San Onofre Nuclear Generating Station
Units 2 & 3

Defueled Safety Analysis Report (DSAR)

November 2020

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1. INTRODUCTION AND GENERAL DESCRIPTION OF PLANT

1.0 SONGS POST SHUTDOWN UFSAR (DSAR) REVISION METHODOLOGY

With the completion of Fuel Transfer Operations (FTO), SCE certified to the NRC that all fuel assemblies have been transferred from the Spent Fuel Pool to an on-site Independent Spent Fuel Storage Installation (ISFSI) to allow the completion of decommissioning of San Onofre Nuclear Generating Station (SONGS). With the relocation of the spent fuel to the ISFSI, the license bases for the majority of the SSCs have changed and only minimal SSCs are needed to support the ongoing active decommissioning. These SSCs and design functions will continue to transition as active decommissioning progresses.

On June 12, 2013, Southern California Edison (SCE) formally notified the NRC that it had permanently ceased operation of SONGS Units 2 and 3. Consistent with NRC decommissioning regulations, SCE submitted letters to the NRC in 2013 certifying cessation of power operation and certifying both Units 2 and 3 as permanently defueled. In 2014, SCE submitted the Post Shutdown Decommissioning Activities Report (PSDAR), the Irradiated Fuel Management Plan (IFMP), and in 2017 the site-specific Decommissioning Cost Estimate (DCE) to the NRC. SCE also submitted License Amendment Requests for Permanently Defueled Technical Specifications (PDTS), Permanently Defueled Emergency Plan (PDEP), and Emergency Action Levels (EAL) which were approved in 2015.

The Defueled Safety Analysis Report (DSAR) transitioned from the SONGS Unit 2 and 3 Updated Final Safety Analysis Report (UFSAR) in 2016. The SONGS Units 2 and 3 Updated Final Safety Analysis Report (UFSAR) has been and will continue to be referred to as the DSAR. While that specific term has little, if any, regulatory basis it reflects the large scope reductions appropriate to evolving plant status and conditions. The terms should be understood as interchangeable.

In preparation for the Post-FTO state, SCE submitted License Amendment Requests in 2016 to revise the Operating License and associated Technical Specifications, the Emergency Plan and EALs, and the Security Plan which were subsequently approved by the NRC. The Quality Assurance requirements for the Post-FTO state were submitted as a revision to the Decommissioning Quality Assurance Plan (DQAP) in 2018 and have also been approved by the NRC. The current Post-FTO DSAR follows the guidance of Regulatory Guide 1.184 and reflects a complete re-write of many chapters and therefore, it was not appropriate to annotate specific changes with change bars.

Some structures, systems, and components (SSCs) are no longer necessary due to the permanently defueled plant condition. The SONGS Quality Equipment List (“Q-List,” Controlled Document 90034) is updated to identify those plant SSCs that are required for decommissioning. Discussion of and references to the SSCs no longer required to be “Available” (e.g., no longer mechanically or electrically active, are no longer radioactively contaminated, have no fluid content or other materials that require special handling considerations, or have been physically removed during the dismantlement process) have been deleted from the DSAR with the exception that subsystem status is retained in tabular form. Details of basic physical makeup of the site is retained in Controlled Plant General Arrangement Drawings. Organizational details are generally deferred to the DQAP. System hazards are administratively controlled through programs such as the Storage Tank Monitoring Program, Waste Management Program, Radiation Protection Program and the Work Control Program.

Additionally, certain information that was previously considered “historical” and not subject to periodic updates has been placed in Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information.” By definition, designating certain information as historical does not remove that information from the DSAR. Reference to paragraphs, tables, figures, and appendices are made throughout various chapters, sections and subsections. If the referenced information does not reside within the DSAR, the information has been relocated to Controlled Document 90216.

Once an SSC is no longer required to be “Available” it is “Removed from Service.” Once the SSC has been removed from the plant during the demolition process, any remaining description will then be removed from the UFSAR (DSAR) and the General Arrangement Drawings.

Removal of systems from service is without regard to future use by a Decommissioning General Contractor (DGC). For instance, the containment polar crane is no longer required for reactor refueling services and thus has been removed from service; however, it may be placed in service again and used in the future by the DGC for demolition purposes.

1.1 INTRODUCTION

Prior versions of this section included brief overviews of the site and plant equipment which were submitted to the NRC in support of initial plant licensing. This information is considered background and is not subject to review or periodic updates. Updated information is found in other chapters and sections. The historical information previously contained in this section has been relocated to Controlled Document 90216.

1.2 GENERAL PLANT DESCRIPTION

The information previously contained in this section is considered historical and has been relocated to Controlled Document 90216.

The major systems including their status discussed in the DSAR for the defueled condition are:

System	Chapter
Reactor	4
Reactor Coolant System and Connected Systems	5
Shutdown Cooling System	5
Engineered Safety Features	6
Habitability Systems	6
Instrumentation and Controls	7
Electrical Systems	8
Spent Fuel Storage	9
Fuel Pool Cooling Systems	9
Fuel Pool Makeup System	9
Fuel Handling System	9
Saltwater Cooling System	9
Component Cooling Water System	9
Domestic Water System	9
Turbine Plant Cooling Water System	9
Compressed Air System	9
Process Sampling System	9
Chemical and Volume Control System	9
Heating, Ventilating, Cooling and Air Conditioning Systems	9
Diesel Generator Auxiliary Fuel Oil Systems	9
Diesel Generator Auxiliary Cooling Water Systems	9
Diesel Generator Auxiliary Starting Air Systems	9
Diesel Generator Auxiliary Lubricating Oil Systems	9
Circulating Water System	9
Fire Protection System	9
Steam and Power Conversion System	10
Radioactive Liquid Waste System	11
Radioactive Gaseous Waste Management System	11
Solid Waste Management System	11

1.3 COMPARISON TABLES

Prior versions of Section 1.3, "Comparison Tables," provided summary information on plant comparisons, design changes since the Preliminary Safety Analysis Report submittal, and compliance with NRC regulations that existed at the time of licensing. This information was submitted to the NRC in support of initial plant licensing. Information is considered to be historical information and is not subject to review or periodic updates. Updated information on design and compliance is found throughout the other sections of this UFSAR. The information relative to Comparisons with Similar Facility Designs and the Comparison of Final and Preliminary Information has been relocated to Controlled Document 90216.

1.4 IDENTIFICATION OF APPLICANTS FOR FACILITY LICENSE, PROJECT MANAGER, AND MAJOR SUPPLIERS/CONTRACTORS AND CONSULTANTS

Prior versions of Section 1.4, "Identification of Applicants for Facility License, Project Manager, and Major Suppliers/Contractors and Consultants," provided overview information submitted to the NRC in support of initial plant licensing, is historical information and is not subject to review or periodic updates. This section has been relocated to Controlled Document 90216.

1.5 REQUIREMENTS FOR FURTHER TECHNICAL INFORMATION

Prior versions of Section 1.5, "Requirements for Further Technical Information," provided information on the status of Combustion Engineering's Research and Development Programs at the time of initial licensing. This information is considered historical and is not subject to review or periodic updates. This section has been relocated to Controlled Document 90216.

1.6 MATERIAL INCORPORATED BY REFERENCE

Prior versions of Section 1.6, "Material Incorporated by Reference," provided a listing of topical reports submitted to the NRC in support of initial plant licensing. The listing represents historical information and is not subject to review or periodic updates. This section has been relocated to Controlled Document 90216.

1.7 ELECTRICAL, INSTRUMENTATION, AND CONTROL DRAWINGS

Prior versions of Section 1.7, "Electrical, Instrumentation, and Control Drawings," provided a listing of drawings submitted to the NRC in support of initial plant licensing. The listing represents historical information and is not subject to review or periodic updates. This section has been relocated to Controlled Document 90216.

1.8 MISCELLANEOUS DRAWINGS AND DATA

Prior versions of Section 1.8, "Miscellaneous Drawings and Data," provided listings of drawings and documents submitted to the NRC in support of initial plant licensing. The listings represent historical information and are not subject to review or periodic updates. This section has been relocated to Controlled Document 90216.

2. SITE CHARACTERISTICS

Significant portions of the data and information that was contained in Section 2, and referenced appendices are historical information developed during San Onofre's original design and licensing to address various site characteristics. Significant portions of the information was used to determine the plant's design basis. The retained design information is referenced in the current licensing basis of the SONGS site and the ISFSI has been maintained in the DSAR. Other historical information has been placed in Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information" as an available reference should it be needed.

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 SITE LOCATION AND DESCRIPTION

2.1.1.1 Site Location

The San Onofre site is located on the coast of Southern California in San Diego County, approximately 62 miles southeast of Los Angeles and 51 miles northwest of San Diego. The site is located entirely within the boundaries of the United States Marine Corps Base, Camp Pendleton, California, near the northeast end of the 18-mile shoreline.

2.1.1.2 Site Area Description

The plant easement boundary (also referred to as the site boundary) is delineated in Figure 2.5-32. The site, comprising 83.63 acres, is approximately 4500 feet long and 800 feet wide. The North Industrial Area (NIA) is located northwest of Units 2 and 3 and occupies 11.7 acres and is the location of the SONGS Independent Spent Fuel Storage Installation (ISFSI) and supporting structures. The former Units 2 and 3 power block occupies 19.5 acres. A spur of the commercial railroad line extends into the site area.

Establishment of an Exclusion Area Boundary (EAB) is required during of initial site licensing by 10 CFR Part 100, 100.11(a). The San Onofre Units 2 and 3 EAB is roughly formed by two semi-circles with a tangent connecting the landward and the seaward arcs of the two semi-circles. The EAB is delineated in Figure 2.1-5. There are no industrial, commercial, institutional, or residential structures within the EAB. The Pacific Ocean as well as a rail corridor and Interstate Highway 5 traverse EAB as allowed by 10 CFR 100.3 "provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety."

The San Onofre State Beach is located along the Pacific Coast on both the north and south ends of the site. Access between open beach areas is provided by a walkway (the beach passage-way) adjacent to the NIA and Units 2&3 seawalls. The passageway extends the length of the seawalls. The seaward side of the walkway is formed by a concrete retaining wall which is protected by riprap to minimize beach erosion caused by wave action.

Old U. S. Highway 101 is immediately adjacent to the east boundary line of the site. This segment of the highway is presently being used primarily as an entrance to the State Beach as well as the access points to the SONGS site. The commercial railroad right-of-way is east of Highway 101. Interstate Highway 5 (also known as the San Diego Freeway) is further east of the railroad right-of-way.

2.1.1.3 Boundaries for Establishing Effluent Release Limits

The site restricted area defined for the purpose of establishing gaseous effluent release limits coincides with the historic EAB. The coastline is the boundary for establishing liquid release limits.

2.1.2 EXCLUSION AREA AUTHORITY AND CONTROL

2.1.2.1 Authority

The applicant's authority to control all activities within the exclusion area was acquired by grant of easement from the United States of America made by the Secretary of the Navy pursuant to the authority of Public Law 88-82. This easement is recorded in the official records of the Recorder of San Diego County, California, on Page 85887, Series 5, Book 1964.

In order to remove any ambiguities contained in the original grant of easement with respect to the applicant's authority to control activities in the exclusion area, an amendment to the grant of easement was executed on September 18, 1975, and is reproduced below, in part:

> "In order to protect the public health and safety, and in accordance with the rules, regulations and requirements of the United States Nuclear Regulatory Commission, successor to the United States Atomic Energy Commission, applicable to the Nuclear Station, the Grantees may determine all activities including exclusion or removal of personnel and property from such exclusion area as is established from time to time by or with the approval of the United States Nuclear Regulatory Commission and is located within the lands described in Exhibit B. Subject to the foregoing, such exclusion area may be used by the Government, its successor or assigns, for military operations (provided same do not endanger operation of the Nuclear Station), agricultural, recreational and such other uses as may be compatible with operation of the Nuclear Station, <u>provided</u> that any and all uses of the exclusion area shall be in accordance with and subject to the rules, regulations and requirements of the United States Nuclear Regulatory Commission applicable to the Nuclear Station, and <u>further provided</u> that no significant hazards to the public health and safety shall result from any such uses."

This amendment to the grant of easement expires on May 12, 2024.

All mineral rights in the land portion of the exclusion area are held by the United States Government.

2.1.2.2 Control of Activities Unrelated to Plant Operation

Recreational activities, such as sunbathing or picnicking are infrequently observed in the small remaining beach between the site and ocean. The adjacent water may be occupied by small numbers of people for passageway transit between the public beach areas upcoast and downcoast from the plant or recreational activities such as paddle-boarding or surfing.

Transient access to an approximately 5-acre area at the southwest corner of the site for the purposes of viewing the scenic bluffs and barrancas is also infrequent and requires access via an unimproved walkway.

2.1.2.3 Arrangements for Traffic Control

The environs of the Site are the Pacific Ocean and the beach passageway on the west, the San Diego Freeway (Interstate 5), old U.S. Highway 101, and the commercial railroad on the southeast and north. These environs of the plant are not a factor in decommissioning activities.

In the event of an emergency, all traffic within the roadways and waterways is subject to control by agencies of state and local governments.

2.1.2.4 Abandonment or Relocation of Roads

There were no public roads abandoned or relocated as a result of construction of San Onofre Units 2 and 3.

2.1.3 POPULATION DISTRIBUTION

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.1.4 REFERENCES

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.1.5 BIBLIOGRAPHY

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.2.1 LOCATION AND ROUTES

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.2.2 DESCRIPTIONS

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.2.3 EVALUATION OF POTENTIAL ACCIDENTS

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.2.4 REFERENCES

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.2.5 BIBLIOGRAPHY

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.3 METEOROLOGY

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.3.1 REGIONAL CLIMATOLOGY

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.3.1.2 Regional Meteorological Conditions for Design and Operating Bases

2.3.1.2.1 Hurricanes

Tropical storms with hurricane force winds (72 mi/h or greater) have not been recorded to approach the southwestern United States. Although hurricanes do exist several hundred miles to the south off of the western coast of Mexico, their impact on the San Onofre area usually only takes the form of a summer thunderstorm.

2.3.1.2.4 Lightning

Estimates have been made of the frequency of occurrence of lightning ground strikes in the vicinity of the San Onofre Nuclear Generating Station utilizing a method developed by Pierce, et al (1) method utilizes an equation to estimate the lightning flashes going to the ground from the frequency of thunderstorm days. The calculated monthly flash density has been found to be less than 0.005 flashes per square kilometer.

2.3.1.2.7 Snow Accumulation

Significant snow accumulation has never been recorded at a coastal location in southern California.

2.3.2 LOCAL METEOROLOGY

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.3.2.1.2 Temperature

The small range in temperature from day to night and from winter to summer produces a very equable regime along the southern California coast. For example, long-term climatological data at San Diego and Los Angeles (see Table 2.3-3) show the average monthly temperature in January is 12.8°C (55°F), while the August value is 21.1-22.2°C (70-72°F). High temperatures along the coast, although infrequent, are associated with Santa Ana winds which occur in the autumn. Both Los Angeles and San Diego recorded their highest maximum temperatures in September, 1963: Los Angeles 43°C (110°F) and San Diego 44°C (111°F). Nighttime temperatures are generally cool, but minimum temperatures below 4.4°C (40°F) are rare and periods of over 10 years may pass with no temperatures below freezing along the coast.

The meteorological summaries for 1973 and 1974 for Los Angeles (Table 2.3-4) and for San Diego (Table 2.3-5) show that these years were rather typical of the normal year at these stations. Therefore, the San Onofre data taken during the 2-year period from 1974 through 1975 may be considered as representative of normal conditions at the site.

The temperature summary (Table 2.3-6) of onsite data presents monthly and annual means, mean maximums, mean minimums, absolute minimums, absolute maximums, and averages by hours of the day. The computations were made from data recorded at the 6.1 meter (20 foot) level during the period from January 25, 1974, through October 25, 1975, and raised to 10 meters through January 24, 1976.

The mean values at San Onofre are 2 to 3°C cooler than the mean values recorded at San Diego and Los Angeles. This variance is caused partially by differences in the instrument exposure. At San Diego and Los Angeles the temperature measurements are made in instrument shelters at a height of about 1 meter above the ground, while at San Onofre the temperatures are measured in a shielded aspirator mounted on a tower 6 meters above the surface. Another factor is the close proximity (60 meters, 197 feet) of the tower to the ocean, while both the observation sites at Los Angeles International Airport and San Diego Lindbergh Field are 1 to 4 kilometers (0.6 to 2.5 miles) from the immediate coast. This difference in distance from the sea coast is sufficient to cause slightly warmer temperatures to be experienced at the airport sites.

Noteworthy temperature statistics for the site include an annual mean temperature of 14.1°C (57.4°F) with a difference between the annual mean maximum at 16.7°C (62.1°F) and the annual mean minimum at 11.3°C (52.3°F) of only 5.4°C (9.8°F). The extremes were an absolute maximum of 34.3°C (93.7°F) on September 23, 1975, with an offshore Santa Ana wind, and an absolute minimum of 0.6°C (33.1°F) on January 25, 1975, with an offshore drainage breeze. The maximum temperature at the site may occasionally reach 38°C (100°F) or more in extreme Santa Ana conditions.

The difference between the monthly mean maximum and minimum temperatures varied from 6.6°C (11.9°F) in January to 3.9°C (7.1°F) in July. These very moderate mean temperatures reflect the strong influence of the adjacent Pacific Ocean. Extreme temperatures occur with offshore land breezes. Occasional Santa Ana winds bring the higher absolute maximum temperatures most evident during the fall and early winter.

2.3.3 ONSITE METEOROLOGICAL MEASUREMENT PROGRAM

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.3.4 SHORT-TERM (ACCIDENT) DIFFUSION ESTIMATES

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.3.5 LONG-TERM (ROUTINE) DIFFUSION ESTIMATES

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.3.6 REFERENCES

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.3.7 BIBLIOGRAPHY

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4 HYDROLOGIC ENGINEERING

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.1 HYDROLOGIC DESCRIPTION

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.2 FLOODS

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

Table 2.4-2

6-HOUR, 1-SQUARE-MILE PROBABLE MAXIMUM THUNDERSTORM PRECIPITATION (PMP)

Time (hours)	PMP Total (inches)	PMP Incremental (inches)	PMP Critically Arranged (inches)
0.25	3.01	3.01	0.14
0.50	4.90	1.89	0.14
0.75	6.16	1.26	0.14
1.00	7.00	0.84	0.14
1.25	7.63	0.63	0.14
1.50	8.12	0.49	0.21
1.75	8.54	0.42	0.21
2.00	8.96	0.42	0.21
2.25	9.31	0.35	0.28
2.50	9.59	0.28	0.35
2.75	9.87	0.28	0.42
3.00	10.15	0.28	0.63
3.25	10.36	0.21	1.26
3.50	10.57	0.21	3.01
3.75	10.78	0.21	1.89
4.00	10.99	0.21	0.84
4.25	11.20	0.21	0.49
4.50	11.41	0.21	0.42
4.75	11.55	0.14	0.28
5.00	11.69	0.14	0.28
5.25	11.83	0.14	0.21
5.50	11.97	0.14	0.21
5.75	12.11	0.14	0.21
6.00	12.25	0.14	0.14

2.4.3 PROBABLE MAXIMUM FLOOD ON STREAMS AND RIVERS

An analysis of the 0.86 square mile foothill drainage area and the 43 square miles San Onofre Creek Basin was conducted to determine the PMF and subsequent contribution to flooding at the San Onofre site. The recommendations of NRC Regulatory Guide 1.59 were used in conducting the PMF analysis.

2.4.3.1 Probable Maximum Precipitation

The San Onofre area is susceptible to frontal storms, usually occurring during the months of October through April, and local thunderstorms which are predominant during summer and early fall. A comparison of the PMP values associated with both types of storms was made to determine the critical event. HMR 36[5] was used to calculate the frontal storm PMP and the National Weather Service Report[6] was used in determining the thunderstorm PMP. By comparison, it was concluded that the thunderstorm PMP was the more critical and consequently was used as the design basis event. The 6-hour, 1-square mile thunderstorm PMP is presented in Table 2.4-2.

The thunderstorm PMP for the foothill drainage basin was derived in a manner similar to the method used for the San Onofre Creek Basin. The 1-square mile PMP total was calculated at 12.25 inches as presented in Table 2.4-2.

2.4.4 POTENTIAL DAM FAILURES, SEISMICALLY INDUCED

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.4.5 PROBABLE MAXIMUM SURGE AND SEICHE FLOODING

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.4.5.2.4 Seiche Water Levels

Some of the most detailed measurements and analyses of long-period waves (normal shelf seiching background levels) over the continental borderland have been conducted near Oceanside, California, about 17 miles southeast of San Onofre.[30][31] 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.

Intersea Research Corporation[37] calculated the seasonal frequency of occurrence of breaking wave significant height, period and direction at the San Onofre beach. The significant breaking wave height exceedance values from that report and the annual average values are presented in Table 2.4-14.

Table 2.4-14

BREAKING WAVE SIGNIFICANT HEIGHT (H_b)
(feet)

H_b>	1	2	3	4	5	6	8	10	12
Summer (J-S)	100.0	86.4	62.5	18.6	10.4	1.4			%
Transition (A,M,O,N)	100.0	67.2	47.2	16.4	10.2	3.9	0.5		%
Winter (D-M)	91.2	52.6	33.0	16.1	11.9	5.9	1.3	0.5	0.2%
Annual	97.2	68.7	47.6	17.0	10.8	3.7	0.6	0.2	0.1%

Inasmuch as the significant wave height is the average of the highest one-third of the waves present, then two-thirds of the waves would be lower, and on an annual basis, the 1% height exceedance for all waves would be about 6 feet.

Thus, the calculated highest run up at the seawall of +27 feet mllw due to storm waves occurring during an extreme high water level of 15.6 feet mllw (including tsunami) presented by Intersea Research Corporation(34) is far more severe than the 1% exceedance surf height.

2.4.5.4 <u>Resonance</u>

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.5.5 <u>Protective Structures</u>

The San Onofre Units 2 and 3 plant grade is elevation +30.0 feet mllw. This is well above the maximum seawater elevation predicted for the occurrence of a maximum tsunami coincident with storm surge.

2.4.6 PROBABLE MAXIMUM TSUNAMI FLOODING

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.6.6 <u>Probable Maximum Tsunami Height</u>

The controlling tsunami occurring during simultaneous high tide and storm surge produces a maximum runup to elevation +15.6 feet mllw at the Unit 2 and 3 seawall. When storm waves are superimposed, the predicted maximum runup is to elevation +27 mllw, as discussed in Paragraph 2.4.5.3.

2.4.7 ICE EFFECTS

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.8 COOLING WATER CANALS AND RESERVOIRS

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.9 CHANNEL DIVERSIONS

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.10 FLOODING PROTECTION REQUIREMENTS

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.11 LOW WATER CONSIDERATIONS

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.12 DISPERSION, DILUTION, AND TRAVEL TIMES OF ACCIDENTAL RELEASES OF LIQUID EFFLUENTS IN SURFACE WATERS

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.13 GROUNDWATER

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.14 TECHNICAL SPECIFICATIONS AND EMERGENCY OPERATION REQUIREMENTS

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.4.15 REFERENCES

1.-4. Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

5. “Interim Report, Probable Maximum Precipitation in California,” U.S. Weather Bureau, Hydrometeorological Report No. 36, Rev 1969.

6. Probable Maximum Thunderstorm Precipitation Estimates - Southwest States, Hydrometerological Branch, National Weather Service, August 1972, Revised March 30, 1973.

7.-29. Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

30. Munk, W. H., Snodgrass, F. E., and Tucker, M. J., Spectra of Low- Frequency Ocean Waves, University of California Press, Berkeley, 1959.

31. Snodgrass, F. E., Munk, W. H., and Miller, G. R., ”Long-period Waves Over California’s Continental Borderland: Part I. Background Spectra,” Journal of Marine Research, Vol 20, No. 1, pp 3-30, 1962.

32.-50. Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

The data and information contained in Section 2.5 and referenced appendices are historical information developed during San Onofre’s original design to address Geology, Seismology, and Geotechnical Engineering. Much of the information has been relocated to the Controlled Document 90216 and is denoted as such. For the decommissioning phase of SONGS, the seismic criteria contained in the California Building Code will be applied.

2.5.1 BASIC GEOLOGIC AND SEISMIC INFORMATION

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.5.2 VIBRATORY GROUND MOTION

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.5.3 SURFACE FAULTING

Subsections relocated to Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information,” if not included within this Section.

2.5.4 STABILITY OF SUBSURFACE MATERIALS AND FOUNDATIONS

The design of the SONGS dry spent fuel storage pads is based on the subsurface soils investigation performed for the original design of the power plant as detailed in this DSAR section. The information is considered historical information as it pertains to SONGS Units 2&3.

2.5.4.1 Geologic Features

The following paragraph describes the geologic conditions of the soil and rock as they pertain to the stability and design of the power plant foundations.

A. Historic and potential uplift and subsidence are discussed in Paragraph 2.5.1.2.5.3.

B. The history of deposition, erosion, and sea level changes is given in Paragraphs 2.5.1.2.4. An analysis of A, B, C and D features(58)(86) which were exposed during excavation for San Onofre Units 2 and 3, has contributed some additional data relative to the loading history of the foundation materials. A hypothetical sequence of events concluded from this analysis is that at some period after the deposition and at least partial consolidation of the San Mateo Formation, a north-south component of horizontal stress began to increase. At the same time, an east-west stress component decreased. These stress changes, probably caused by lateral extension of the San Mateo block, eventually resulted in the generation of the nearly vertical conjugate set of joint-like shears (A and B features). Down-dropping of the San Mateo block caused by dip-slip displacements along the Cristianitos fault could have caused such an extension. The presence of grain crushing associated with the A and B features indicates that at the time of their formation the thickness of sediment above the present plant grade was at least 90 meters (300 feet). The lateral extension permitting the reduction in the east-west component eventually stopped, when the shearing displacement reached the level currently observed. Erosion of the upper surface proceeded, lowering the surface by about 60 meters (200 feet), when the generally north-south compression continued, or was reactivated with some rotation towards a more northerly direction. The consequence was the development of the C and D features. It would appear that these features were generated when the upper level of the San Mateo block was in a position similar to its present elevation, but before deposition of the overlying terrace gravels.

C. Geologic discontinuities which were exposed within the San Mateo Formation during site excavation are discussed in Paragraph 2.5.1.2.5.1.

D. Erosion of several hundred meters of terrace material and San Mateo Formation in the geologic past may have resulted in some amount of unequal unloading of the subsurface rock. There is no indication, however, that the resulting unrelieved residual stresses would adversely affect the site. This is substantially supported by no noticeable changes in the material properties or by construction problems during excavation at the site.

E. Extensive studies have been performed to examine static and dynamic properties of rock units exposed at the site in order to evaluate their potential for becoming unstable or hazardous to the safety of the plant. The results of these studies are discussed in Paragraphs 2.5.4.8 and 2.5.5.2.

2.5.4.2 Properties of Subsurface Materials

The properties of the materials underlying the site were investigated by drilling, sampling and laboratory testing, and by geophysical techniques. Exploration techniques are presented in Paragraph 2.5.4.3 and geophysical surveys are summarized in Paragraph 2.5.4.4.

The descriptions of subsurface materials and their static and dynamic properties are presented in the following paragraphs. Specifically, the general soil conditions and static material properties are discussed in Paragraph 2.5.4.2.1 and the dynamic material properties are discussed in Paragraph 2.5.4.2.2. Details of material property testing and evaluation are presented in Appendix 2.5D.

2.5.4.2.1 General Soil Conditions and Static Properties

2.5.4.2.1.1 General

Static material properties were assessed by an evaluation of all the data obtained during field and laboratory phases of the investigation. Identification tests were made to confirm field classification and additional laboratory tests were completed to assess the strength and compressibility characteristics of foundation soils. Chemical and X-ray diffraction analyses were also performed on selected granular samples from the San Mateo Formation to identify potential cementing agents.

Based on the boring data presented in Appendix 2.5C and a careful inspection of surfaces exposed during excavation, simplified subsurface conditions along a typical east-west section through the plant area between stations 17+00 and 25+00 (Figure 2.5-32) are shown on Figure 2.5-33. Prior to the start of construction, the plant and switchyard areas were relatively flat at elevation +105 to elevation +120 feet, with near-vertical bluffs at the beach. During construction, the site is being excavated to the configuration shown on Figure 2.5-33. As is indicated on Figure 2.5-33, the soils underlying the site consist of two major geologic categories:

- Terrace deposits
- San Mateo Formation

As indicated on Figure 2.5-33, the plant area is underlain entirely by the San Mateo Formation below approximately elevation 50 feet. Major plant structures, including all Seismic Category I structures, will be founded in this material. The terrace deposits occur only in the area of switchyard slopes and will support switchyard structures.

Soil conditions and material properties for the two formations are described in the following paragraphs.

2.5.4.2.1.2 Terrace Deposits

The upper part of the terrace, elevations 24+ to 35 meters (+80 to +115 feet), consists of generally cohesive clayey sands to silty clays. In the lower part of the terrace, deposits at elevation +15 to ± 24 meters (+50 to +80 feet) are quite variable, and consist primarily of gravelly sand with occasional zones containing clay, silt and cobbles. Because of their variability, the properties of terrace deposits were specifically investigated in a drilling program described in Appendix 2.5C. The drilling program was designed to yield indicator properties of terrace deposits such as moisture content and dry density, unconfined compressive strength, grain-size distribution and triaxial strength of representative driven-tube samples. In addition, the properties of the terrace deposits were estimated by back-calculating the strength required for stability assuming that existing 1/2:1 slopes at the San Onofre Unit 1 site are at limit equilibrium. Those calculations yielded soil-strength values conservatively within the bounds of laboratory data (Appendix 2.5D). Based on all available data as summarized in Appendix 2.5D, the static strength properties of both the cohesive and granular parts of the terrace deposits are summarized in Table 2.5-11. Due to extreme variability, average grain-size distribution curves could not be drawn. Actual grain-size distribution curves for net individual samples are referenced in Appendix 2.5D.

Measured compressional and shear wave velocities for the terrace deposits ranged from 304 to 945 m/s (1000 to 3100 ft/s,) and 100 to 304 m/s (330 to 1000 ft/s), respectively.

2.5.4.2.1.3 San Mateo Formation

The plant and offshore areas are underlain to a depth of about 275 meters (900 feet) by very dense well graded sands of the San Mateo Formation. The range of grain-size distribution for the San Mateo sandstone is shown on Figure 2.5-34. Some variation in gradation was found at a few locations during excavation.[96] The range of grain-size distribution for the finer-grained zone constitutes less than 10% of the total San Mateo sandstone observed during excavation. The static properties of the San Mateo sandstone were calculated by extensive laboratory testing. The sand exhibits a high degree of effective cohesion due primarily to efficiency in grain packing. Static properties of the San Mateo sandstone are summarized in Table 2.5-12.

Table 2.5-11

TYPICAL STATIC SOIL PROPERTIES FOR TERRACE DEPOSITS

Soil Property	Cohesive Materials (El +80 to +115 ft)	Granular Materials (El +50 to +80 ft)
Natural water content, w (%)	10	4
Dry unit weight, γ_d (lb/ft^3)	118	115
Degree of saturation (%)	85	15
Unconfined compressive strength, q_u (k/ft^2)	6-10	Not applicable
Plasticity index	13	Nonplastic
Liquid limit	28	---
Shear strength:		
Strength intercept c (k/ft^2)	2.6	0.2
Angle of shearing resistance, ϕ (degrees)	17	38

Table 2.5-12

TYPICAL STATIC SOIL PROPERTIES OF SAN MATEO FORMATION

Property	Value
Natural water content, w(%)	2 (above water table) 11 (below water table)
Dry unit weight, γ_d lb/ft^3)	123
Shear strength:	
Strength intercept, c’ (k/ft^2)	0.8
Angle of shearing resistance, ϕ’ (degrees)	41
Relative density (%)	100
Plasticity index	Nonplastic

The measured compressional and shear wave velocities for the San Mateo sandstone ranged from 913 to 2286 m/s (3000 to 7500 ft/s), and 304 to 838 m/s (1000 to 2750 ft/s), respectively.

2.5.4.2.2 Dynamic Material Properties

A wide variety of procedures, including laboratory and field tests, are currently available to determine the shear modulus (G) and damping characteristics of foundation materials. In general, laboratory tests such as cyclic triaxial compression tests are employed for measuring moduli and damping factors under moderate to relatively high strains. Field measurements of wave velocities (compressional, shear, and Rayleigh waves) are commonly used to estimate soil moduli for low strain conditions. Dynamic material properties of the foundation soils were determined using field seismic surveys and laboratory cyclic triaxial tests. Data obtained during field testing for soil-structure interaction studies (Appendix 3.7C) were used to confirm the modulus and damping values obtained from field seismic and laboratory test results.

In addition to an evaluation of modulus and damping characteristics of the terrace deposits and San Mateo Formation, dynamic shear strength of the terrace deposits and San Mateo sand was determined by cyclic triaxial tests for slope stability and liquefaction evaluations.

2.5.4.4 Geophysical Surveys

2.5.4.4.1 General

A number of geophysical surveys were made to determine the subsurface conditions in the plant area and offshore areas adjacent to the plant. Table 2.5-16 lists the investigations and summarizes the main purpose and the measurements made during each investigation. The table also indicates the location where details of each investigation can be found. Locations of all onshore seismic lines are shown on Figure 2.5-32. Offshore seismic lines for study No. 4 in Table 2.5-16 are indicated on Figure 2.5-48. Slip track lines for study No. 5 are shown in Subsection 2.5.3.

2.5.4.2.2 Seismic Velocity Measurements

Seismic velocity measurements were made during the first three investigations indicated on Table 2.5-16. The results of the first two investigations, including compressional and shear wave velocities are presented in Figures 2.5-56 through 2.5-58. The Rayleigh wave velocity tests made in exposed San Mateo Formation between elevation +30 feet and elevation +15 feet during the third investigation indicated velocities in the range of 850 to 1200 ft/s, with a velocity of 930 ft/s as a representative average for the upper 15 feet of soils. Because, for all practical purposes, the Rayleigh wave velocity is equal to the shear wave velocity, the shear wave velocity in the near-surface soils (upper 15 feet) was assumed to be of the order of 900 to 1000 ft/s.

Based on the geophysical velocity measurements presented in Figures 2.5-56 through 2.5-58, the range of shear and compressional wave velocities are summarized as follows:

Material	Shear Wave Velocity (ft/s^2)	Compressional Wave Velocity (ft/s^2)
Terrace	330-1000	1000-3100
San Mateo Formation:		
(upper 50 ft)	1000-2200	3000-7000
(below 50 ft)	1900-2750	7000-7500

The values of shear and compressional wave velocities in the upper 50 feet of San Mateo Formation measured in two different investigations (Figures 2.5-56, 2.5-57, and 2.5-58) vary considerably. The smaller near-surface values shown on Figures 2.5-57 and 2.5-58 are due to the reduced overburden since the measurements were made after the removal of the overlying terrace deposits to about elevation 30 feet. The measurements in San Mateo Formation shown in Figure 2.5-56 were made with at least 45 feet of overlying terrace deposits.

