similarly, the inlet to this pipe was also found covered with sediment carried down the north drainage channel.

The top-hinged flapgate on the upper 30-in CMP was moved with difficulty when manipulated by two people. Improper design and infrequent maintenance may have caused the difficulty.

The discharge efficiency of the seawall conduit system, at best, can be considered poor due to sediment in the lower pipe and to the improper operation of the flapgate attached to the upper pipe. Clogging of the seawall pipes by outflowing debris will also effectively reduce the ability of these pipes to pass floodwaters.

The second set of discharge pipes for the north drainage channel consists of a pair of 48-in-diameter culverts that convey floodwater beneath the plant site to the cold water intake structure. After the entrance to these pipes is submerged, the hydraulic control for this system is an arch pipe constriction located about mid-length on the pipes. At the inlet is a large-capacity grated catch basin that will enable the pipes to flow without significant impedance when clogged. This pipe system is the primary discharge conduit for the north drainage channel.

During extreme flood events, the conveyance capacity of the twin 48-in CMPs and the 42-in and 30-in seawall pipes will be exceeded, resulting in flooding of the north drainage channel. The maximum capacity of this flooded channel is controlled in part by a plant access road and a low flood wall, identified as the overflow section on Figure 5. The volume of the flooded channel between the invert and the roadbed and wall top elevation of 23.2 ft mllw is about 1.2 acre-ft. Further flooding of the channel will result in floodwaters entering the onsite drainage area through the overflow section.

Within the onsite drainage area is the yard drainage system that collects runoff and conveys it underground to the oil-water separator and then to the Pacific Ocean. Once the open-grating manhole cover for catch basin 5 is submerged by floodwaters, the seaward discharge from the yard drainage system is controlled hydraulically by the 30-in-diameter reinforced-concrete pipe (SCE Drawing No. 5153114-1) [15] that connects catch basin 5 with the oil-water separator.

The second onsite drainage system, identified in Figure 5, is a yard sump that discharges into the cold water intake structure. This system is controlled hydraulically by the limiting box culvert size of 3 ft x 5 ft. A schematic drawing of the yard sump showing the shape and dimensions of the outflow structure can be seen on Figure 6.

Probable Maximum Flood

The PMF for the offsite and onsite drainage study was simulated by the U.S. Corps of Engineers' HEC-1 flood hydrograph program [20]. This computer program used the rainfall/runoff algorithm found in the Soil Conservation Service TR-20 model [21].

The HEC-1 model simulated the hydrographs for the two watersheds based on assumed rainfall and watershed response functions. Rainfall amount and intensity were calculated using procedures outlined on HMR-49 [19]. The watershed response function was independently determined based on background information provided by the Licensee and by analytical methods presented by the Soil Conservation Service [21]. Verification of the watershed boundaries and response functions was made during a site visit on March 30, 1980 [18].

The watershed response function contained a lumped parameter, called a "curve number," that was dependent upon soil type and antecedent soil moisture. The soil type covering the San Onofre watershed was classified as "SCS Group D" based on field observations made during the site visit. Assuming that the soils were saturated prior to PMP (AMC III), the curve number for San Onofre Unit 1 watersheds was set equal to 98.

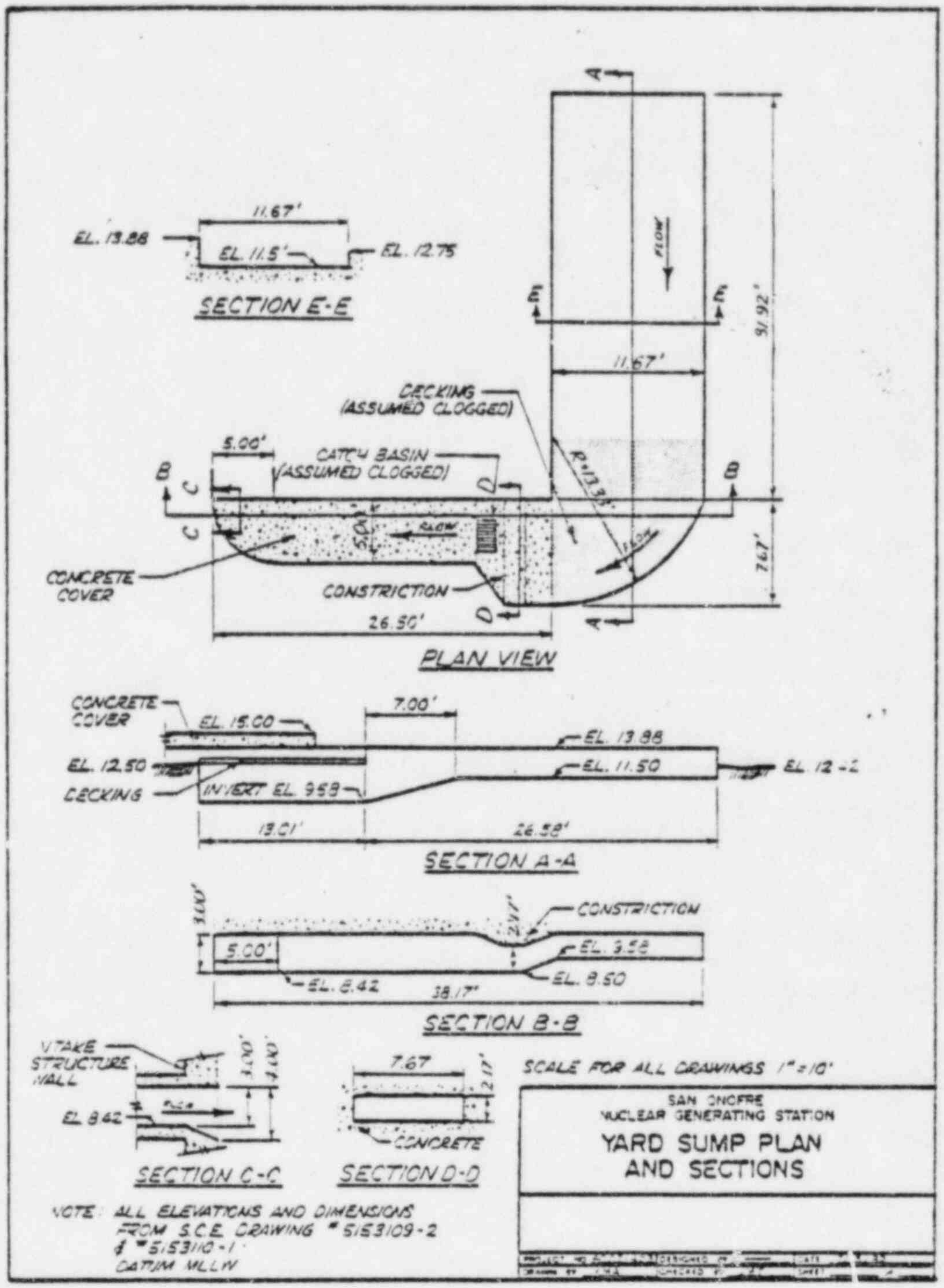

Figure 6. Yard Sump Plan and Sections

Maximum discharge during the offsite PMF was 385 cfs and represents the combined flow from watersheds A, B, E, and F. The offsite PMF hydrograph and the PMP hyetograph can be seen in Figure 7. Sub-basin C, the onsite watershed, will produce a maximum PMF discharge of 168 cfs. The calculated volumes of offsite and onsite runoff were 60 and 17 acre-ft, respectively.

