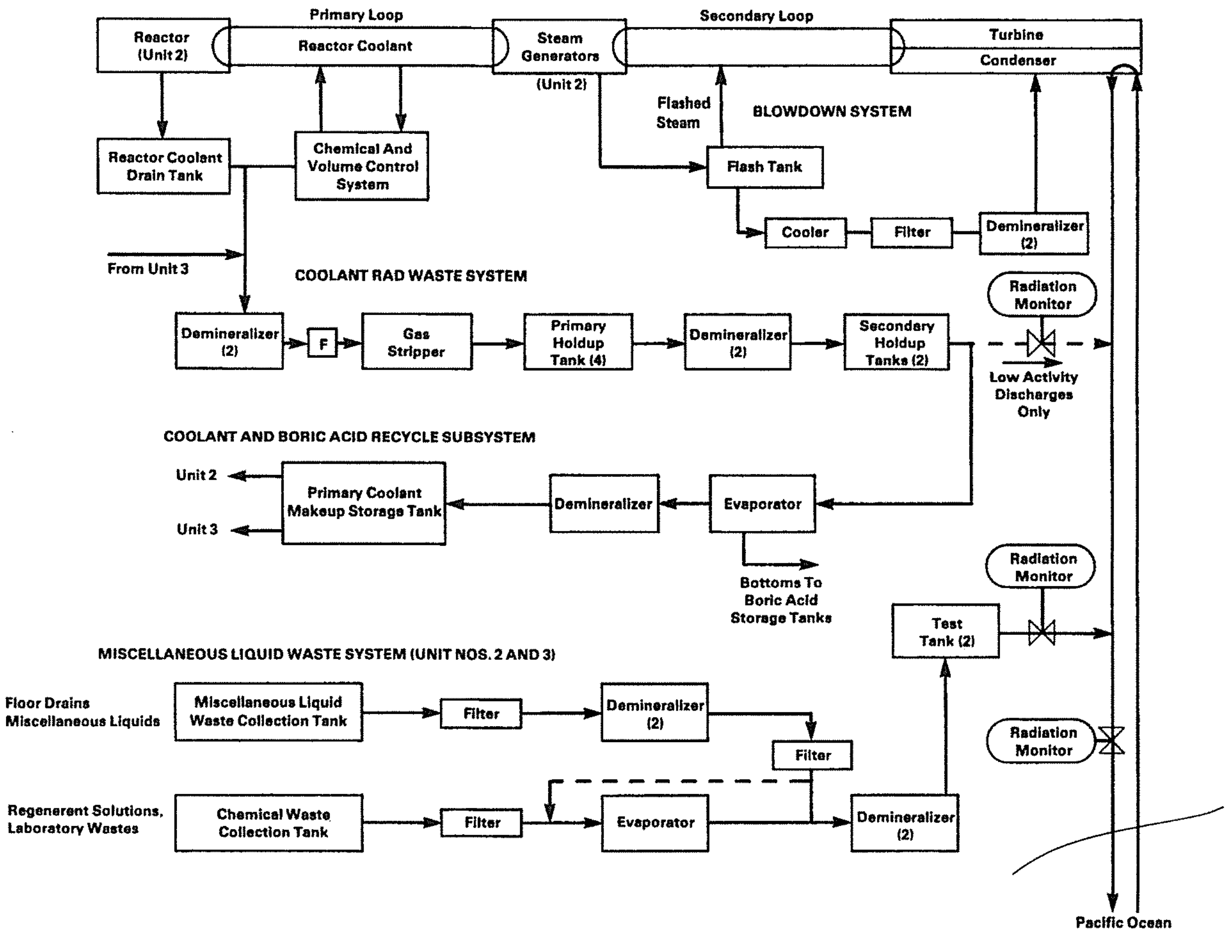

Fig. 3.5. SONGS 2 & 3 radioactive liquid waste treatment systems.

reactor containment, as well as excess spent fuel pit water, will be processed as above and will be transferred to the radwaste primary holdup tanks where it will be combined with the shim bleed. These streams will form the inputs to the coolant radwaste system and will be processed batchwise from the four radwaste primary holdup tanks. The combined streams are next processed batchwise through two mixed bed demineralizers (H_3BO_3 form) and routed to one of two 454,248-liter (120,000-gal) radwaste secondary holdup tanks. From the radwaste secondary holdup tanks, the processed liquid can be recycled to the reactor coolant makeup tank, can be discharged to the circulating water outfall if radioactivity concentrations are within established limits, or can be processed further through a boric acid evaporator and mixed bed deborating and polishing demineralizers.