From the seismic tests the low-strain range Poisson's ratio was found to lie between 0.4 and 0.45.

2.5.4.5 Excavation and Backfill

Subsections relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information," if not included within this Section.

2.5.4.5.3 Backfill

All soil backfill use in Seismic Category I areas of the site consists of San Mateo Sand which was excavated for construction of the plant facilities. Properties of this material are discussed in Paragraph 2.5.4.2.

All backfill on the site is compacted to a density of at least 95% and 100% of the maximum determined in accordance with ASTM Test Method D1557-70 for fill above and below elevation +5 feet, respectively. The backfill was placed and compacted while at a moisture content within about 2% of optimum moisture content determined from ASTM D1557-70. Grain-size bands for the material are presented on Figure 2.5-34.

2.5.4.6 Groundwater Conditions

Groundwater conditions are described in the following paragraphs.

2.5.4.6.1 Groundwater Conditions Relative to Plant Facilities

A detailed description of groundwater conditions is given in Subsection 2.4.13. Studies have shown that the groundwater table beneath the site is quite stable. Monitoring of piezometers near the site has shown that the average elevation of the groundwater table at the site is 1.5 meters (+5 feet) MLLW datum. Design of structures at the site is based on this value. Because any changes of the groundwater level beneath the site will be minor as discussed in Paragraph 2.4.13.2, they will have no impact upon the stability of plant facilities.

2.5.4.6.2 Control of Groundwater Levels

Because groundwater conditions at the site are stable, there is no need for control of groundwater levels. The groundwater table lies approximately 7.6 meters (25 feet) below the surface elevation at the site. Groundwater seepage at the surface is not expected to occur and, therefore, systems for collection and control of seepage are unnecessary.

2.5.4.6.6 History of Groundwater Fluctuation

The history of groundwater fluctuations is discussed in Paragraph 2.4.13.2. Observation wells nearest to the site have shown only minor fluctuations in response to maximum fluctuations occurring in the central basin area. Observed fluctuations in groundwater levels at the site are related directly to tidal fluctuations. Future groundwater fluctuations are projected to correspond closely to past fluctuations which at the site have been less than 0.46 meters (1.5 feet). Because of the semi-impermeable nature of the San Mateo Formation, flooding on the San Onofre Creek area is expected to have little effect on groundwater levels at the site.

2.5.4.6.8 Direction of Groundwater Flow, Gradients, and Velocities

Direction of groundwater flow, including groundwater contour maps, which indicate gradients and velocities is discussed in Paragraph 2.4.13.2.

2.5.4.7 Response of Soil and Rock to Dynamic Loading

2.5.4.7.1 Introduction

The terrace deposits have been removed from the plant area, so that the only soil/rock responding to dynamic loading in the plant area is the San Mateo sand. The properties of the San Mateo sand have been presented in Paragraph 2.5.4.2. The fundamental dynamic relationships between stiffness, damping and strain for the San Mateo sand, used in analyses for its response to dynamic loading, have been presented in Paragraph 2.5.4.2.2, and are presented for reference in Figure 2.5-62. Response analyses were made to develop the shape of the response spectrum for the design basis earthquake (DBE) (Paragraph 2.5.2.6), to study the stability of switchyard slopes (Subsection 2.5.5), to study the liquefaction potential at the site (Paragraph 2.5.4.8), to evaluate stresses on buried pipelines and conduits (Paragraph 3.7.1.4), and to evaluate the sliding potential of shallowly buried structures (Paragraph 3.7.1.4).

2.5.4.7.2 Analyses

To develop the shape of response spectrum for the DBE, the dynamic response of the soil/rock at the site was studied by using lumped-mass models of the site and strain-dependent values of shear modulus and hysteretic damping. An abstract of the program is presented in Paragraph 2.5.4.7.3.1. The San Mateo sand at the site was modeled as being 300- and 1000-foot thick, with a few calculations done for a 2500-foot thick model, in order to cover the possible ranges in the site-stiffness characteristics. Details of the various analyses and their results are presented in Appendix 2.5B.

Dynamic stability analyses of switchyard slopes, liquefaction evaluation, and evaluation of sliding potential of shallowly buried structures were made by static and dynamic finite-element procedures. The computer program LOCKS was used for static finite-element analyses, and the computer program QUAD4 was used for the dynamic finite-element analyses. Abstracts of these programs are presented in Paragraphs 2.5.4.7.3.2 and 2.5.4.7.3.3. Details of the slope-stability analyses are presented in Subsection 2.5.5, the liquefaction analyses in Paragraph 2.5.4.8, and sliding-potential analyses in Paragraph 3.7.1.4.

The response of buried pipelines and conduits were evaluated by examining their critical instantaneous profiles which were calculated by traveling wave dynamic finite-element procedures. These analyses are presented in Paragraph 3.7.2.1.1.4. An abstract of the traveling-wave finite-element program used is presented in Paragraph 2.5.4.7.3.4. Other response analyses for soil-structure interaction studies are also described in Paragraph 3.7.2.1.

2.5.4.8 Liquefaction Potential Evaluation

2.5.4.8.1 General

Soil conditions at the site are described in Paragraphs 2.5.4.1 and 2.5.4.2. Of particular relevance to this subject are the facts that: (1) the upper terrace deposits were removed from the plant area, thus, all safety-related structures are founded on San Mateo sand; (2) in the onshore area, the water table is at elevation +5 feet and the top of San Mateo sand is at elevation +50 feet, thus, only San Mateo sand lies below the water table; and (3) in the offshore region, San Mateo sand is the principal soil. Thus, the liquefaction potential of only San Mateo sand was examined. A generalized section, showing soil conditions in the switchyard slope area, plant area, and offshore conduit area is presented in Figure 2.5-33.

2.5.4.8.3.2 Evaluation of In-situ Dynamic Strength of San Mateo Sand

A number of factors such as density and recompaction, confinement, anisotropy, degree of overconsolidation and drainage were studied to evaluate the in-situ dynamic strength of San Mateo sand, used in the analyses described in Appendix 2.5A. A schematic explanation of the various steps involved in determining the field dynamic strength of San Mateo sand from laboratory tests is presented in Table 2.5-17. The in-situ dynamic strength curves used in those analyses are presented in Figures 2.5-46 and 2.5-47. Subsequent to the analyses described in Appendix 2.5A there have been recent changes in the static-of-the-art of evaluating in-situ dynamic strength from dynamic strength tests.[103][104][105][106][107][108] These changes in the state-of-the-art and their implementation in obtaining the in-situ dynamic strength of San Mateo Sand are described below.

Table 2.5-17

EVALUATION OF FIELD DYNAMIC STRENGTH OF SAN MATEO SAND (Sheet 1 of 1)

1.	A total of 112 cyclic triaxial tests were conducted on samples of San Mateo sand. These included 8 tests on carved block samples, 40 tests on intact Pitcher tube samples and 64 tests on recompacted samples. Tests were done at different dry densities, confining pressures, and anisotropic consolidation ratios to incorporate these factors in evaluating in-situ dynamic strength (Appendix 2.5A, pages 2.5A-62 and 2.5A-141). The results are plotted as $\sigma_d/2\sigma_{3c}$ vs. N as shown for σ_{3c} = 4000 lb/ft^2 and γ_{d1} through γ_{d3} for remolded samples and γ_{d2} for intact samples.
2.	Results of a large number of field density tests on the native soils were plotted as a histogram of a number of tests yielding different densities. Based on this plot, an average dry density of 123 lb/ft^3 was adopted for the in-situ San Mateo sand. For the compacted, backfilled San Mateo sand and native soils in the plant area, a conservative value of dry density of 120 lb/ft^3 was corresponding to the minimum density specification for compaction of backfill (Appendix 2.5A, page 2.5A-138).
3.	Because it was not possible (without degradation of material) to reproduce small lab samples to densities as high as indicated in Step-2, the lab test results for remolded samples at lower densities from Step-1 were used to extrapolate strengths of in-situ densities by cross-plotting data from Step-1 as the normalized strength ($\sigma_d/2\sigma_c$) vs. dry density (γ_d) for various members of cycles required to induce ±5% strain. From these plots, the normalized strengths at various cycles for San Mateo sand in the plant area were obtained for a dry density of 120 lb/ft^3 and in the offshore area for a dry density of 123 lb/ft^3 (Appendix 2.5A, page 2.5A-63).
4.	To evaluate the effect of remolding on dynamic strength, the test results on carved block samples were compared with those for sister remolded samples compacted at the same dry density as that of the carved sample. The results were compared for K_c = 1. From this comparison, it was found that the carved block sample had a strength about 15% larger than the recompacted sample. This factor was used to obtain in-situ strength from recompacted samples tested at various densities, confining pressures, and K_c values (Appendix 2.5A, pages 2.5A-64 and 2.5A-65).
5.	Using the results of Steps-3 and 4 and state-of-the-art interpretation discussed in Paragraph 2.5.4.8.3.2, field dynamic strengths of San Mateo sand in the plant and offshore areas were obtained by first obtaining the laboratory strength at field density from Step-3, then increasing it by 15% to account for remolding from Step-4, and multiplying by appropriate C_r values listed in Table 2.5-19. For the plant area the field strength was conservatively based on the strength of in-situ material at a dry density of 120 lb/ft^3 and K_c = 1. Similar interpretations were made to obtain strengths at other K_c values. For the offshore area, the in-situ strength was based on a dry density of 123 lb/ft^3 and K_c = 1 (Figures 2.5-74 and 2.5-75).
6.	Many of the tests in Step-1 were done at confining pressures higher than 4000 lb/ft^2. Based on interpretation procedures outlined in Steps-3, -4 and -5 field dynamic strengths at other confining pressures for the plant area were obtained. These strengths were normalized at σ_{3c} = 4000 lb/ft^2 as indicated and used in the development of field strength parameters. Strengths at lower confining pressures, appropriate for the offshore area are shown on Figure 2.5-75 (Appendix 2.5A, page 2.5A-69).

Table 2.5-18

LIST OF DEFINITION OF TERMS USED IN FIGURES 2.5-66 THROUGH 2.5-73 AND TABLE 2.5-17

C_r	-	Correction factor to obtain in-situ dynamic strength from cyclic triaxial test results
F.S.	-	Factor of safety
K_c	-	Ratio of principal stress used to consolidate the sample in cyclic triaxial tests
K_o	-	Coefficient of earth pressure at rest
OCR	-	Overconsolidation ratio
τ_{max}	-	Maximum cyclic shear stress
σ_3, σ_{3c}	-	Confining stress used to consolidate the sample for cyclic triaxial tests
σ_{fc}	-	Normal stress on the potential failure plane of a sample
σ_d	-	Dynamic deviator stress applied to the sample
γ_d	-	Dry density of the soil sample

Table 2.5-19

SUMMARY OF C_r FACTORS

Area	X(ft)[(a)]	Elevation (ft)[(a)]	Approximate OCR	Updated C_r Values[(b)]
Plant area	600	0	3.75	0.75
	600	-20	3.25	0.72
	600	-40	2.25	0.65
Offshore conduit	2000	-10	5 to 8	0.83 to 1.0
	2000	-20	5 to 8	0.83 to 1.0
	2000	-40	5 to 8	0.83 to 1.0

(a) For location see Figure 2.5-33.

(b) C_r based on overconsolidation ratio (OCR).

Table 2.5-20

SUMMARY OF PARAMETERS USED IN THE ANALYSIS

No.	Report[a]	Value of C_r Used	Basis for Choice of C_r	Number of Uniform Equivalent Stress Cycles @ 65% Maximum Stress	Minimum Factor of Safety[b]	
					Local	Areal
1	Site Liquefaction Study	0.8	D_r ~ 100%	variable w/elevation ~30 to 80	1.3	1.5
2	Offshore Liquefaction	0.9	K_o = 0.8	30	1.2[c]	1.5

[a] See Appendix 2.5A.

[b] Factor of Safety defined as: stress to cause ±5% strain/induced stress.

[c] Very near surface.

A. Field Dynamic Strength (C_r Parameter)

For the studies reported in Appendix 2.5A, the parameter C_r (parameters used herein are defined in Table 2.5-18) used to obtain in-situ dynamic strength from cyclic triaxial tests was based on relative density and coefficient of earth pressure at rest, K_o. Recent studies[103][104] indicate that C_r is relatively insensitive to relative density, and is principally sensitive to K_o in the form of the overconsolidation ratio (OCR). The relationship between K_o or OCR and C_r developed in these studies[107] is presented in Figure 2.5-68. Utilizing the available information about the overburden which existed at the site in its geologic history[101] and the known amount of overburden removal in the switchyard and plant areas, along with the measured values of K_o in the offshore area, presented in Appendix 2.5A, new values for C_r were obtained. Table 2.5-20 presents the C_r values used in the previous analyses. New value of C_r, along with the estimated values of OCR, are presented in Table 2.5-19. Applying these modified C_r factors to the laboratory strength curves, developed in Appendix 2.5A, Sections 2.5A.2 and 2.5A.3, new field strength curves were developed for the plant and the offshore areas and are presented in Figures 2.5-74 and 2.5-75, respectively. The effect of confinement above $\sigma_{3c} = 4000$ lb/ft^2 on the curves on Figure 2.5-74 is presented on page 2.5A-69 of Appendix 2.5A.

B. Number of Uniform Equivalent Stress Cycles

In the previous calculations for the plant area, the number of equivalent uniform cycles of loading at 65% of the maximum stress during the DBE was conservatively selected to be between 30 and 80 (Table 2.5-19). Recent studies[108] have shown that the number of equivalent uniform cycles at 65% of the maximum stress are about 10 to 30 cycles for actual high-magnitude earthquakes, as shown in Figure 2.5-69. On this basis, a conservative analysis of liquefaction at the site would incorporate dynamic strengths from the field strength curves corresponding to 30 uniform equivalent stress cycles. Therefore, the use of 30 uniform equivalent stress cycles was adopted for the modified analyses described below.

C. Limiting Shear-Strain Potential

Based on the results of large-scale laboratory tests[103] a limiting shear-strain potential has been established as a function of relative density, as shown in Figure 2.5-71. For the San Mateo sand which has an average relative density of 100% (Paragraph 2.5.4.2), the shear-strain potential is quite small (much smaller than 5%), as indicated on Figure 2.5-71. Such a small value of limiting shear strain indicates that large strains which are associated with complete liquefaction are not possible for the San Mateo sand, due to effects of dilatency. This is further substantiated by the standard penetration resistance measured at the site compared to the values presented in the literature as relative to limiting strain for sands,[105][107] as shown on Figure 2.5-72. Because of the very low shear-strain potential for the soils at the site, factors of safety higher than 1.0 for the development of ±5% strain from cyclic triaxial testing are considered ample.

D. Effects of Drainage on Stability

Recent work(106) indicates that material such as gravels and coarse sands with high permeability do not liquefy, due to the drainage-caused reduction of pore pressures. For the San Mateo Formation sand, the permeability ranges between 0.005 and 0.025 ft/min (Appendix 2.5A, Section 2.5A.2). For these permeabilities, and based on the results of parametric studies,(106) the potential for liquefaction near the water table (or other free-draining boundaries at the site) is lower than would be calculated from the analyses which assume no drainage. Further, the results of tests incorporating small amounts of drainage (presented in the offshore liquefaction report, Appendix 2.5A, Section 2.5A.2), indicate about a 15% increase in strength due to the effects of drainage.

2.5.4.8.4 Analysis

2.5.4.8.4.1 General Approach

Basically the evaluation of liquefaction potential is accomplished by a comparison of the stresses induced by the DBE to the in-situ dynamic shear strength of the soil. The induced stresses are obtained by analyzing two-dimensional plane-strain models using dynamic finite-element procedures. The in-situ dynamic strength of the San Mateo sand was evaluated by dynamic triaxial tests as discussed in Paragraph 2.5.4.8.3 and summarized on Figures 2.5-74 and 2.5-75.

2.5.4.8.4.2 Induced Stresses

The dynamic shear stresses induced by the DBE were obtained by two-dimensional finite-element procedures. Both horizontal and vertical acceleration components were used in the analyses. These analyses are described in detail in Appendix 2.5A, Sections 2.5A.2 and 2.5A.3.

2.5.4.8.4.3 Results and Conclusions

The induced shear stresses obtained as described in Paragraph 2.5.4.8.4.2 were compared with the in-situ strength obtained as described in Paragraph 2.5.4.8.3 to obtain factors of safety against liquefaction (ratio of stress necessary to cause ±5% strain to earthquake induced stress). The stresses necessary to cause ±5% strain were determined from Figures 2.5-74 and 2.5-75 for plant and offshore areas, respectively, for 30 cycles of loading and for the in-situ stress conditions (k_c and σ_{3c}) as defined in Appendix 2.5A, Sections 2.5A.2 and 2.5A.3. The earthquake-induced stresses as described in Appendix 2.5A, Sections 2.5A.2 and 2.5A.3, for plant and offshore areas were used directly without modifications. As a result, a composite cross-section of the site was developed showing factor-of-safety contours for the San Mateo sand below water in plant and offshore areas of the site as presented on Figure 2.5-73. It is noted that the potentially beneficial effect of drainage described in Paragraph 2.5.4.8.3.2 was not incorporated into the determination of factor-of-safety presented in Figure 2.5-73. As indicated on Figure 2.5-73, the minimum factor-of-safety in the plant area is 1.5 to 2 and in the offshore area is 1.2 to 1.5. Based on the discussions of limiting shear strain potential and effects of drainage on stability presented in Paragraph 2.5.4.8.3.2, it is concluded that these calculated factors-of-safety against liquefaction of San Mateo sand at the site, for the DBE loading, are ample. Therefore, there should be no adverse effects due to liquefaction at the site.

2.5.4.9 Earthquake Design Basis

2.5.4.9.1 Derivation of the DBE and the OBE

The synthetic acceleration-time history for the DBE was developed so that its response spectrum appropriately matched the design response spectrum (Paragraphs 2.5.2.6 and 3.7.1.2). The general shape of the design response spectrum was developed from an analysis of the response of the site to earthquakes scaled so that the maximum acceleration at or near the site surface was 0.5 to 0.67g. This shape was verified by analyzing the response of the site to a number of earthquakes credible to the site. This time-history has a maximum acceleration of 0.67g and a duration of 80 seconds. The development of the response spectrum for the DBE and its verification are discussed in Paragraph 2.5.2.6 and described in detail in Appendix 2.5B.

The OBE (Paragraph 2.5.2.7) is characterized by a maximum acceleration of 0.33g (one-half of the maximum acceleration for the DBE) and a duration of 36 seconds.

2.5.4.9.2 Selection of Earthquakes for Liquefaction and Switchyard Slope Stability Analyses

The evaluations of the potential for liquefaction of the San Mateo sand at the site and the stability of switchyard slopes are presented in Paragraph 2.5.4.8 and Subsection 2.5.5, respectively. These evaluations depend on the level of the maximum acceleration, number of cycles of loading and the spectral characteristics of the earthquake motion. The liquefaction and slope stability analyses presented in Paragraph 2.5.4.8 and Subsection 2.5.5 were done for the DBE which is an extremely severe event as described above. As described in Paragraph 2.5.4.8 and Subsection 2.5.5, an equivalent number of uniform cycles of loading for the DBE was developed from the upper bound of the available data for large-magnitude earthquakes.

2.5.4.10 Static Stability

All Seismic Category I structures were analyzed for static loading conditions. Foundation bearing capacity, soil heave, total and differential settlement were evaluated under the excavation unload and design loads due to the plant structures. Lateral earth pressures on structures from backfills were considered. Design soil parameters used in the foundation stability analyses and the results of the analyses are discussed in the following sections. Soil and foundation conditions observed during construction were compared with those assumed in the analyses and the impact of different conditions on the design was evaluated.

2.5.4.10.1 General

All Seismic Category I structures are shown on the plot plan, Figure 2.5-32, and relationships of the plant structures to the subsurface conditions are presented in Figure 2.5-13. All Seismic Category I structures are founded in the San Mateo sand below finished plant grade, elevation +30. Since the San Mateo sand supports all major plant structures, its properties and selected design parameters used in the analyses are summarized in Paragraph 2.5.4.10.2. The size, embedment below elevation +30, unloading due to excavation below elevation +30 and, gross structure loading are summarized in Table 2.5-21. Bearing capacity, settlement and heave and lateral earth pressures are discussed in Paragraphs 2.5.4.10.3 through 2.5.4.10.5. Differences in observed and assumed soil conditions are discussed in Paragraph 2.5.4.10.6.

2.5.4.10.2 Soil Parameters

The preconstruction site grade in the plant area was between elevation +95 and elevation +110. The finished plant grade at elevation +30 was attained by excavating more than 65 feet of terrace deposits and San Mateo sand.

Figure 2.5-52 indicates that all Seismic Category I structures are founded below elevation +30 in the San Mateo sand. The foundation soils have thus been unloaded to the extent of at least 8 k/ft^2 and are reloaded in relation to the overburden pressures from the finished plant grade, elevation +30. Details of the pertinent properties of the San Mateo sand are given in Paragraphs 2.5.4.2 and Appendix 2.5D. Soil parameters used in the subsequent analyses are summarized in Table 2.5-22.

The shear strength properties used in the bearing capacity analyses are: strength intercept, c = 800 lb/ft and angle of internal friction $\phi = 41^{\circ}$.

The shear strength was evaluated by means of extensive triaxial compression and direct-shear testing as described in Appendix 2.5D. Strength values were also confirmed by back-calculating the shear strength required for stability assuming that the existing one-half to one (horizontal to vertical) slopes at San Onofre Unit 1 are in limiting equilibrium.

Table 2.5-22

SUMMARY OF MATERIAL SEISMIC WAVE TRANSMISSION PROPERTIES FOR SAN MATEO FORMATION SAND[(a)]

Item	Quantity
Seismic compressional velocity	
Above water table, ft/s	3,000 - 7,000
Below water table, ft/s	7,000 - 7,500
Seismic shear velocity	
Above water table, ft/s	1,000 - 2,000
Below water table, ft/s	1,900 - 2,750
Soil properties	
Natural water content	
Above water table, %	2
Below water table, %	11
Dry unit weight, lb/ft^3	123
Shear strength:	
Strength intercept, k/ft^2	0.8
Angle of shearing resistance, degrees	41
Relative density, %	100
Plasticity index	Nonplastic
Unified soil classification	SW
Shear modulus	Figure 2.5-31
Poisson's ratio	
High stress	0.25 - 0.33
Low stress	0.40 - 0.45
Hysteretic damping	Figure 2.5-31
Water table elevation, ft MLLW	+5
Water table variation	Minor

(a) For more details of properties and methods used to obtain them, see Paragraph 2.5.4.2.

2.5.4.10.3 Bearing Capacity

Ultimate bearing capacity was computed by using the following properties for San Mateo sand:

Cohesion	= 800 lb/ft^2
Angle of internal friction	= 41 ^{o}
Total unit weight	= 130 lb/ft^3
Buoyant unit weight	= 68 lb/ft^3

Calculated ultimate bearing capacity for the structures listed in Table 2.5-21 is greater than 400 k/ft^2 and the factor of safety against shear failure for the most heavily loaded building is in excess of 100.

Other buildings have correspondingly higher factors of safety. Therefore, it is concluded that all Seismic Category I structures have very high factors of safety against shear failure under static loading conditions.

2.5.4.10.4 Settlement and Heave

The heave of foundation soils due to excavation depends upon the magnitude of unload, areal extent of the excavation and the compressibility of the foundation soils. The settlements of structures depend upon size, shape, depth of embedment, configuration and intensity of the applied loading and soil compressibility.

To evaluate the elastic settlement and heave under various loading and unloading conditions, a formula of the following form was used:

$$S = \frac{P\,T\,(1-\nu^2)\,I\rho}{E}$$

where:

S = settlement or heave

P = bearing pressure or unload

B = foundation width

ν = Poisson's ratio

E = modulus of elasticity of the soil

Iρ = influence factor depending upon foundation shape and rigidity.

Effects of adjacent structures were included in the calculation for settlement and heave.

A number of methods were used to estimate the compressibility of over-consolidated, dense San Mateo sand.

These methods included:

A. Back-calculations of a modulus based on measured settlements of the containment building, Unit 1.

B. Standard penetration test (SPT) blow counts (N-value) obtained during sampling (ASTM D1586).

C. Seismic modulus based on shear wave velocity measurements corrected for strain levels.

It has been shown[109] that, for small strains experienced under large nuclear plant structures, elastic modulus of dense sands determined by laboratory odometer or triaxial tests is not appropriate. Consequently, laboratory data were not used to estimate the sand compressibility.

Measured settlement at the center of the reactor containment for Unit 1 under a load of 3.4 k/ft^2 and equivalent radius of 70 feet was 0.38 inches. For a circular area of 140 feet diameter loaded to 3.4 k/ft^2 and a Poisson's ratio of 0.35, the elastic modulus is calculated by equation[1] to be about 13,000 k/ft^2.

The minimum SPT N-value in the San Mateo sand is about 100 blows/ft with the average value exceeding 200. Estimated settlement for containment Unit 2, using Mayerhoff's[110] equation is:

$$S = \frac{P\,(B)^{1/2}}{N}$$

where:

S = settlement, in.

P = soil bearing pressure, k/ft^2

B = foundation width, ft

N = SPT blow count, blows/ft

for

S = 0.63 in.

P = 4.63 k/ft^2

B = 184 ft

N = 100 (minimum)

Using equation[1] for a circular area, this settlement yields a minimum elastic modulus of about 14,000 k/ft^2.

The seismic moduli determined from shear wave velocity measurements[110] and corrected for strain levels have been used for estimated in-situ compressibility of sand deposits. Average shear wave velocity in the top 100 to 150 feet (zone of influence of structure loads) is about 1900 ft/s yielding a seismic shear modulus of $G = 14{,}700$ k/ft^2 and seismic elastic modulus $E = 40{,}000$ k/ft^2. For reloading conditions which are applicable to San Onofre sands due to the removal of more than 8 k/ft^2 of loads (Paragraph 2.5.4.10.2), a static modulus equal to about 40 to 50% of the seismic modulus is suggested.[110] This yields a minimum static modulus of $E = 16{,}000$ k/ft^2. This modulus is also compatible with the average estimated strain below the containment.

From the above analyses, the minimum static modulus was estimated to be on the order of 13,000 k/ft^2 for the size of structures under consideration. This was used for subsequent settlement calculations.

Settlement and heave calculations were made using equation[1] for the loading and unloading on structures shown in Table 2.5-21, an elastic modulus of 13,000 k/ft^2 and a Poisson's ratio of 0.35. The results of these calculations indicate that the maximum heave due to the excavation unload and settlement due to the gross structure loads are on the order of 1 inch, and occur at the center of the auxiliary building. The maximum computed settlements under other structures range between 1/2 to 1 inch. The maximum differential settlements are less than 1/2 inch. Due to the high permeability of the San Mateo sand, all settlements are expected to occur simultaneously with the application of loads and the post-construction settlements will be negligible. The computed settlements are based on a conservatively estimated minimum elastic modulus of 13,000 k/ft^2. The actual soil modulus is expected to be significantly higher and consequently the settlements to be lesser than the computed values. Results of stability analyses will be confirmed with as-built data as it becomes available.

2.5.4.10.5 Lateral Earth Pressures

For static conditions the at-rest pressure is considered applicable for the evaluation of static lateral earth pressure against rigid walls from the in-situ or backfill San Mateo sand. An at-rest earth pressure coefficient K_o equal to 0.34 was used in the design. This yields an equivalent fluid pressure from a fluid with a unit weight of 45 lb/ft^3 above the water table and 85 lb/ft^3 below the water table. Ultimate passive resistance due to static lateral loads was estimated by using a passive pressure coefficient, K_p, of 4.8 yielding an equivalent fluid weight of 625 lb/ft^3 above the water table and 390 lb/ft^3 below the water table (including hydrostatic pressure).

2.5.4.10.6 Design Verification and Variations from the Assumed Conditions

2.5.4.10.6.1 Density Verification

Strength data for the San Mateo sand used in bearing capacity analyses in Paragraph 2.5.4.10.4 were obtained by testing intact and recompacted samples. The dry intensity of these samples ranged between 118 and 122 lb/ft^3. During construction, in-situ density measurements were made at all structure locations at the exposed foundation grade level to verify the density of the natural San Mateo sand. The results of these tests are presented in Figure 2.5-65. These tests indicate that the in-place density at all locations was in the range of laboratory-test densities.

2.5.4.10.6.2 Fine-Grained San Mateo Sand

After excavations were made to the foundation grade, it was found that the San Mateo sand encountered in about 10% of the plant areas had a gradation finer than the sand obtained from borings and found in the majority of the plant areas. Samples of this material were obtained to determine its static and dynamic properties, and the results are given in Appendix 2.5D. These studies indicated that the strength of the finer-grained San Mateo sand is as high or higher than the strength of the coarse-grained material. Consequently, the different gradation material encountered during the excavation does not have any adverse impact on the strength properties used in the design analyses.

2.5.4.11 Design Criterion

The size, embedment, relative configuration, and loading of all Seismic Category I facilities were determined from safety and operational considerations. The geotechnical design criteria used for evaluation of various structures were:

A. The structure foundation is safe against a bearing capacity failure in the supporting soil.

B. The heave and settlements under the excavation unload and structure loading are small and within reasonable limits for the safe operation of the structure and equipment.

C. The preceding two criteria are satisfied under static as well as seismic or other severe loading conditions.

The ultimate static bearing capacity was evaluated by the formula:[101]

$$q_u = cN_c\zeta_c + qN_q\zeta_q + 1/2\gamma BN_\gamma\zeta_\gamma$$

where:

q_u = ultimate bearing capacity

c = cohesion

γ = unit weight

q = overburden

N_c, N_q, N_γ = bearing capacity factors

B = foundation width

$\zeta_c, \zeta_q, \zeta_\gamma$, = shape factors

Using conservatively estimated strength parameters for San Mateo sand, cohesion c = 800 lb/ft^2 and angle of shearing resistance, $\phi = 41\,^{\circ}$ C the computed ultimate bearing capacities for various structures have factors of safety in excess of 100 against static loading (Paragraph 2.5.4.10).

The maximum stresses in the soil below the basemat of any structure during seismic or other severe loading are less than 10 times the maximum static stresses (Subsection 3.7.2). This represents an adequate factor of safety against bearing capacity failure of greater than 10.

The settlement and heave analyses presented in Paragraph 2.5.4.10 indicate maximum settlements of less than 1 inch and maximum differential settlements of less than 1/2 inch. Post construction settlements are negligible, less than 1/10 inch. The total and differential settlements are very small, and there are virtually no post construction settlements; therefore, the structures are considered safe against detrimental settlement or heave.

The San Mateo sand is very dense and no instability due to liquefaction during the DBE loading conditions is expected (Paragraph 2.5.4.8).

In summary, the structures are safe against bearing failure or detrimental settlements under all conditions.

2.5.4.12 Techniques to Improve Subsurface Conditions

The undisturbed San Mateo sand, upon which all safety-related structures are founded, is a material which has 100% relative density and which exhibits extremely efficient grain packing. The strength of this material in its natural state is very high, consequently, no techniques were implemented to improve its properties.

2.5.5 SLOPE STABILITY

The design of the SONGS dry spent fuel storage pads is based on the subsurface soils investigation performed for the original design of the power plant as detailed in this DSAR section. The other information is considered historical information as it pertains to SONGS Units 2&3.

All native near-vertical bluffs and cut slopes to the north and south of the Unit 2 and 3 site are at great enough distances from Unit 2 and 3 structures so as not to affect safety of these structures. Switchyard slopes northeast of Units 2 and 3 are the only permanent slopes in the vicinity of plant structures. Therefore, these were the only slopes studied in detail for evaluation of plant safety. These 2:1 cut slopes are about 90 feet high and have two benches. The characteristics and design of these slopes are discussed in summary in this section. The antecedent background subsurface information and details of previous studies are given in Appendix 2.5E.

2.5.5.1 Slope Characteristics

The switchyard slopes are located to the northeast of Unit 2 and 3 reactors, and rise from elevation +30 feet at the plant level to about elevation +120 feet, Figure 2.5-80. The slopes are a little over a thousand feet in length, extending alongside the various plant structures, which are located in a flat area at the base of the slopes. The plan width of slopes is about 280 feet, including the two benches, which constitutes an overall slope inclination slightly flatter than 3 (horizontal) to 1 (vertical). All the slope surface is composed of cut materials with the exception of approximately 5 feet of fill along the base of slopes from about elevation +30 to +35 feet.

2.5.5.1.1 Cross-Sections and Profiles

A typical section across the switchyard slope area showing the pre- and post-construction conditions is given in Figure 2.5-81. Before construction began, the ground surface sloped gently toward the southwest and had an average elevation of approximately +110 feet. The gentle slope terminated near the beach at near-vertical bluffs.

After construction, the area adjacent to the beach is planned to be generally at elevation +30 feet, the finished grade around the plant. The switchyard slopes are to rise at an inclination of 2:1 from elevation +30 to +120 feet away from the beach, being interrupted by two benches at elevation +55 and +78 feet.

As indicated in Figure 2.5-81, the upper portions of the switchyard slope consist of terrace deposits. These materials, which extend beneath the surface to approximately elevation +50 feet, consist of very dense and very stiff soils. The upper portions of the terrace deposit (above approximately elevation +80 feet) are generally clayey sands to silty clays. These materials are underlain by predominantly gravelly sand materials, with occasional lenses of clay, silt, and cobbles. The soils which constitute the base of the terrace deposit (approximately elevation +50 to +60 feet) are quite variable. In some areas, coarse gravel and cobbles are present, while in others silty sand, sandy silt, or silty clay exists. These materials are underlain by the San Mateo Formation, which extends to approximately elevation -850 feet. This formation consists of a dense to very dense, well graded sand with apparent cohesion due to efficient particle arrangement.

The soil profile shown in Figure 2.5-81 is an idealized representation of boring and other field identification data. Materials exposed in temporary construction slopes in the switchyard area were logged as a field check, and a simplified representation is given in Figure 2.5-82, providing a general confirmation of the idealized profile.

Stability analyses, as described in Paragraph 2.5.5.2, have been performed on not only the most likely stratification of terrace deposit soils (as evidenced by boring logs and slope-face logging during construction), but also on two additional terrace-deposit profiles (the first assuming the terrace deposit to consist of only clay materials, and the second of only sand).

2.5.5.1.2 Groundwater

The normal groundwater elevation at the site is approximately +5 feet, as measured during the period 1963 to 1975. No significant rise or drop in this level is anticipated, as discussed in Appendix 2.5E, and Subsection 2.4.13.