Onsite Flooding

The depth of onsite flooding was dependent upon the rate at which the flood water discharge systems operate. Maximum site flooding was controlled by the lowest seawall elevation of 28.2 ft mllw, located at the mouth of the north drainage channel.

Two separate scenarios were tested involving the degree to which the storm drain systems were clogged by debris. The lower 42-in-diameter RCP at the mouth of the north drainage channel was assumed clogged by sediment for both scenarios tested. The first case assumed that all other drain systems were operating, but not to 100% capacity. Only the twin 48-in CMPs and the yard sump were assumed operational in the second scenario; the 30-in and 42-in seawall conduits and the yard drainage system were assumed to be clogged by debris.

Scenario 1 was based on 10% blockage of the twin 48-in CMPs, 60% blockage of the 30-in CMP, and 100% blockage of the 42-in RCP. This case represents the most optimistic discharge conditions based on observations made during a site visit [18].

The twin 48-in CMPs and the 30-in CMP will discharge 310 cfs and 26 cfs, respectively, with a water surface elevation of 23.5 ft mllw in the north drainage channel. There will be 49 cfs remaining from the offsite discharge that will flow into the onsite drainage area through the overflow section. This peak flow was assumed to occur simultaneously with the onsite peak discharge of 168 cfs. The combined flow of 217 cfs will pass through the yard sump and yard drainage system with discharges of 67 cfs and 150 cfs, respectively.

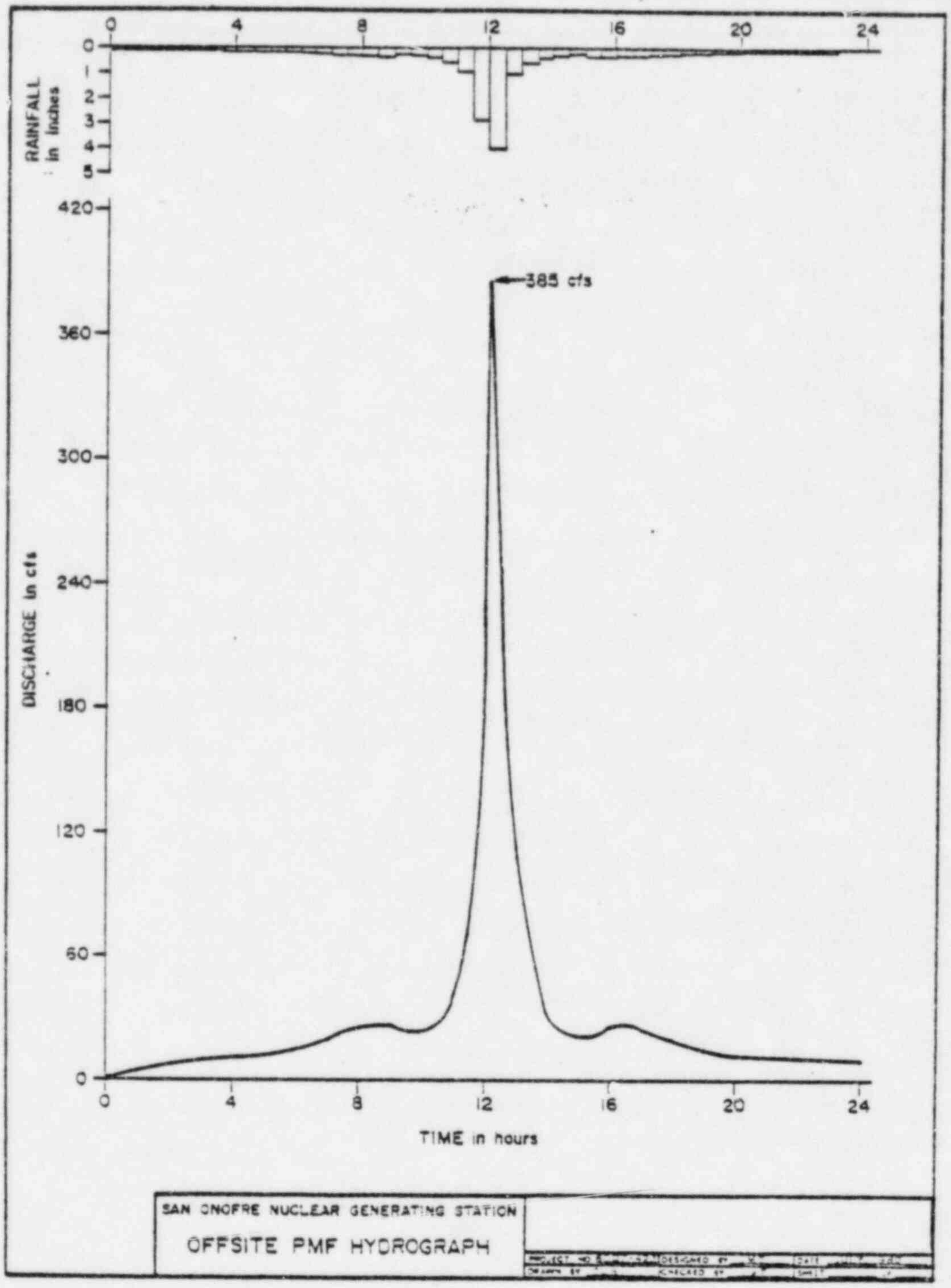

Figure 7. Offsite PMF Hydrograph

The water surface elevation resulting from scenario 1 will be 15.5 ft mllw. Safety-related equipment, located in the administration and control building at elevation 14 ft 2 in mllw, and in the fuel storage building at the same elevation, will be inundated. Safety-related equipment at 14.0 ft mllw at the turbine east and west heater platforms and in the turbine north extension will also be flooded. In the intake structure, safety-related equipment at elevation -6 ft 6 in mllw will be underwater. Table 2 shows elevations of protection for safety-related equipment.

The second scenario was conservative in its assumptions that both the seawall culverts were clogged, the twin 48-in CMPs were operating with 10% blockage, and the yard drainage system was completely blocked. As in the first scenario, the second case also assumed that the yard sump was operating without obstructions. These conditions can be reasonably expected to occur based on the site visit [8] and assuming no comprehensive inspection program. With these assumptions, there will be 310 cfs discharged through the twin 48-in CMPs and the remaining 75 cfs from the offsite area will overflow into the onsite area during the PMF. The combined offsite and onsite flow of 243 cfs will discharge through the yard sump with a water surface elevation of 23.2 ft mllw within the San Onofre Unit 1 plant site.

Safety-related equipment at elevation 20 ft mllw in the administration and control building, at 20 ft 6 in mllw in the diesel generator building, and at 20.0 ft mllw in the turbine south extension will be flooded. Safety-related equipment at 7 ft 8 in mllw in the sampling station building and at 20.0 ft mllw in the ventilation building will all be flooded, in addition to the equipment flooded in Scenario 1.