In the latter mode of operation, the boric acid recovered in the evaporator bottoms can be recycled. Because the system is capable of continuously operating in the boron recovery mode with inputs from both Units 2 and 3, and because the staff's source term calculation assumes a failed fuel rate of 0.12%, the staff's evaluation was made on the basis of the system being operated in the boron recycle mode. The staff calculated the collection time in a radwaste secondary holdup tank to be about 38 days, based on a combined input flow rate of 9463 liters/day (2500 gpd) from Units 2 and 3. Based on an assumption of 80% tank capacity and process flow rate of 189 liter/min (50 gpm), the staff calculated the decay time during processing to be about 1.3 days. If the radioactivity is below predetermined value, the treated stream may be pumped to the waste monitor release tank and discharged. The staff assumed that 10% of the treated stream will be discharged to the circulating water outfall and to the Pacific Ocean because of anticipated operational occurrences and for tritium inventory control. The decontamination factors listed in Table 3.1 were applied for radionuclide removal in the coolant radwaste system. The concentrated bottoms from the evaporator and the spent resins from the demineralizers will be transferred to the radioactive solid waste system for disposal by burial offsite.

Miscellaneous liquid waste system

The miscellaneous liquid waste system of the liquid radioactive waste treatment system is designed to collect and treat non-reactor-grade water for reuse within the plant from auxiliary building sumps, the containment sumps, and other miscellaneous sources. These wastes will be collected in a shared 22,712-liters (6000-gal) waste holdup tank at an input flow rate of about 5300 liters/day (1400 gpd) per unit. The staff calculated the collection time to be about 1.7 days. The wastes will be processed through four series connected mixed bed demineralizers and collected in a 94,635-liter (25,000-gal) test tank. The staff calculated the decay time during processing to be about 0.03 days. If necessary, the stream can be diverted to the evaporator in the chemical waste system for additional treatment.

The decontamination factors listed in Table 3.1 were applied for radionuclide removal in the miscellaneous liquid waste system of the liquid waste treatment system. The contents of the treated stream will be sampled periodically, recycled for further treatment, recycled for in-plant use, or discharged. The staff assumed that 100% of the treated stream will be released to the Pacific Ocean.

Evaporator bottoms and spent resins will be transferred to the radioactive solid waste system for disposal by burial offsite.

Chemical waste system

The chemical waste system of the liquid radioactive waste treatment system is designed to collect and treat non-reactor-grade liquid wastes from laboratory drains and from the regeneration of demineralizers. These wastes will be collected in a shared 94,635-liter (25,000-gal) chemical waste tank and sampled and analyzed. The wastes will be treated through the chemical waste system evaporator and two series connected mixed bed demineralizers prior to entering the waste monitor tanks. The staff calculated the collection time to be about 25 days, based on an input flow of about 1514 liters/day (400 gpd) per unit, and a decay time during processing of about 0.1 day.

Turbine building drain

The turbine building drains will be released through a radiation monitor to the Pacific Ocean via the circulating water outfall without treatment. The monitor will automatically terminate liquid discharge if radioactivity exceeds a predetermined level. The staff assumed a release of 27,255 liters/day (7200 gpd) per reactor and that the wastes will be discharged without processing.

Table 3.1. Principal parameters and conditions used in calculating releases of radioactive material in liquid and gaseous effluents from SONGS 2 & 3

Reactor power level, MWt	3600
Plant capacity factor	0.80
Failed fuel, percent	0.12[a]
Primary system:	
Mass of coolant, lb	5.6×10^5
Letdown rate, gpm	40
Shim bleed rate, gpd	1×10^3
Leakage to secondary system, lb/day	100
Leakage to containment building	[b]
Leakage to auxiliary building, lb/day	160
Frequency of degassing for cold shutdowns, per year	2
Secondary system	
Steam flow rate, lb/hr	1.5×10^7
Mass of liquid steam generator, lb	1.7×10^5
Mass of steam/steam generator, lb	1.2×10^4
Secondary coolant mass, lb	2.2×10^6
Rate of steam leakage to turbine building, lb/hr	1.7×10^3
Containment building volume, ft^3	2×10^6
Annual frequency of containment purges, shutdown	4
Containment low volume purge rate (cfm)	2000
Iodine partition factors, gas/liquid	
Leakage to auxiliary building	0.0075
Leakage to turbine building	1.0
Main condenser/air ejector, volatile species	0.15

Liquid radwaste system decontamination factors (DF)

	Coolant radwaste system (CRS)	Miscellaneous liquid-waste system	Chemical-waste system
I	1×10^5	1×10^3	1×10^4
Cs, Rb	2×10^5	2×10^1	1×10^5
Others	1×10^6	1×10^3	1×10^5

	All nuclides except iodine	Iodine
Radwaste evaporator DF	10^4	10^3
Coolant radwaste system evaporator DF	10^3	10^2

	Anions	Cs, Rb	Other nuclides
Boron recycle feed demineralizer DF, H_3BO_3	10	2	10
Primary coolant letdown demineralizer DF, Li_3BO_3	10	2	10
Evaporator condensate polishing demineralizer, H^+OH^-	10	10	10
Mixed-bed radwaste demineralizer	10^2(10)	2(10)	10^2(10)
Steam generator blowdown demineralizer	10^2(10)	10(10)	10^2(10)
Containment building internal recirculation system charcoal filter DF, iodine removal			10
Main condenser air-removal system charcoal bed DF, iodine removal			10

[a]This value is constant and corresponds to 0.12% of the operating power fission product source term as given in NUREG-0017 (April 1976).