The base of switchyard slopes is at approximately elevation +30 feet, or about 25 feet above the maximum groundwater level as shown on Figure 2.5-81. Temporary dewatering for construction of facilities has lowered the groundwater surface to approximately elevation -36 feet at the lowest point (intake structure). The temporary groundwater surface beneath the switchyard slope area was probably at an elevation substantially higher than -36 feet as a result of this dewatering, although no measurements were made. However, stability analyses indicate that groundwater level reduction has no appreciable adverse effect on slope stability (Appendix 2.5E).

2.5.5.1.4 Soil Properties

The major soil types are of interest in these slope-stability studies: San Mateo Formation sand, and terrace deposit soils. The properties of San Mateo sand were studied in detail for the plant structures foundation design and are described in Paragraph 2.5.4.2. In addition to the laboratory tests on drive-tube, carved-block, and bulk soil samples, strength parameters of existing slopes were back-calculated from static finite-element analysis.

2.5.5.1.4.1 Static Soil Properties

The San Mateo sand is a homogeneous dense deposit of sand that derives its high strength and some apparent cohesion from an efficient grain-packing arrangement. The overlying terrace deposit is composed of a variable sandy portion overlain by a clayey portion.

Because of the variability of terrace deposit materials, their properties were somewhat difficult to characterize. For this reason, the 1972 drilling and sampling program was designed to yield indicator properties such as moisture and density, unconfined compressive strength, grain-size distribution, and triaxial strength of representative driven-tube samples of the terrace deposit soils.

These data, boring log data, and observation of existing slopes and bluffs on the site indicate the terrace deposits consist of interbedded dense to very dense sandy soils and stiff clays, with occasional lenses of gravel and silt in a clay matrix (conglomerate). A generalized profile of the existing soil profile is given on Figure 2.5-81. The clayey soils appear to predominate in the upper portions of the terrace deposit (elevation +80 to +120 feet), while the sandy soils generally constitute the material directly above the San Mateo Formation sand (elevation +45 to +80 feet).

Finite-element calculations were made to estimate the required strength of the soils, assuming that the existing 1/2 to 1 slopes at San Onofre Unit 1 are just at limit equilibrium (which is probably quite conservative). Those calculations yielded soil-strength values conservatively within the bounds of the laboratory data. More recent in-situ bearing-capacity tests, conducted in the San Mateo sands at the plant elevation and taken to complete failure, indicate that the laboratory and calculated strength values for San Mateo sand used for all analyses could be conservative with respect to cohesion by a factor of 2 to 2-1/2. Based on the finite-element analyses and laboratory tests the static strength properties of San Mateo sand and the sandy and clayey portions of the terrace deposit materials were conservatively estimated and are summarized in Table 2.5-24.

2.5.5.1.4.2 Dynamic Soil Strength

For slope stability analyses, dynamic testing of terrace deposits was performed on Pitcher, Shelby-tube, and carved-block samples by stress-controlled cyclic triaxial techniques. For conservatism, the strength values from the more disturbed drive-tube samples were used for analysis. A total of 28 specimens were tested.

Table 2.5-24

STATIC STRENGTH PARAMETERS

Material Property	Materials		
	Terrace Deposit Clays	Terrace Deposit Sands	San Mateo Formation Sand
Bulk unit wt, γ_t (lb/ft^3)	130	120	130
Angle of shearing resistance, ϕ (degrees)	17	38	41.5
Cohesion, c, lb/ft^2	2,600	200	750

In general, the results of the dynamic testing program indicate the terrace soils have strengths as high as, or higher than, the static strength used during initial stability studies. There do appear to be occasional thin lenses of weaker materials in the lower part of the terrace deposit which: (1) appear to be horizontally stratified; (2) are not continuous through the slopes; and (3) are generally less than 3 feet thick. Our analyses have considered the possibility that weak lenses exist throughout the sandy lower portion of the terrace deposit. A summary of the interpreted strengths for this material, as well as others presented in terrace deposits is presented in Figure 2.5-83 for ease of reference. These curves were drawn considering the lower bound of strength data to be defined at ±5% strain or 10% total strain, whichever occurred first.

2.5.5.2 Design Criteria and Analyses

The primary criterion for the switchyard slope design is that slopes be stable through the design basis earthquake.

The basis for selection of the methods of analysis was that they be the most reliable, up-to-date procedures available. Therefore, static and dynamic finite-element analyses were used to estimate in-situ and earthquake-induced stresses in the slope-foundation system. Details of the computer programs are given in Appendix 2.5A. The output stresses from the computer programs were compared with appropriate soil strengths in order to evaluate stability. The Bishop Modified Method of Slices was used for comparison of results. Analyses were made assuming: (1) the most likely soil conditions which exist (based on boring log data, examination of graded slopes, etc.); and (2) weak lenses are present throughout the lower portion of the terrace deposit.

Based on the results of these analyses it is concluded that, during DBE loading: (1) the overall factor-of-safety of the switchyard slopes is in excess of unity; (2) surficial sloughing to a maximum depth of 5 feet may occur on the uppermost switchyard slope; and (3) overstressed zones may develop in localized portions of the terrace deposit. These zones are shown schematically on Figure 2.5-84. Interpreted factors of safety of each finite element in the slope are presented on Figure 2.5-84. It is expected that the overstressed zones will not cause instability because they are localized between understressed stable zones (Appendix 2.5F).

Further dynamic analyses were done recently to incorporate changes in the state-of-the-art of the evaluation of dynamic strength tests.(103)(104)(105)(106)(107) The factor of safety results of the previous evaluations were modified by a correction factor C_r (stress-correction factor for cyclic triaxial tests). A composite cross-section of the site showing factor-of--safety contours for the switchyard slope and other areas is presented on Figure 2.5-73. Only one small area near the surface of the upper slope shows a factor of safety of unity or less. This would likely manifest itself as minor surface sloughing which would be accommodated by the upper bench just below this area. No safety-related structures or equipment are located on this area. Furthermore, it is likely that the zone of surficial sloughing would not be continuous along the length of the slope because only the worst soil conditions found were used in the analysis. All other areas show a factor of safety of 1.1 or substantially higher.

Based on the above considerations, it is concluded that the factors of safety against slope and liquefaction instability (see Paragraph 2.5.4.8) presented on Figure 2.5-85 for the DBE condition are ample and that the response of the site to DBE excitation in terms of stability would not lead to any adverse consequences to structures or equipment.

2.5.6 EMBANKMENTS AND DAMS

There are no earth fill embankments or dams located in the general vicinity of the San Onofre site. A flood protection structure is located as shown in Figure 2.4-4.

Following the decision to permanently cease power operations, an additional hydrologic analysis was performed that determined that the diversion structure was not required for site flood protection as discussed in Section 2.4.3.5.

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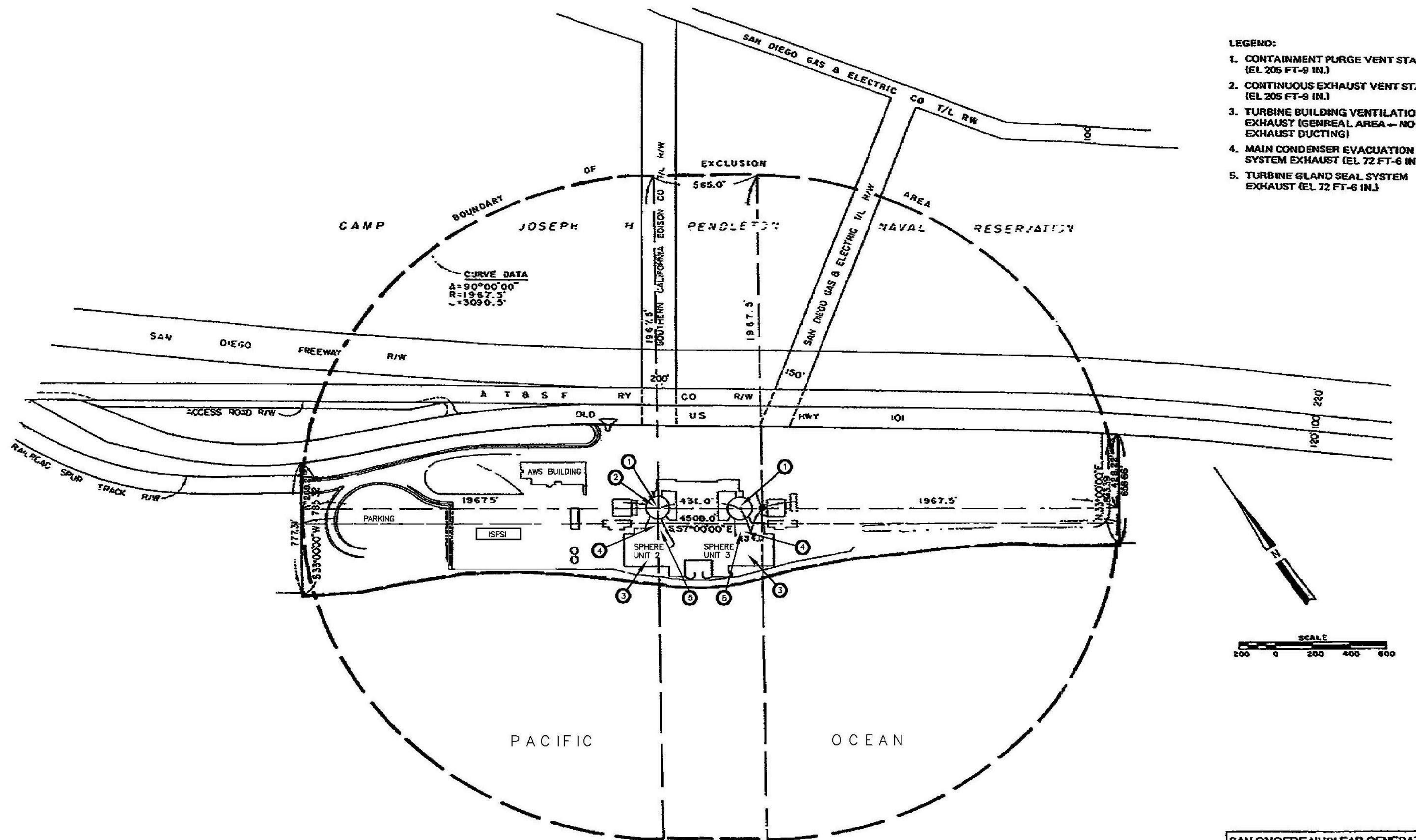


SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 & 3
Updated Final Safety Analysis Report

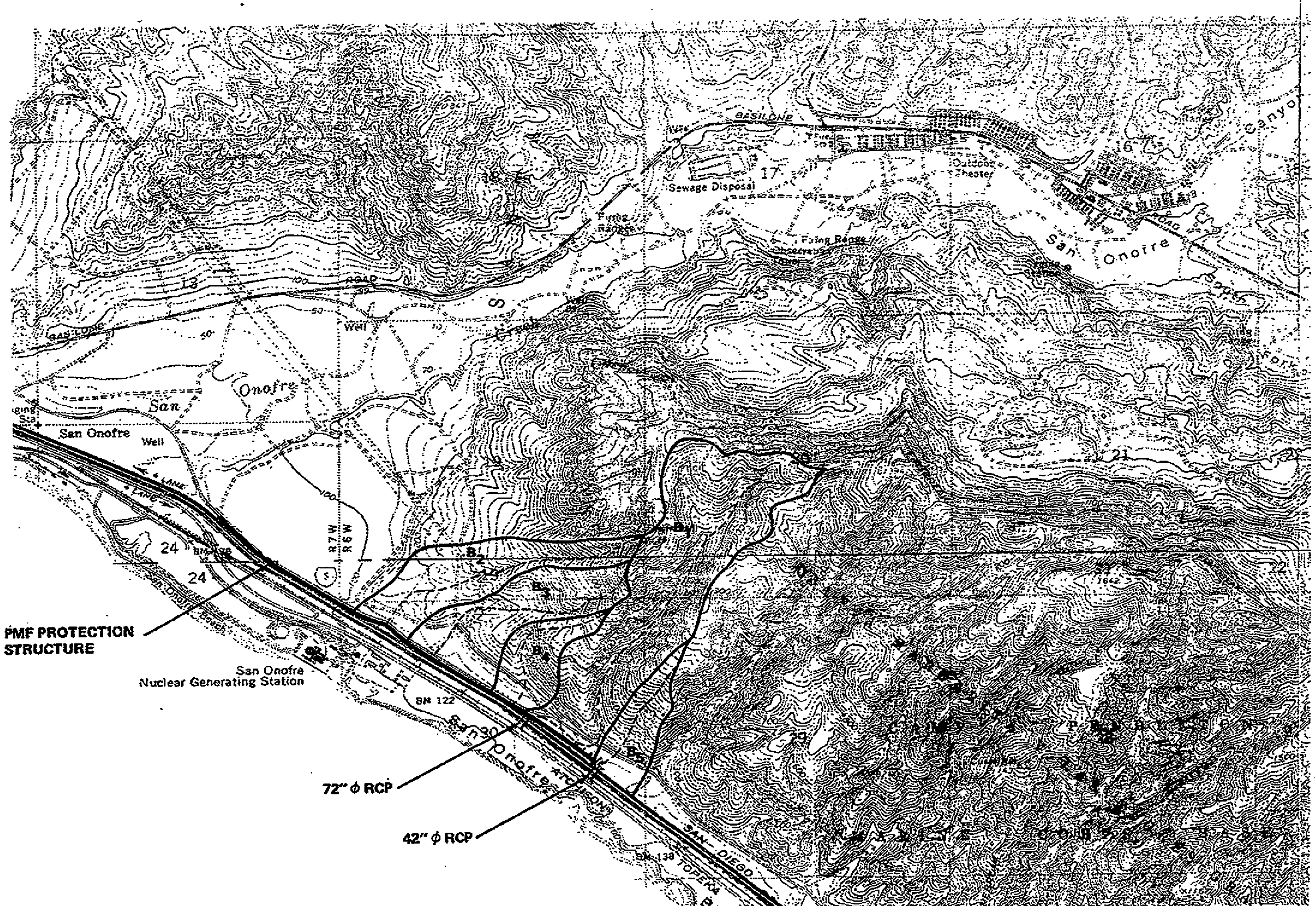
Effluent Release Points

Figure: 2.1-5

REV. 5

ACAD2009

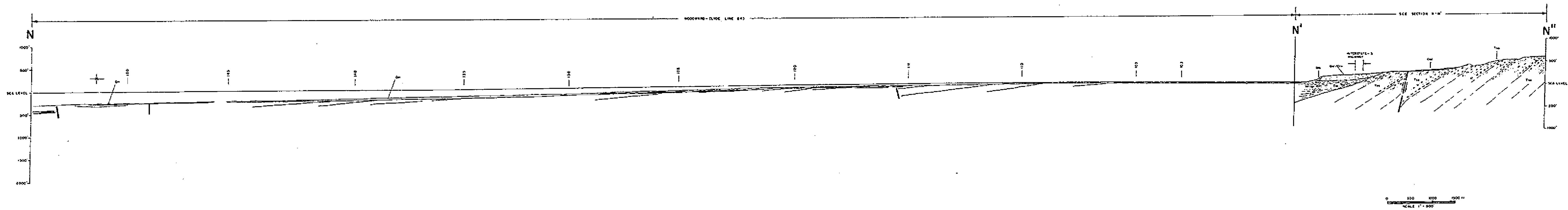
REV 5



SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

PMF PROTECTION
STRUCTURE ALIGNMENT

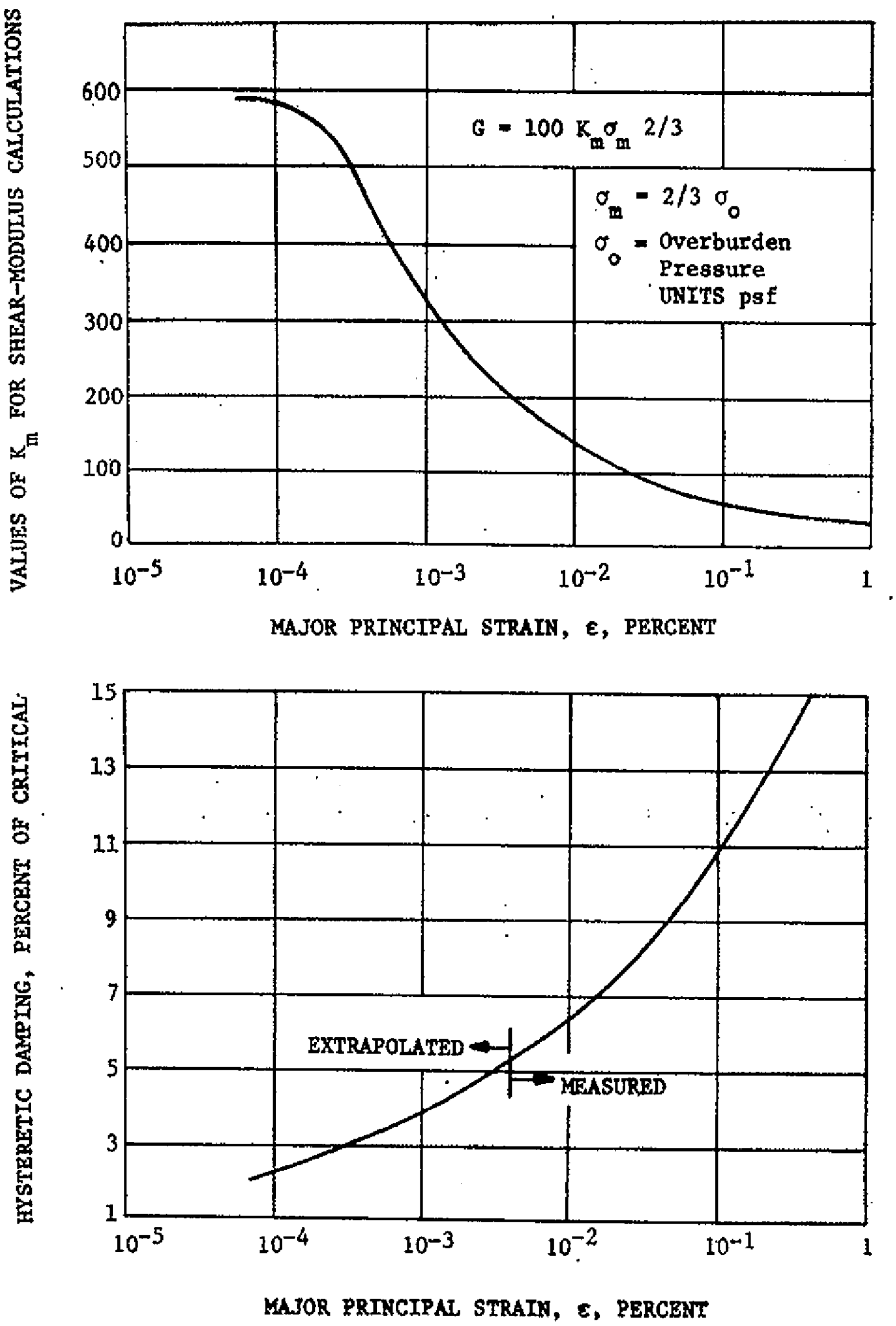
Figure 2.4-4



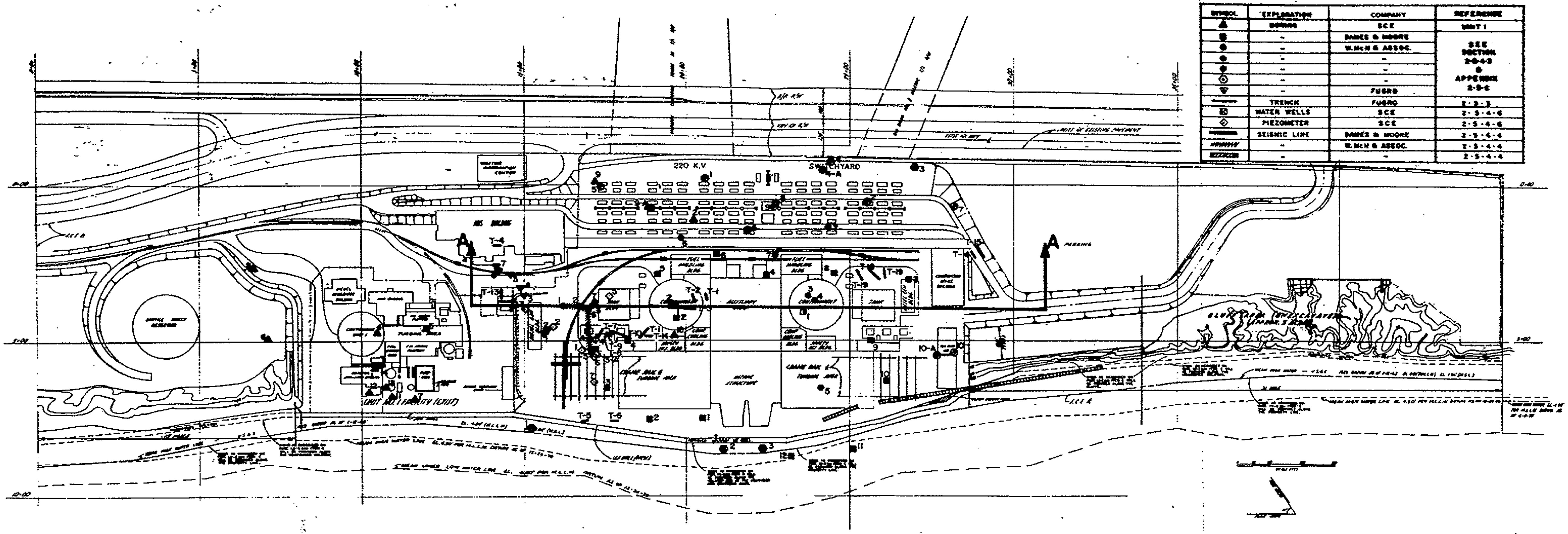
SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

COMPOSITE GEOLOGIC CROSS-SECTION
N-N'-N" AUGUST 1980

Figure 2.5-13



SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
VALUES OF ELASTIC PARAMETERS FOR USE IN FEASIBILITY STUDIES
Figure 2.5-31

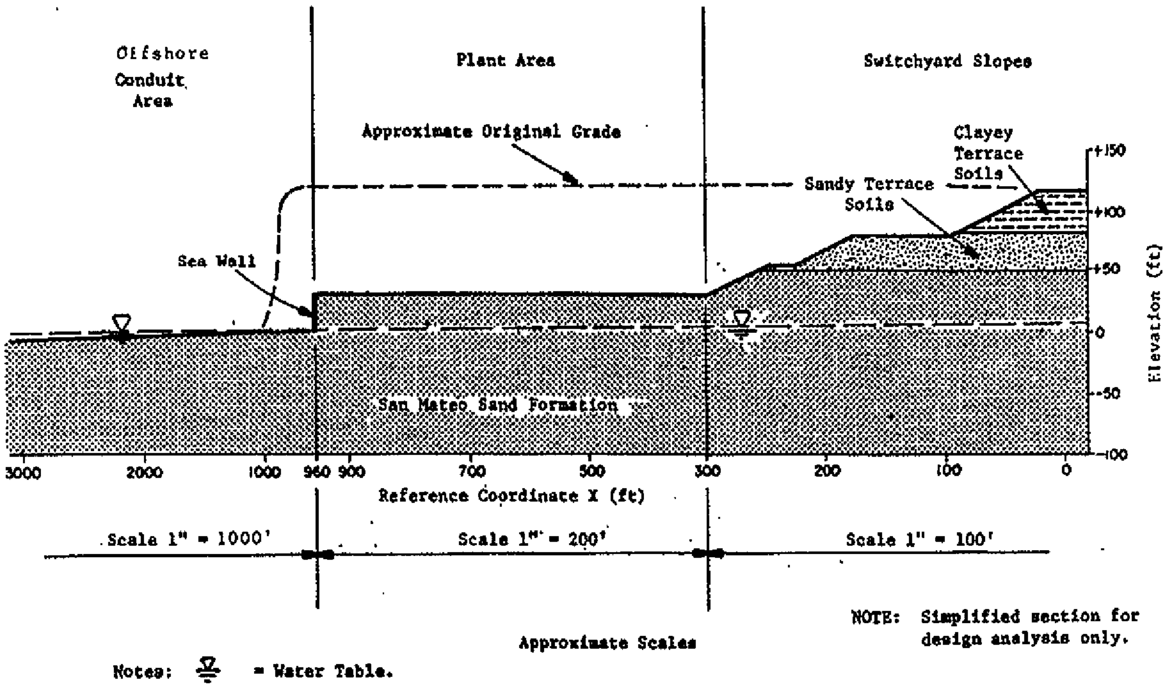


SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

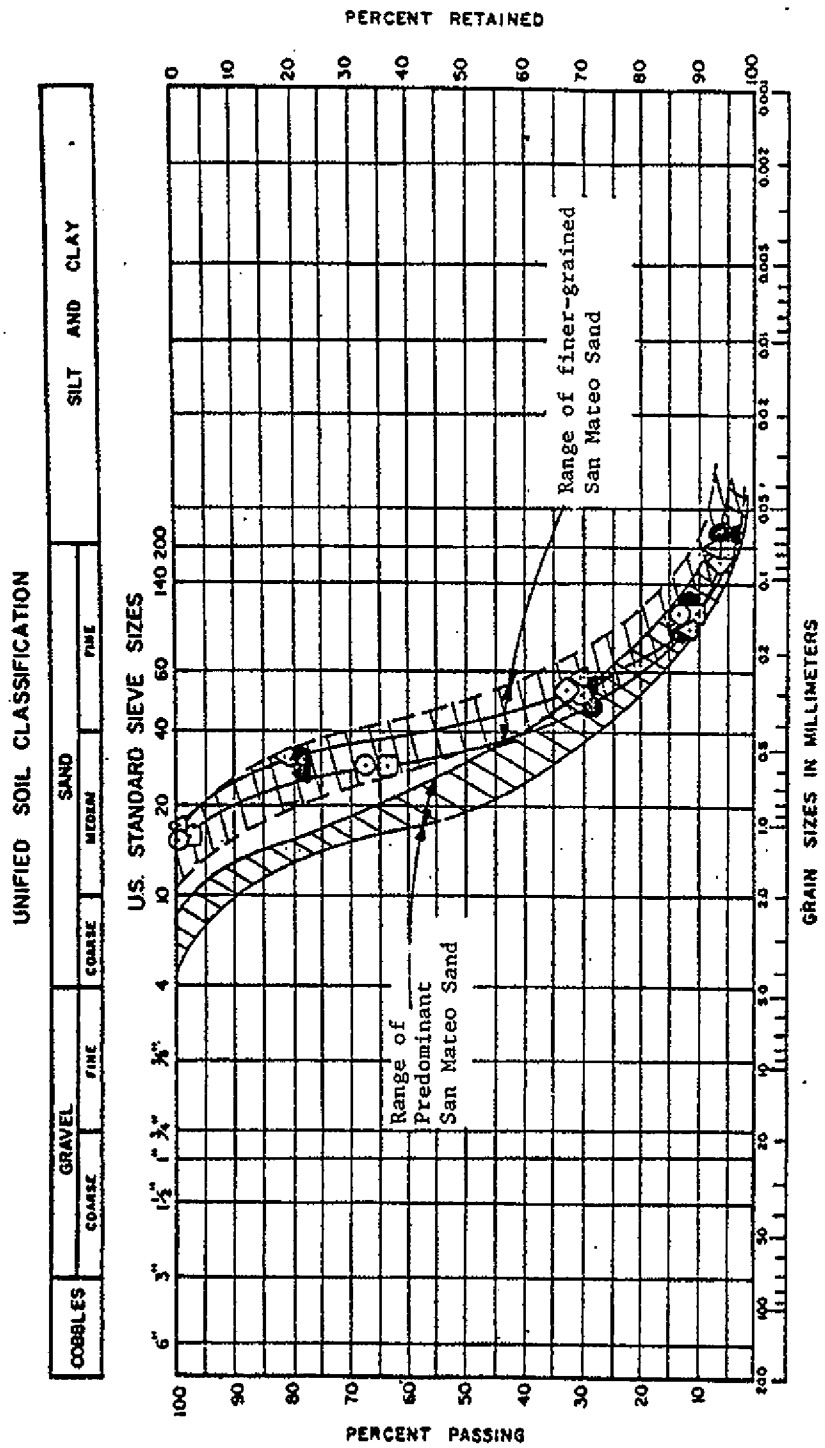
PLOT PLAN

Figure 2.5-32

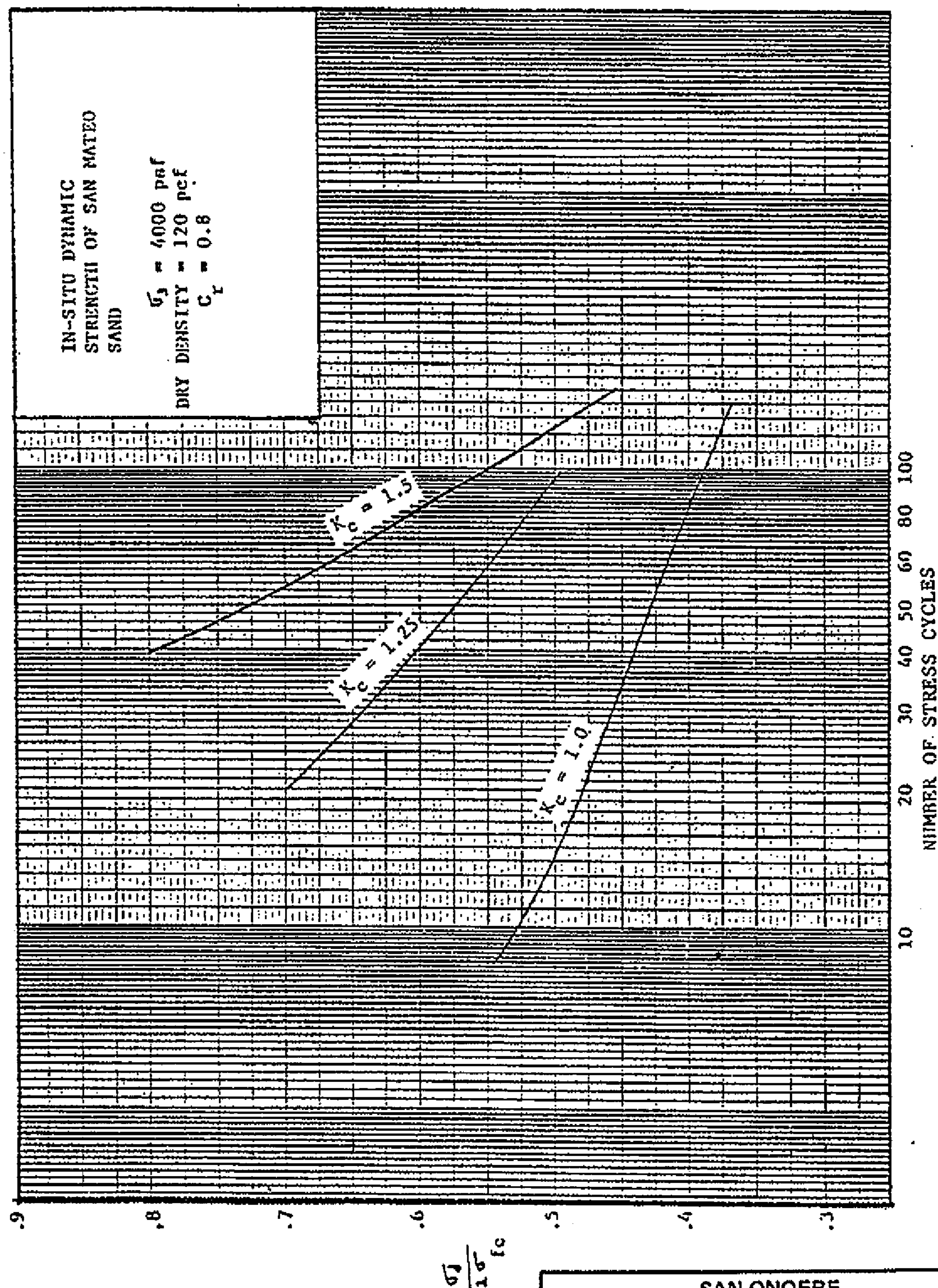
Amended: April 2009 TL: E048000



SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
COMPOSITE CROSS-SECTION OF THE SITE
Figure 2.5-33

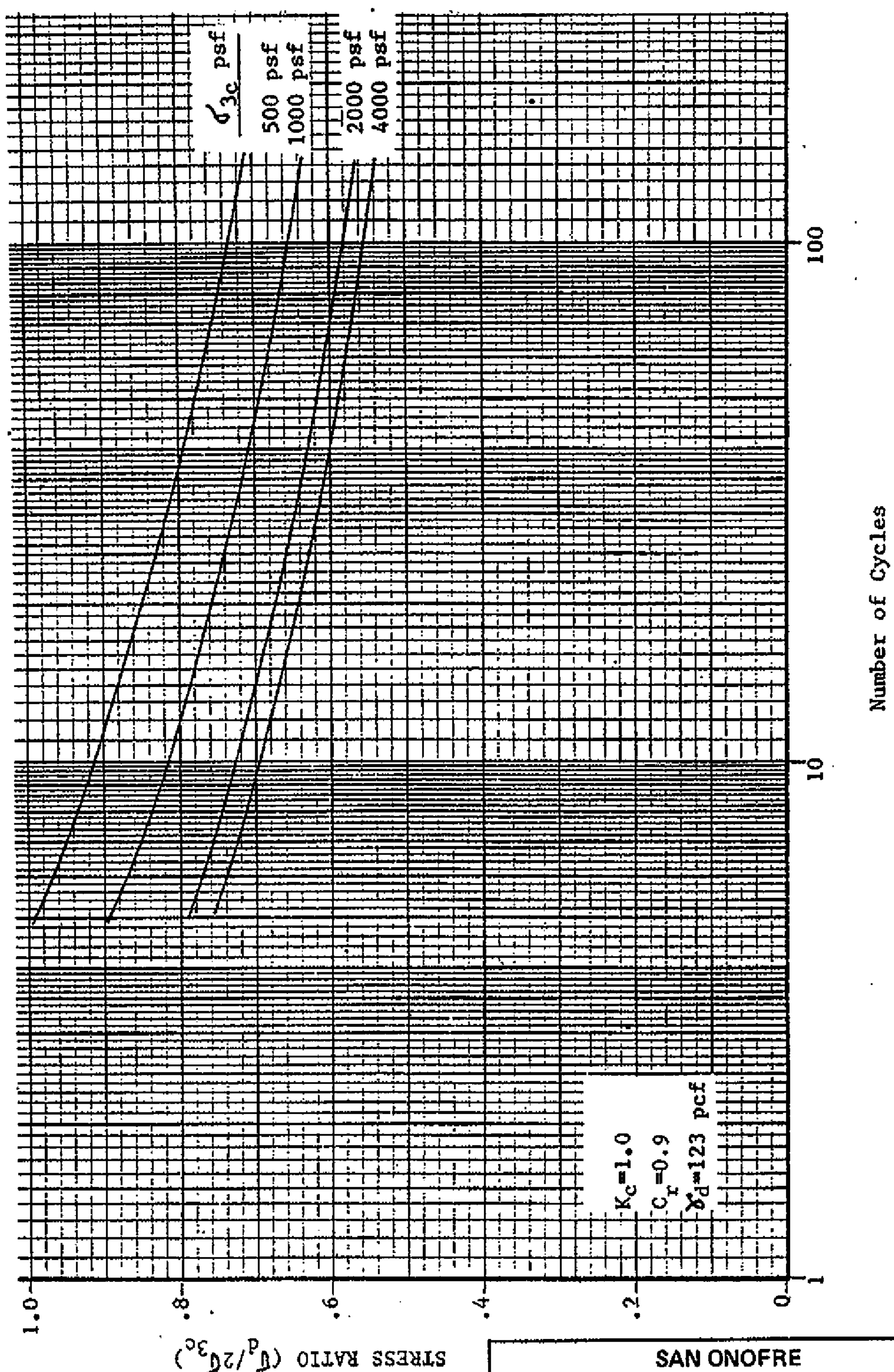


SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
GRAIN SIZE DISTRIBUTION CURVES FOR SAN MATEO SAND
Figure 2.5-34



NOTE: THIS FIGURE IS UPDATED BY FIGURE 2.5-74.

SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
IN-SITU DYNAMIC STRENGTH OF ANISOTROPICALLY CONSOLIDATED SAN MATEO SAND
Figure 2.5-46

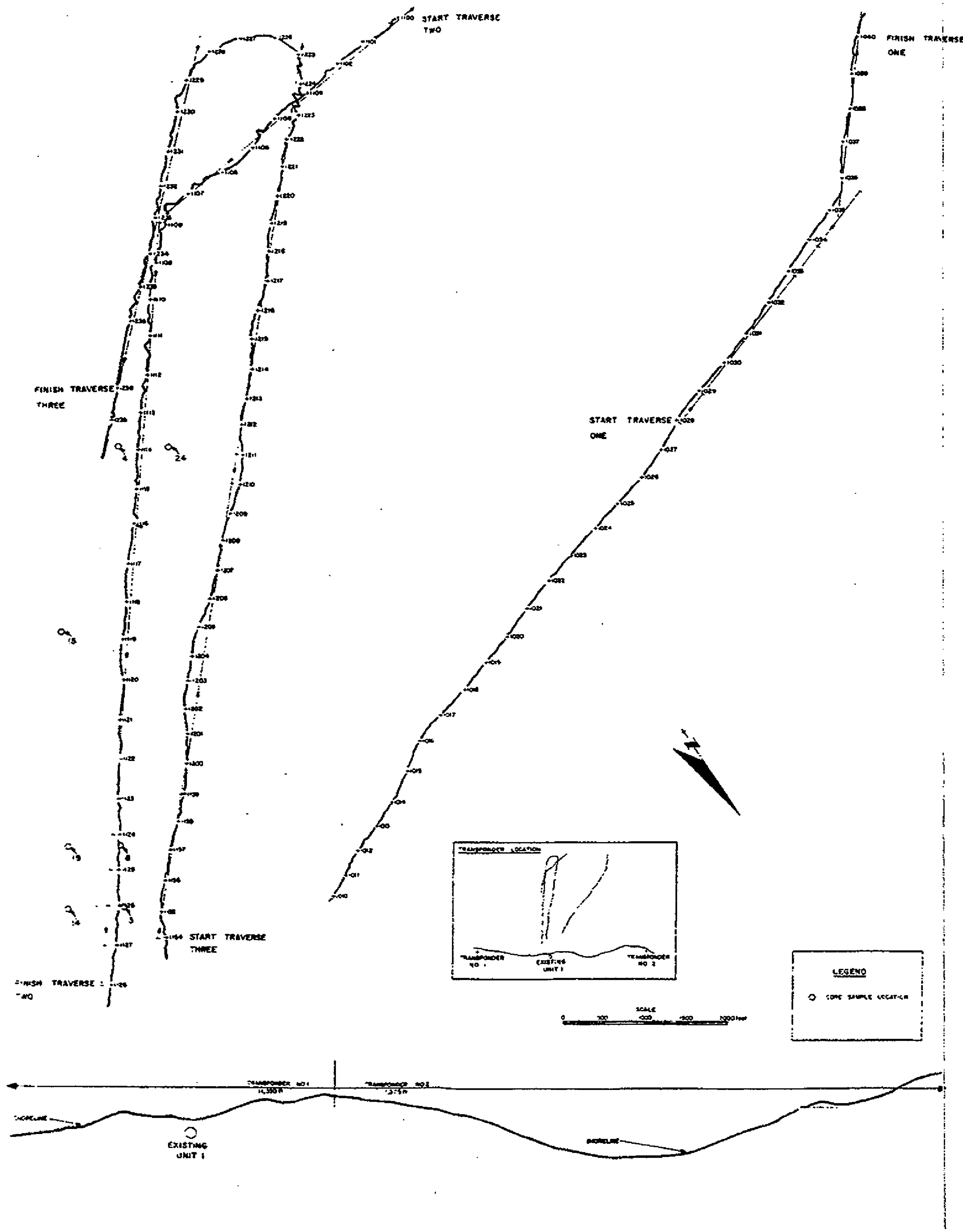


NOTE: THIS FIGURE IS UPDATED BY FIGURE 2.5-75.

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

IN-SITU DYNAMIC STRENGTH
OF SAN MATEO SAND

Figure 2.5-47

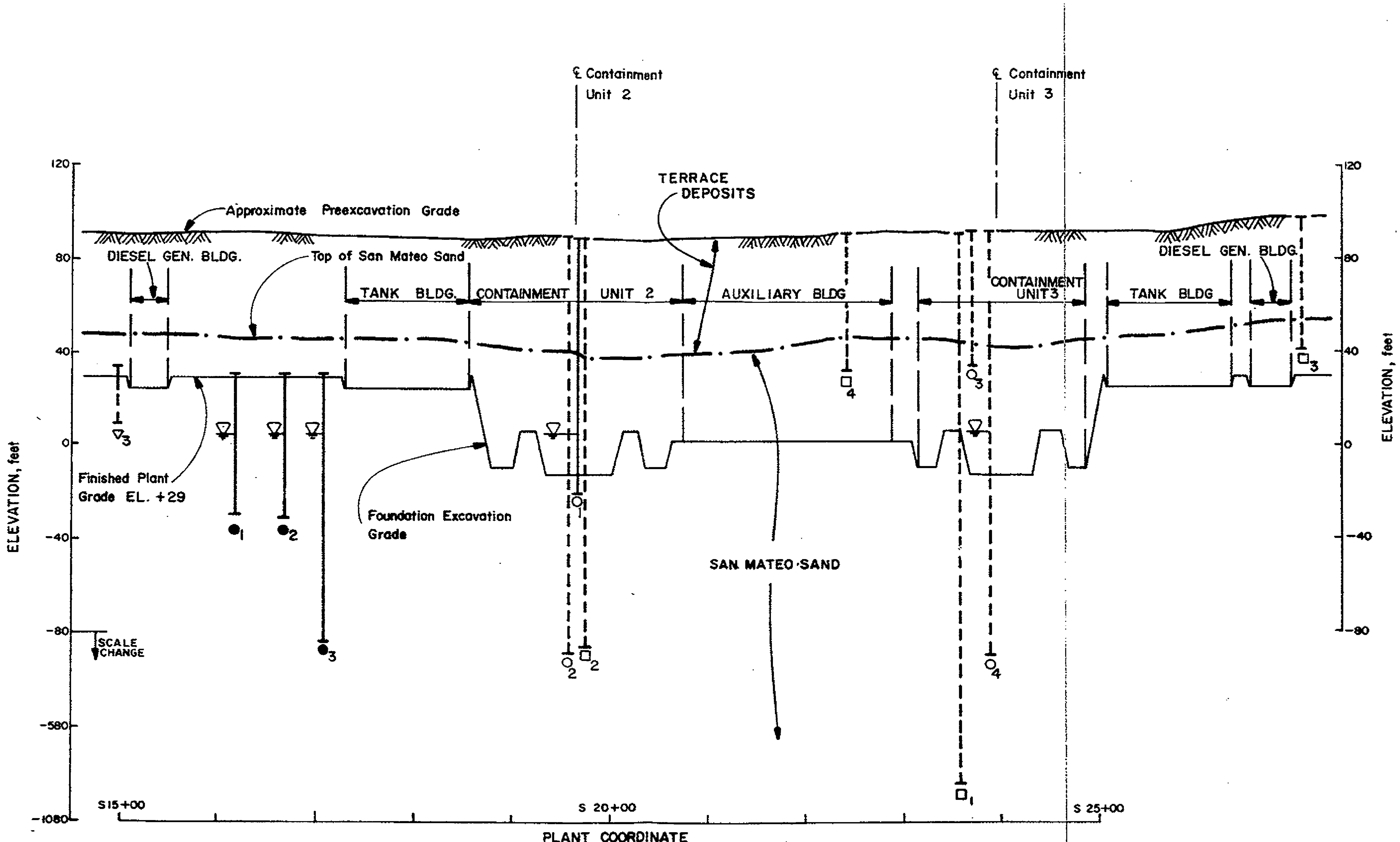


SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

TRAVERSE FOR BOOMER SURVEY AND LOCATIONS FOR VIBRACORE SAMPLING

Figure 2.5-48

Amended: April 2009 TL: E048000



NOTES
1. See Fig. 2.5-40 for Section location.
2. Groundwater levels ▽ on borings are measured values at the time of investigation.
3. Borings shown as dashed(-----)lines are projected onto the section line.
4. Borings with top elevation below preexcavation grade were made after excavation.
5. Number and symbol below boring line refer to boring number and identification as shown on Plan, Fig. 2.5-36
6. Bottom elevations and locations of buildings other than Containments and Auxiliary Bldg. are subject to revision.

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

GENERALIZED SOIL PROFILE
(NORTH-SOUTH) SECTION A-A

Figure 2.5-52

DEPTH IN FEET	DESCRIPTION	COMPRESSIONAL WAVE VELOCITY (FT./SEC.)	POISSON'S RATIO	SHEAR WAVE VELOCITY (FT./SEC.)	TOTAL UNIT WEIGHT (LBS./CU. FT)
0	TERRACE DEPOSITS - silt, sand, gravel & cobbles	1000 3100	(.44)	(330) (1000)	120
	SAN MATEO FORMATION - fine to coarse sandstone, some gravel & siltstone	* 6600	.44	2200	130
		7500	.42	2750	135
1000	CAPISTRANO FORMATION - thin bedded siltstone & shale	7000	.40	2800	131
2000	MONTEREY FORMATION - diatomaceous shale	7000	.35	3350	110
3000	SAN ONOFRE BRECCIA - conglomerate, sandstone & siltstone	11000	(.30)	(6000)	(140)
4000 5000	UNDIFFERENTIATED SEDIMENTS INCLUDING SANTIAGO FORMATION - siltstone, sandstone & shale	(9000)	(.28)	(5000)	(154)
11000	CRYSTALLINE BASEMENT - undifferentiated igneous & metamorphics	(16000)	(.20)	(10000)	(172)

* VALUES FOR UPPER 50' OF FORMATION

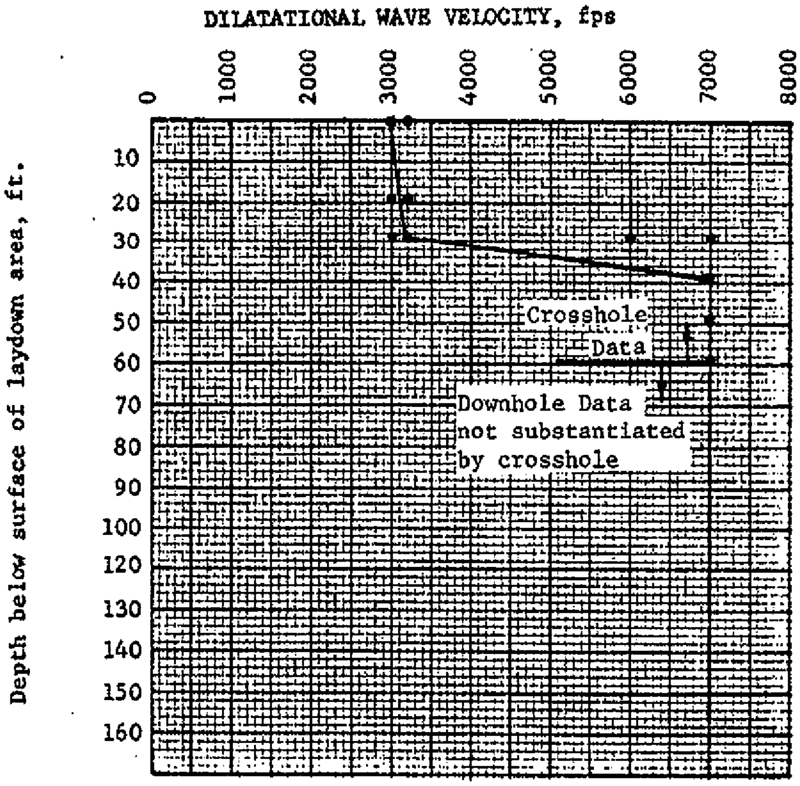
( ) INDICATES ESTIMATED VALUES

—•— APPROXIMATE FOUNDATION LEVEL

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

STRATIGRAPHIC COLUMN
SHOWING GEOPHYSICAL DATA

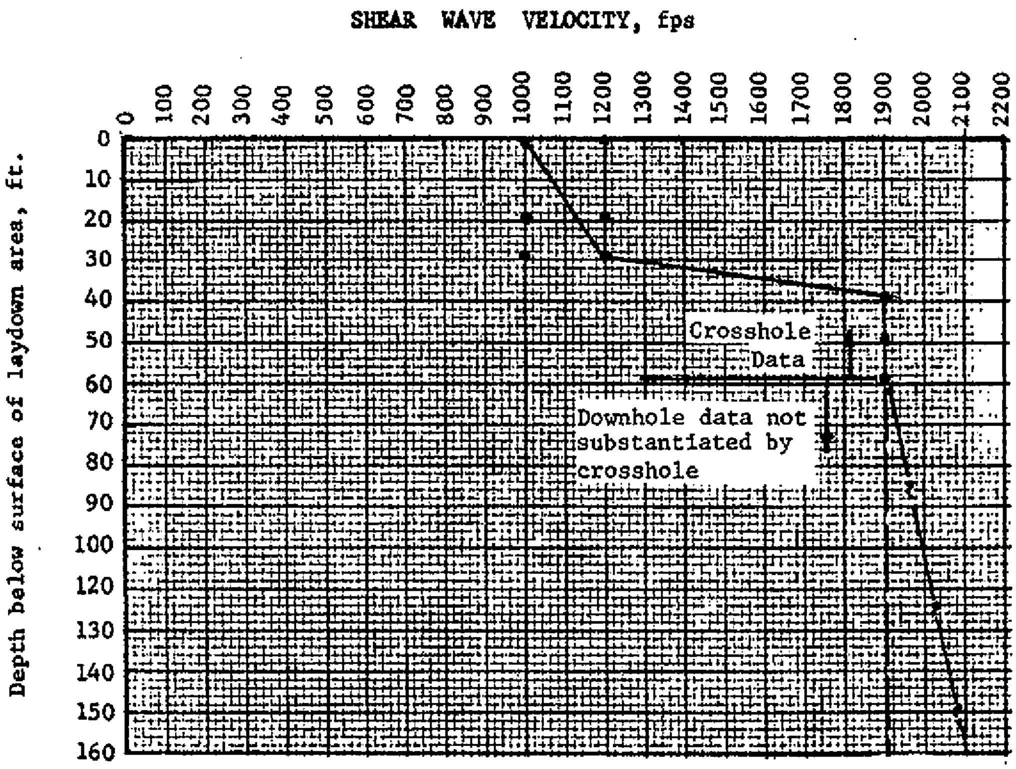
Figure 2.5-56



SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

DILATATIONAL WAVE VELOCITIES

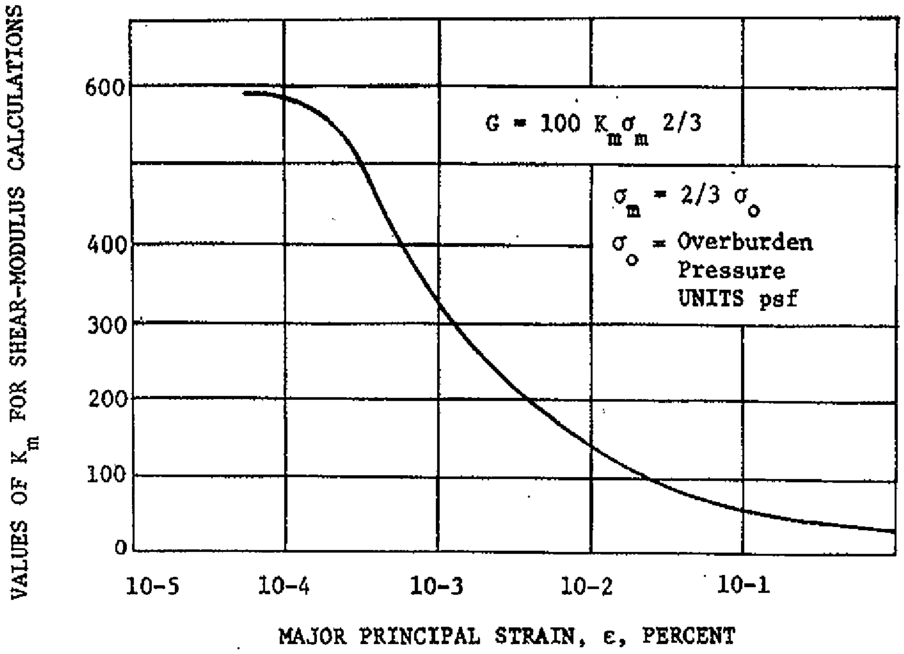
Figure 2.5-57

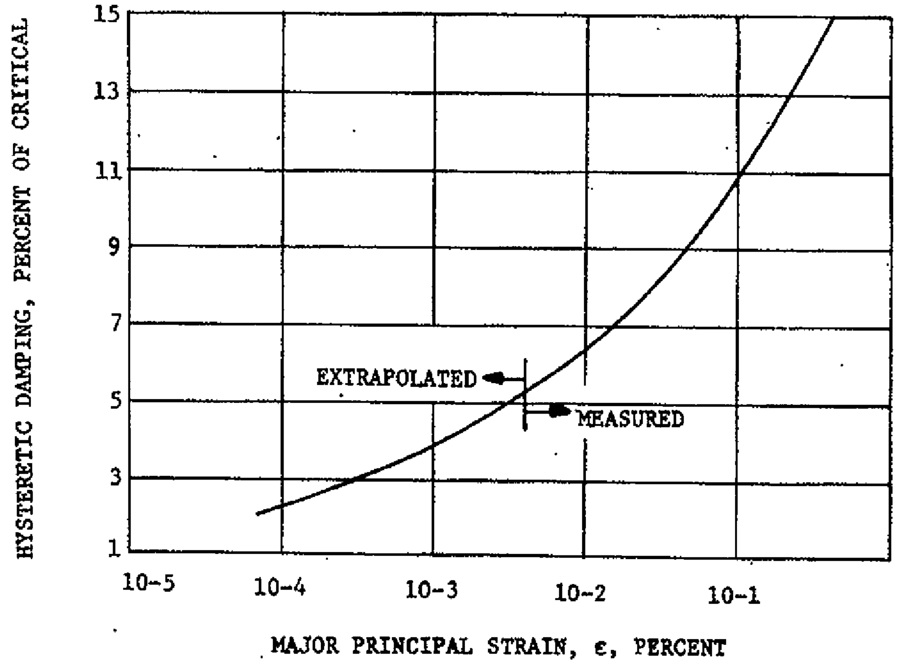


SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

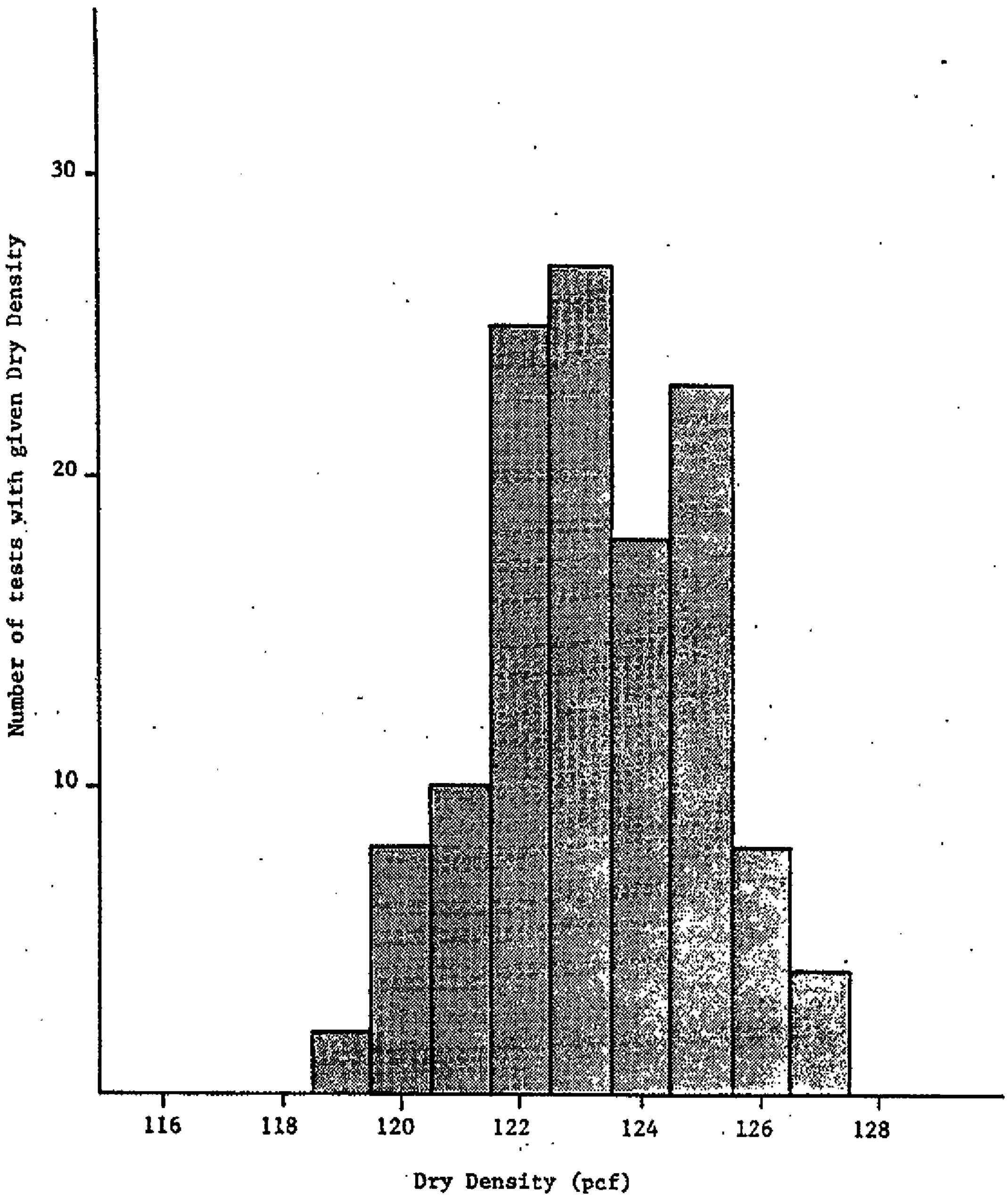
SHEAR WAVE VELOCITIES

Figure 2.5-58





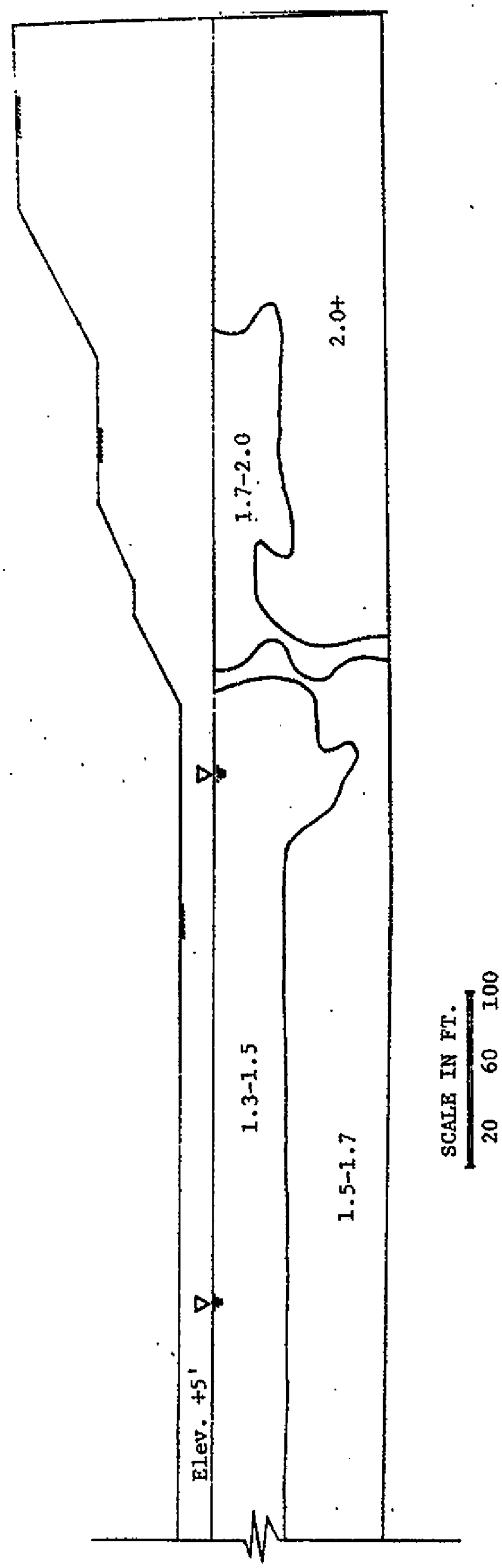
SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
MODULUS AND DAMPING vs. STRAIN SAN MATEO FORMATION SAND
Figure 2.5-62



SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

RESULTS OF SAND CONE TESTS
ON IN-SITU SAN MATEO SAND

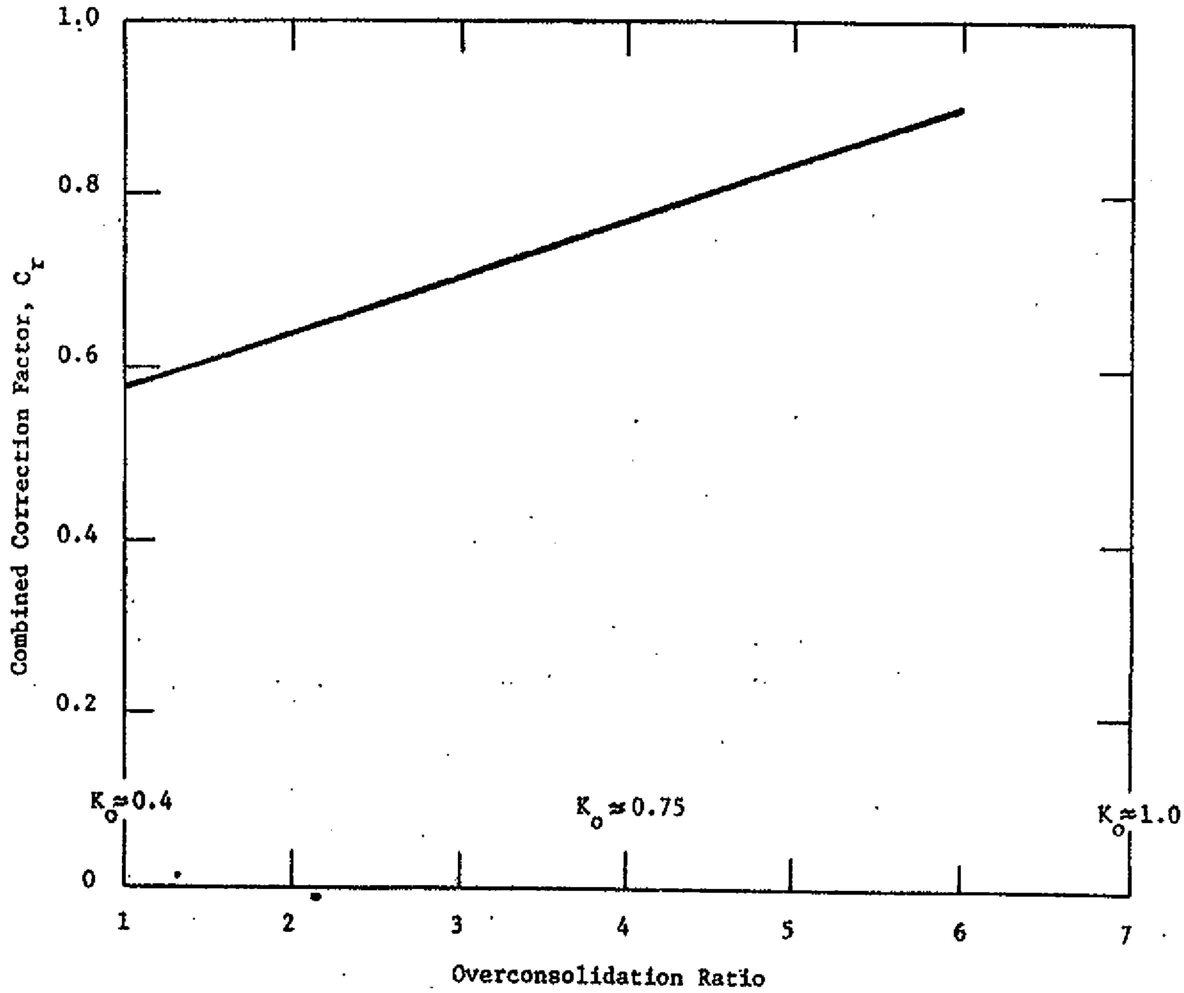
Figure 2.5-65



SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

ZONES OF EQUAL FACTOR-OF-SAFETY

Figure 2.5-66

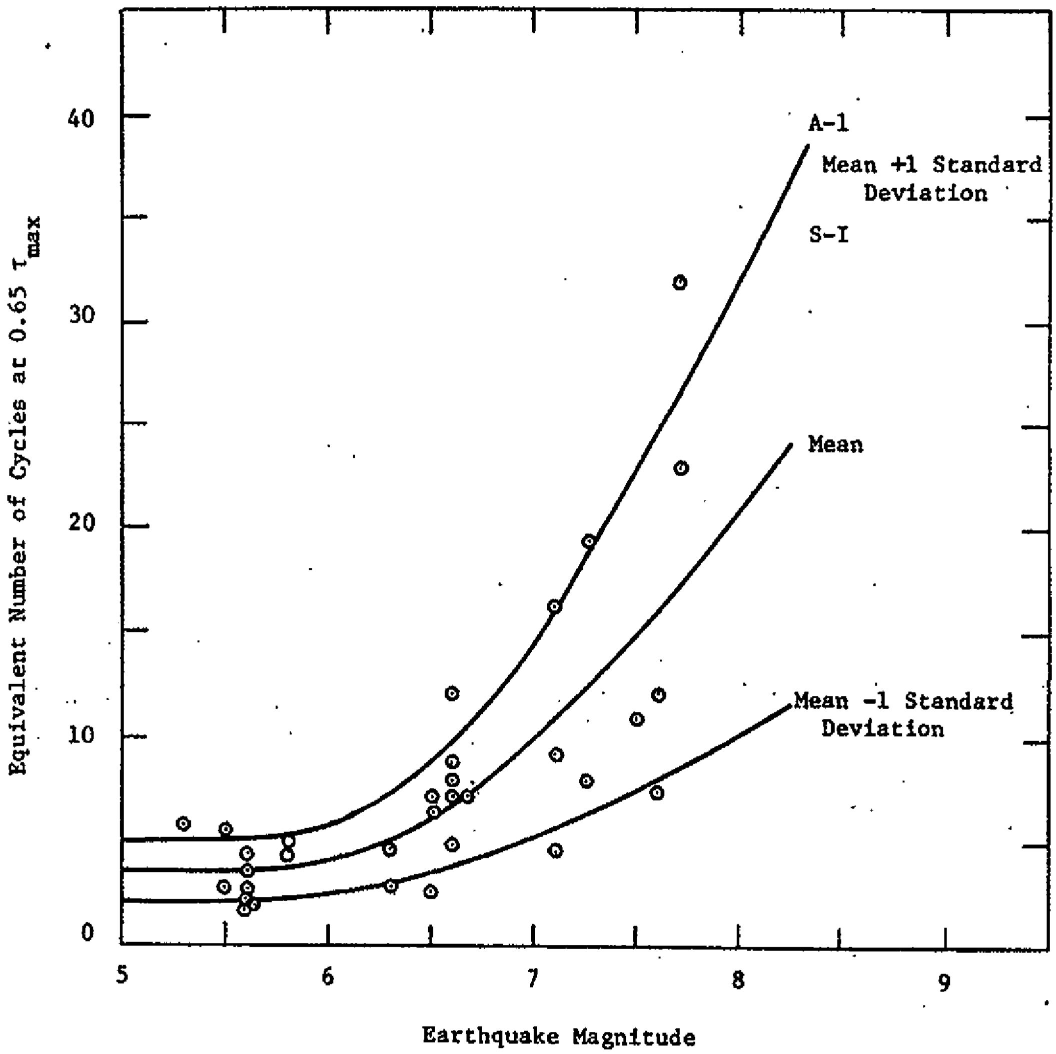


*(after Seed, Arango and Chan, 1975)

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

COMBINED CORRECTION FACTOR FOR CYCLIC TRIAXIAL COMPRESSION TESTS ACCOUNTING FOR MULTIDIRECTIONAL SHAKING AND OVERCONSOLIDATION*