Based on conditions noted during a site visit, and the Licensee's statement [18] that it does not intend to take credit for the culverts which perforate the tsunami wall, the second scenario represents a reasonable condition and should be used to determine compliance with NRC standards. Since Scenario 2 results in flooding of safety-related equipment in several structures during local PMP, San Onofre Unit 1 does not meet current NRC criteria for flooding during local PMP.

Other hydrologic information of interest to reviewers of Hydrology Topic III-3.A, Effects of High Water Level on Structures, is the water surface elevation in the north channel under local PMF conditions. This information would be used to determine the structural capability of the floodwall to retain the floodwater loading. The water surface elevation in the north drainage channel under local PMF conditions would be 23.5 ft mllw during both scenarios of drain blockage investigated in this report.

Roof Drainage

The Licensee states [16] that the control building, the reactor auxiliary building, the sphere enclosure building, and the post-accident sampling building have no parapets or are below grade with the surface graded for free drainage. Review of plant drawings [15] shows that the sphere enclosure building is free-draining, and that there are no parapets around the roof of the control and administration building. There are, instead, extruded aluminum gravel stops around the edges of the control and administration building, and a difference in elevation of 3 inches between the low points at the drains and the high points around the perimeter of the roof. This confirms the Licensee's conclusion that the control building roof design basis loading will not be exceeded during PMP.

A site visit [18] has shown that there are no parapets around the edges of the roofs of the turbine building or the east and west turbine building extensions, called heater platforms. These roofs would drain freely and would not be subject to rooftop ponding. The turbine building and its east and west extensions meet current NRC standards.

The Licensee has stated [16] that the diesel generator building roof is designed to withstand the load resulting from water ponded to the top of the parapets, which are 9 to 12 in above the roof. Plant drawings [15] and a site visit by reviewers [18] also show that the parapets are 9 in above the high points and 12 in above the low points of the diesel-generator building roof. Therefore, water will not pond higher than 12 in, or higher than the design basis, according to the Licensee. The design basis of the diesel generator building roof is adequate for rooftop ponding which occurs during PMP, so the roof meets current NRC criteria. During a site visit [18], it was noted that the exhaust and ventilation vents for the diesel generator building provide access for rainwater directly into the building. Further analysis is needed to determine the effects on safety-related equipment of PMP entering through the vents.

In response to a request for additional information, the Licensee stated [16] that the design basis for live loading on the roof of the fuel storage building, expressed in inches of ponded water, is less than the height of the parapets. The parapet height on the fuel storage building varies between 8 and 14 in. Plant drawings [15] show that the parapet extends to 10 in above the high points of the top of steel and 16 in above the low points of the top of steel. The Licensee further stated [16] that, in addition to two drains at the low points of the roof, a 2 in x 8 in scupper is located above each drain. According to plant drawings, these scuppers are situated on the north and south sides of the structure between elevations 65 ft and 65 ft 2 in. These openings are adequate to ensure that ponding on the rooftop during PMP does not exceed a depth of 9 inches.

The design basis live loading of the fuel storage building roof has not been specified, so its compliance with NRC criteria cannot be determined. However, if the design basis live loading can be ascertained, and if it is 46.6 psf or higher, then the ponding resulting from local PMP will not exceed the design basis live loading, and current NRC criteria will be met.

The Licensee states that parapet height on the ventilation building varies from 10 in above the high points of the roof to 15 in above the drain at the low point of the roof. A 2 in x 8 in scupper is located over the drain [16]. Plant drawings confirm this information, and show the scupper on the east wall of the ventilation building extending horizontally between 5 and 7 in above the low point of the top of roof steel [15]. This scupper is sufficient to ensure that rainwater during PMP does not pond more than 7.5 in above the low points of the roof.

Since the Licensee has failed to provide the design basis live loading of the ventilation building rooftop, compliance with current NRC criteria cannot be determined. However, the roof is designed so that loading from PMP stormwater will not exceed 38.9 psf.

The roofs of the control building, the reactor auxiliary building, the sphere enclosure building, the post-accident sampling building, the turbine building, the east and west heater platforms, and the diesel generator building all meet current NRC criteria. The roofs of these structures are designed to withstand ponding from local PMP.

The fuel storage building and the ventilation building roofs are not designed to withstand ponding to the top of the parapets. Instead, they are equipped with 2 in x 8 in scuppers above the drains. If the drains are clogged during local PMP, the scuppers will be adequate to ensure that ponding does not rise to the top of the parapets. On the fuel storage building roof, ponding will not exceed 9 in above the low point of the roof, exerting 46.6 psf. On the roof of the ventilation building, ponding will not exceed 7-1/2 in above the low point of the roof, exerting a live loading of 38.9 psf. If these roofs have design basis live loading less than 46.6 psf for the fuel storage building and 38.9 psf for the ventilation building, they do not fulfill NRC criteria for local PMP. Since the Licensee has failed to provide design bases for these two buildings, compliance with NRC requirements cannot be determined.

3.2.3.3 Rivers, Streams, and Dams

There are no rivers in the area of the San Onofre plant. There are two intermittent streams nearby, San Onofre and San Mateo Creeks. Flooding of these two streams could not affect the plant site. There are no dams in the vicinity of the San Onofre plant, and therefore no threat to plant safety exists from dam failure.

3.2.3.4 Probable Maximum Tsunami (PMT)

The PMT at San Onofre Unit 1 would be generated by local offshore seismic activity. The runup elevation of the PMT is 15.6 ft mllw, when it occurs simultaneously with an astronomical tide of 7.0 ft mllw, an isostatic anomaly of 0.33 ft, and a surge of 1.98 ft [11]. Because the tsunami has a long period (approximately 12 min), the tsunami runup elevation is used as the stillwater level (SWL) in conjunction with storm waves.

The tsunami wall complex west of San Onofre Unit 1 is shown in Figures 8 and 9. The present beach elevation, approximately 11.5 ft mllw, is at the middle of the lower of the drainage pipes which penetrate the seawall and walkway. The Licensee states that, according to the recollection of an engineer familiar with the site before construction began, the final beach elevation should be between 10 and 14 ft mllw. This would not be substantially altered by the tsunami. A conservative estimate of final beach elevation is 7.0 ft mllw. A beach bottom elevation of 7.0 ft mllw and a SWL of 15.6 ft mllw limits storm waves to 7.0 ft. This configuration is illustrated in Figure 10. Should the beach elevation drop below 7.0 ft mllw (as would be determined under SEP Topic III-3.C, Inservice Inspection of Water Control Structures), the Licenseee should reevaluate the level of protection.

It has previously been demonstrated that the PMT will cause failure of the steel sheetpile seawall if the walkway, the walkway retaining wall, and the riprap berm do not exist [24]. The Licensee claims that the walkway complex, with riprap berm, will withstand the PMT wave forces and reduce the impact on the sheetpile seawall so that failure does not occur and protection of the plant structures is maintained [17]. The issues addressed in this report are (1) whether the walkway retaining wall and riprap berm will withstand the PMT and (2) whether the walkway retaining wall and riprap berm will prevent failure of the sheetpile seawall.