[b]One percent per day of the primary coolant noble gas inventory and 0.001% per day of the primary coolant iodine inventory.

(To convert lb to kg, multiply by 0.4536; to convert gals to liters, multiply by 3.7854; to convert ft^3 to m^3, multiply by 0.0283.)

Steam generator blowdown

The steam generator blowdown system for Units 2 and 3 will continuously process steam generator blowdown at an average flow rate of 325,545 liters/day (86,000 gpd) per reactor (design flow rate is 1136 liters/min (300 gpm)). The blowdown from the two steam generators for each unit will be directed to a common flash tank. The liquid will be cooled, filtered, and treated through two series connected demineralizers before being returned to the main condenser. The flashed steam will be condensed in the main condenser hotwell. The staff did not consider any direct releases from this system to the environment.

Liquid waste summary

Based on the staff's evaluation of the radioactive liquid waste treatment systems and the parameters listed in Table 3.1, the staff calculated the release of radioactive materials in liquid waste effluent to be about 1.1 Ci per year per reactor, excluding tritium and dissolved gases. The staff estimates that about 300 Ci per year per reactor of tritium will be released to the Pacific Ocean. In comparison, the applicant estimated a release of radioactive material in liquid effluent, exclusive of tritium, to be about 0.67 Ci per year per reactor and a tritium release of 710 Ci per year per reactor. The differences between the staff's values and those of the applicant lie principally in assumptions as to the parameters used for each radwaste system component and the distribution of tritium between gaseous and liquid releases. The staff's calculations of the radionuclides expected to be released annually from SONGS 2 & 3 are given in Table 3.2.

On the basis of the calculated releases of radioactive materials in liquid effluents given in Table 3.2, the staff calculated the annual dose or dose commitment to the total body or to any organ of an individual in an unrestricted area, as shown in Table 5.3, to be less than 3 millirem per reactor and 10 millirem per reactor, respectively, in conformance with Sect. II.A of Appendix I to 10 CFR Part 50.

Cost-benefit analysis of liquid radwaste system augments

The staff evaluated potential liquid radwaste system augments based on a study of the applicant's system designs, the population dose information provided in Table 5.3 of this statement, a value of $1000 per total body man-rem and $1000 per man-thyroid-rem for reductions in dose by the application of augments, and the methodology presented in Regulatory Guide 1.110.[3]

The principal parameters used in this cost-benefit analysis are: (1) labor cost correction factor, FPC Region VIII, 1.2 (Regulatory Guide 1.110[3]); (2) indirect cost factor, 1.75 (Regulatory Guide 1.110[3]); (3) cost of money, 15%; and (4) capital recovery factor, 0.0806 (Regulatory Guide 1.110[3]).

The calculated total body and thyroid doses from liquid releases to the projected population within a 80 km (50-mile) radius of the station, when multiplied by $1000 per total body man-rem and $1000 per man-thyroid-rem, resulted in cost-assessment values of $170 per year per unit and $140 per year per unit respectively. Potential radwaste system augments were selected from the list given in Regulatory Guide 1.110.[3] The most effective augment was the optional use of an existing 0.189 liters/min (50-gpm) evaporator in the miscellaneous liquid waste system; however, the calculated total annualized cost of $80,000 for operation and maintenance of the augment exceeded the cost-assessment values of $170 per unit for the total body man-rem dose and $140 per unit for the man-thyroid-rem dose. The staff concludes, therefore, that there are no cost-effective augments to reduce the cumulative population dose at a favorable cost-benefit ratio, and that the proposed liquid waste management system meets the requirements of Sect. II.D of Appendix I to 10 CFR Part 50.

3.2.3.2 Gaseous radioactive waste treatment system

The gaseous radioactive waste treatement and building ventilation exhaust systems will be designed to collect, store, process, monitor, recycle, and/or discharge potentially radioactive gaseous wastes that will be generated during normal operation including anticipated operational occurrences. The system will consist of equipment and instrumentation necessary to reduce releases of radioactive gases and particulates to the environment.