Figure 2.5-68

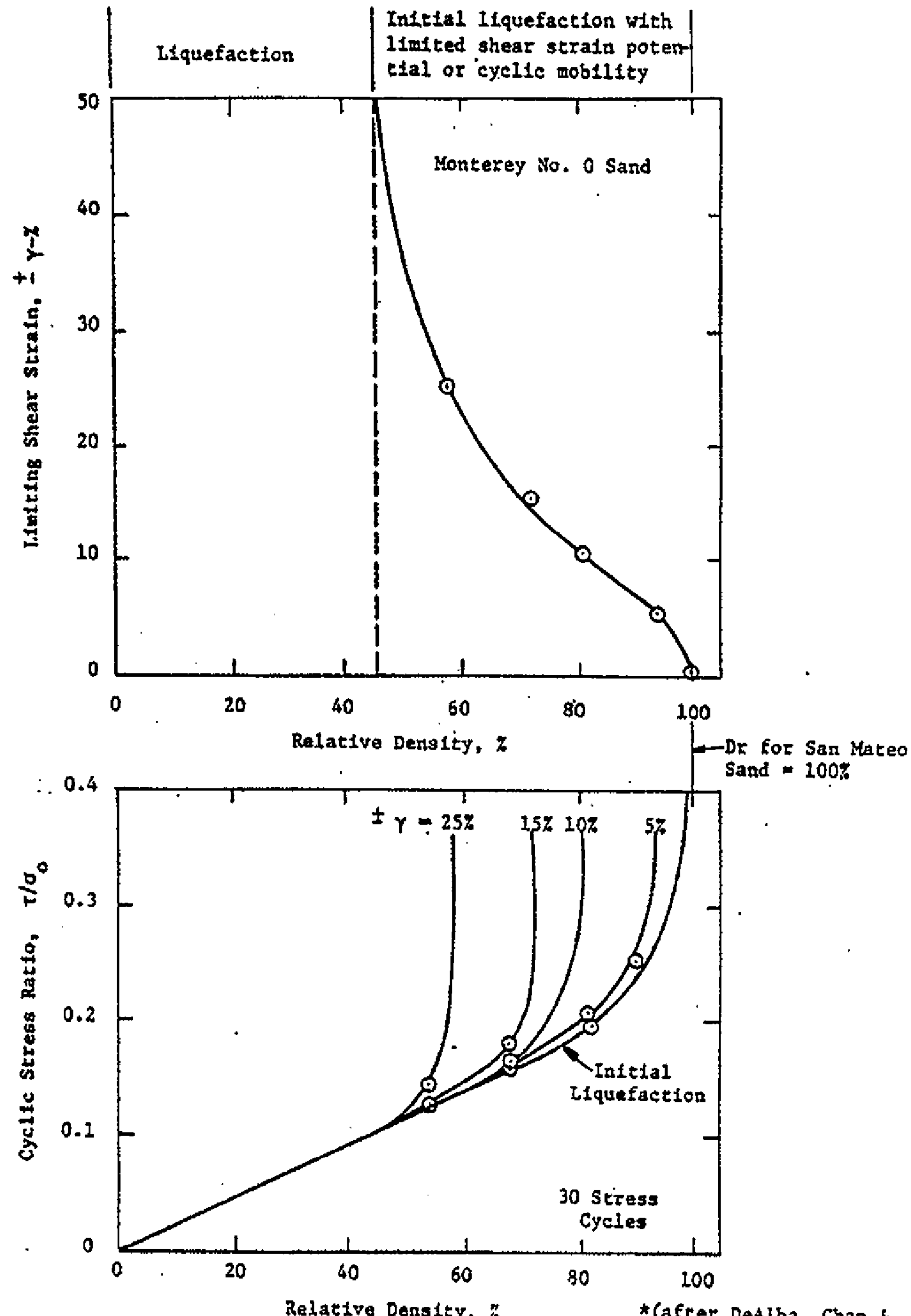


*(after Seed, Idriss, Makdisi and Banerjee, 1975)

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

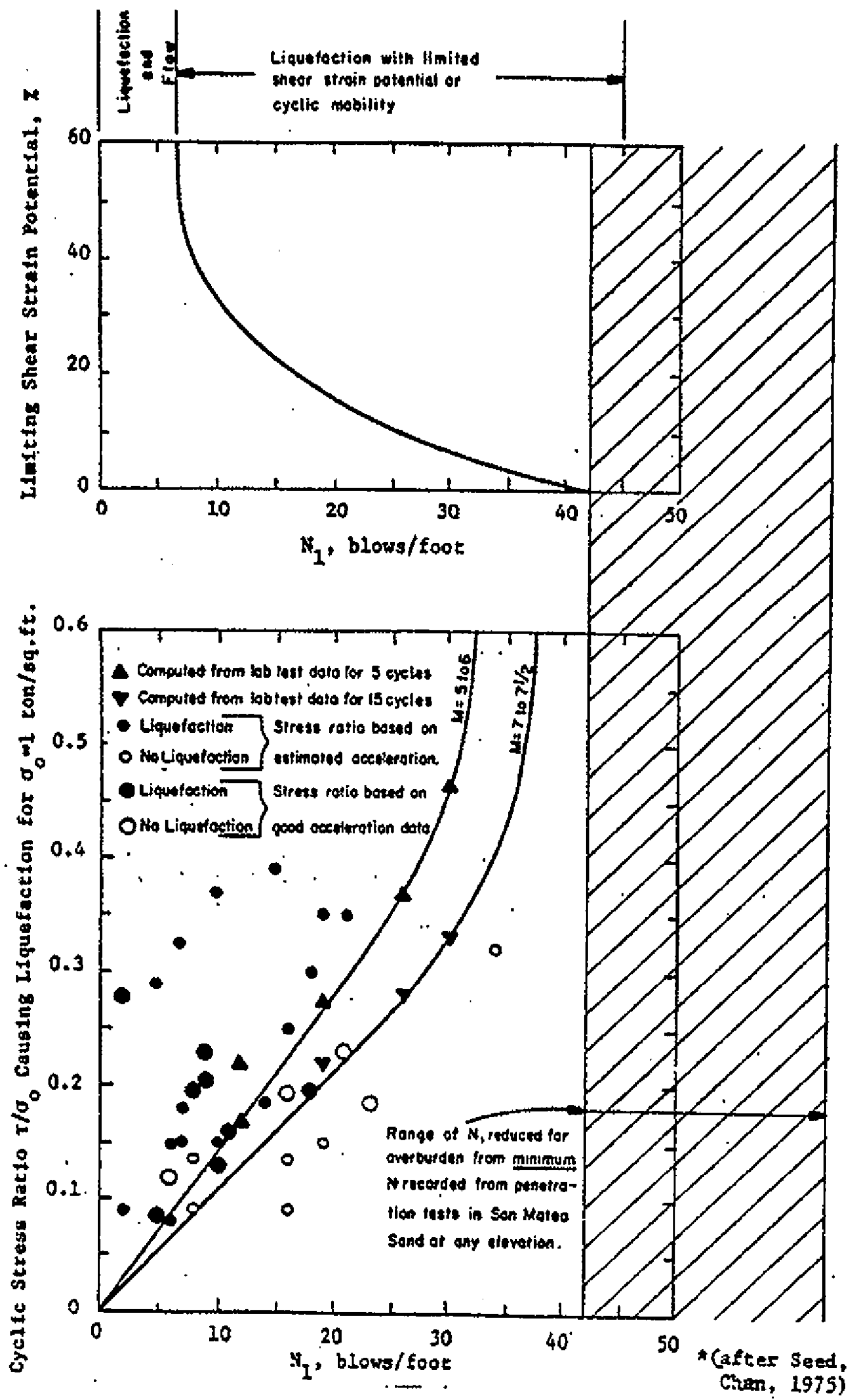
EQUIVALENT NUMBERS
OF UNIFORM STRESS CYCLES
BASED ON STRONGEST COMPONENTS
OF GROUND MOTION*

Figure 2.5-69



*(after DeAlba, Chan & Seed 1975)

SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
RELATIVE DENSITY - LIMITING SHEAR STRAIN RELATIONSHIPS FOR 30 STRESS CYCLES*
Figure 2.5-71

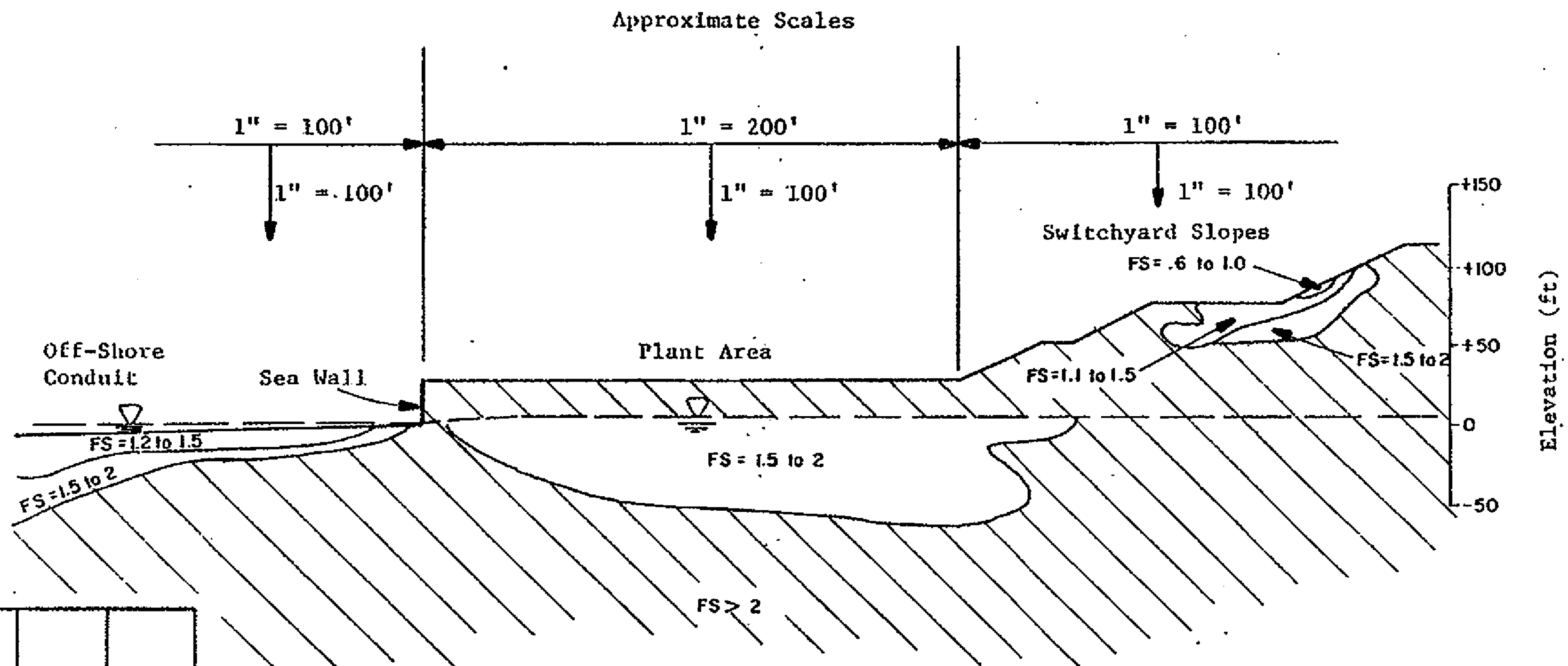


*(after Seed, Arango, and Chan, 1975)

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

CORRELATION BETWEEN STRESS RATIO CAUSING VARIOUS DEGREES OF LIQUEFACTION IN THE FIELD AND IN THE LABORATORY AND PENETRATION RESISTANCE OF SAND

Figure 2.5-72



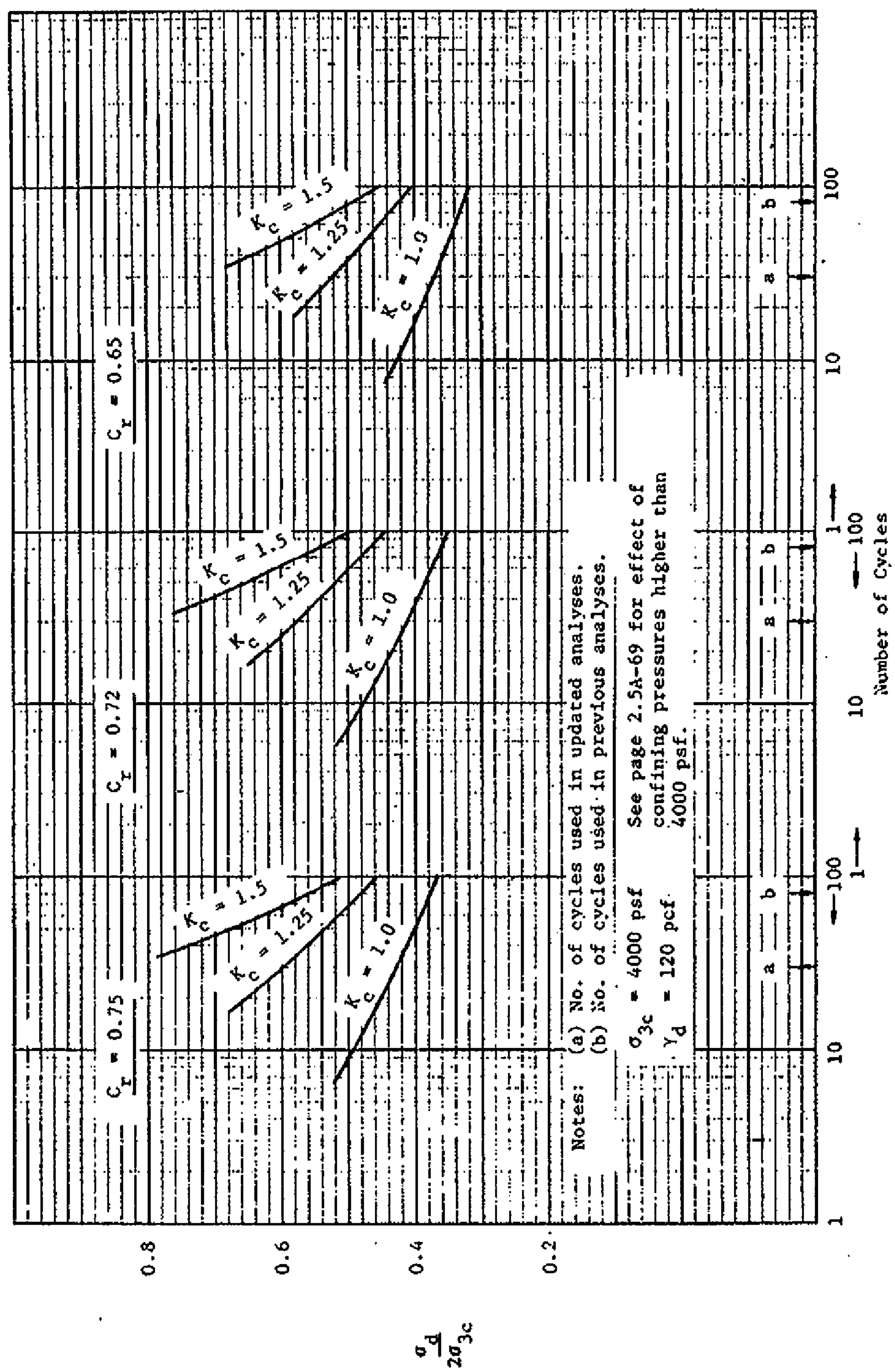
Notes:

1. F.S. defined as the ratio of the stress necessary to cause ± 5% strain to the induced stress.
2. ▽ = water table
3. Based on choice of worst conditions encountered for all analysis values.

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

COMPOSITE SUMMARY OF
F.S. TO DEVELOP ±5% STRAIN

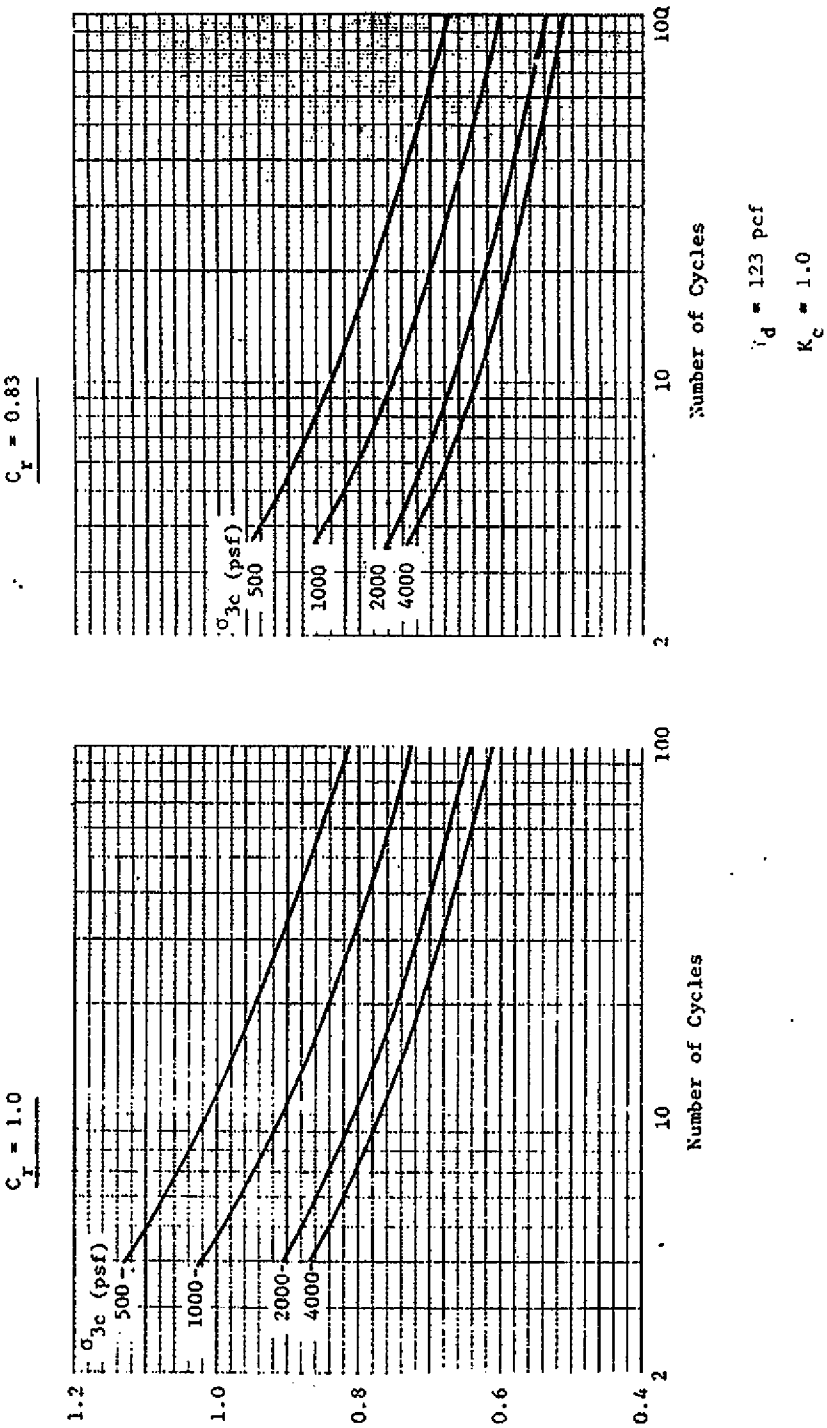
Figure 2.5-73



SAN ONOFRE NUCLEAR GENERATING STATION
Units 2 & 3

FIELD DYNAMIC STRENGTH OF SAN MATEO SAND (PLANT AREA)

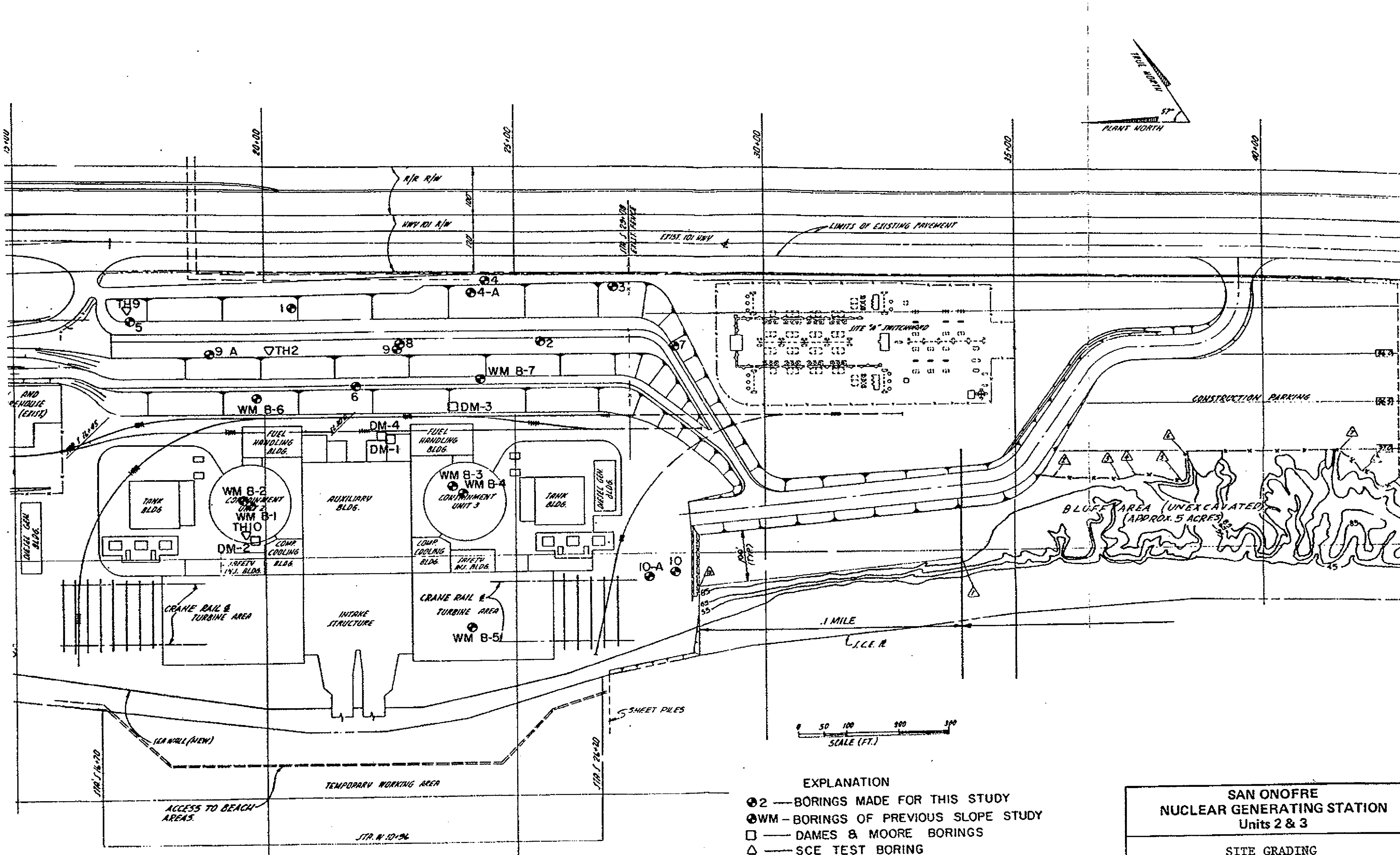
Figure 2.5-74



**SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3**

FIELD DYNAMIC STRENGTH
OF SAN MATEO SAND
(OFFSHORE AREA)

Figure 2.5-75



EXPLANATION

- ⊕2 —— BORINGS MADE FOR THIS STUDY
- ⊕WM – BORINGS OF PREVIOUS SLOPE STUDY
- □ —— DAMES & MOORE BORINGS
- △ —— SCE TEST BORING

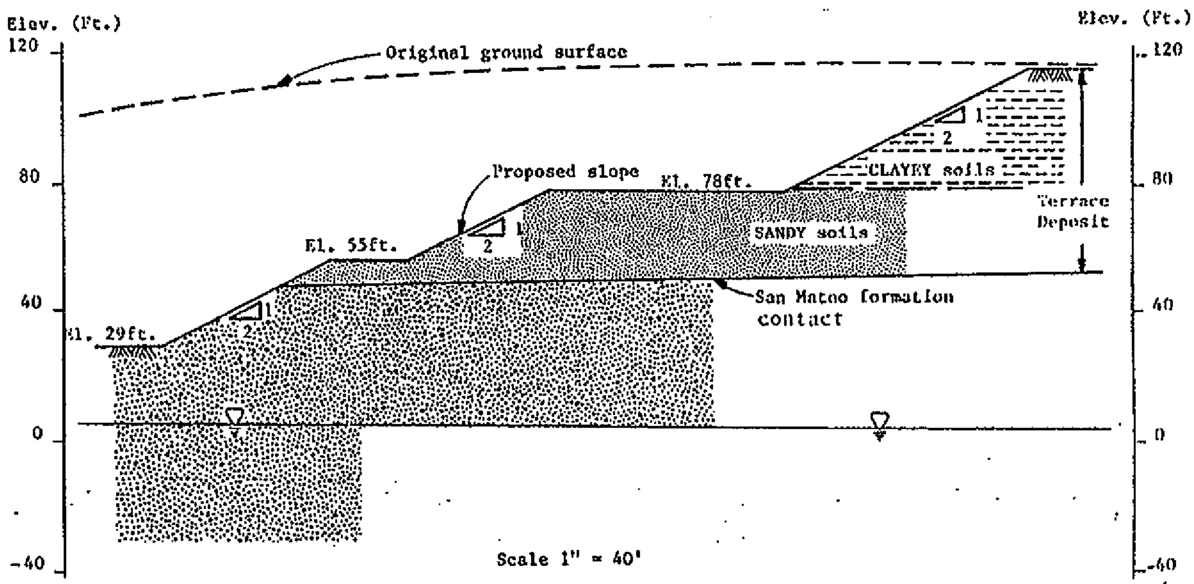
SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3

SITE GRADING AND ACCESS ROADS

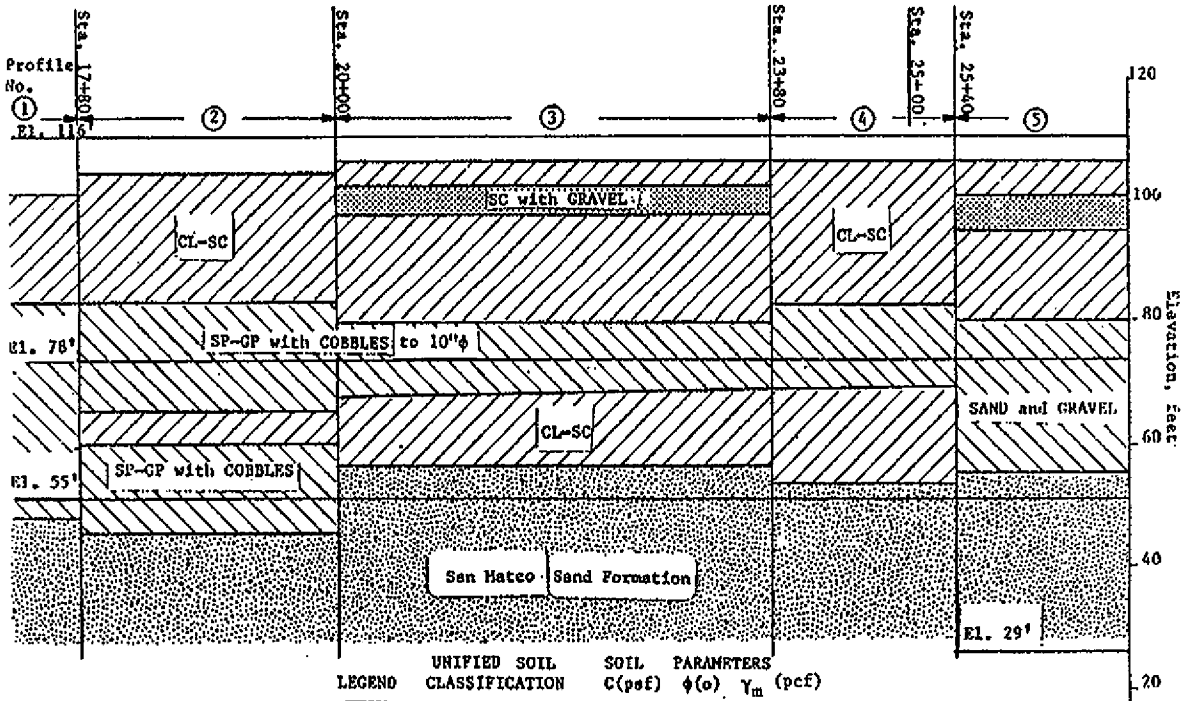
Figure 2.5-80

Amended: April 2009 TL: E048000

Site File Copy



SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
SECTION OF PROPOSED SWITCHYARD SLOPES
Figure 2.5-81



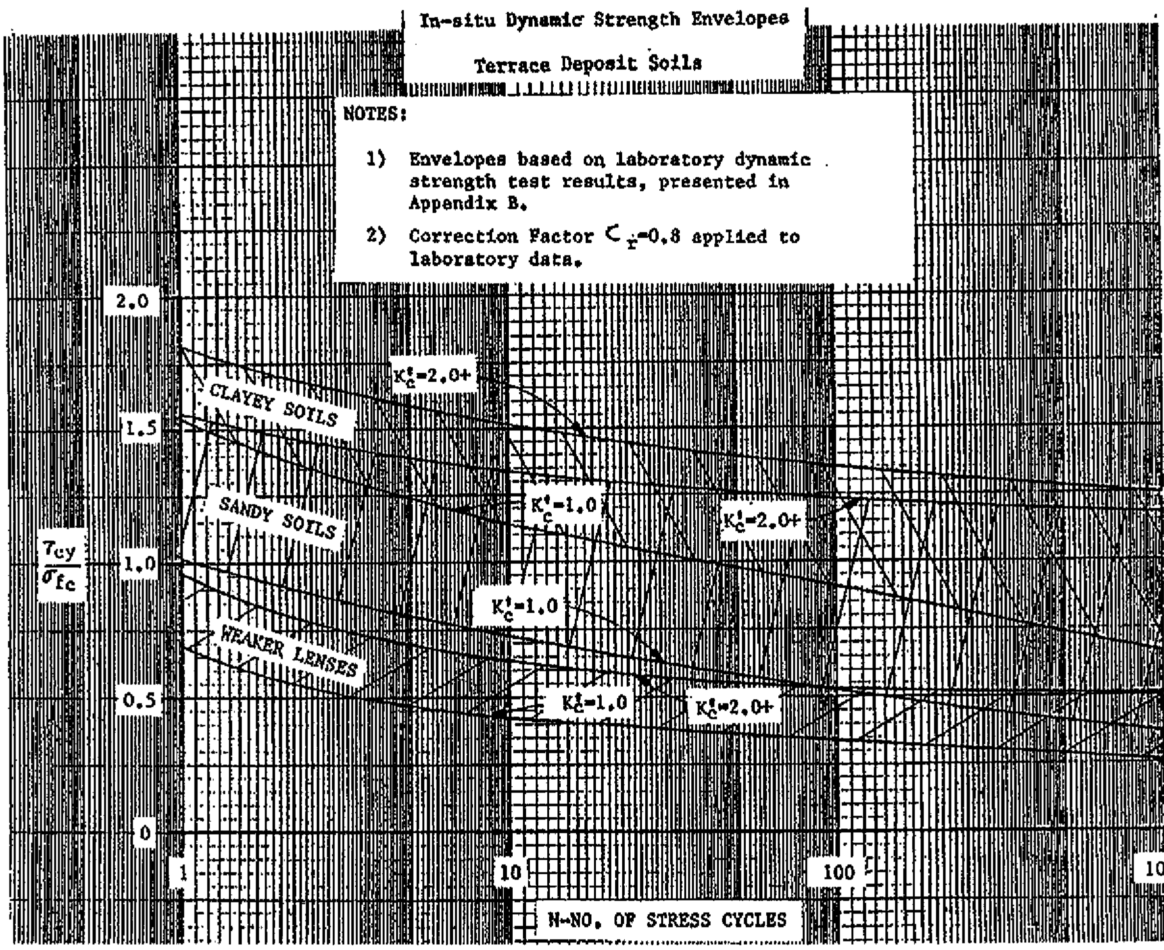
LEGEND	UNIFIED SOIL CLASSIFICATION	SOIL PARAMETERS C(psf)	ϕ(o)	γ_m (pcf)
	Fill	500	33	135
	CL-SC	2600	17	130
	SC with GRAVEL	1400	17	140
	SP-GP	200	38	132
	San Mateo SAND	800	41	126

Vertical Scale 1 in. = 20 ft
Horizontal Scale 1 in. = 100 ft

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

IDEALIZED SWITCHYARD PROFILE

Figure 2.5-82

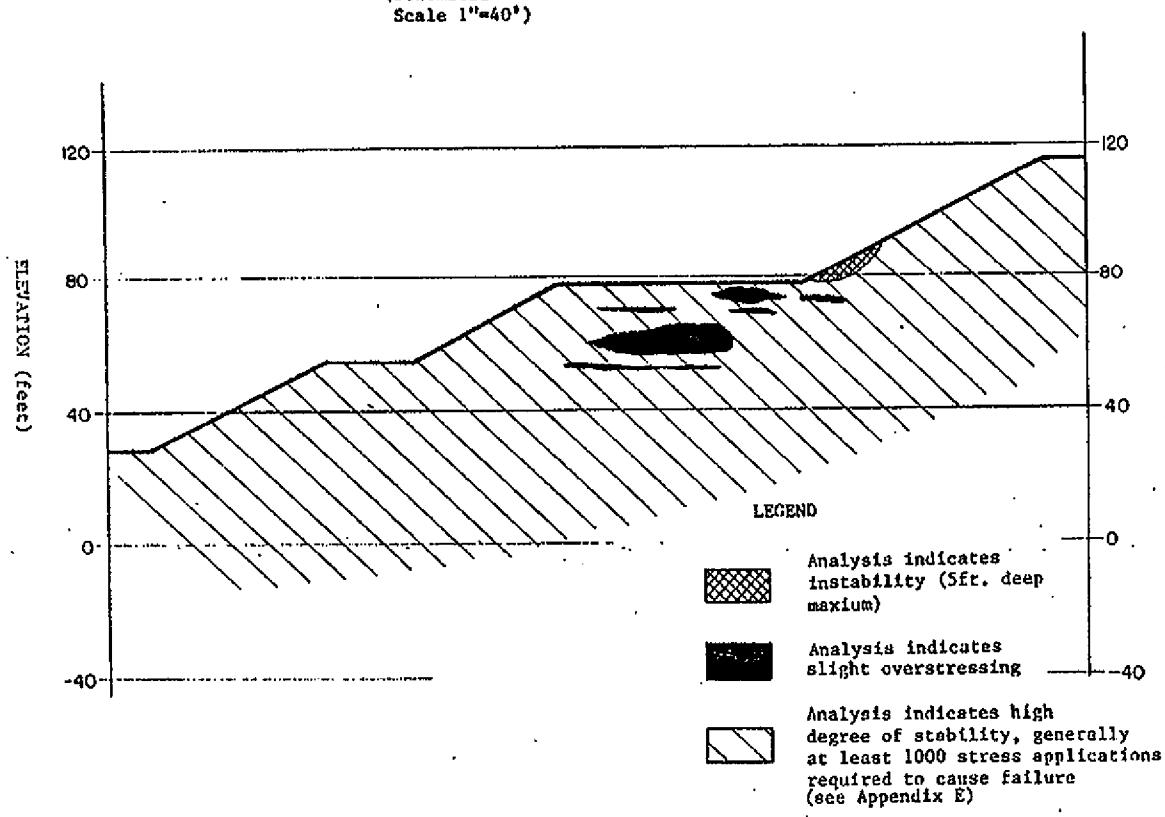


SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

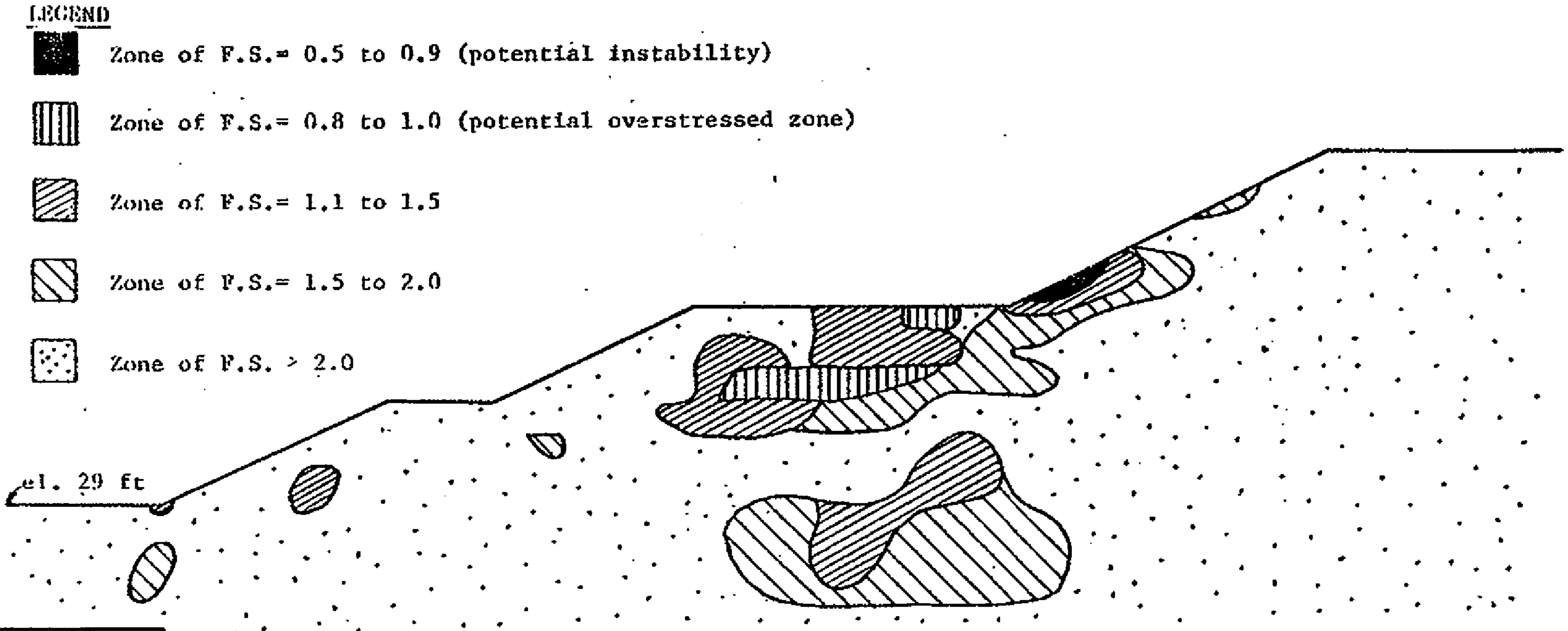
IN-SITU DYNAMIC STRENGTH ENVELOPES - TERRACE DEPOSIT SOILS

Figure 2.5-83

RESULTS OF SWITCHYARD SLOPE STABILITY EVALUATION
(Schematic
Scale 1"=40')



SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
RESULTS OF STABILITY EVALUATION
Figure 2.5-84



Scale 1" = 40'

(See Fig. 7 for interpreted results)

$$F.S. = \frac{\text{Dynamic Stress at 10\% strain for 80 stress applications}}{\text{65\% of Seismic Induced Stress}}$$

SAN ONOFRE
NUCLEAR GENERATING STATION
Units 2 & 3

ZONES OF FACTOR-OF-SAFETY

Figure 2.5-85

3. DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT, AND SYSTEMS

The information contained in this section describes design considerations for structures, components, equipment, and systems. Some of the information in this chapter was prepared in accordance with the original plant licensing requirements and has been retained since it remains pertinent to the plant design after all spent fuel has been relocated to the ISFSI. Historical information has been relocated to Controlled Document 90216, "SONGS Unit 2 and 3 UFSAR Historical Information."