A conservative analysis of the wave and hydrostatic forces on the seawall is provided in Appendix A. It shows that the riprap berm and the walkway retaining wall will withstand the impact of the PMT and storm waves. Appendix A also provides an analysis of the wave forces assuming the upper portion of

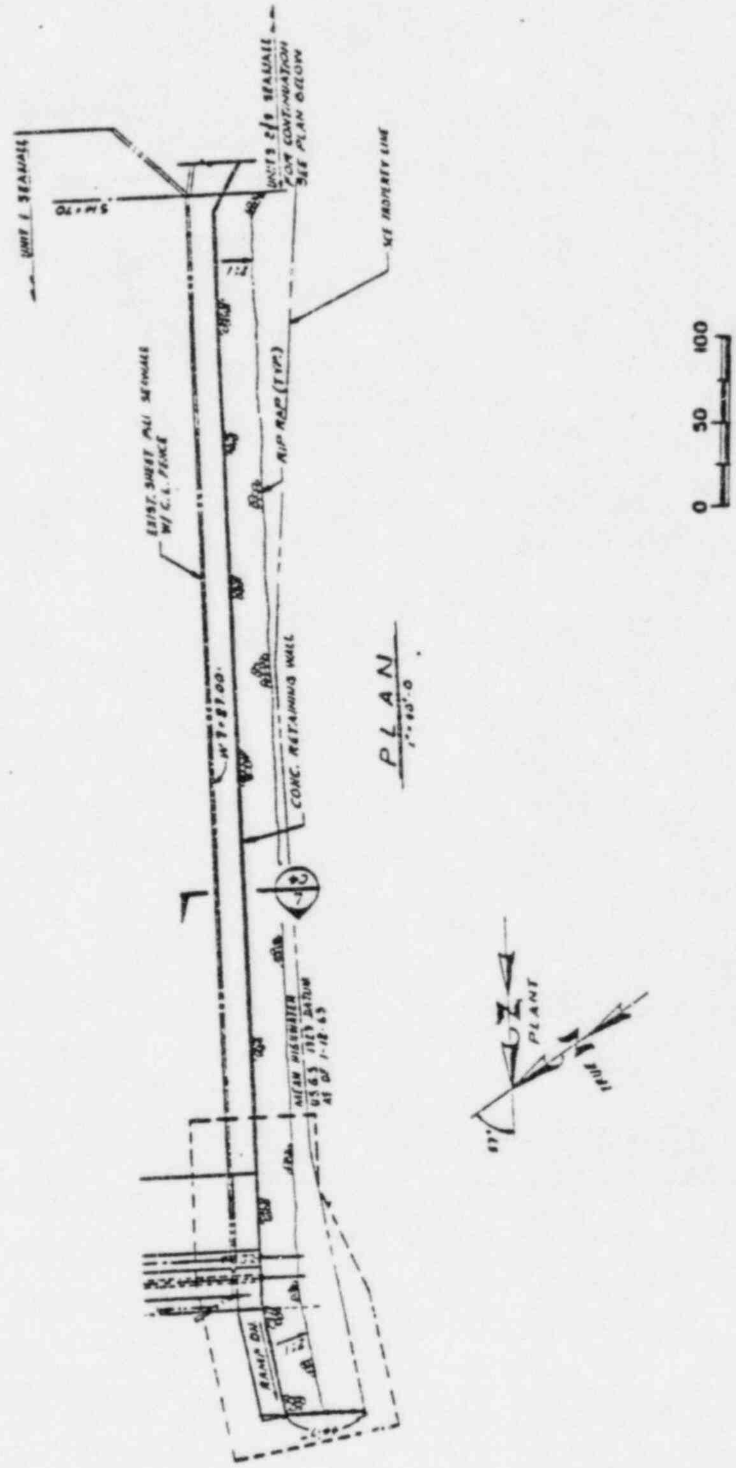

Figure 8. Tsunami Wall Plan

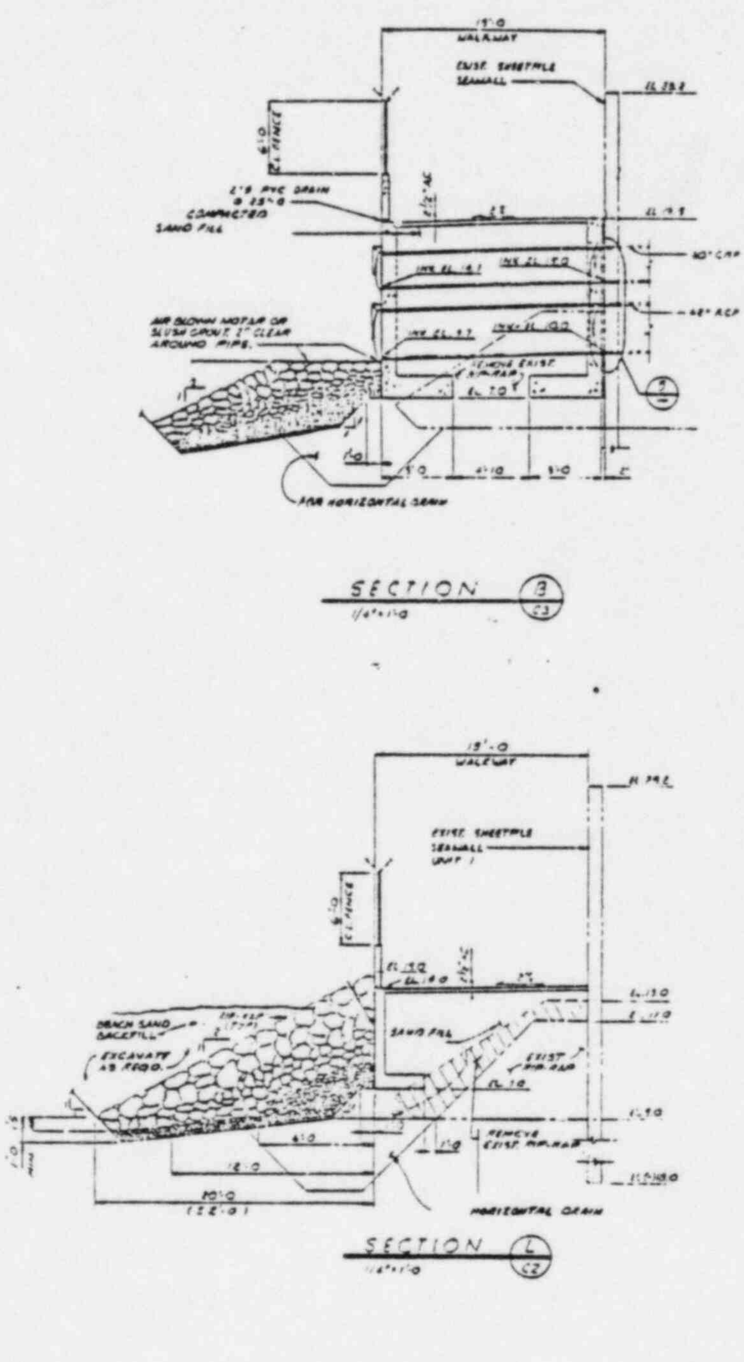

Figure 9. Tsunami Wall Sections

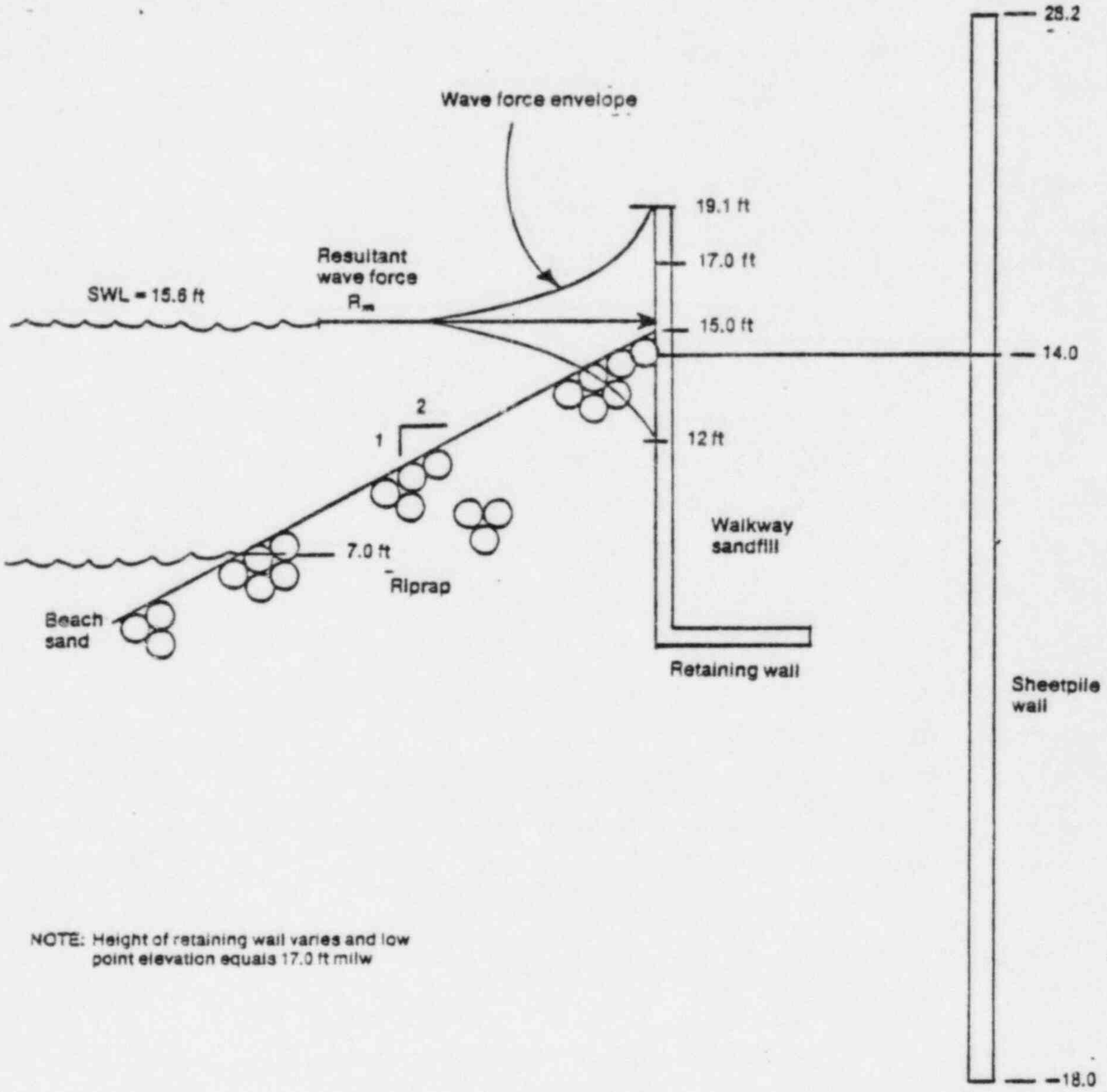

Figure 10. Tsunami Wall with Wave Forces

the walkway retaining wall fails at elevation 15.0 ft mllw. It demonstrates that the riprap berm and the sand and debris from the failed retaining wall and walkway reduce the hydrodynamic force on the sheetpile seawall to 3200 lb/ft acting at elevation 15.6 ft mllw, as developed by the Licensee [16] and confirmed by the analysis in Appendix A. The hydrostatic force is 832 lb/ft, acting at elevation 15.7 ft mllw. The lowest ground level on the landward side of the sheetpile seawall is believed to be 11 ft mllw [24], and the bending stress in the sheetpile wall, caused by moment of those two forces about a point at elevation 11 ft mllw, is 7.4 ksi. This value is far below the allowable stress of 25 ksi, the minimum yield stress of 38.5 ksi, and the allowable stress including an increase for seismic loading of 40 ksi, all specified for the sheetpile section by the Licensee [16].

Based on this analysis, the tsunami wall complex west of San Onofre Unit 1, consisting of sheetpile seawall, walkway and retaining wall, and riprap berm, is adequate to resist forces caused by the PMT and the highest coincident storm waves which could be transmitted to the wall.

This report has not shown consideration for a postulated flood hazard resulting from seismic failure of the seawall. Should the seawall fail due to the forces resulting from the earthquake which generated the tsunami, a flood hazard may exist. To date, SEP Topic III-6, Seismic Design Considerations, has not rendered an analysis of the seismic stability of the tsunami wall. Should completion of SEP Topic III-6 demonstrate that the seawall is unstable under seismic loading, further evaluation of flooding would be warranted under SEP Topic II-3.B.