The principal source of radioactive gaseous wastes are the gaseous waste processing system, condenser vacuum pump, and ventilation exhausts from the auxiliary, radwaste, fuel handling, containment, and turbine buildings. The principal system for treating gaseous wastes stripped from the primary coolant will be the gaseous waste processing system (GWPS). The GWPS will be a once-through nitrogen system containing a surge tank, two compressors, and six pressurized storage tanks. The off-gas from the main condenser air ejector will be processed through HEPA

Table 3.2. Calculated releases of radioactive materials in liquid effluents from SONGS 2 & 3

Nuclide	Curies per year per unit
Corrosion and activation products	
Cr-51	5.6(−4)
Mn-54	9(−5)
Fe-55	4.9(−4)
Fe-59	3(−4)
Co-58	4.8(−3)
Co-60	6.1(−4)
Np-239	2.5(−5)
Fission products	
Br-83	7(−5)
Rb-86	1.1(−3)
Rb-88	1.4(−2)
Sr-89	1(−4)
Sr-91	4(−5)
Y-91m	3(−5)
Y-91	2(−5)
Zr-95	2(−5)
Nb-95	1(−5)
Mo-99	1.9(−2)
Tc-99m	1.5(−2)
Ru-103	1(−5)
Rh-103m	1(−5)
Te-127m	8(−5)
Te-127	1.1(−4)
Te-129m	4.1(−4)
Te-129	2.8(−4)
I-130	1.9(−4)
Te-131m	4(−4)
Te-131	7(−5)
I-131	8.1(−2)
Te-132	6.2(−3)
I-132	7.8(−3)
I-133	5.3(−2)
I-134	2.3(−4)
Cs-134	3.5(−1)
I-135	9.5(−3)
Cs-136	1.7(−1)
Cs-137	2.5(−1)
Ba-137m	1.6(−1)
Ba-140	6(−5)
La-140	4(−5)
Ce-141	2(−5)
Pr-143	1(−5)
All others	5(−5)
Total, except H-3	1.1
H-3	300

filters and charcoal absorbers prior to release to the environment. The containment building atmosphere will be recirculated through HEPA filters and charcoal absorbers prior to release to the environment. Ventilation exhaust air from the auxiliary building and the fuel handling area will not be processed prior to release to the environment. The turbine building ventilation exhaust air will be released to the environment without treatment. The gaseous waste and ventilation treatment systems are shown schematically in Fig. 3.6.

Gaseous waste processing system (GWPS)

The GWPS will be designed to collect and process gases stripped from the primary coolant in the CVCS, coolant radwaste system, and miscellaneous tank cover gases. The GWPS is shared between Units 2 and 3. The GWPS will contain an inventory of nitrogen and hydrogen which will act as a carrier gas to transport radioactive gases removed from the primary coolant. Hydrogen and nitrogen cover gases from the volume control and reactor coolant drain tanks, and gases stripped in the coolant radwaste system degasifier will be collected, compressed, and stored in one of six pressurized storage tanks. The storage tanks will collect and store gases to allow short-lived radionuclide decay. After holdup, the gases will be discharged to the environment.

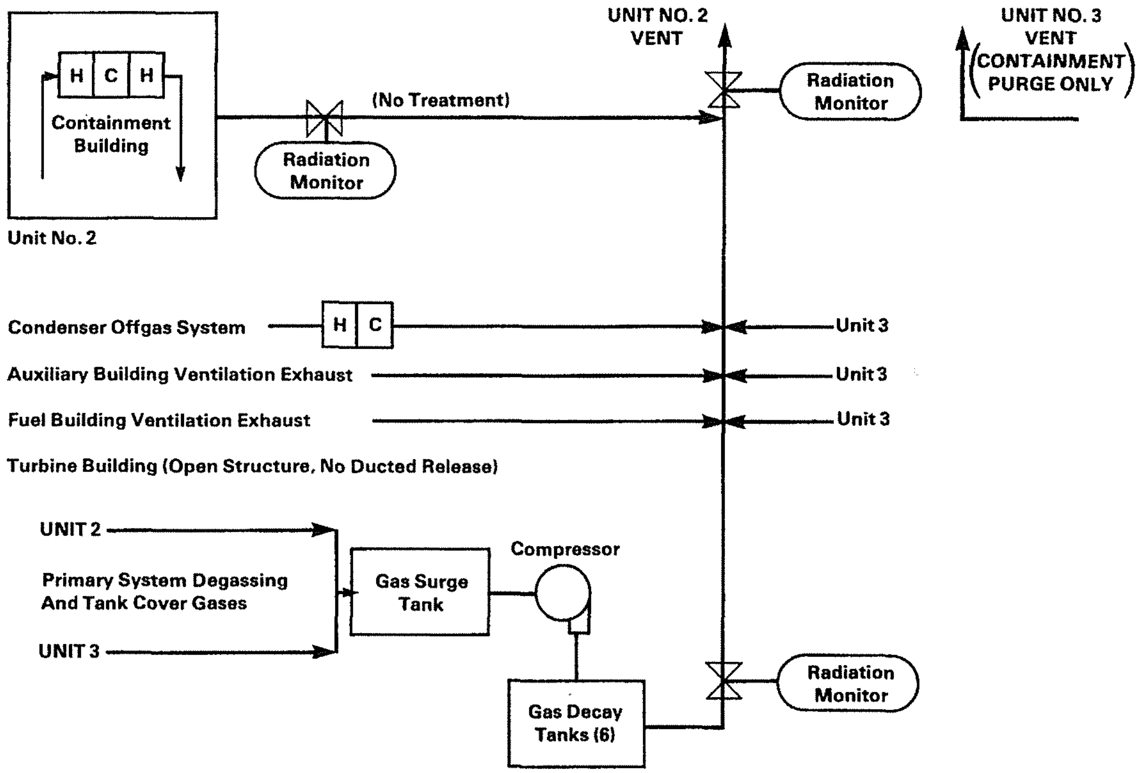

Fig. 3.6. SONGS 2 & 3 radioactive gaseous waste treatment systems.