3.1 CONFORMANCE WITH NRC GENERAL DESIGN CRITERIA

This section discusses the extent to which the design criteria for the plant structures, systems, and components needed to support the post-FTO condition meet the applicable NRC General Design Criteria for Nuclear Power Plants specified in Appendix A to 10 CFR Part 50. For each applicable criterion, a summary is provided to show how the principal design features meet the criterion. The design complies with all applicable general design criteria, with no exceptions other than NRC approved exemptions. Those GDCs that are no longer applicable from the original design, as a result of the plant no longer having any safety related or important to safety SSCs, have been deleted. For those GDCs that remain, some aspects of the specified criterion may not apply; only the applicable portion of the GDC is addressed in the respective response provided.

In the discussion of each criterion, the sections of this UFSAR where more detailed information is presented are referenced to demonstrate compliance with the criterion. Controlled Document 90215, NRC Regulatory Guide Applicability, identifies which NRC Regulatory Guides are applicable and lists exceptions as appropriate.

3.1.1 OVERALL REQUIREMENTS

3.1.1.1 Criterion 1 - Quality Standards and Records

3.1.1.1.1 Criterion

Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. A quality assurance program shall be established and implemented in order to provide adequate assurance that these structures, systems, and components will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

3.1.1.1.2 Response

A Decommissioning Quality Assurance Program (DQAP) was established in accordance with 10 CFR 50, Appendix B, to ensure that structures, systems, and components will satisfactorily perform their intended function. The applicants and their special vendors implement the DQAP. The applicants will maintain, either in their possession or under their control, the appropriate records of the design, erection, and testing of structures, systems, and components for the life of the plant.

3.1.6 FUEL AND RADIOACTIVITY CONTROL

3.1.6.1 Criterion 60 - Control of Releases of Radioactive Materials to the Environment

3.1.6.1.1 Criterion

The nuclear power unit design shall include methods to control the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.

3.1.6.1.2 Response

The facility controls the release of radioactive materials in liquid effluents and handles radioactive solid wastes produced. The radioactive waste management systems minimize the potential for an inadvertent release of radioactivity from the facility and ensure that the discharge of radioactive wastes is maintained in accordance with the limits of 10 CFR 20 and 10 CFR 50, Appendix I. The radioactive waste processing system, the design criteria, and the amounts of estimated releases of radioactive effluents to the environment are described in Chapter 11.

3.1.6.2 Criterion 61 - Fuel Storage and Handling and Radioactivity Control

3.1.6.2.1 Criterion

The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to ensure adequate safety under normal and postulated accident conditions. These systems shall be designed:

A. With a capability to permit appropriate periodic inspection and testing of components important to safety

B. With suitable shielding for radiation protection

C. With appropriate containment, confinement, and filtering systems

D. With a residual heat removal capability having a reliability and testability that reflects the importance to safety of decay heat and other residual heat removal

E. To prevent significant reduction in fuel storage coolant inventory under accident conditions

3.1.6.2.2 Response

Fuel storage and handling design criteria is provided in the cask specific FSAR for the spent fuel located in the ISFSI and in the respective SONGS NUHOMS and HI-STORM UMAX 72.212 Reports. Fuel handling is no longer performed.

For radioactive waste systems and other systems which may contain radioactivity, the facility contains means for monitoring the effluent discharge paths and the facility environs for radioactivity which could be released under any postulated condition. The radioactive waste processing system is not important to safety; however, the system has been designed with suitable shielding and appropriate containment and confinement to ensure adequate safety to personnel and the environment.

3.1.6.3 Criterion 62 - Prevention of Criticality in Fuel Storage and Handling

3.1.6.3.1 Criterion

Criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.

3.1.6.3.2 Response

Fuel storage and handling systems design criteria is provided in the cask specific FSAR and in the respective SONGS NUHOMS and HI-STORM UMAX 72.212 Reports for the spent fuel located in the ISFSI. Fuel handling is no longer performed.

3.1.6.4 Criterion 63 - Monitoring Fuel and Waste Storage

3.1.6.4.1 Criterion

Appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas: (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions.

3.1.6.4.2 Response

Appropriate radiation monitoring and control of waste storage and handling are described in Chapter 11.

3.1.6.5 Criterion 64 - Monitoring Radioactivity Releases

3.1.6.5.1 Criterion

Methods shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of LOCA fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, anticipated operational occurrences, and postulated accidents.

3.1.6.5.2 Response

Radioactivity levels contained in the facility effluent and discharge paths in the plant environs are monitored by the station radiation monitoring system. In addition to the installed detectors, periodic plant environmental surveillance is established. Measurement capability and reporting of effluents are consistent with the recommendations of Regulatory Guides 4.1 and 1.21, with the exception described in Controlled Document 90215.

Chapter 11 discusses the process and effluent radiological monitoring.

3.2 CLASSIFICATION OF STRUCTURES, COMPONENTS, AND SYSTEMS

3.2.1 SEISMIC CLASSIFICATION

General Design Criterion 2 of Appendix A to 10CFR50, General Design Criteria for Nuclear Power Plants, and Appendix A to 10CFR100, Seismic and Geologic Siting Criteria for Nuclear Power Plants, require that nuclear power plant structures, components, and systems important to safety be designed to withstand the effects of earthquakes without loss of capability to perform their safety functions.

Controlled Document 90034, "Q-List" provides a listing of structures, components, and systems as decommissioning progresses, the seismic classification of each SSC will be lowered to Class III in a graded approach to safety.

3.2.2 SYSTEM QUALITY GROUP CLASSIFICATIONS

Controlled Document 90034, "Q-List" identifies the quality group classification of systems, and portions of systems, and lists industry codes and standards applicable to components and systems.

3.2.3 QUALITY ASSURANCE PROGRAM CLASSIFICATIONS

To fulfill the requirements of the SONGS Decommissioning Quality Assurance Program (DQAP), those items that are subject to the DQAP are identified in Controlled Document 90034, "Q-List."

In the Post-FTO environment, Quality Class I and II SSCs no longer exist in the plant. SSCs previously classified as Quality Class III, Quality Class III-Augmented Quality and Quality Class IV have been re-evaluated to determine if they are important to the defueled condition (ITDC) or not important to safety (NITS).

The following criteria are used to determine SSCs designated as ITDC:

1. SSCs necessary to comply with the requirements for effluent monitoring in accordance with the ODCM,
2. SSCs necessary to comply with the requirements of the Fire Protection Program in accordance with 10 CFR 50.48(f).

Any SSC that meets any of the criteria above is classified as ITDC.

The design of SSCs that are considered NITS and ITDC are subject to the California Building Code. SSCs classified as ITDC are subjected to specified management controls that are implemented as a means to assure conformance to regulatory and site requirements for the radiological safety of station personnel, the general public, and the environment.

3.3 WIND AND TORNADO LOADINGS

3.3.1 WIND LOADINGS

Wind design loadings are in accordance with the CA Building Code requirements.

3.3.2 TORNADO LOADINGS

The following original plant tornado design parameters are applicable to the SONGS ISFSI design:

Wind Speed - The dynamic wind speed is caused by a tornado funnel having a peripheral tangential speed of 220 mi/h and a translational speed of 40 mi/h.

Differential Pressure - The atmospheric pressure change during a tornado is 1.5 psid.

Tornado Generated Missiles - The missiles considered in the design and their characteristics are listed in Table 3.5-6.

Table 3.5-6

TORNADO-GENERATED MISSILES CONSIDERED
IN DESIGN OF STRUCTURES THAT
PROVIDE MISSILE PROTECTION

Description	Weight (lbs)	Impact Area (ft^2)	Maximum Velocity (ft/s)	Kinetic Energy (ft-lbs)
A 12-foot wood plank, 4 x 12 inches in cross-section, weighing 108 pounds, traveling end on at a speed of 220 mi/h, striking the structure at any elevation	108	0.33	322	1.74×10^5
A steel pipe, Schedule 40, 3 inches in diameter by 10 feet long, weighing 75.8 pounds, traveling end on at 100 mi/h, striking the structure at any elevation	75.8	0.067	147	2.54×10^4
An automobile of 4,000 pounds weight, striking the structure at 50 mi/h on a contact area of 20 ft^2, any portion of the impact being not more than 25 feet above grade.	4000	20.0	73.5	3.36×10^5
A utility pole, 13-1/2 inches in diameter, Missile F of Standard Review Plan (SRP) 3.5.1.4, any portion of the impact being not more than 25 feet above grade.	1490	0.994	$V_H = 152$ $V_V = 122$	5.35×10^5 3.44×10^5
A steel rod, 1-inch in diameter x 3 feet long, Missile C of SRP 3.5.1.4	8	0.0054	$V_H = 229$ $V_V = 183$	6.51×10^3 4.16×10^3

3.7 SEISMIC DESIGN

In the post-FTO environment, seismic design will be in accordance with the CA Building Code.

3.8 DESIGN OF CATEGORY I STRUCTURES

The following sections are relocated to Controlled Document 90216, "SONGS Units 2 and 3 UFSAR Historical Information":

3.8.1.1 Description of the Containment

3.8.1.1.1 General

3.8.4 OTHER STRUCTURES

3.8.4.1 Description of the Structures

3.8.4.1.1 Auxiliary Building

3.8.4.1.2 Fuel Handling Building

3.8.4.1.4 Intake Structure

3.8.4.1.5 Electrical and Piping Gallery Structure

3.8.4.1.6 Diesel Generator Building

3.8.4.1.7 Condensate and Refueling Tank Enclosure Structure

3.8.4.1.8 Miscellaneous "Category I" Structures

3.8.4.1.9 Box Conduit Structure

3.8.4.1.10 Auxiliary Intake Structure

3.8.5 FOUNDATIONS

3.8.5.1 Description of the Foundations

3.8.5.1.1 Containment

3.8.5.1.3 Fuel Handling Building

3.8.5.1.5 Intake Structure

3.8.5.1.7 Condensate and Refueling Tank Enclosure Structure

3.8.5.1.8 Diesel Generator Building

3.8.5.1.9 Intake Circular Conduits

3.8.5.1.10 Auxiliary Intake Structure

3.8.5.1.11 Box Conduit Structure

3.9 MECHANICAL SYSTEMS AND COMPONENTS

All subsystems and programs of the Mechanical System are not required to support permanent plant shutdown or defueled operations. The operational information has been removed from the UFSAR to indicate that the systems perform no licensing bases or design basis function.

4. REACTOR

As a result of the cessation of power operation, all of the Units 2 and 3 reactor systems, including the Control Element Drive Mechanisms (CEDM) and Vibration and Loose Parts Monitoring (VPLM), have been permanently removed from service and no longer have a design, licensing basis, or operational function.

Furthermore, with the completion of Fuel Transfer Operations (FTO), the Spent Fuel (fuel rods, poison rods, assemblies) and Control Element Assemblies (CEAs), have been transferred from the spent fuel pool to an onsite Independent Spent Fuel Storage Facility (ISFSI), licensed under a general 10 CFR Part 72 license (based on the existing 10 CFR Part 50 site licenses), for interim storage until the spent fuel and CEAs are shipped offsite.

After the completion of FTO, it will also be necessary to relocate certain other radioactive materials stored in cans located in the Spent Fuel Pool to the ISFSI. As part of site Decontamination and Dismantlement (D&D), the reactor vessel and reactor vessel internals (RV/RVI) will be removed, segmented, and stored on the ISFSI. Both the Spent Fuel Pool and RV/RVI waste steams will be classified in accordance with 10 CFR 61.55 which will include Greater than Class C (GTCC) waste. Storage of GTCC on the ISFSI will conform to the applicable requirements of 10 CFR 72 as guided by SFST-ISG-17. The storage will also conform with off-site transportation canister requirements (10 CFR Part 71 Certificates of Compliance) to ensure the ability to transport the GTCC to an offsite disposal facility when available.

Effluent and radiation monitoring for activity generated during large component removal and the radiation protection controls are discussed in Chapter 11 and Chapter 12 of the DSAR.

Additional Historical information has been placed in Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information” should it need to be referenced.

4.1 SUMMARY DESCRIPTION

4.1.1 REACTOR SYSTEM

The reactor system, listed below, has been removed from service. It no longer has a design, licensing, or operational function.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Reactor	Removed from Service
Control Element Drive Mechanism (CEDM)	Removed from Service
Vibration and Loose Parts Monitoring (VLPM)	Removed from Service

4.1.2 FUEL AND ASSOCIATED COMPONENTS

The fuel (fuel rods, poison rods, assemblies) and CEAs, are removed from service. SONGS has permanently ceased operation and removed all nuclear fuel and CEAs from both unit's reactor vessels to the Spent Fuel Pool. Subsequently, the irradiated fuel assemblies and CEAs are being stored in the ISFSI until they are shipped offsite.

4.2 FUEL DESIGN

4.2.1 DESCRIPTION AND DESIGN

This subsection summarizes the mechanical design characteristics of the fuel and associated components. Typical mechanical design parameters are presented in Table 4.2 1 and a typical fuel assembly is presented in Figure 4.2-1.

4.2.1.1 Fuel Assemblies

A fuel assembly consists of 236 UO2 fuel, Urania-erbia (U, Er) fuel and poison rods, five control element guide tubes, 11 fuel rod spacer grids, upper and lower end fittings, and a hold-down device.

The outer guide tubes, spacer grids, and end fittings form the structural frame of the assembly.

The fuel spacer grids maintain the fuel rod array by providing positive lateral restraint to the fuel rod but only frictional restraint to axial fuel rod motion.

The ten Zircaloy 4 spacer grids are fastened to the Zircaloy 4 guide tubes by welding, and each grid is welded to each guide tube at eight locations, four on the upper face of the grid and four on the lower face of the grid, where the spacer strips contact the guide tube surface. The lowest spacer grid (Inconel) is not welded to the guide tubes due to material differences.

The upper end fitting is an assembly consisting of two cast 304 stainless steel plates, five machined posts and five helical Inconel X-750 springs, which attaches to the guide tubes to serve as an alignment and locating device for each fuel assembly and has features to permit lifting of the fuel assembly. The lower cast plate locates the top ends of the guide tubes and is designed to prevent excessive axial motion of the fuel rods.

Markings provided on the fuel assembly upper end fitting enable verification of fuel enrichment and orientation of the fuel assembly.

4.2.1.2 Fuel Rods

The 236 fuel rods consist of enriched UO2 or (U, Er) O2 cylindrical ceramic pellets and other sub-components encapsulated within a tube seal welded to end caps. The fuel rods are internally pressurized with helium during assembly.

The compression spring located at the top of the fuel pellet column maintains the column in its proper position during handling and shipping.

4.2.1.3 Burnable Poison Rods

A small number of fixed burnable neutron absorber (poison) rods remain in selected fuel assemblies. They replace fuel rods at selected locations. The poison rods are mechanically similar to fuel rods, but contain a column of burnable poison pellets instead of fuel pellets.

Each burnable poison rod assembly includes a serial number and visual identification mark. The serial number is used to record fabrication information for each component in the rod assembly.

4.3 CONTROL ELEMENT ASSEMBLY DESCRIPTION AND DESIGN FIGURES

The San Onofre Units 2 and 3 have three different types of CEAs: full-length five-element, full-length four-element, and part-length five-element. Each CEA interfaces with the guide tubes of one fuel assembly, except for the four-element CEA, which straddles two adjacent fuel assemblies.

The control elements of a full-length CEA consist of an Inconel 625 tube loaded with a stack of cylindrical absorber pellets. The absorber material consists of boron carbide (B4C) pellets, except for the lower portion of all full length CEAs, which contain silver-indium-cadmium (Ag-In-Cd) alloy cylinders.

Each full-length control element is sealed by welds, which join the tube to nose cap at the bottom and an end fitting at the top. The end fittings, in turn, are threaded and pinned to the spider structure, which provides rigid lateral and axial support for the control elements.

The control elements of a part-length CEA consist of solid Inconel 625 over the bottom section of their length, an Inconel 625 tube open to its environment over the next section and a sealed chamber containing B4C pellets in the top section. See Table 4.2-1 for dimensions.

Table 4.2-1 (Sheet 1 of 2)

MECHANICAL DESIGN PARAMETERS

Spacer Grids And Fuel Rods

Spacer Grid		
Type	Leaf spring	
Material	Zircaloy-4	
Number per assembly	10 (6 HID-1 and 4 HID-2)	
Weight each, lb	3.6 HID-2 1.8 HID-1	
Bottom Spacer Grid		
Type	Leaf spring	
Material	Inconel 625	
Number per assembly	1	
Weight each, lb	2.6	
Weight of fuel assembly, lb	1,500	
Outside dimensions		
Fuel rod to fuel rod, inches	7.972 x 7.972	
Fuel Rod		
Fuel rod material (sintered pellet)	UO_2	$(U, Er)O_2$
Pellet diameter, inches	0.3255	
Pellet length, inches	0.390	
Pellet density, g/cm^3	10.47	10.44
Pellet theoretical density, g/cm^3	10.96	10.90
Pellet density (% theoretical)	95.5	95.8
Stack height density, g/cm^3	10.315	10.289
Clad material	Zircaloy-4 or ZIRLO™	
Clad ID, inches	0.332	
Clad OD, (nominal), inches	0.382	
Clad thickness, (nominal), inches	0.025	
Diametral gap (cold, nominal), inches	0.0065	
Active length, inches	150.0	
Plenum length, inches	9.138	
Fuel rod pitch, inches	0.506	
Fuel rod array arrangement	16 x 16	

NOTE: This table presents typical nominal values to provide familiarity with the Mechanical Nuclear Fuel Design.

Table 4.2-1 (Sheet 2 of 2)

MECHANICAL DESIGN PARAMETERS

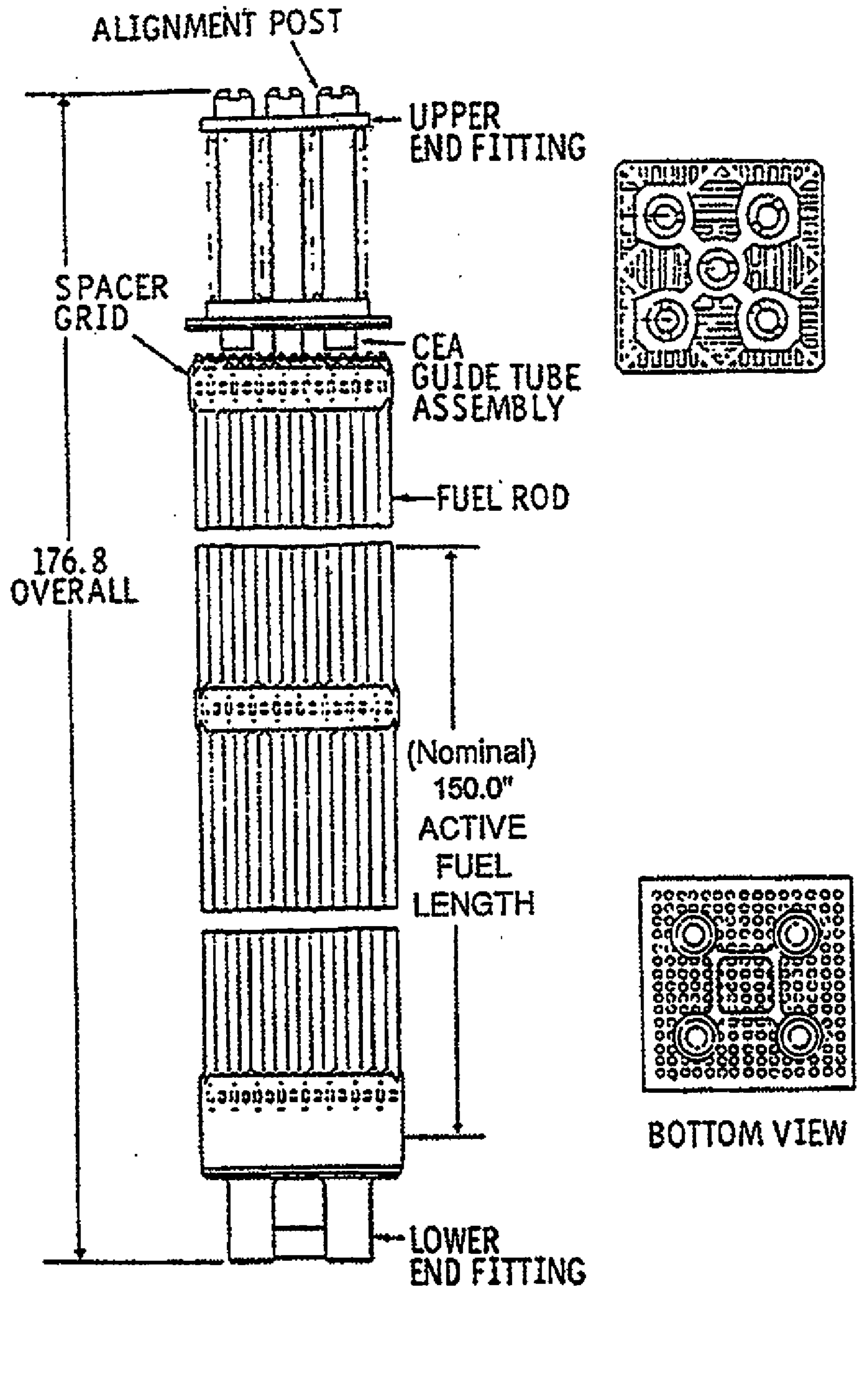
Control Rods (Control Element Assemblies)

Control Element Assembly (CEA)	Full Length	Part Length
Number/Absorber Elements per ass'y	79/5 element CEAs	8/5 element CEAs
	4/4 element CEAs	
Type	Cylindrical rods	Cylindrical rods
Clad material	Inconel 625	Inconel 625
Clad thickness, inches	0.035	0.035
Clad OD, inches	0.816	0.816
Diametral gap, inches	0.009	0.009
Poison		
Material Length, in.	B_4C/Ag In Cd/Inconel	Inconel/H_2O/Spacer/B_4C
5 element CEAs	136/12.5/0.6	76.4/55/2/16
4 element CEAs	126.5/12.5/10.13	
B_4C Pellet		
Diameter, inches	0.737	0.737
Density, % of theoretical density of 2.52 g/cm^3, nominal	73	73
Weight % boron, minimum	75	75
Finger Array Dimensions		
5 element CEAs, inches	4.050 x 4.050	4.050 x 4.050
4 element CEAs, inches	4.050 x 4.130	

NOTE: This table presents typical nominal values to provide familiarity with the Mechanical Nuclear Fuel Design.

Figure 4.2-1

FUEL ASSEMBLY TYPICAL



5. REACTOR COOLANT SYSTEM AND CONNECTED SYSTEMS

5.1 SUMMARY DESCRIPTION

With the cessation of power operation, all of the Units 2 and 3 Reactor Coolant Systems (RCS), including connected systems, have been permanently removed from service. They no longer have Design Basis, Licensing Basis, or operational functions.

With the completion of FTO, all spent fuel has been transferred from the spent fuel pool to an onsite interim dry storage facility, licensed under a general 10 CFR Part 72 license (with an existing 10 CFR Part 50 site license).

During the Decontamination and Dismantlement (D&D) phase, RCS SSCs, including connected systems, will be removed, segmented, intermittently stored and transported to an offsite disposal facility. Waste generated by the removal or segmentation of the RCS or the connected systems will be classified in accordance 10 CFR 61.55.

Effluent and radiation monitoring for activity generated during large component removal and the radiation protection controls are discussed in Chapter 11 and Chapter 12 of the DSAR.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Reactor Vessel	Removed from Service
Reactor Coolant Pumps	Removed from Service
Steam Generators	Removed from Service
Reactor Coolant Piping	Removed from Service
Main Steam Line Flow Restrictors	Removed from Service
Main Steam Line Isolation System	Removed from Service
Residual Heat Removal System (Shutdown Cooling System)	Removed from Service
Main Steam Line and Feedwater Piping	Removed from Service
Pressurizer	Removed from Service
Quench Tank (Pressurizer Relief Tank)	Removed from Service
Valves	Removed from Service
Safety and Relief Valves	Removed from Service
Associated Component Supports	Removed from Service

6. ENGINEERED SAFETY FEATURES

6.1 INTRODUCTION

With the cessation of power operation, all of the Units 2 and 3 Engineered Safety Features (ESF) have been permanently removed from service and no longer have a Design Basis, Licensing Basis, or operational function.

With the completion of Fuel Transfer Operations (FTO), all of the spent fuel has been transferred from the spent fuel pool to an onsite interim dry storage facility, licensed under a general 10 CFR Part 72 (with an existing 10 CFR Part 50 site license).

During the Decontamination and Dismantlement (D&D) phase, ESF SSCs will be removed, segmented, intermittently stored and transported to an offsite disposal facility. Waste generated by the removal ESF SSCs will be classified in accordance with 10 CFR 61.55.

Habitability is no longer an ESF function; lighting and ventilation for buildings (including the containment) that support not important to safety D&D activities are discussed in Chapter 9 of the DSAR.

Effluent and radiation monitoring for activity generated during large component removal or open-air demolition and the radiation protection controls are discussed in Chapter 11 and Chapter 12 of the DSAR.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Containment Building	Removed from Service
Habitability	Removed from Service
Containment Spray	Removed from Service
Emergency Operation Containment Ventilation	Removed from Service
Containment Isolation	Removed from Service
Safety Injection	Removed from Service
ESF Filter	Removed from Service
Auxiliary Feedwater	Removed from Service
Containment Dome Circulation	Removed from Service
Hydrogen Monitoring System	Removed from Service
Hydrogen Gas System	Removed from Service
Toxic Gas Isolation	Removed from Service

6.2 CONTAINMENT BUILDING SYSTEMS

In the permanently defueled condition, the Containment Building no longer provides an Engineered Safety Feature function. The containment building's remaining function to retain the residual radioactive material is a passive function.

7. INSTRUMENTATION AND CONTROLS

7.1 INTRODUCTION

With the cessation of power operation, the only remaining Units 2 and 3 Instrumentation and Controls Systems still required are effluent and area radiation monitors. These systems are described in Chapter 12.

With the completion of FTO, all spent fuel has been transferred from the spent fuel pool to an onsite interim dry storage facility, licensed under a general 10 CFR 72 license (with an existing 10 CFR Part 50 site license).

The Command Center/Control Room (CC/CR) is no longer required in the post-FTO condition and General Design Criteria 19 no longer applies. However, to facilitate Decommissioning & Dismantlement activities, the CC/CR can be utilized to centrally monitor certain site conditions such as dilution parameters, fire alarms, effluent and area radiation monitor status, and meteorological data. Habitability for the CC/CR is discussed in Chapter 9.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Plant Protection System (PPS)	Removed from Service
Engineered Safety Feature (ESF) System	Removed from Service
Auxiliary Supporting Systems	Removed from Service
Systems Required for Safe Shutdown	Removed from Service
Safety-Related Display Instrumentation	Removed from Service
All Other Systems Required for Safety	Removed from Service
Control Systems Not Required for Safety	Removed from Service

8 ELECTRIC POWER

8.1 INTRODUCTION (ELECTRIC POWER SYSTEMS)

The San Onofre Nuclear Generating Station (SONGS) is permanently shutdown. With the completion of Fuel Transfer Operations (FTO), all of the spent fuel has been transferred from the spent fuel pool to an onsite Independent Spent Fuel Storage Installation (ISFSI) facility, licensed under a general 10 CFR Part 72 license (with an existing 10 CFR Part 50 site license). There are no support systems that require electric power for the storage and cooling of spent fuel at the ISFSI; power is supplied to support Security and radiation monitoring as well as facility needs.

With the relocation of the spent fuel to the ISFSI, the license bases for the majority of the plant SSCs has changed and only minimal SSCs are needed to support the ongoing active decommissioning and have been designated important to decommissioning, refer to Section 3.2.3. These SSCs and functions will continue to transition as active decommissioning progresses. All power supplied to onsite SSCs is classified as not important to safety.

The electric power for the site is provided from the offsite transmission system via connections directly with the transmission system in the San Onofre Substation as well as from the San Diego Gas & Electric (SDG&E) Mesa 12kV distribution system. An added “Ring Bus” system powered from the transmission system connections is the primary source that powers the ISFSI and Decontamination and Dismantlement (D&D) load centers. The SDG&E Mesa 12kV distribution system provides power for miscellaneous facilities located on SONGS property on the north and south end of the site.

Although systems and subsystems removed or partially removed from service no longer support operation, equipment may not have been physically removed from the plant.

LEGACY STRUCTURES/SYSTEMS/COMPONENTS	**STATUS**
6.9kV	Removed from Service
4.16kV	Removed from Service
480 VAC	Removed from Service (See note 1)
120 VAC	Removed from Service (See note 1)
Emergency Diesel Generators	Removed from Service
DC Power	Removed from Service (See note 1)
Main Generators	Removed from Service
Iso-phase Buses	Removed from Service
Substation (renamed from Switchyard)	Available
Main, Auxiliary, and Reserve Auxiliary Transformers	Removed from Service

ADDED STRUCTURES/SYSTEMS/COMPONENTS	STATUS
12kV Ring Bus	Available
480 VAC Load Centers	Available (See note 1)
120 VAC	Available (See note 1)

[1] Some components of the legacy system have been repurposed and repowered from the added ring bus.

8.2 UTILITY GRID AND ITS INTERCONNECTIONS (OFFSITE ELECTRIC SYSTEM)

SONGS is connected to the utility grid system for Southern California Edison (SCE) and SDG&E at the San Onofre Substation. The San Onofre Substation operates at 220kV and is the interconnection between the SDG&E and SCE electric systems. The offsite electric system is controlled by the California Independent System Operator Corporation and operated by SCE and SDG&E in their respective territories.

There are four transmission circuits that provide power to the SCE portion of the substation. In addition, there are five transmission circuits that provide power to the SDG&E portion of the substation. Site connections with the offsite power system are described in Section 8.3.

8.3 OFFSITE POWER SYSTEM

Offsite power is provided by the 220kV San Onofre Substation and connections with the SDG&E Mesa 12kV distribution system.