3.2.3.5 Groundwater

The focus of this evaluation is to define groundwater elevation for use in evaluating flood or structure hazards. Specifically, the probable maximum groundwater elevation will be defined. In addition, the normal high groundwater elevation to be used in combination with an appropriate seismic load (safe shutdown earthquake) is presented.

Generally, to define these elevations with a minimum of error requires that the site be monitored for long periods of time, incorporating groundwater data recorded during seasonal fluctuations and ocean level changes. No such data exist for the San Onofre site. Hence, the levels presented are the best estimates based on the data available. Should the Licensee present further data for evaluation, these conclusions could be revised.

According to the Licensee [9], the average groundwater elevation at the site is 5 ft mllw. Groundwater readings have been made at irregular intervals from 1967 to 1977, and show that under some conditions groundwater levels exceed 5.0 ft [22]. Thus, 5 ft mllw is not a conservative design basis for groundwater loading. It is recommended that 10 ft mllw be used as a conservative design basis for normal high groundwater in conjunction with earthquake loading. During heavy rainfall and high sea level, groundwater could pond to higher elevations; therefore, it is concluded that the design basis for probable maximum groundwater should be plant grade elevation.

3.2.4 Conclusions

The following conclusions pertaining to specific aspects of flood potential at the San Onofre Unit 1 site are presented.

Local Flooding

San Onofre Unit 1 does not meet current NRC criteria for flooding from local PMP. Under conditions which can be reasonably foreseen to occur, ponding will rise to elevation 23.2 ft mllw in the plant yard during PMP, and safety-related equipment in all plant structures listed in Table 2 will be flooded.