In its evaluation, the staff assumed three tanks for storage, with two tanks held in reserve for back-to-back shutdowns, and one tank in the process of filling. Each tank has a volume of 14.16 m^3 (500 ft^3) and operates at 300 psig. On this basis, the staff calculated a holdup time of 90 days prior to discharge of gases to the environment.

Containment ventilation system

Radioactive material will be released inside the containment when primary system leakage occurs. The staff assumed on the basis of system parameters that the containment will be purged continuously during power operations at 56.6 m^3/min (2000 cfm) and in addition will have four high volume shutdown purges per year at 1132 m^2/min (40,000 cfm). Prior to purging, the containment atmosphere will be recirculated through HEPA filters and charcoal absorbers. The staff assumed radionuclide removal during the recirculation phase to be based on a flow rate of 453 m^3/min (16,000 cfm), system operation for 16 hr, a mixing efficiency of 70%, a particulate decontamination factor of 100 for HEPA filters, and an iodine decontamination factor of 10 for charcoal absorbers. The purge exhaust gases are released without filtration or other treatment.

Ventilation releases from other buildings

Radioactive materials will be released into the plant atmosphere due to leakage from equipment transporting or handling radioactive materials. Ventilation air from the auxiliary building and fuel building is not processed prior to release. The staff estimated that 72.58 kg (160 lb) of primary coolant per day will leak to the auxiliary building with an iodine partition factor of 0.0075. Small quantities of radionuclides will be released to the open turbine building, based on an estimated 771 kg/hr (1700 lb/hr) of steam leakage. The open turbine building releases will be released directly to the environment.

Main condenser air ejector

Off-gas from the main condenser air ejectors will contain radioactive gases as a result of primary to secondary leakage. In its evaluation, the staff assumed a primary to secondary leak rate of 45 kg/day (100 lb/day). Noble gases and iodine will be contained in steam generator leakage and released to the environment through the main condenser air ejectors in accordance with the partition factors listed in Table 3.1. The air ejector exhaust will be released to the environment through HEPA filters and charocal absorbers.

Gaseous waste summary

Based on the staff's evaluation of the gaseous radioactive waste treatment and building ventilation systems and the parameters listed in Table 3.1, the staff calculated the release of radioactive materials in gaseous effluents to be about 15,000 Ci per year per unit for noble gases and 0.44 Ci per year per unit for iodine-131. In comparison, the applicant estimated a release of 8600 Ci per year per unit for noble gases and 0.096 Ci per year per unit for iodine-131. The staff estimated a release of 0.39 Ci per year per unit of particulates and 1100 Ci per year per unit of tritium. The applicant estimated a release of 0.2 Ci per year per unit of particulates and 710 Ci per year per unit of tritium.

The staff's calculated annual releases of radioactive materials in gaseous effluents from radionuclides expected to be released annually from SONGS 2 & 3 are given in Table 3.3. Based on the calculated releases of radioactive materials in gaseous effluents given in Table 3.3, the staff calculated the annual air in an unrestricted area, as shown in Table 5.3. to be less than 10 millirads per reactor for gamma radiation or 20 millrads per reactor for beta radiation and the annual external doses to the total body and skin of an individual in an unrestricted area to be less than 5 millirems and 15 millirems, respectively, and an organ dose of less than 15 millirems per reactor for radioiodine and radioactive particulates in conformance with Sect. II.B and II.C of Appendix I to 10 CFR 50.

Table 3.3. Calculated releases of radioactive materials in gaseous effluents from SONGS 2 & 3 (Curies per year per unit)