The San Onofre Substation is separated into two sections: The north section is the SCE section, and the south section is the SDG&E section. The two sections are connected by two bus-tie circuit breakers. Normal power to the SONGS Ring Bus is from two 220kV/12kV transformers located in the SCE section of the substation. These transformers can each separately supply the 12kV Ring Bus. Supply of the Ring Bus from the SDG&E Mesa 12kV distribution system can be made with SDG&E physical assistance. Miscellaneous facilities located on the south part of the SONGS property, (e.g., K-buildings and South Yard Facility) are powered by connections with the SDG&E Mesa 12kV distribution system.

The Ring Bus distribution system provides power to support D&D and the ISFSI.

8.4 ONSITE POWER SYSTEMS

The onsite power system consists of a 12kV Ring Bus system which supplies the site D&D systems and provides load drop centers for other loads. The distribution system consists of 480V load centers and Motor Control Centers (MCC) as well as 480V and lower voltage distribution panels.

8.4.1 AC POWER SYSTEMS

The 12kV Ring Bus is the source of AC power to SONGS in the D&D configuration. In the D&D plant configuration, electrical power is provided to the auxiliary systems and the radioactive waste management systems described in Chapters 9 and 11 of the DSAR.

The Ring Bus system includes the following:

- A substation tie-in with 220kV/12kV power through two 10/14 MVA transformers installed in positions three and six in the SCE portion of the San Onofre Substation.
- Underground power cable routing from the substation transformers to 12kV switchgear.
- A 12kV Ring Bus around the Unit 1 North Industrial Area and the Units 2 and 3 power block area. This system includes exposed above-ground cables.
- D&D 12kV power drops.

8.5 SAFETY ANALYSIS

The electrical power is not important to safety (NITS). There are no postulated accidents or transients resulting from loss of power discussed in Chapter 15 of the DSAR.

9 AUXILIARY SYSTEMS

With the cessation of power operation, some of the Auxiliary Systems that were no longer required to support post-defueled plant condition were removed from service.

With the completion of FTO, all of the spent fuel has been transferred from the spent fuel pool to an onsite interim dry storage facility licensed under 10 CFR Part 72. The interim dry storage facility is described in Section 9.6. The storage system is described in the respective dry storage system FSARs (e.g. NUHOMS and UMAX). The Auxiliary Systems in the post-FTO condition are limited to SSCs required to support Decontamination & Dismantlement (D&D) activities and spent fuel dry storage facility. In the D&D post-FTO condition, there are no safety related functions that Auxiliary System SSCs support. Spent fuel wet storage is no longer required and information previously contained is considered obsolete and has been deleted. The spent fuel pool may serve to provide shielding of any remaining materials until which time surveys, removal, and cleaning can be completed; Chapter 12 addresses shielding.

During the D&D phase, the Auxiliary Systems are comprised of dilution systems, sumps and drains, lighting, ventilation, fire protection, domestic water, and communications.

Historical information not subject to periodic updates has been placed in Controlled Document 90216, “SONGS Units 2 and 3 UFSAR Historical Information” until such time that the information is no longer needed.

9.1 FUEL STORAGE AND HANDLING

STRUCTURES/SYSTEMS/COMPONENTS	**STATUS**
New Fuel Storage	Removed from Service
Spent Fuel Storage	Removed from Service
Independent Spent Fuel Pool Cooling System (ISFPCS)	Removed from Service
Fuel Pool Make Up System (FPMUS)	Removed from Service
Fuel Handling System	Removed from Service
Independent Spent Fuel Storage Installation (ISFSI)	Available

9.1.6 INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI)

The ISFSI is a fenced, protected area located within the Unit 1 north Industrial Area, dedicated to the storage of dry spent fuel from Units 1, 2, and 3.

The ISFSI configuration consists of multiple rows of NUHOMS Advanced Horizontal Storage Modules (AHSM) and an additional pad containing Holtec UMAX MSE storage systems. See the respective Dry Fuel Storage FSARs for more detailed information.

The ISFSI is protected by a security fence and features described in the SONGS Physical Security Plan. Lightning protection is provided for the modules and the security light towers. Except for periods of facility expansion (adding additional modules), routine inspections, and during actual fuel loading operations, the ISFSI will be empty of vehicles, extraneous equipment, and personnel. Transient combustibles are controlled by administrative procedure.

9.2 WATER SYSTEMS

Not all subsystems of Water Systems are required to support permanent plant shutdown or defueled operations. The status of these subsystems is listed in the table below.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Saltwater Cooling System	Removed from Service
Component Cooling Water System	Removed from Service
Makeup Demineralizer System	Removed from Service
Domestic Water System	Partially Removed from Service
Ultimate Heat Sink (Pacific Ocean)	Removed from Service
Ultimate Heat Sink (Atmosphere)	Removed from Service
Condensate Storage and Transfer System	Removed from Service
Nuclear Service Water System	Removed from Service
Turbine Plant Cooling Water System	Removed from Service
Dilution System	Available

9.2.1 DOMESTIC WATER SYSTEM

The domestic water system is not important to safety (NITS). City water provides the water supply to the domestic water system. In the post-FTO condition, domestic water is not required for plant equipment. The domestic water system is designed to provide potable water supply to permanent continuously occupied buildings and temporary facilities. Until domestic water supply is isolated from the plant legacy domestic water system, the domestic water supply also provides water to various legacy hose stations for convenience.

9.2.3 DILUTION SYSTEMS

Dilution water and the ultimate path for effluents are provided by the Pacific Ocean. Radiological and non-radiological effluents are diluted before they are released to the unrestricted area (e.g., Pacific Ocean). Dilution flow is accomplished by the Saltwater Dilution System. The dilution path is provided by portions of the Circulating Water structures.

9.2.3.1 Circulating Water System

In the permanent defueled post-FTO plant condition, portions of the Circulating Water SSCs are required to support dilution and effluent releases throughout D&D. The portions of the circulating water structures required for dilution have no safety function. The following describes the applicable portions of the circulating water SSCs used in the post-FTO condition:

A. Units 2 and 3 gates, slots #1 and #2, used to support the Saltwater Dilution System (SWDS) pump frames and pipe supports. Gate slots #1 and #2 are also needed for dewatering the intake/outfall structures with the insertion of stop gates.

B. Units 2 and 3 intake conduits used for drawing Pacific Ocean water for dilution.

C. Unit 2 discharge conduit used for discharging diluted effluents to the Pacific Ocean. Although the discharge conduits have diffusers that are designed to disperse, no credit is taken for the diffusers for dilution.

D. Unit 2 recirculating gates, in the closed position, to prevent recirculation of diluted effluents. No gate operators are required.

E. The Units 2 and 3 Primary Offshore Intake and Auxiliary Offshore Intake structures have a Large Organism Exclusion Devise required by the State Water Resource Control Board to prevent large marine organisms from entering the plant intake structure.

9.2.3.2 Saltwater Dilution System

The Saltwater Dilution System (SWDS) provides saltwater from the Pacific Ocean to the Unit 2 circulating water system outfall for diluting radiological and non-radiological effluents. The SWDS is common to both units. Two 100% capacity pumps are located in the Unit 2 circulating water system intake and two 100% capacity pumps are located in the Unit 3 circulating water system intake. However, all four pumps discharge to the Unit 2 circulating water system outfall gate slot #1. The pump discharge heads are located approximately 4-feet below 30-ft elevation in the gate slot #2 on the west road. The gate slots are also used for inserting stop gates to dewater the circulating water system intake structures.

The design bases for the saltwater dilution system is as follows:

A. The SWDS is designed so that the dilution water flows may return to the Pacific Ocean.

B. The SWDS is designed to provide the minimum flow rate to meet the dilution factors. Dilution is discussed in Chapters 2 and 11 of the DSAR but controlled by the Offsite Dose Calculation Manual (ODCM) and SONGS National Pollutant Discharge Elimination System (NPDES) permit.

C. The SWDS is also designed to provide dilution water supply for radiological effluent releases. Radiological effluent collection, processing and release point is discussed in Chapter 11 of the DSAR.

D. The SWDS is designed to provide dilution water supply for non-radiological effluent releases. Non-radiological effluent releases consists of discharges from the east/west oily waste holding sumps, Sewage Treatment Plant (STP), and the North Industrial Area (NIA) sump.

9.3 PROCESS AUXILIARIES

Not all subsystems of Process Auxiliaries are required to support permanent plant shutdown or defueled operations. The status of these subsystems is listed in the table below.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Compressed Air System	Removed from Service
Process Sampling System	Removed from Service
Sump and Drain Systems	Partially Removed from Service
Chemical and Volume Control System	Removed from Service
Hydrogen System	Removed from Service
Post-Accident Sampling System	Removed from Service
Reactor Coolant Gas Vent System	Removed from Service

9.3.1 SUMP AND DRAIN SYSTEMS

A description of the design and use of the sump and drain systems is as follows:

A. The radioactive sump and drain systems collect potentially radioactive liquid wastes, at atmospheric pressure, from equipment and floor drains inside the radiological controlled area. Radioactive sumps are designed to discharge to the liquid radwaste collection and processing system.

B. The potentially radioactive sump and drain systems collect potentially radioactive liquid wastes, at atmospheric pressure, from equipment and floor drains outside the radiological controlled area that have the potential for being radiologically contaminated. Potentially radioactive sumps are designed to discharge to the Pacific Ocean through a monitored release path.

C. The nonradioactive sumps and drain systems collect nonradioactive liquid waste, at atmospheric pressure, from equipment and floor drains outside the radiological controlled area that have no potential to be radiologically contaminated. Nonradioactive sumps are designed to discharge to the Pacific Ocean.

D. The Sewage Treatment Plant (STP) is designed to collect sewage from site facilities and release treated sewage to the Pacific Ocean.

Nonradioactive liquid releases into the Pacific Ocean meet the requirements of the NPDES permit. Radioactive liquid releases meet the requirements of the NPDES permit and ODCM. Radioactive liquid processing and releases are discussed in Chapter 11 of the DSAR.

9.3.1.1 Radioactive Sumps and Drains

Collected water from the radioactive sumps are routed to the common radwaste sump. The radwaste sump discharges to the liquid radwaste collection and processing systems discussed in Chapter 11 of the DSAR.

9.3.1.2 Potentially Radioactive Sumps

Collected water from potentially radioactive sumps are routed to the Unit 2 east turbine plant area sump. The Unit 2 east turbine plant area sump is normally non-radioactive and discharges to the east/west oily waste holding sumps through a monitored release path. If activity is detected by the effluent radiation monitor (2RE7821), the discharge is automatically isolated and the Unit 2 east turbine building sump discharge is manually aligned to the common radwaste sump.

The Southyard Facility sump contents are normally non-radioactive. The sumps collect rainwater from equipment and area floor drains, and surface drainage from rainwater. The sumps are manually sampled and operated. If the sample is nonradioactive, the sumps are batch released into storm drains that lead to the unrestricted area (i.e., the Pacific Ocean).

The monitored release paths for the Unit 2 turbine plant sump is discussed in Chapter 11 of the DSAR. The processes for releasing contaminated water from the Southyard Facility sumps through a monitored release path are discussed in Chapter 11 of the DSAR.

The NIA sump collects rainwater, surface drainage, and sewage overflow. The NIA sump was historically radioactive due to Unit 1 legacy detectible tritium. The NIA sump discharge is a monitored release path.

9.3.1.3 Nonradioactive Sumps and Drains

Nonradioactive sumps discharge directly to the east/west oily waste holding sumps. The east/west oily waste holding sumps have an oil separator. The oil-free side of the east/west oily waste holding sump passively discharges into storm drains. The oil side is manually pumped and transported to an offsite disposal facility.

The sewage treatment plant (STP) is located in the NIA footprint. The STP collects sewage from site facilities. The STP discharges directly to the Unit 2 outfall and is diluted by the Saltwater Dilution System before it is released to the Pacific Ocean. Overflow of the STP is directed to the NIA sump.

9.4 HEATING, VENTILATING, COOLING, AND AIR CONDITIONING SYSTEMS

Not all subsystems of the Heating, Ventilating, Cooling, and Air Conditioning Systems are required to support permanent plant shutdown or defueled operations. The status of these subsystems is listed in the table below.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Containment Building Ventilation Systems	Partially Removed from Service
Auxiliary Building Heating, Ventilating, and Air Conditioning Systems	Partially Removed from Service
Support Building Ventilation Systems	Partially Removed from Service

9.4.1 CONTAINMENT BUILDING VENTILATION SYSTEMS

The containment building ventilation systems was removed from service shortly after cessation of power operation. Consequently, to support D&D, portions of the containment ventilation system were placed back in service along with the containment vent stack radiation monitors 2(3)RE7828 for particulate effluent monitoring. The radiation monitors are discussed in Chapter 11 of the DSAR.

In the post-FTO condition, the Containment Building Ventilation System is designed to:

A. Maintain the ambient air temperature at a level which permits continuous personnel comfort.

B. Maintains the containment buildings at normal temperatures for continuous D&D equipment operation.

C. Minimize the possibility of exfiltration to the outside area by maintaining a negative pressure inside containment and discharging to the containment vent stack were it is monitored for radiation by effluent radiation monitors 2(3)RE7828. Effluent radiation monitors are discussed in Chapter 11 of the DSAR.

9.4.2 AUXILIARY BUILDING VENTILATING SYSTEMS

In the Post-FTO condition, the auxiliary building ventilation system is designed to:

A. Maintain the ambient air temperature at a level which permits continuous personnel comfort for occupied buildings and rooms, including the limited scope Command Center/Control Room.

B. Maintains appropriate buildings and rooms with D&D equipment at normal temperatures for continuous equipment operation.

C. Minimize the possibility of exfiltration to the outside area by maintaining a negative pressure inside the buildings and discharging to the plant vent stack were it is monitored for particulate by effluent radiation monitor 2/3RE7808. The plant vent stack radiation monitors are discussed in Chapter 11 of the DSAR.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Normal Auxiliary Building HVAC Systems	Partially Removed from Service
Emergency Auxiliary Building HVAC Systems	Removed from Service
Normal Chilled Water System	Removed from Service
Emergency Chilled Water System	Removed from Service
Chilled Water System (New)	Partially Removed from Service

9.4.3 SUPPORT BUILDING VENTILATION SYSTEMS

This subsection provides system descriptions for ventilation systems for the fuel handling building, safety equipment building, turbine building, diesel generator building, penetration building, electric and piping tunnels, intake structure, auxiliary feedwater pump room, the safety equipment building elevator machine room and South Yard Facility. Following is the status of each of the ventilation systems in these areas.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Fuel Handling Building Ventilation System	Removed from Service
Safety Equipment Building HVAC System	Removed from Service
Turbine Building HVAC System	Removed from Service
Diesel Generator Building Ventilation System	Removed from Service
Penetration Building and Electric Piping Tunnels Ventilation System	Removed from Service
Intake Structure Ventilation System	Removed from Service
Auxiliary Feedwater Pump Room Ventilation System	Removed from Service
Safety Equipment Building Elevator Machine Room	Removed from Service
Full Flow Condensate Polishing Demineralizer Building Control Room and Laboratory Room	Removed from Service
South Yard Facility Ventilation Systems	Available

9.4.3.5 South Yard Facility Ventilation Systems

In the post-FTO condition, the south yard facility ventilation system is designed to:

A. Maintain the ambient air temperature at a level which permits continuous personnel comfort and D&D equipment operation.

Minimize the possibility of exfiltration from the hot machine shop, decontamination shop, and REMS work area and discharge to the ventilation stack where it is continuously sampled for particulate by effluent radiation sampler SYFU-7904 discussed in Chapter 11 of the DSAR.

9.5 <u>OTHER AUXILIARY SYSTEMS</u>

Not all subsystems of Other Auxiliary Systems are required to support permanent plant shutdown or defueled operations. The status of these subsystems is listed in the table below.

STRUCTURES/SYSTEMS/COMPONENTS	**STATUS**
Fire Protection System	Partially Removed from Service
Communications Systems	Partially Available
Lighting Systems	Available
Diesel Generator Fuel Oil Storage and Transfer System	Removed from Service
Diesel Generator Cooling Water System	Removed from Service
Diesel Generator Starting System	Removed from Service
Diesel Generator Lubrication System	Removed from Service
Diesel Generator Combustion Air Intake and Exhaust System	Removed from Service

9.5.1 FIRE PROTECTION SYSTEM

A description of the SONGS Units 2 and 3 fire protection system and current credited functions are contained in the Defueled Fire Hazards Analysis (DFHA) which is included in the DSAR by reference. City water provides the water supply to the fire protection system.

9.5.2 COMMUNICATION SYSTEMS

The communication systems is not important to safety (NITS) and is designed to provide convenient communications among various plant locations and between the plant and locations external to the plant. The communication system consists of mostly wireless and portable equipment to facilitate D&D activities.

9.5.3 LIGHTING SYSTEMS

The plant lighting systems and their components are not important to safety (NITS), although some are qualified to Seismic Category I standards, as described in Section 9.5.3.3. All lighting levels are designed to be equal to, or in excess of, the levels stipulated in IES Lighting Handbook (1972). Discussion and evaluation of the electric power systems are contained in Chapter 8.

The design of the lighting systems is for area lighting intensities to provide the illumination required for comfort and worker efficiency in the performance of the visual activities required in that area. The lighting systems conform to applicable local codes, standards, and ordinances. Generally, design of the plant lighting systems follows the guidance provided by the Handbook of the Illuminating Engineering Society.

Permanent lighting is provided throughout the plant for areas with continuous occupancy or areas required to be traversed on a frequent basis (such as hallways and corridors). When adequate illumination is not obtainable by permanent lighting sources, temporary lighting is used. In any dark area that does not have permanent or temporary lights, where lights are not working, or where lights are not readily accessible, portable light requirements are posted.

9.6 SAFETY ANALYSIS

With the exception of the dry storage systems in the ISFSI, the auxiliary systems are not important to safety (NITS). Therefore, no safety analysis is provided. Safety analysis for the dry storage systems is provided in the respective NUHOMS or UMAX FSARs.

10 STEAM AND POWER CONVERSION SYSTEM

With the cessation of power operation, all of the Units 2 and 3 Steam and Power Conversion Systems have been permanently removed from service and no longer perform a licensing bases or design bases function.

With the completion of FTO, all of the spent fuel has been transferred from the spent fuel pool to an onsite interim dry storage facility, licensed under a general 10 CFR Part 72 license (with an existing 10 CFR Part 50 site license).

During the Decontamination and Dismantlement (D&D) phase, steam and power conversion systems will be removed, segmented, surveyed, decontaminated (as required) and transported offsite for disposal / recycling; with the exception of certain structure portions of the Circulating Water System that support the D&D activity of dilution for effluent releases and is discussed in Chapter 9 of the DSAR. Processing of liquid radwaste is discussed in Chapter 11 of the DSAR.

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Turbine Generator	Removed from Service
Main Steam Supply System	Removed from Service
Main Condenser	Removed from Service
Main Condenser Evacuation System	Removed from Service
Turbine Gland Sealing	Removed from Service
Turbine Bypass	Removed from Service
Circulating Water System	Partially Removed from Service (See Chapter 9)
Condensate Cleanup System	Removed from Service
Full Flow Condensate Polishing Demineralizer (FFCD)	Removed from Service
Condensate and Feedwater System	Removed from Service
Steam Generator Blowdown Processing System	Removed from Service
Auxiliary Feedwater System	Removed from Service
Turbine Plant Chemical Addition System	Removed from Service

11. RADIOACTIVE WASTE MANAGEMENT

With the cessation of power operation, some of the Radioactive Waste Management systems that were no longer required to support the post-defueled plant condition were removed from service. With the completion of FTO, all of the spent fuel has been transferred from the spent fuel pool to an onsite interim dry storage facility licensed under 10 CFR Part 72. The Radioactive Waste Management in the post-FTO condition is limited to SSCs required to support Decontamination & Dismantlement (D&D) activities. The status of these systems are listed in the table below.

Not all subsystems of the Radioactive Waste Management Systems are required to support D&D activities. During the D&D phase, the Radioactive Waste Management systems include the effluent radiological monitoring system and liquid and gaseous radwaste collection and processing systems. The capacity and limitations of these systems are taken into consideration in the Offsite Dose Calculation Manual (ODCM) for calculating release rates.

Plant Radioactive Waste Management Systems are described in this chapter in three separate areas where waste handling will occur: Plant Area, South Yard Area, and the North Industrial Area (NIA). With the completion of FTO, it is more appropriate to provide descriptions of the radioactive waste management systems within the areas by the general processes that are performed (e.g., liquid radwaste, gaseous radwaste, and solid radwaste).

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Plant Area Radwaste Management Systems	
Liquid Radwaste	Partially Removed from Service
Gaseous Radwaste	Partially Removed from Service
Solid Radwaste	Removed from Service
South Yard Area Radwaste Management Systems	
Liquid Radwaste	Partially Removed from Service
Gaseous Radwaste	Removed from Service
Solid Radwaste	Available
North Industrial Area Radwaste Management Systems	
Liquid Radwaste	Available
Gaseous Radwaste	Removed from Service
Solid Radwaste	Removed from Service

See General Arrangement Drawings for the current plant configuration. The seismic and quality classifications for the radioactive waste management SSCs are provided in the Controlled Document 90034, "Q-List."

11.1 LIQUID RADWASTE

To support D&D activities, the liquid radwaste collection system consists of tanks, pumps, and associated valves and piping. The collection system is used to collect water from various radioactive or potentially radioactive sources generated during D&D, such as:

A. Water used for reactor cavity flood-up during reactor vessel segmentation

B. Water from abandoned obsolete large structures such as the spent fuel pool

C. Surface drainage and rainwater intrusion into buildings

D. Residual liquid from low-points of abandoned miscellaneous obsolete components such as low-point piping, bottom of tanks, etc.

The collected liquid radwaste is processed, diluted, and released to the unrestricted area (i.e., the Pacific Ocean) via a release path monitored by effluent radiation monitor 2/3RE7813. The saltwater dilution system used to support liquid radwaste discharges is discussed in Chapter 9 of the DSAR.

The liquid radwaste processing system consists of the following major components: portable liquid radwaste processing skid, discharge paths used to release to the unrestricted area, effluent radiation monitors, and the associated instrumentation and controls.

Releases of processed liquid radwaste are protected from exceeding ODCM concentration limits in excess of 10 CFR 20 and 10 CFR 100 dose concentration release limits by the following engineered and administrative controls:

A. The radwaste discharge line air-operated valve is automatically isolated on high radiation, loss of power/instrument air, or loss of one out of two saltwater dilution system pumps.

B. The radwaste discharge line air-operated valve is interlocked closed until two saltwater dilution system pumps are operating based on MCC status; only one saltwater dilution system pump flow is required for 10 CFR 20 dose concentration release limits.

C. Releases are procedurally suspended when one saltwater dilution system pump receives a trouble alarm (pressure/flow).

D. Redundancy and diversity by design; two 100% capacity saltwater dilution system pumps are operated on separate intakes, each pump discharges to the Unit 2 outfall by independent piping systems. Operating 100% capacity saltwater dilution pumps on different intakes protects against a common mode failure associated with an intake.

The collected water from the Unit 2 East Turbine Building Area Sump is normally non-radioactive and continuously monitored and released to the unrestricted area (i.e., the Pacific Ocean) via a release path monitored by 2RE7821.

Because remediation of Unit 1 is not complete, water from the soil or drainage pipes could potentially be radioactive. The collected water from the North Industrial Area Sump is normally non-radioactive and continuously monitored and released to the unrestricted area via a release path monitored by RE2101.

The Southyard Facility does not have a continuously monitored liquid release path. The Southyard Facility sumps are sampled prior to release into storm drains and if contaminated, then the contents are manually pumped into storage containers and transported to be processed and/or released through a monitored release path.

The sump and drain systems used to collect radioactive and potentially radioactive liquids are discussed in Chapter 9 of the DSAR.

The plant area liquid waste systems consisted of four subsystems:

STRUCTURES/SYSTEMS/COMPONENTS	**STATUS**
Plant Area	
Coolant Radwaste System (CRS)	Removed from Service
Coolant and Boric Acid Recycle System (CBARS)	Removed from Service
Miscellaneous Liquid Waste System (MLWS)	Partially Removed from Service
Mixed Waste Processing (MWP) Unit	Removed from Service
South Yard Area	Partially Removed from Service
North Industrial Area	Available

11.1.1 LIQUID WASTE SYSTEMS – PLANT AREA

Some of the components from the CRS, CBARS, and MLWS have been repurposed since plant shutdown. The equipment that remains powered and in-service includes sumps and tanks to facilitate storage and periodic processing:

- Radwaste sump and pumps
- Outlying radioactive sumps and pumps
- Chemical Waste Tank (T064) and one pump (P180)
- Condensate Monitor Tanks (T075, T076) and one pump (P188)
- Radwaste Secondary Tanks (T057 and T058)
- Radwaste Primary Tanks (T065, T066, T067, T068)
- Interconnecting piping for above
- Radwaste Discharge Line to Unit 2 Outfall via associated Radiation Monitor (2/3RE7813) and Salt Water Dilution System
- A processing skid that meets the ODCM requirements

11.1.1.1 Design Basis of MLWS

The principal design objectives of the MLWS liquid waste system are:

A. Collection of all liquid wastes generated during plant shutdown which may contain radioactive nuclides.

B. Sufficient processing capability so that liquid waste may be discharged to the environment at concentrations below the regulatory limits of 10 CFR 20 and consistent with the As Low As Reasonably Achievable (ALARA) guidelines set forth in 10 CFR 50.

Special equipment design provisions have also been incorporated for consideration of ALARA, reduce maintenance, equipment downtime, liquid leakage, or gaseous releases of radioactive materials to the building atmosphere. Where practicable, welded connections are used in lieu of flanged ones. Butt welds are used where justified in the liquid waste systems to reduce crud trap formation. Pumps are provided with mechanical seals to minimize leakage. The frequency of equipment maintenance is minimized by utilizing corrosion-resistant materials wherever feasible. Diaphragms in some radwaste tanks are provided to prevent release of tritium and dissolved noble gases to the building atmosphere, and prevent air from dissolving into the liquid.

Tanks receive liquid until processing begins or until tank liquid volume reaches a predetermined level. The tank is then isolated from the feed while its contents are stored until processed. Appropriate alarms are utilized to alert operators of tank high or low level. Overflow lines are connected to the radwaste sump via a loop seal. Overflow of tanks would accumulate in lower levels and the drain is piped to the radwaste building area sump. Sump is then pumped to chemical waste tank (T064).

The function of the MLWS liquid waste systems is to collect and process radioactive liquid wastes generated during plant shutdown and to reduce their radioactivity and chemical concentrations to levels acceptable for discharge.

11.1.1.2 System Description of MLWS

The MLWS, in permanently shutdown configuration, consists of sumps, nine tanks (T057, T058, T064, T065, T066, T067, T068, T075, and T076) and associated pumps.

The processing skid consists of ion exchangers and supporting sample and process equipment to allow processing of waste water to prepare for discharge. The processing system is capable of reducing activity to meet the isotopic limits in 10 CFR 20 App B, and discharge per the Offsite Dose Calculation Manual.

Features and procedures used to prevent inadvertent releases to the environment from the liquid waste systems include automatic discharge pump shutoff, administrative procedures, and discharge radiation monitors which provide alarms.

Miscellaneous liquid wastes are piped into the chemical waste tank (T064). In addition, liquid waste from the radwaste sump is normally pumped into chemical waste tank (T064). The miscellaneous liquid waste system normally collects, stores, and processes liquids from the following major sources:

A. Radioactive chemical laboratory drains (chemical waste tank)

B. Floor drains (miscellaneous wastes tank or chemical waste tank)

From the chemical waste tank (T064), the chemical waste passes through a duplex strainer in the suction line of the chemical waste pump (P180). The chemical waste tank can then be pumped to the liquid radwaste processing skid then discharge to either the condensate monitor tanks (T075 and T076) or the Radwaste Secondary Tanks (T057 and T058). If sampling results so dictate, the chemical waste tank and / or condensate monitor tanks can be pumped to the Radwaste Primary Tanks (T065, T066, T067, and T068). Wastes are discharged to the Unit 2 outfall in accordance with Offsite Dose Calculation Manual (ODCM) specification limits.

Fluid in the turbine plant area sumps is normally pumped to an oily waste holding sump and then discharged to the Unit 2 Outfall via the Salt Water Dilution System in accordance with the ODCM and the National Pollutant Discharge Elimination System (NPDES). Piping is also provided to pump liquid from the turbine plant area sumps to the radwaste area sump. From there, the turbine plant area sump water may be processed by the MLWS via the Chemical wastes tank. Storage and processing by the MLWS may be done when the turbine plant area sump water exceeds a predetermined specific activity.

11.1.1.3 Operation of MLWS

Operation of the MLWS consists of a series of automatic and operator-controlled operations. Sump water collection can be accomplished automatically, and storage tank(s) and processing paths, if needed, are selected by the operator.

The MLWS is normally utilized to process floor and equipment drains. The MLWS may also receive wastes collected in the turbine building floor drains. The Chemical Waste Tank, T064, receives waste from the radwaste sump as well as various drains from the chemistry laboratory, decontamination shower, and other minor waste streams. From the chemical waste tank the waste water is pumped to the liquid radwaste processing skid then discharges to either the Condensate Monitor Tanks, (T075 and T076) or the Radwaste Secondary Tanks (T057 and T058). When activity levels are appropriately reduced, provisions are made for recirculation and sampling. The waste is then batch released via a monitored pathway with appropriate dilution in a process controlled by the ODCM to ensure compliance with 10 CFR 20, Appendix B, Table II, Column 2, and 10 CFR 50 App I.

If waste inventory exceeds the capacity of T075 and T076, the Radwaste Primary Tanks, T065, T066, T067, and T068, as well as Radwaste Secondary Tanks T057 and T058 have been repurposed from the retired Liquid Radwaste System. Waste water from the MLWS can be stored in the primary tanks until it is appropriate to process and release the waste water per the process described above.

Prior to batch releasing liquid radwaste the tank to be released, either a Condensate Monitor Tank (T075, T076) or a Radwaste Secondary Tank (T057, T058), is sampled and either discharged to the Unit 2 Outfall via the Salt Water Dilution System or stored for further processing.

The primary function of the Chemical Waste Tank, T064, is to receive water from the radwaste sump. Area sumps where potentially contaminated liquids are routed to T064 as shown in controlled drawings.

After filling any tank (T075, T058, T075, or T076) with the intention to release the tank is isolated. The contents of the isolated tank are analyzed for chemical and radiochemical contamination and, depending upon analytical results and plant water requirements, are either discharged offsite via a monitored path, or retained for further storage or processing.

11.1.2 LIQUID WASTE SYSTEMS – SOUTH YARD AREA

Currently no liquid radwaste is handled in the South Yard Area, except as discussed in the sections below for the MPHF area.

11.1.2.1 Mixed Waste Room of South Yard Facility Radiological Work Area

11.1.2.1.1 Design Basis of Mixed Waste Room of SYF Rad Work Area

The South Yard Facility is designed to process non-Resource Conservation and Recovery Act (RCRA) mixed wastes, in particular used oil, generated by SONGS. Other examples of mixed waste generated at SONGS are paints, solvents, caustics, acids, and freon.

11.1.2.1.2 System Description of Mixed Waste Room of SYF Rad Work Area

Mixed waste is defined as a material that is both hazardous as defined by the EPA criteria in 40 CFR and by the State of California in 22 CCR, and radiologically contaminated with licensed radioactive material per 10 CFR. These wastes are collected at various satellite accumulation areas and brought to the hazardous materials pad for consolidation and storage. As treatment or disposal opportunities become available, these wastes are disposed of in accordance with all applicable regulations.

11.1.2.2 Multipurpose Handling Facility (MPHF)

11.1.2.2.1 Design Basis of MPHF

The MPHF is designed for low-level solid radwaste staging in accordance with federal, state, and local permits for Class III combustible or non-combustible liquid radwaste staged in leak tight containers.

11.1.2.2.2 System Description of MPHF

The MPHF provides storage and staging areas only. Within the MPHF, liquid radwaste containers are placed in either the High Specific Activity Waste area or the Low Specific Waste area. Any liquid radwaste leakage will be collected through floor trenches and underground drain lines within the building, sampled, processed, and disposed-of according to applicable site procedures.

Refer to the DFHA incorporated by referenced for storage of combustibles in the MPHF.

11.1.3 LIQUID WASTE SYSTEMS – NORTH INDUSTRIAL AREA

The NIA is located north of Units 2&3 on the land previously occupied by Unit 1. It is the present location for the Independent Spent Fuel Storage Installation (ISFSI). There is a sump on the property which directs surface drainage from the NIA and surrounding property to the Unit 2 outfall. On occasion, the sump also receives water from sampling wells. Sump effluent is monitored via RE-2101.

11.1.3.1 Design Basis of NIA

Drainage and monitoring well water in the NIA sump could potentially be radioactive. Sump effluent is monitored. Because remediation of Unit 1 is not complete, water from the soil or drainage pipes could potentially be radioactive.

11.1.3.2 System Description of NIA

Effluent from the NIA sump is directed to the Unit 2 outfall. Radiation Monitor RE-2101 samples the NIA sump discharge flow. Upon detection of radiation RE-2101 trips the sump pumps. Overflow of the NIA sump is contained within the NIA site. Compensatory measure provide for batch release after sampling.

11.1.3.3 Operation of NIA

NIA pumps can be set in auto or manual. In auto they start and stop based on level. High radiation will trip the pumps and alarm in the Control Room.

11.2 GASEOUS RADWASTE

Airborne (i.e., gaseous) effluents generated during D&D activities inside the radiological control area buildings (such as component removal other than inside containment), fume hoods, laboratories, vent headers, and exhaust from ventilation systems are collected and routed to the continuous exhaust plenum. The continuous exhaust plenum discharges to the plant vent stacks that disperse effluents into the atmosphere. The plant vent stacks are continuously monitored by the common effluent radiation monitor 2/3RE7808.

Airborne effluents generated during D&D activities inside the containment buildings (such as reactor vessel segmentation) are collected and routed to the unit specific containment vent stacks. The containment vent stacks disperse effluents into the atmosphere. The containment vent stacks are continuously monitored by effluent radiation monitors 2(3)RE7828.

Airborne effluents generated by radioactive material stored in the Southyard facility are collected and routed to the Southyard Facility exhaust ventilation system. The Southyard Facility exhaust ventilation system disperses effluents into the atmosphere. The Southyard Facility exhaust ventilation system is continuously monitored by sampler SYFRU-7904.

The status of these systems is as follows:

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Plant Area	
High-activity reactor coolant gaseous radwaste system	Removed from Service
Low-activity vent gas collection header	Available
Main condenser evacuation system	Removed from Service
Turbine gland seal system	Removed from Service
Building ventilation systems	Partially Removed from Service
South Yard Area	Removed from Service
North Industrial Area	Removed from Service

11.2.1 GASEOUS WASTE SYSTEMS – PLANT AREA

The plant area radioactive waste gases are collected and processed through the following systems depending upon their origin.