During PMP, the reactor auxiliary building, the diesel generator building, the turbine building with north and south extensions, the east and west heater platforms, the sampling station building, the administration and control building, the fuel storage building, the intake structure, and the ventilation building would be flooded. Safety-related equipment would be subjected to flood waters between 3 ft and 15 ft deep. Safe operation and safe shutdown of the reactor would be impossible.

Roof Drainage

The roofs of the control building, the reactor auxiliary building, the sphere enclosure building, the post-accident sampling building, the turbine building, the east and west heater platforms, and the diesel generator building all meet current NRC criteria for local PMP.

The fuel storage building and the ventilation building rooftops will be subject to 46.6 psf and 38.9 psf, respectively, over the low points of the roofs. Since the Licensee has failed to provide the design basis, compliance with NRC criteria cannot be determined.

Tsunami

The tsunami wall and walkway complex west of San Onofre Unit 1 fulfills current NRC requirements. It will protect the safety-related structures from the probable maximum tsunami with coincident storm waves, if the tsunami gates in the intake and discharge lines are closed.

Groundwater

Normal high groundwater elevation for use with coincident seismic loads is +10.0 ft mllw. Probable maximum groundwater elevation is plant grade.

3.3 CAPABILITY OF OPERATING PLANTS TO COPE WITH DESIGN BASIS FLOOD CONDITIONS (TOPIC II-3.B.1)

3.3.1 Topic Background

Information pertaining to the SEP Topic II-3.B.1, "Capability of Operating Plants to Cope with Design Basis Flood Conditions," for San Onofre Unit 1 was reviewed.

The findings presented in this section were derived from NRC docketed information, NRC staff files, and drawings provided by the Licensee.

3.3.2 Topic Review Criteria

The following references were used as review criteria:

- ANSI N170-1976 [8]
- NRC Regulatory Guide 1.59 [4]
- Standard Review Plan, Sections 2.4.3, 2.4.5, 2.4.6, and 2.4.14. [2]

3.3.3 Evaluation

3.3.3.1 Introduction

The purpose of this review is to identify and review technical specifications and emergency procedures which are intended to protect San Onofre Unit 1 from flood conditions, and to identify and review the effectiveness of these procedures in protecting the plant.

3.3.3.2 Emergency Procedures

In response to an NRC request, the Licensee indicated two emergency procedures for flood protection [16]. They are Operating Instruction #S01-1.5-4, "Condenser Bay Flooding," and Operating Instruction #S01-1.6-2, "Tsunami Warning."

Operating Instruction #S01-1.5-4 describes flooding caused by a failure of circulating water system piping. It is not applicable to flooding from hydrological events, and does not fall within the scope of this review.

Operating Instruction #S01-1.6.2 is designed in two parts addressing protection against both predicted and unpredicted tsunamis. Both versions include closing of the inlet and outlet hydraulic stop gates, the most important action necessary to complete the protection provided by the tsunami wall. The greater part of both versions addresses bringing the plant to hot standby and cold shutdown conditions.

Part A of Operating Instruction #S01-1.6.2, "Predicted Tsunami Warning," is initiated by information from the Energy Control Center or other sources, and confirmed by the System Operations Supervisor, who periodically reconfirms the prediction throughout the procedure. One hour prior to the predicted time of the tsunami, the operator is instructed to watch for tsunami wave action by monitoring the screenwall level, the storm drains, and the area intake structure for potential seawater in-leakage. However, no actions are prescribed if in-leakage is observed. Such a contingency should be addressed.

"Unpredicted Tsunami Warning" is Section B of Operating Instruction #S01-1.6.2. It is initiated by earth tremors followed by "intake structure high level" alarm or by off- or on-site seismic trigger alarms. Item 4.5 under 4.0, Subsequent Operator Actions, is an instruction to close the intake and outlet hydraulic stop gates. It is suggested that the instruction to close the intake and outlet hydraulic stop gates should be under 3.0, Immediate Operator Action, as item 3.3, to prevent flooding of the plant yard.

There are no emergency procedures for flooding from heavy local precipitation at San Onofre Unit 1. No such procedures could fulfill current NRC criteria for flood protection, since the time available between receipt of a warning and accumulation of runoff is inadequate to implement protective actions.

3.3.3.3 Technical Specifications

There are no technical specifications at San Onofre Unit 1 to protect the plant against flooding from any hydrologic event.

3.3.4 Conclusion

The Operating Instructions provided by the Licensee, Tsunami Warning (#S01-1.6-2) and Condenser Bay Flooding (#S01-1.5-4), will be adequate with the following changes:

- The procedure for predicted tsunami warning should include instructions for dealing with seawater in-leakage at the screenwell, the storm drains, and the intake structure.
- The procedure for predicted tsunami should be modified so that the instruction to close the intake and outlet hydraulic stop gates is an immediate operator action, rather than a subsequent one.

3.4 SAFETY-RELATED WATER SUPPLY (TOPIC II-3.C)

3.4.1 Topic Background

This topic reviews the acceptability of a particular feature of the cooling water system, namely, the ultimate heat sink (UHS). The review is based on current criteria contained in Regulatory Guide 1.27, Rev. 2, which is an interpretation of General Design Criterion (GDC) 44, "Cooling Water," and GDC 2, "Design Bases For Protection Against Natural Phenomena," of 10CFR50, Appendix A.

GDC 44 requires, in part, that suitable redundancy of features be provided for cooling water systems to ensure that they can perform their safety function. GDC 2 requires, in part, that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena without loss of ability to perform their safety functions. Regulatory Guide 1.27 has been specifically cited by the NRC's Regulatory Requirements Review Committee as needing consideration for backfitting operating reactors. This guide is used in judging whether the facility design complies with current criteria.

The UHS as reviewed under this topic is the complex of water sources, including necessary retaining structures (e.g., a pond with its dam or a cooling tower supply basin) and the canals or conduits connecting the sources to the cooling water system intake structures, but excluding the intake structures themselves. The UHS performs two principal safety functions: (1) dissipation of residual heat after reactor shutdown and (2) dissipation of residual heat after an accident.

Availability of an adequate supply of water for the UHS is a basic requirement for any nuclear power plant. Since there are various methods of satisfying the requirement, UHS designs tend to be unique to each nuclear plant, depending upon its particular geographical location. Regulatory Guide 1.27 provides UHS examples that the NRC staff has found acceptable.

The UHS must also be able to dissipate the maximum possible total heat, including the effects of a LOCA under the worst combination of adverse environmental conditions. The maximum tolerable temperature of a UHS such as cooling pond may significantly limit its ability to dissipate the heat load following a LOCA or plant shutdown, while for a UHS such as a large lake, river, or ocean, maximum temperature may not be a significant concern.

Because of its importance, the UHS should be able to perform its safety function during and following the most severe natural phenomena or accidents postulated at the site. In addition, the sink safety functions should be ensured during other applicable site-related events that may be caused by less severe natural phenomena and accidents in reasonable combination.