Nuclide	Decay tanks	Reactor building	Auxiliary building	Turbine building	Air ejector	Total
Kr-83m	*a*	2	*a*	*a*	*a*	2
Kr-85m	*a*	24	2	*a*	2	28
Kr-85	430	170	5	*a*	3	610
Kr-87	*a*	5	1	*a*	*a*	6
Kr-88	*a*	30	4	*a*	3	37
Kr-89	*a*	*a*	*a*	*a*	*a*	*a*
Xe-131m	*a*	90	3	*a*	2	95
Xe-133m	*a*	140	5	*a*	3	150
Xe-133	*a*	13,000	410	*a*	260	14,000
Xe-135m	*a*	*a*	*a*	*a*	*a*	*a*
Xe-135	*a*	120	8	*a*	5	130
Xe-137	*a*	*a*	*a*	*a*	*a*	*a*
Xe-138	*a*	*a*	*a*	*a*	*a*	*a*
Total noble gases						15,000
I-131	*a*	0.35	0.08	0.0042	0.005	0.44
I-133	*a*	0.27	0.09	0.0033	0.0056	0.37
Mn-54	4.5(−3)[b]	2.2(−2)	1.8(−2)	*c*	*c*	4.4(−2)
Fe-59	1.5(−3)	7.4(−3)	6(−3)	*c*	*c*	1.5(−3)
Co-58	1.5(−2)	7.4(−2)	6(−2)	*c*	*c*	1.5(−2)
Co-60	7(−3)	3.3(−2)	2.7(−2)	*c*	*c*	6.7(−2)
Sr-89	3.3(−4)	1.7(−3)	1.3(−3)	*c*	*c*	3.3(−3)
Sr-90	6(−5)	2.9(−4)	2.4(−4)	*c*	*c*	5.9(−4)
Cs-134	4.5(−3)	2.2(−2)	1.8(−2)	*c*	*c*	4.4(−2)
Cs-137	7.5(−3)	3.7(−2)	3(−2)	*c*	*c*	7.4(−2)
Total particulates						1.2
H-3						1,100
C-14	7	1	*a*	*a*	*a*	8
Ar-41	*a*	25	*a*	*a*	*a*	25

[a] Less than 1 Ci/year for noble gases and carbon-14, less than 10^{-4} Ci/year for iodine.
[b] Exponential notation: 4.5(−3) = 4.5×10^{-3}.
[c] Less than 1% of total for this nuclide.

Cost-benefit analysis of gaseous radwaste system augments

The staff has evaluated potential gaseous radwaste system augments based on a study of the applicant's system designs, the population dose information provided in Table 5.3 of this statement, a value of $1000 per total body man-rem and $1000 per man-thyroid-rem for reductions in dose by the application of augments, and the methodology presented in Regulatory Guide 1.110.[3]

The calculated total body and thyroid doses from gaseous releases to the population within a 80 km (50-mile) radius of the station, when multiplied by $1000 per total body man-rem and $1000 per man-thyroid-rem, resulted in cost-assessment values of $21,000 per year per unit and $46,000 per year per unit respectively. Potential radwaste system augments were selected from the list given in Regulatory Guide 1.110. The most effective augment considered was the installation of charcoal adsorbers and HEPA filters on the containment mini-purge ventilation exhaust. The addition of this augment would result in a dose reduction of approximately 6.3 total-body man-rem and 23.8 thyroid man-rem with corresponding cost assessment values of $6,300 and $23,800, respectively. The calculated total annualized cost of $26,500 for the augment is more than the annual cost assessment values of $6,300 and $23,800 given above. The staff concludes, therefore, that there are no cost-effective augments to reduce the cumulative population dose at a favorable cost-benefit ratio, and the proposed gaseous waste treatment and ventilation systems meet the requirements of Sect II.D of Appendix I to 10 CFR Part 50.[1]

The staff concludes that the gaseous radwaste system for Units 2 and 3 is capable of maintaining releases of radioactive materials in gaseous effluents to "as low as is reasonably achievable" levels in accordance with 10 CFR Part 50.34a and meets the requirements of Appendix I to 10 CFR Part 50. The staff, therefore, concludes that the proposed system is acceptable.

3.2.3.3 Solid wastes

The solid waste system will be designed to process two general types of solid wastes: "wet" solid wastes which require solidification prior to shipment, and "dry" solid wastes which require packaging and, in some cases, compaction prior to shipment to a licensed burial facility. "Wet" solid wastes will consist mainly of spent filter cartridges, demineralizer resins, and evaporator bottoms which contain radioactive materials removed from liquid streams during processing. "Dry" solid wastes will consist mainly of low-activity ventilation air filters, contaminated clothing, paper, and miscellaneous items such as laboratory glassware and tools. Spent resins from the demineralizers will be collected in the spent resin storage tank. When the resin is to be packaged, it will be sluiced to a disposable liner and dewatered before solidification. The resin beads are solidified by filling the void spaces with urea formaldehyde and catalyst. A disposable paddle is used to agitate the mixture in the liner during the solidification process. Concentrated evaporator wastes will be collected in an evaporator bottoms tank, and then pumped batchwise through an inline mixer where they are blended with a urea formaldehyde solution. From the inline mixer, the mixture is sprayed into a disposal liner while a liquid catalyst is simultaneously sprayed into the liner by a separate nozzle to assure intimate mixing of the waste-urea formaldehyde solution and the catalyst.

On the basis of its evaluation and on recent data from operating plants, the staff has determined that about 425 m^3 (15,000 ft^3) per unit of "wet" solid wastes, containing about 1060 Ci of activity, will be shipped offsite annually. The principal radionuclides in the solid wastes will be long-lived fission and corrosion products, mainly Cs-134, Cs-137, Co-58, Co-60 and Fe-55. The applicant estimated the combined production of solid wastes from Units 2 and 3 to be 283 m^3/yr (10,000 ft^3/ year) of solidified wastes. The applicant calculated the total curie content of these solid wastes to be about 6500 Ci. The waste containers will be stored in a shielded area, as required, to reduce contact radiation levels.