11.2.1.1 Design Basis of Plant Area Gaseous Waste Systems

The gaseous waste management systems collected and processed the radioactive noble gases, airborne halogens, and particulates to reduce the anticipated annual releases and personnel exposure in restricted and unrestricted areas to levels as low as is reasonably achievable. The design objective of the remaining gaseous waste management systems is the collection of potentially low-radioactive gaseous wastes.

11.2.1.2 System Description of Plant Area Gaseous Waste Systems

The vent gas collection system collects various low-activity gases from potentially radioactive liquid storage tanks, thereby minimizing radiation doses to plant operating personnel. These gases consist mainly of air collected in the vapor space above storage tanks and ventilation discharges from plant sample hoods.

The sources for the vent gas collection header include the gases from:

A. Miscellaneous waste tank vent
B. Chemical waste tank vent
C. Miscellaneous waste evaporator condensate monitor tanks vents
D. Radwaste area sump
E. Sampling system vent hoods

The vent gas collection system is shared between Units 2 and 3.

A continuous exhaust plenum is used to collect discharges from plant ventilation systems and remaining components (via gas collection header) for monitoring before discharge.

The containment building ventilation systems are independent systems that draw outside air into the containment buildings and discharges to the containment purge vent stacks for monitoring upon release.

11.2.1.3 Operation of Plant Area Gaseous Waste Systems

Remaining plant components and systems are vented to a gas collection header. The header is piped to the continuous exhaust plenum, where effluents are monitored. The HVAC systems servicing these rooms are also directed to the continuous exhaust plenum. The HVAC system operates continuously.

The containment ventilation systems discharge into the containment purge vent stacks. The containment ventilation system is controlled locally and normally operates continuously while performing activities within the containment buildings. The system provides radiation levels, flow data and alarm indication to the Command Center & CDAS. The ventilation system trips if high radiation is detected. Interlocks and logic prevent operation of the fans when a high radiation level is detected. Following a system trip, administrative processes and controls are used to isolate the system and clean-up containment air to resume containment ventilation system operation.

11.2.2 GASEOUS WASTE SYSTEMS – SOUTH YARD AREA

There is no Gaseous Radwaste System in the South Yard Facility (SYF). HVAC systems in the SYF building is capable of being monitored for radioactive effluent releases via RE-7904.

11.2.3 GASEOUS WASTE SYSTEMS – NORTH INDUSTRIAL AREA

There is no Gaseous Radwaste System in the North Industrial Area (NIA). By letter dated November 4, 2014 and documented in the ODCM Appendix B, the NIA does not require airborne effluent monitoring. There is no longer an airborne radioactive effluent source at the NIA and the SSCs used for monitoring the NIA have been removed from service.

11.3 SOLID RADWASTE

The status of the solid radwaste systems are listed in the table below:

STRUCTURES/SYSTEMS/COMPONENTS	STATUS
Plant Area	
Solid Waste Management System (SWMS)	Removed from Service
South Yard Area	
SYF Radiological Work Area	Available
SYF Decontamination Shop	Removed from Service
Multipurpose Handling Facility (MPHF)	Available
North Industrial Area	Removed from Service

11.3.1 SOLID RADWASTE SYSTEM – PLANT AREA

The Plant Area solid waste management system (SWMS) was designed to provide holdup, transfer, solidification and packaging for radioactive wastes generated by plant operation, and to store these wastes until they are shipped offsite. Shipment offsite may be to an intermediate processor or directly to a licensed burial site depending on the method by which the wastes were packaged on site. The processing system is no longer in service and has been removed from the radwaste building. However, within the plant area, packaging, storing and shipping of solid radwaste is still available. Underwater demineralizers and filtration systems may be used in the spent fuel pools.

11.3.2 SOLID RADWASTE SYSTEM – SOUTH YARD AREA

Radioactive waste management systems can be found in the South Yard Facility (Areas T10 and T20) and in the Multipurpose Handling Facility, MPHF (Area T60).

The South Yard Facility is located on the south side of the plant outside the Protected Area. The Radiological Work Area within the South Yard Facility includes the Radioactive Equipment and Materials System (REMS) Rebuild Area, Mixed Waste Room and REMS Work Area. The SYF also had a decontamination shop.

The MPHF consists of an office building, a staging building and an equipment pad. The facility is surrounded by a chain link fence. The MPHF is located at the southern edge of the SONGS owner controlled area.

11.3.3 SOLID RADWASTE SYSTEM – NORTH INDUSTRIAL AREA

There is no Solid Radwaste System in the North Industrial Area (NIA). However, the NIA is used from time to time for temporary staging of large contaminated equipment from Units 2 and 3 as it is decontaminated or prepared for shipment to an off-site facility for treatment and / or disposal. Portions of NIA may be used to support SONGS 2/3 decommissioning activities. Appropriate contamination control, spill prevention, and effluent control measures, based on the activity, would be developed and implemented to prevent unplanned, unmonitored releases of radioactive liquids and/or radioactive airborne material during temporary storage, treatment, and packaging activities of the contaminated equipment in outside areas such as the NIA.

11.3.4 GENERAL HANDLING AND DISPOSAL

Packaging of radioactive materials (filters), dry active waste, and radioactive sources may be by either encapsulation with an approved solidification agent (such as cement) in a liner or placement into a High Integrity Container (HIC). The liner/HIC is then normally transferred to the Multipurpose Handling Facility (MPHF), see Section 11.3.2, for temporary storage and is ultimately shipped to a licensed burial site or alternate processor for disposal of final waste form in an appropriate shielded shipping cask.

11.3.5 GENERAL PACKAGING, STORAGE, AND SHIPMENT

All radioactive wastes will be prepared for shipment in containers which meet the requirements of the U. S. Department of Transportation (DOT) regulations and the U. S. Nuclear Regulatory Commission (NRC) regulations and burial site license requirements, as applicable.

Shipping containers will be stored in appropriate storage areas onsite and appropriately posted to the content material in various areas onsite within the RP Restricted Area. Filters and/or demineralizers may be stored for a limited time in the spent fuel pools prior to removal for packaging.

After the radioactive waste has been packaged it is normally sent to the MPHF for offsite shipment. The MPHF has an in-process staging area for the accumulation of solid radwaste until it is released for shipment.

Containers, solidification liners and HICs could be shipped promptly after filling, provided the proper shielding is available, without exceeding DOT radiation limits. If 49 CFR 173 dose limitations cannot be met with the available shielding, the containers (liners and/or HICs) are stored and allowed to decay until the appropriate shielding is available.

11.4 EFFLUENT RADIOLOGICAL MONITORING SYSTEM

In the post-FTO condition, radiation monitors are used for monitoring effluents. Area radiation monitors used for personnel radiation protection are discussed in Chapter 12 of the DSAR.

The effluent monitoring system is designed to perform the following functions in order to meet the requirements of 10CFR20, 10CFR50, and follow the recommendations of Regulatory Guide 1.21 during normal operations, including anticipated operational occurrences:

A. Provide continuous representative sampling, monitoring, and indication of liquid and gaseous radioactivity levels, and, as a minimum, continuous representative sampling of particulate and iodine radioactivity levels along principal effluent discharge paths.

B. Provide the capability, during the release of radioactive liquid wastes, to alarm and automatically secure liquid waste releases before the limits of the ODCM specifications are exceeded.

C. Provide radiation level indication and alarm annunciation to the Control Room operators whenever ODCM specification limits for release of radioactivity are approached or exceeded.

D. For continuous effluent paths, provide a means for collection and laboratory analysis of required routine samples.

E. For batch releases, provide a means for collection and laboratory analysis of required routine samples prior to release.

The liquid effluent radiation monitors are as follows:

- 2/3RE7813 – Liquid Radwaste Processing Skid Radwate Discharge Line
- 2RE7821 – Unit 2 East Turbine Plant Area Sump Discharge
- RE2101 – NIA Sump Discharge

The airborne effluent radiation monitors are as follows:

- 2/3RE7808 – Common Plant Vent Stack
- 2RE7828 – Unit 2 Containment Vent Stack
- 3RE7828 – Unit 3 Containment Vent Stack
- SYFRU-7904 – South Yard Facility (SYF) Work Area Exhaust

Note: The radiation monitors are not credited for postulated accidents, but for monitoring containment gaseous effluent radioactivity during D&D activities.

11.5 RELEASE POINTS, ESTIMATED DOSES, AND DILUTION FACTORS

Release points, estimated doses, and dilution factors, are discussed and calculated per the ODCM to satisfy 10 CFR 20 dose concentration release limits and are incorporated by reference.

11.6 ROUTINE SAMPLING

The requirements of the system design bases for routine continuous and discrete sampling of radioactivity are satisfied by a system of liquid and airborne samplers, laboratory equipment for sensitive radiochemical analyses, and a program of procedures for obtaining and analyzing representative samples when and where appropriate in accordance with the requirements of the ODCM.

The plant vent stacks are continuously monitored and sampled isokinetically in accordance with ANSI N13.1-1969 for particulates. The particulate and tritium samples are collected and analyzed once a week.

Southyard Facility ventilation stacks are continuously monitored for particulates and sampled isokinetically in accordance with ANSI N13.1-1969 for particulates. The particulate are collected and analyzed weekly.

Liquid composite samples are prepared in proportion to the volume of each batch of effluent releases or in proportion to the rate of flow of the effluent stream. Prior to analysis, the composite is thoroughly mixed so that the sample is representative of the average effluent release. Gaseous particulate samples are mixed in proportion to the volume of release or in proportion to the rate of flow from each effluent pathway. Samples are composited and analyzed at an off-site facility in accordance with standard procedures.

11.7 POTENTIAL RADIOLOGICAL EVENTS

A review was performed of potential radiological events during decommissioning consistent with NUREG-0586 Final Generic Environmental Impact Statement (GEIS) and those non-fuel related accidents that existed in DSAR Chapter 15 prior to all spent fuel being located at the SONGS ISFSI. The following three events were determined applicable to SONGS Units 2 & 3 during the decommissioning activities:

- A High Integrity Container (HIC) fire containing spent ion exchange resin
- Radioactive Waste System Leak or Failure
- Postulated Radioactive Releases Due to Liquid Tank Failures

11.7.1 HIC FIRE CONTAINING SPENT RESIN

The potential accidents during active decommissioning were evaluated and determined that an accident involving spent ion exchange resin has the highest potential off-site dose consequences. The release activity from a two-hour duration fire was calculated assuming 100% combustion of the contents and a conservative airborne release fraction (ARF). Ground release atmospheric dispersion coefficients (X/Q) were calculated using Regulatory Guide 1.145 methodology. The deposition coefficients (D/Q) were calculated using the undepleted X/Q and the Regulatory Guide 1.111 ground release deposition. The calculated atmospheric releases and dispersion and deposition coefficients were used to calculate the airborne radioactivity and ground surface concentrations at the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) outer boundary. The Federal Guidance Report 11 and 12 dose conversion factors were used to calculate the doses from the inhalation, submersion, and ground surface direct radiation pathways. Administrative controls have been implemented to limit any potential off-site dose consequences to below the criteria of 10 CFR 50.67 (i) and (ii) in accordance with Regulatory Guide 1.183.

11.7.2 RADIOACTIVE WASTE SYSTEM LEAK OR FAILURE

The evaluation of the radiological consequences for a Liquid Radioactive Waste System leak or failure (with release to atmosphere) conservatively does not assume any post-shutdown decay time. The doses would be less if a decay time was assumed. This event is modeled with the Alternative Source Term (AST). The most limiting of these is defined as an unexpected and uncontrolled release of the radioactive liquid stored in a radwaste secondary tank. A radwaste secondary tank is assumed to rupture, releasing the contents of the tank to the auxiliary building. All of the radioactive fission gases are assumed to be released to the outside atmosphere in two hours. The resulting offsite doses are much less than the 100 mRem TEDE offsite dose criterion per Regulatory Issue Summary 2006-04.

11.7.3 POSTULATED RADIOACTIVE RELEASE DUE TO LIQUID TANK FAILURES

Accidents involving release of radioactive liquids from tanks may involve rupture of tanks inside the containment, inside the auxiliary building, or of the refueling water or condensate storage tanks located outside. The contents of tanks located inside containment and the auxiliary building were drained and/or processed after plant operation was terminated. Any residual contents will be collected and disposed of through administrative controls. Radioactive liquids released from a RWST or the condensate storage tank would be contained in the concrete retention basins surrounding each tank. The Condensate Storage Tank is administratively controlled to ensure that any overflow will be within 10 CFR 20 limits. No credible accident scenarios exist that would exceed 10 CFR 20 limits. Therefore, no formal radiological consequence evaluation of this event is warranted.

12. RADIATION PROTECTION

With the completion of FTO, all of the spent fuel has been transferred from the spent fuel pool to an onsite interim dry storage facility licensed under a 10 CFR Part 72 license.

During the Decontamination and Dismantlement (D&D) personnel will be exposed to radiated SSCs and will be protected as discussed in this section.

12.1 ENSURING THAT OCCUPATIONAL RADIATION EXPOSURES ARE AS LOW AS IS REASONABLY ACHIEVABLE (ALARA)

Consistent with station modification, maintenance, operational requirements, and economic and social considerations, the policy of SONGS Units 2 and 3 is to:

A. Maintain the occupational dose equivalent to the individual As Low as is Reasonably Achievable (ALARA);

B. Maintain the sum of occupational dose equivalents received by all exposed workers ALARA; and

C. Limit the number of workers authorized to receive exposure to radiation.

Regulatory Guide 8.8, Revision 3, Sections C.1, C.3, and C.4 is used as a basis for developing the ALARA and radiation protection programs.

Station management's commitment to this policy is reflected in radiological procedures and programs. The Radiation Protection staff provides the radiological conditions and protective requirements necessary to complete work safely. Each individual's responsibility to adhere to these requirements and the procedures governing their work is key to the success of the program.

12.2 RADIATION SOURCES

The source terms used in the original design and evaluation of SONGS Units 2 and 3 consists of the types and quantities of radionuclides that are produced in the fuel, primary coolant, and structural materials of the reactor coolant system, and the rate of transfer of these nuclides into other systems for an operating plant. Based on the post-FTO condition, the number and magnitude of potential radiation sources have been and continue to be reduced substantially from the original design bases source terms. The source terms used in the original plant design is obsolete information and have been deleted. The radiation protection program will continue to monitor appropriate areas and activities to ensure impacts from decommissioning are assessed and license basis requirements are maintained.

Each area including its enveloped SSCs subject to removal for decommissioning is evaluated for potential radioactive material and is removed with personnel protection provided as specified by the program procedures.

Radiation sources would also include those generated during D&D activities, such as open-air demolition, irradiated component removal, and liquid and airborne effluents. During containment building removal, a fixative may be applied to surfaces to affix any transferable contamination to preclude release of contamination during the open-air demolition of the containment structure.

12.3 RADIATION PROTECTION DESIGN FEATURES

Radiation protection design features include administrative programs and procedures, as well as physical elements that generate limits to access, installs permanent and temporarily shielding, and provides monitoring commensurate with the levels of potential radiological hazard.

12.3.1 RADIATION ZONING AND ACCESS CONTROL

The controls for entry and exit of personnel to controlled access areas, and the procedures, ensure that radiation levels and allowable working time are within the limits prescribed by 10 CFR 20.

12.3.2 SHIELDING

The nuclear radiation shielding was designed to prevent persons from being exposed to radiation in excess of that allowed by 10 CFR 20. The source terms used in the design of plant shielding are based on full power operations, reactor shutdown, and design basis accidents.

During decommissioning, the primary function of permanent and temporary shielding is for filters, resins or other radioactive material needed for personnel protection. Administrative controls will be used to supplement the protection of personnel afforded by shielding.

12.3.4 AREA RADIATION MONITORS

There are no permanently installed area radiation monitors. All area radiation monitors are portable and are provided as determine by the radiation protection program. Liquid and airborne radiation monitors are discussed in Chapter 11 of the DSAR and are only used for effluent monitoring.

12.4 RADIATION PROTECTION PROGRAM

Areas where an increased potential exists for exposure to radiological hazards such as the containment building, fuel handling building, radwaste building, safety equipment building, and radiochemistry laboratories are radiological controlled areas. Personnel entering these areas are protected by administrative controls and written procedures in accordance with the radiation protection program described in the following sections.

12.4.1.1 Radiation Protection Program Basis

This program consists of rules, practices, and procedures that are used to assure personal exposure and any environmental releases remains within 10 CFR 20 permissible levels. Releases governed by 10 CFR 71 and 49 CFR are controlled directly by the Radiation Protection section while liquid and gaseous effluent releases are controlled and monitored by the Chemistry and Environmental section of the Radiation Protection Division. The Radiation Protection Program will remain in effect continuously until the units are decommissioned.

The radiation protection program ensures that:

A. Personnel receive appropriate radiation protection training.

B. Appropriate control techniques and protective clothing are used to limit external contamination.

C. Respiratory protection equipment is used as appropriate to limit internal exposure and assure that the total effective dose equivalent (TEDE) is maintained ALARA.

D. Radiation, airborne radioactivity, radioactive material and contamination areas are appropriately posted to limit exposure.

E. Radiation Protection Instruments and equipment used for quantitative radiation measurements are properly calibrated and maintained so that accurate radiological surveys can be performed.

F. Appropriate personnel monitoring devices are provided to personnel requiring external monitoring and exposure records are maintained.

G. An internal dose assessment program (whole body counting and/or bioassay) is supplied and implemented as required to determine internal exposure and records are maintained.

H. Incoming and outgoing shipments of licensed radioactive materials are properly handled.

I. Necessary measures are employed to keep exposures within 10 CFR 20 limits and ALARA.

J. Licensed Radioactive material is controlled to minimize the potential for releases to unrestricted areas.

12.4.3 RADIATION PROTECTION FACILITIES

The radiation protection facilities include access control facilities, decontamination areas, radiation protection laboratory and offices, calibration areas, and storage areas for protective clothing, respiratory protection equipment, air sampling equipment, fixed and portable radiation detection instruments, and personnel monitoring devices as discussed below.

Additional facilities including additional access control points may be initiated at the personnel entrance to additional radiological controlled areas.

12.4.4 PROCEDURES

The Radiation Protection Program and Procedures are designed to provide protection of personnel against exposure to radiation and radioactive materials in a manner consistent with 10 CFR 20 and applicable regulations.

Additionally, the policy of SONGS Units 2 and 3 is to maintain personnel radiation exposure As Low as is Reasonably Achievable (ALARA). Radiation protection procedures are in-place which factor in ALARA controls. ALARA reviews are performed, as necessary, as decommissioning progresses.

12.4.4.1 Personnel Monitoring

Administrative controls provide the requirements and controls for personnel entering radiologically posted areas onsite and the need to wear personnel monitoring devices based on the radiological hazards. These administrative controls also provide for the use of portal personnel radiation monitors and/or frisker(s).

A portal personnel radiation monitor is provided at the plant exit for monitoring of surface and internal activity of people leaving the plant. The portal monitor provides for complete head-to-foot coverage. The portal console monitor includes status lights including a contamination alarm.

For areas that would cause personnel to be potentially exposed to high-radiation doses in excess of 10 CFR 20 limits, in a short period of time because of system failure or improper personnel action, portable area radiation monitors or self-reading dosimeters are provided or the area is locked or controlled to prevent entry/access.

12.4.4.2 Radioactive Materials Safety Program

Some types of sealed and unsealed sources are used to calibrate the process and effluent radiation monitors, the area radiation monitors, and the portable and laboratory radiation detection instruments. Radiation protection personnel and other individuals who routinely work with sources have received training in the safe use and handling of sources as part of their normal job training. Check sources that are integral to the monitors or portable instruments, and are exempt quantities, do not require special handling, storage, or procedures for radiation protection purposes. This also applies to exempt quantities of sources used to calibrate or check laboratory instruments.

Sealed radionuclide sources having activities greater than the quantities of radionuclides defined in Appendix C to 10 CFR 20 and Schedule B of 10 CFR 30 will be subject to material controls for radiological protection.

12.4.4.3 Radiation Protection Training

Training of site personnel in radiation protection principles and procedures is given at the beginning of their work assignments and periodically retraining thereafter as defined in radiation protection procedures.

Radiation protection training includes instructions in applicable provisions of the NRC regulations for the protection of personnel from radiation and radioactive material (10 CFR 20) and instructions concerning prenatal radiation exposure (NRC Regulatory Guide 8.13).

Radiation protection technicians receive additional training in such areas as radiation and contamination surveys, air sampling techniques, use of portable and laboratory instrumentation, release limits, and safe handling of sources that apply to their specific job functions.

12.4.4.4 Radiation and Contamination Surveys

Radiation protection personnel evaluate radiological conditions during decommissioning in accordance with established radiation protection procedures, which are required to be followed by all personnel. They ensure that all applicable regulations are complied with and that the required radiation protection records are adequately maintained.

Radiation Protection and Chemistry personnel utilize both lab-based alpha and beta counting instruments and portable alpha, beta, gamma, or neutron radiation detection equipment to determine contamination levels. Instruments are recorded, tracked and calibrated at specified intervals.

12.4.4.6 Controlling Access and Stay Time

Areas of the site, whether temporary or persistent, where an increased potential exists for exposure to radiological hazards are Radiologically Controlled Areas and are controlled by radiation protection personnel.

Areas within radiologically controlled areas are further designated as radiation areas, high radiation areas, very high radiation areas, airborne radioactivity areas, and radioactive materials areas consistent and in compliance with 10 CFR 20. In addition, contaminated areas are posted at limits discussed in appropriate procedures. Dosimetry and personal protective equipment will be provided and worn when required by regulatory guidance.

Positive control over High Radiation Areas having dose rates in excess of 1000 mrem/hr is exercised by locked barriers, if possible. When it is not reasonable to construct a barrier, the area will be roped off and a flashing warning light will be activated. Access to other high radiation areas (less than 1000 mrem/hr) administratively requires the individual to use a dose rate instrument, an alarming dosimeter, or be accompanied by a radiation protection qualified individual who performs dose rate surveys and who exercises positive control over the activities within the area. Control over entries into radiologically controlled areas is normally provided by using radiation work permits that identify work to be done and necessary radiological controls to be observed.

12.4.4.7 Contamination Control

Contamination limits for personnel, equipment, and areas are provided in the station procedures. Surveys are performed routinely and after some maintenance work to determine contamination levels. Any area found contaminated is roped off or otherwise delineated with a physical barrier, posted with appropriate signs, and decontaminated as soon as practical.

Tools and equipment used in contaminated areas are monitored and may be bagged or decontaminated prior to being removed to a clean area to prevent the spread of contamination.

If the tools or equipment do not meet the release limits, they may be decontaminated, disposed of as radioactive waste, or restricted to use within radiologically controlled areas.

Control of personnel contamination (external and internal) is provided by using protective clothing and respiratory equipment. Each individual is responsible for personnel monitoring of body and clothing when crossing a local control point or the main access control point. If contamination is found, the individual is decontaminated, under the direction of radiation protection personnel.

12.4.4.8 Airborne Activity Control

Airborne contamination is minimized by keeping loose contamination levels low and by reducing sources of leakage as much as practical. Ventilation airflow prevents the buildup of air contamination concentrations. Airflow is always directed from normally occupied or routinely accessible areas of low-potential contamination to areas of higher potential contamination.

Portable, temporary ventilation systems with a variety of filtration capabilities are available to control local sources of airborne radioactivity.

When airborne radioactivity is detected in excess of the limits of 10 CFR 20, the area is posted as an airborne radioactivity area, access is controlled and the radiation work permit will cite the appropriate respiratory requirements to maintain 10 CFR 20 limits. Radiation work permit may include area survey data and/or specify personal required training, qualifications or activities.

12.4.4.9 Protective Clothing

The nature of the work to be performed during decommissioning and the radiological conditions are the governing factors in the selection of protective clothing to be worn. Examples of the protective apparel available are shoe covers, rubber overshoes, head covers, beanies, gloves (cotton liners and rubber gloves), and coveralls or lab coats. Additional items of specialized apparel such as plastic or rubber suits, face shields, and respirators are available for activities involving high level contamination and airborne radioactivity areas. In all cases, administrative controls provide the requirements and controls for radiation protection to evaluate the radiological conditions and specify the required items of protective clothing.

Radiological controlled areas are posted as radiation areas, high radiation areas, radioactive materials areas, airborne radioactivity areas, contaminated areas or combinations thereof. Access to radiological controlled areas for all work is authorized in accordance with the radiation protection procedures.

12.4.5 RECORDS

Radiation protection related records are maintained in accordance with administrative procedures and the records management system.

12.5 SAFETY ANALYSIS

The Radiation Protection has no safety function and therefore no safety analysis is provided.

13 CONDUCT OF OPERATIONS

13.1 ORGANIZATIONAL STRUCTURE

13.1.1 MANAGEMENT

This section provides information relative to the management of the Independent Spent Fuel Storage Installation (ISFSI) and decommissioning of the SONGS Units 2&3 plant site.

13.1.1.1 Corporate Structure

Southern California Edison (SCE) is the Operator of the San Onofre Nuclear Generating Station (SONGS). SCE is a subsidiary of Edison International (EIX). The ultimate responsibility for all aspects of SONGS rests with the EIX President and Chief Executive Officer (CEO). The CEO of SCE reports to the President and CEO of EIX, and has responsibility for SCE. The Chief Nuclear Officer and Vice President Decommissioning (CNO) is directly responsible for the SONGS Organization, reporting to the CEO of SCE. The Nuclear Site Management Organization chart is functionally described in the SONGS Decommissioning Quality Assurance Program (DQAP) and detailed in site administrative control procedures.

The CNO is responsible for overall plant management of SONGS Units 1, 2, and 3 and the Independent Spent Fuel Storage Installation (ISFSI). The bulk of the SONGS site is undergoing active decommissioning (decontamination and dismantlement) through the services of a Decommissioning General Contractor (DGC). The balance of the SONGS Staff is also referred to as the SCE Decommissioning Agent (DA) or SCE DA Staff. The CNO has delegated oversight of the Decommissioning Project to the Director, Decommissioning Project and has delegated management of the ISFSI to the Manager, ISFSI. The CNO has further delegated various nuclear support responsibilities to the Manager of Nuclear Regulatory Affairs (NRA) and the Manager of Nuclear Oversight & Safety Culture (NOD) to facilitate management of the ISFSI and balance of the plant site as well as other areas not specifically discussed in the UFSAR (DSAR).

13.1.1.3 Nuclear Oversight and Nuclear Safety Concerns (NOD)

The Manager, Nuclear Oversight and Nuclear Safety Concerns reports to the CNO and has no other assigned responsibilities that would prevent the required attention to important to safety matters. The Manager, NOD manages both the nuclear oversight organization as well as the nuclear safety concerns program.

13.1.1.3.1 Nuclear Oversight

Nuclear Oversight reports to the Manager, NOD and is responsible for the establishment and execution of the Quality Assurance Program in compliance with 10 CFR 50, Appendix B. The Quality Assurance Program is described in the DQAP, which is common to all three units. The DQAP satisfies the requirements of 10 CFR 50, Appendix B, 10 CFR 71, Subpart H and 10 CFR 72, Subpart G, and provides control over activities affecting quality to an extent consistent with their importance to ensure safety and compliance.

Nuclear Oversight is responsible for establishing quality assurance policies, goals, and objectives and ensuring that these policies are followed and that the goals and objectives are achieved. Nuclear Oversight is also responsible for the development, maintenance, and surveillance of the DQAP, surveillance of Important to Safety activities, and has the authority to stop work.

13.1.1.3.2 Nuclear Safety Concerns

Nuclear Safety Concerns are investigated by personnel reporting to the Manager Nuclear Oversight. The Nuclear Safety Concerns Program supports the Safety Conscious Work Environment (SCWE) in which workers feel free to raise concerns both to SCE and the Nuclear Regulatory Commission (NRC) without fear of retaliation. SCE's policy addresses two specific concepts: 1) A SONGS Nuclear Safety Culture, which is this organization's values and behaviors modeled by its leaders and internalized by its members that serves to make nuclear safety the overriding focus, and; 2) To build and maintain a strong nuclear safety culture, a key component is the establishment and maintenance of effective lines of communication for safety concerns such that workers are encouraged to raise concerns and that such concerns are promptly reviewed, properly prioritized, and resolved with timely feedback to workers.

13.1.1.5 Nuclear Regulatory Affairs (NRA)

The Manager, Nuclear Regulatory Affairs reports to the CNO.

NRA is delegated the overall responsibility for licensing and nuclear regulatory compliance functions. NRA is responsible for maintaining licensing documents, submitting routine regulatory agency reports, and developing strategies for addressing NRC issues.

13.1.2 ISFSI ORGANIZATION

13.1.2.1 Manager, ISFSI

The Manager, ISFSI has ultimate responsibility for the safe operation of the SONGS ISFSI. The manager also assures all regulatory requirements are met including those addressed in the DQAP.

The Manager, ISFSI is responsible for:

- ISFSI Maintenance
- Corrective Action Program Implementation
- Emergency Planning
- Security (including operations, training and other ISFSI functions)
- ISFSI Engineering

13.1.2.1.1 ISFSI Engineering

The Manager, ISFSI Engineering reports to the Manager, ISFSI and has responsibility for providing engineering support for the ISFSI. The Manager, ISFSI Engineering maintains Design Authority for the ISFSI organization assuring configuration management and other design activities meet program requirements. The engineering staff requests and coordinates support from other departments in the company, or from outside consultants and engineering firms, as needed.

13.1.2.1.2 Manager, Security

The Manager, Security reports to the Manager, ISFSI. The Manager, Security is responsible for the development and implementation of the Security Plan. The Security organization provides continuous coverage of the ISFSI from both a physical security and operations perspective. The security organization also includes appropriate staff to support Access Authorization, required training and other programmatic support.

13.1.2.1.2.1 ISFSI Shift Supervision and Shift Staff

The ISFSI Shift Supervisor (ISS) directs the shift staff through the supervisors and is the Emergency Director during declared Emergency Conditions. On-duty shift crews support security functions while also monitoring the conditions of the ISFSI Storage Systems including temperature monitoring, physical and basic radiological conditions.

13.1.2.1.2.2 Manager, EP/RP

The Manager, EP/RP reports to the Manager, ISFSI and is responsible for the development and implementation of the Emergency Plan. The Manager, EP/RP also coordinates required ISFSI RP support beyond surveying conducted by Security staff.

13.1.3 DECOMMISSIONING PROJECT ORGANIZATION

13.1.3.1 Director, Decommissioning Project

The Director, Decommissioning Project reports directly to the CNO and oversees the quality of DGC work quality and to assure activities meet the requirements set forth in the DQAP.

13.1.3.2 General Manager, Environmental/Waste and Radiation Protection

The General Manager, Environmental Waste and Radiation Protection reports directly to the Director, Decommissioning Project and has responsibility for the oversight of DGC activities in the environmental, radiological waste and radiation protection areas. This includes compliance with applicable SCE Management Control Elements (MCE), QA and regulatory requirements delegated to the DGC.

13.1.3.3 General Manager, Decommissioning Agent Contract Management

The General Manager, Decommissioning Agent Contract Management reports directly the Director, Decommissioning Project and has responsibility for the oversight of DGC activities in the field and miscellaneous programs including maintenance, engineering, work controls and operations. This includes compliance with applicable SCE MCE, QA and regulatory requirements delegated to the DGC.

13.1.3.4 General Manager, DA Business Services

The General Manager, DA Business Services reports to the Director, Decommissioning Project provides support services including project management project controls and prudency.

13.1.4 QUALIFICATION OF NUCLEAR PLANT PERSONNEL

The SCE DA staff has a level of education, experience, and skill, commensurate with their level of responsibility. The qualifications provide reasonable assurance that decisions and actions during the decommissioning of SONGS will not constitute a hazard to the health and safety of the public.

The recommendation of Regulatory Guide 1.8, Revision 1, September 1975, "Personnel Selection and Training," and ANSI N18.1-1971, "Standard for Selection and Training of Personnel for Nuclear Power Plants," for equivalent positions within the ISFSI organization is used as the basis for establishing minimum qualifications for applicable management, supervisory, and professional-technical and other personnel in the plant organization as directed by the DQAP and implemented through appropriate administrative controls.

13.1.5 INDEPENDENT REVIEWS

A description of the Independent Safety Review and Independent Management Assessment scope, responsibilities and qualifications are established DQAP Appendix D and detailed in appropriate administrative controls.

13.1.6 DECOMMISSIONING GENERAL CONTRACTOR (DGC)

While SCE retains the legal and regulatory responsibilities associated with the entire SONGS site, SCE had delegated the decommissioning responsibilities to a Decommissioning General Contractor. The DGC operates under the oversight of the SCE Director, Decommissioning Project and is responsible for adhering to the regulatory and quality requirements pertinent to decommissioning as established and incorporated from the Licensee's administrative controls.

The DGC's functions primarily focus on safely decontaminating and dismantling the SONGS Units 2 and 3 facilities. This includes packaging and shipment of the resulting waste material to offsite disposal facilities thereby reducing residual radioactivity to levels that permit release of the property for unrestricted future use consistent with that specified in the applicable regulatory, permit and property owner requirements.

14. INITIAL TEST PROGRAM

14.1 SPECIFIC INFORMATION TO BE INCLUDED IN PSAR

Not applicable to the DSAR.

14.2 SPECIFIC INFORMATION TO BE INCLUDED IN DSAR

Section 14.2 previously included overviews of the site startup test program, which were submitted to the NRC in support of initial plant licensing. This information is considered historical and is not subject to review or periodic updates. This historical information has been relocated to Controlled Document 90216.

15. ACCIDENT ANALYSES

15.0 TRANSIENT ANALYSES

During decontamination and dismantlement there are no important to safety (ITS) or safety related (SR) systems remaining in-service and thus there is no possibility of any transients with radiological consequences as defined in NUREG-0800.

16 TECHNICAL SPECIFICATIONS

The Permanently Defueled Technical Specifications for Units 2 and 3 are incorporated in the Facility Operating Licenses, NPF-10 and NPF-15, as Appendix A.

Certain requirements originally located in Technical Specifications that did not meet 10 CFR 50.36 scope requirements were relocated to either the Licensee Controlled Specifications (LCS), the Decommissioning Quality Assurance Program (DQAP), or the UFSAR.

17. QUALITY ASSURANCE

17.2 QUALITY ASSURANCE PROGRAM

17.2.1 ORGANIZATION AND RESPONSIBILITIES

17.2.1.1 The information contained in this section has been superseded by the SONGS Decommissioning Quality Assurance Program Manual (SONGS DQAP). SONGS DQAP revisions are prepared as required by 10 CFR 50.54(a).