3.4.2 Topic Review Criteria

The criteria by which the UHS was evaluated in this topic review are taken from Regulatory Guide 1.27, "Ultimate Heat Sink For Nuclear Power Plants." Regulatory Guide 1.27 criteria are as follows:

"1. The ultimate heat sink should be capable of providing sufficient cooling for at least 30 days (a) to permit simultaneous safe shutdown and cooldown of all nuclear reactor units that it serves and to maintain them in a safe shutdown condition, and (b) in the event of an accident in one unit, to limit the effects of that accident safely, to permit simultaneous and safe shutdown of the remaining units, and to maintain them in a safe shutdown condition. Procedures for ensuring a continued capability after 30 days should be available.

2. The ultimate heat sink complex, whether composed of single or multiple water sources, should be capable of withstanding, without loss of the sink safety functions specified in regulatory position 1, the following events:

   a. the most severe natural phenomena expected at the site, with appropriate ambient conditions, but with no two or more such phenomena occurring simultaneously,

   b. the site-related events (e.g., transportation accident, river diversion) that historically have occurred or that may occur during the plant lifetime,

   c. reasonably probable combinations of less severe natural phenomena and/or site-related events,

   d. a single failure of manmade structural features.

3. The ultimate heat sink should consist of at least two sources of water, including their retaining structures, each with the capability

to perform the safety functions specified in regulatory position 1, unless it can be demonstrated that there is an extremely low probability of losing the capability of a single source.

4. The technical specifications for the plant should include provisions for actions to be taken in the event that conditions threaten partial loss of the capability of the ultimate heat sink or the plant temporarily does not satisfy regulatory positions 1 and 3 during operation."

In addition to Regulatory Guide 1.27 [3], clarifications are contained in Standard Review Plan (SRP) [2], Sections 2.4.11, "Low Water Considerations," and 9.25, "Ultimate Heat Sink."

3.4.3 Evaluation

The UHS for San Onofre Unit 1 is the Pacific Ocean. Water is drawn through a 12-ft diameter, reinforced-concrete pipe that extends 3200 ft into the ocean. The intake pipe conveys water to a concrete intake structure that houses stop gates, reversing gates, traveling water screens, bar screens, circulating water pumps, saltwater pumps, and screen wash pumps. The saltwater cooling system cools the component cooling water (CCW) heat exchangers. An auxiliary saltwater cooling pump is also available to provide cooling water to the CCW heat exchangers. After passing through the tube side of the CCW heat exchangers, the cooling water is discharged to the ocean through a 12-ft-diameter, reinforced-concrete pipe that extends 2600 ft into the ocean.

Criterion 1 of Regulatory Guide 1.27 was established for heat sinks in which the supply may be limited and/or the temperature of plant intake water from the heat sink may become critical. At San Onofre Unit 1, the ability to dissipate the total essential heat load, the effect of environmental conditions on the ability of the UHS to furnish the required quantities of cooling water for extended times after shutdown, and the sharing of cooling water with other units do not require further consideration due to the type, size, and proximity of the water supply.

Similarly, Criterion 2 was established to ensure that the heat sink function would not be lost due to natural phenomena, site- related events, or a single failure of manmade structural features. An ocean is cited as acceptable in Regulatory Guide 1.27. However, the heat sink function at San Onofre could be lost by failure of the intake piping. The effect of earthquakes on the UHS intake piping is being reviewed under Topic III-6, "Seismic Design Considerations." The effect of earthquakes on the Pacific Ocean is not considered to pose a significant threat to the availability of the water source.

Low water level caused by tidal action and other natural phenomena is not considered a threat to the water source at San Onofre Unit 1. The extreme low tide, observed at San Diego and adjusted for the San Onofre Plant, is -2.66 ft mllw. Reference 11 describes low water resulting from surges, seiches, or tsunami.

For surges, SCE states:

"Winds that blow offshore at the San Onofre would cause the greatest lowering of water as a result of surge. Surge drawdown would be most pronounced during Santa Ana wind conditions. A maximum credible Santa Ana condition for San Onofre would produce northeast winds of 35 knots sustained for 12 hours. The greatest correspondent drawdown from the antecedent water level associated with maximum Santa Ana wind conditions is -0.55 ft."

For seiches, SCE states:

"Some of the most detailed measurements and analyses of long-period waves (normal shelf seiching background levels) over the continental borderland has been conducted near Oceanside, California, about 17 miles southeast of San Onofre. Seiche has been found to affect sea surface elevation by only 0.7 cm, which is considered negligible for water level calculations for southern California."

For tsunamis, SCE indicates that the most severe low water that could be assumed would involve the worst tsunami drawdown, which would be -12.3 ft mllw. The intake structure is partially buried in the ocean bottom such that the lip of the intake structure is approximately 10 ft above the ocean floor. To prevent debris and fish life from entering the intake structure, a 1-ft-thick velocity cap is provided. The bottom of the velocity cap is located 12.5 ft below mllw and the lip of the intake structure is located 16.5 ft below mllw. Since only a portion of the velocity cap of the intake structure would be exposed during the worst tsunami drawdown and this natural phenomenon would persist for only a few minutes, it can be concluded that low water caused by tsunami would not preclude the intake crib from providing water to the intake line.

Other natural phenomena such as tornadoes and floods do not endanger the intake piping or the water source.

The effect of site-related events (e.g., a transportation accident) on the intake and discharge piping is being reviewed separately under Topic II-1.C, "Potential Hazards Due to Nearby Industrial, Transportation, and Military Facilities," and Topic III-4.D, "Site Proximity Missiles." Site-related events are not considered a threat to the availability of the San Onofre Unit 1 water source.

A single catastrophic failure of the intake piping would result in the partial loss of cooling capacity. An intake piping failure would remove the water supply to the salt water cooling pumps and to the circulating water pumps. In this situation, the plant does not have the ability to conduct a normal shutdown and does not have the ability to remove heat from the reactor coolant system through the residual heat removal system. The consequences of a passive failure resulting in the loss of the heat sink would be mitigated by the plant's ability to remove reactor decay heat by the release of steam through the atmospheric dump valves. In Reference 25, the water sources that provide water to the auxiliary feedwater system for steam generator makeup are described. The condensate storage tank (CST) has a capacity of 240,000 gal with a technical specification minimum capacity of 15,000 gal. Following a loss of offsite ac power, makeup to the CST is available from the primary plant makeup tank (PPMUT) or from the service water reservoir (SWR). The PPMUT has a capacity of 150,000 gal and the SWR has a capacity of 3,000,000 gal. Technical specifications require at least 105,000 gal to be available from the PPMUT and/or the SWR. Water from the PPMUT can be pumped directly into the CST, while the water from the SWR can be supplied to the CST by using the fire protection system. Reference 25 states that "the total secondary makeup water inventory, required by the technical specification 120,000 gal, is enough either to keep the plant at hot shutdown for 20 hours, or to complete a shutdown to the point of RHR initiation, 350°F, in about 15 hours."

Therefore, it can be concluded that sufficient time is available for the plant operators to provide additional makeup capacity and/or to devise an alternate cooling scheme for reaching safe shutdown. It should also be noted that the diesel generators for onsite emergency power are air-cooled and that the main feed pumps do not need seal cooling in the safety injection mode of operation. Therefore, emergency power and safety injection are not lost following a catastrophic failure of the intake structure.