Dry solid wastes will be packaged in cardboard boxes, wooden boxes, and special DOT-approved containers. Compressible wastes such as clothing and rags will be compressed prior to packaging. The staff estimates the dry solid wastes to total 283 m^3 (10,000 ft^3) per unit per year with a total activity content of less than 5 Ci. The applicant estimates the combined production of dry wastes from Units 2 and 3 to be 207 m^3/yr (7300 ft^3/year) with a calculated total curie content of about 21 Ci.

3.2.4 Chemical, sanitary, and other waste effluents

3.2.4.1 Chemical effluents

Several design changes have had significant impacts on chemical discharges. The condenser tubes are made of titanium (ER, Table 3.4-1) rather than of a copper-nickel alloy; this should eliminate the small amounts of copper and nickel in the discharge as described previously

(FES-CP, Sect. 3.5.1). An Amertap condenser tube cleaning system has been installed (ER, Sect. 3.4.4). In this system, sponge rubber balls are injected into the inlet piping of the condenser and are forced through the condenser tubes to scrape them clean. The balls are collected in the circulating water discharge conduit and are recirculated. This change helps to control fouling within the circulating water system and should reduce the frequency of chlorination necessary to maintain a clean condenser system. A makeup demineralizer system will replace the flash evaporators. Chemicals originally indicated as being discharged from the flash evaporators (FES-CP, Table 3.9) will not be discharged. A cellulose sealant for the circulating water system (FES-CP, Sect. 3.5.1) will not be used. Steam generator blowdown will be treated by filtration and demineralization and will be recycled to the condenser. Phosphates will not be added to the blowdown (FES-CP, Sect. 3.5.2), and the discharge of salts and heavy metal ions will be eliminated.

The only significant chemical discharge results from the use of sodium hypochlorite as a biocide. The chlorination system is common to both Units 2 and 3. The two units will not be treated at the same time. Hypochlorite solution will be injected into the circulating water pump discharge headers three times each day. Each injection will last about 15 min but will not exceed 90 min per unit per day. The chlorine residual in the circulating water discharge line is monitored by amperometric titration, and the addition of hypochlorite is adjusted to maintain a 0.5-mg/liter (1.89 grains/gal) maximum concentration of free available chlorine. The applicant estimates that this will result in a maximum free available chlorine concentration of 0.1 mg/liter (0.38 grains/gal) in the immediate vicinity of the discharge.

Other chemicals may be discharged at certain times. These chemicals generally will be discharged at low concentrations and, when mixed with the circulating water flow, represent a negligible concentration at the discharge to the ocean. During restarts the discharge of condensate from the hotwell may contain concentrations of several milligrams per liter of iron and copper. These substances will be reduced to negligible concentrations in the circulating water discharge. The discharge from the regeneration of demineralizers will contain sodium and sulfate ions; the concentrations at the discharge to the ocean will be less than 10 mg/liter (38 grains/gal) – negligible concentrations as compared to the natural concentrations in seawater. Small amounts of oil, not to exceed 5 mg/liter (19 grains/gal), will be discharged from the oil removal system and diluted to negligible concentration in the circulating water discharge. Various closed-loop cooling systems will be treated with potassium chromate to inhibit corrosion.

Offsite rainfall runoff from the coastal hills and from Interstate Highway 5 (I-5) is collected by the storm runoff drainage system for the highway. Part of this drainage is discharged directly to the ocean and part is discharged with the onsite plant drainage. Onsite plant drainage is collected in catch basins and is discharged with the circulating water discharge. Drainage collected in areas in which significant quantities of oil or grease might be present are routed through the oil removal system.

A National Pollutant Discharge Elimination System (NPDES) permit for SONGS 2 & 3 was issued on June 14, 1976, by the California Regional Water Quality Control Board, San Diego Region. The chemical effluent limitations for the combined discharges (cooling water, low-volume wastes, and storm drains) are: (1) the monthly average free available chlorine discharged shall not exceed 0.2 mg/liter (0.757 grains/gal), and the daily maximum shall not exceed 0.5 mg/liter (1.89 grains/gal); (2) discharge of free available chlorine or total residual chlorine from any plant unit for more than 2 hr in any one day or for more than one unit in the plant at any one time is prohibited; (3) the pH of the effluent shall be within the range of 6.0 to 9.0; and (4) after July 1, 1976, the discharge shall not exceed the limits given in Table 3.4. The permit prohibits the discharge of any chemicals or pollutants from the fish handling system. The low-volume waste discharge shall not exceed the following limits: (1) a monthly average of 30 mg/liter (113.6 grains/gal) and a daily maximum of 100 mg/liter (378.6 grains/gal) for total suspended solids and (2) a monthly average of 15 mg/liter (56.78 grains/gal) and a daily maximum of 20 mg/liter (75.7 grains/gal) for oil and grease. The discharge from the storm drains shall not exceed a monthly average of 10 mg/liter (38 grains/gal) and a daily maximum of 15 mg/liter (56.78 grains/gal) for oil and grease.