Criterion 3 of Regulatory Guide 1.27 was established to provide a high level of assurance that a plant's UHS would be available when needed. For a once-through cooling system such as that at San Onofre Unit 1, the Regulatory Guide suggests at least two aqueducts connecting the Pacific Ocean, in this case, with the intake structure and at least two discharge aqueducts to carry the cooling water away to preclude plant flooding, unless it can be demonstrated that the probability is extremely low that a single aqueduct will fail to function as a result of natural or site-related phenomena. As previously stated, an unlikely single failure would not result in a total loss of UHS function. A failure within the intake and discharge piping would not preclude the use of the auxiliary feedwater system and the steam generators. A failure within the intake or discharge piping would threaten the ability of the plant to provide sufficient cooling for at least 30 days; however, it has been demonstrated that sufficient time is available for the plant operators to provide additional makeup capacity and/or devise an alternative cooling scheme for reaching safe shutdown. Since the loss of a single aqueduct would not result in a total loss of UHS function and it has been demonstrated that the likelihood is extremely low that a single aqueduct will fail to function as a result of natural or site-related phenomena, it can be concluded that the San Onofre UHS complex satisfies that intent of Criterion 3.

Criterion 4 requires that the plant technical specifications include provisions for actions to be taken in the event that conditions threaten partial loss of the UHS. This criterion was established to ensure that the manner in which plant technical specifications were written was such that the plant would be placed in a safe condition or provisions would be implemented if a condition existed which threatened the availability of the UHS. An example of such a condition might be the prediction of a severe flood which would jeopardize a UHS dike or retaining structure, a severe drought with the potential to reduce the capacity of a cooling pond, or severe river icing conditions that could preclude or inhibit water flow for a once-through cooling system. In each of these situations, technical specifications requiring the plant to be placed in a safe condition or implementation of procedures to mitigate the consequences of a threatened partial loss of the UHS would be prudent.

As described previously, the San Onofre UHS, including the Pacific Ocean and the intake and discharge piping, is not susceptible to damage from natural phenomena and most site-related events. The UHS complex is potentially susceptible to damage from single catastrophic failures and earthquakes, but events of this type cannot be predicted sufficiently in advance to allow the plant to be placed in a safe shutdown condition. Alternate core cooling by use of the auxiliary feedwater system and the steam generators has been described in this evaluation as a cooling method by which a total loss of heat sink function can be prevented following a single catastrophic failure of the UHS. The present technical specifications do not include provisions for actions to be taken in the event that conditions threaten partial loss of the UHS. However, technical specifications are provided for the auxiliary feedwater system and water sources. Since the San Onofre UHS is not susceptible to damage from natural phenomena and most site-related events and the alternate cooling mode has technical specification provisions, the intent of Criterion 4 is met.

3.4.4 Conclusion

The following is a summary of the degree of conformance of the San Onofre UHS to the criteria of Regulatory Guide 1.27:

Criterion 1 - complies with no exceptions or clarifications

Criterion 2 - partially complies pending SEP evaluations of the effects of earthquakes and site-related events on the intake and discharge piping

Criterion 3 - complies with the clarification that the auxiliary feedwater system and the steam generators augment the UHS complex to further reduce the likelihood of a total loss of heat sink function

Criterion 4 - complies with the intent of the criterion.

In summary, the UHS at San Onofre Unit 1 is a dependable design that partially complies with the intent of the Regulatory Guide 1.27. Full compliance can be attained by a satisfactory review of the SEP Topics III-6, III-1.C, and III.4.D.

4. CONCLUSIONS

4.1 SEP TOPIC II-3.A, HYDROLOGIC DESCRIPTION

The design bases for low water and rooftop ponding are not adequately described. Measurements of groundwater elevation at the San Onofre Unit 1 site are not sufficient to allow an accurate identification of probable maximum groundwater level. On other subjects, the hydrologic environment is adequately described.

4.2 SEP TOPIC II-3.B, FLOOD POTENTIAL AND PROTECTION REQUIREMENTS

The following conclusions pertaining to specific aspects of flood potential at the San Onofre Unit 1 site are presented.

Local Flooding

San Onofre Unit 1 does not meet current NRC criteria for flooding from local PMP. Under conditions which can be reasonably foreseen to occur, ponding will rise to elevation 23.2 ft mllw in the plant yard during PMP. Safety-related equipment in all plant structures listed in Table 2 will be flooded.

During PMP, the reactor auxiliary building, the administration and control building, the fuel storage building, the diesel generator building, the turbine building with north and south extensions, the sampling station building, the intake structure, the east and west heater platforms, and the ventilation building would be flooded. Safety-related equipment would be subjected to flood waters between 3 ft and 15 ft deep.

Roof Drainage

The roofs of the control building, the reactor auxiliary building, the sphere enclosure building, the post-accident sampling building, the turbine building, the east and west heater platforms, and the diesel generator building all meet current NRC criteria for local PMP.

The fuel storage building and the ventilation building rooftop will be subject to 46.6 psf and 38.9 psf respectively over the low points of the roofs. Since the Licensee has failed to provide the design basis, compliance with NRC criteria cannot be determined. This issue should be evaluated under SEP Topic III-3.A, Effects of High Water Level on Structures.

Tsunami

The tsunami wall and walkway complex west of San Onofre Unit 1 fulfills the current NRC requirements. It will protect the safety-related structures from the probable maximum tsunami with coincident storm waves, if the tsunami gates in the intake and discharge lines are closed.

Groundwater

Normal high groundwater elevation for use with coincident seismic loads is +10.0 ft mllw. Probable maximum groundwater elevation is plant grade.

4.3 SEP TOPIC II-3.B.1, CAPABILITY TO COPE WITH DESIGN BASIS FLOODING CONDITIONS

The Operating Instructions provided by the Licensee, Tsunami Warning (#SO1-1.6-2) and Condenser Bay Flooding (#SO1-1.5-4), will be adequate with the following changes:

- o The procedure for predicted tsunami warning should include instructions for dealing with seawater in-leakage at the screenwell, the storm drains, and the intake structure.
- o The procedure for predicted tsunami should be modified so that the instruction to close the intake and outlet hydraulic stop gates is an immediate operator action, rather than a subsequent one.

4.4 SEP TOPIC II-3.C, SAFETY-RELATED WATER SUPPLY

The following is a summary of the degree of conformance of the San Onofre UHS to the criteria of Regulatory Guide 1.27:

Criterion 1 - complies with no exceptions or clarifications

Criterion 2 - partially complies pending SEP evaluations of the effects of earthquakes and site-related events on the intake and discharge piping

Criterion 3 - complies with the clarification that the auxiliary feedwater system and the steam generators augment the UHS complex to further reduce the likelihood of a total loss of heat sink function

Criterion 4 - complies with the intent of the criterion.

In summary, the UHS at San Onofre Unit 1 is a dependable design that partially complies with the intent of the Regulatory Guide 1.27. Full compliance can be attained by a satisfactory review of the SEP Topics III-6, III-1.C, and III.4.D.

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TER-C5257-309

APPENDIX A

WAVE FORCES AT THE SAN ONOFRE UNIT 1 SEAWALL

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