3.2.4.2 Sanitary and other waste effluents

Sanitary wastes from Units 2 and 3 will receive secondary level treatment in the sewage treatment plant located at Unit 1, which will serve all three units. The treated wastes will have the following water quality characteristics (average daily concentration): suspended solids, 30 mg/liter (113.6 grains/gal); biological oxygen demand, 30 mg/liter(413.6 grains/gal); coliform, mean probable number of 200 per 100 ml (59 per ounce); pH, 7.0 to 8.5; and total residual chlorine, 2.0 mg/liter (7.57 grains/gal) (ER, Table 5.4-1). The treated wastes will be discharged into the Unit 1 circulating water discharge at an average rate of about 0.02 m^3/min (5 gpm). Because the circulating water discharge at Unit 1 is about 1200 m^3/min (320,000 gpm), the sanitary waste effluents will be reduced to negligible concentrations at the point of discharge to the ocean. The sanitary waste effluents for all three units will be within the

Table 3.4. NPDES chemical effluent limitations

Constituent	Concentration (mg/liter) not to be exceeded more than	
	50% of time	10% of time
Arsenic	0.01	0.02
Cadmium	0.02	0.03
Total chromium	0.005	0.01
Copper	0.2	0.3
Lead	0.1	0.2
Mercury	0.001	0.002
Nickel	0.1	0.2
Silver	0.02	0.04
Zinc	0.3	0.5
Cyanide	0.1	0.2
Phenolic compounds	0.5	1.0
Total chlorine residual	1.0	2.0
Ammonia (as N)	40	60
Total identifiable chlorinated hydrocarbons	0.002	0.004
Toxicity concentration	1.5[a]	2.0[a]

[a]Toxicity units.
Source: ER, Appendix 12C.

(To convert mg/liter to grains/gal, multiply by 3.785.)

limitations established for Unit 1 by the California Regional Water Quality Board and the Environmental Protection Agency.

Some gaseous wastes from the operation of diesel generators and the auxiliary boiler will be discharged intermittently. Four diesel generators will serve Units 2 and 3, and it is anticipated that these will operate for about 2 hr once per month. The estimated hourly full-load emission in kilograms (pounds) from each generator is nitrogen oxides, 84 (185); sulfur dioxide, 11 (25); particulates, 0.9 (2); hydrocarbons, 3.9 (8.5); and carbon monoxide, 9.5 (21) (ER, Sect. 3.7.4.1). A single auxiliary boiler will be used for both Units 2 and 3. This boiler will be operated for varying time periods throughout the life of the plant (ER, Sect. 3.7.4.2). The maximum annual use is expected to be 1250 hr at full load and 3130 hr at half load. Under these conditions, the anticipated annual emissions in tonnes (tons) are nitrogen oxides, 44 (49); sulfur dioxide, 98 (108); and particulates, 34 (38).

Trash from screens for the circulating water system for Units 2 and 3 will be taken to the Bonsall Sanitary Landfill near the city of Vista, California. This landfill is used for the disposal of trash from Unit 1.

3.2.5 Transmission lines

Much of the description of the transmission lines presented in Sect. 3.7 of the FES-CP is no longer valid. Construction of SCE's transmission line from SONGS to Santiago Substation will be completed only up to Santiago Tap, thereby deleting that portion between Santiago Tap and Santiago Substation. SDG&E's line from Telega Substation to Escondido Substation has also been deleted. SCE will retrofit transmission lines from SONGS to Santiago Tap, Santiago Tap to Santiago Substation, and Santiago Tap to Black Star Canyon Tap. SDG&E will add a line from SONGS to Mission Substation. SDG&E's lines from SONGS to Telega Substation and SONGS to Encina Substation will still be constructed but the staff has received additional information with regard to these lines since issuance of the FES-CP. Therefore, these lines will be further discussed in Sect. 3.2.5.2. All transmission lines for operation of SONGS Units 2 and 3 are illustrated in Figs. 3.7 and 3.8. Generally, the lines are coastal, using existing rights-of-way traversing northward from SONGS to Talega Substation, Santiago Tap, Santiago Substation, and Black Star Canyon Tap, and southeast to Encina and Mission Substations. A total of about 159.1 km (98.9 miles) will be crossed by the transmission lines. No new rights-of-way, however, will be required.

The SCE and SDG&E transmission lines will each be supported by two steel horizontal portal structures (Fig. 3.9) for the initial 0.6 km (0.4 mile) of right-of-way northeast of the SONGS switchyard. These structures will replace the steel lattice towers now supporting the existing circuits in this area. No additional land for tower bases or access roads will be required.

ES-4080

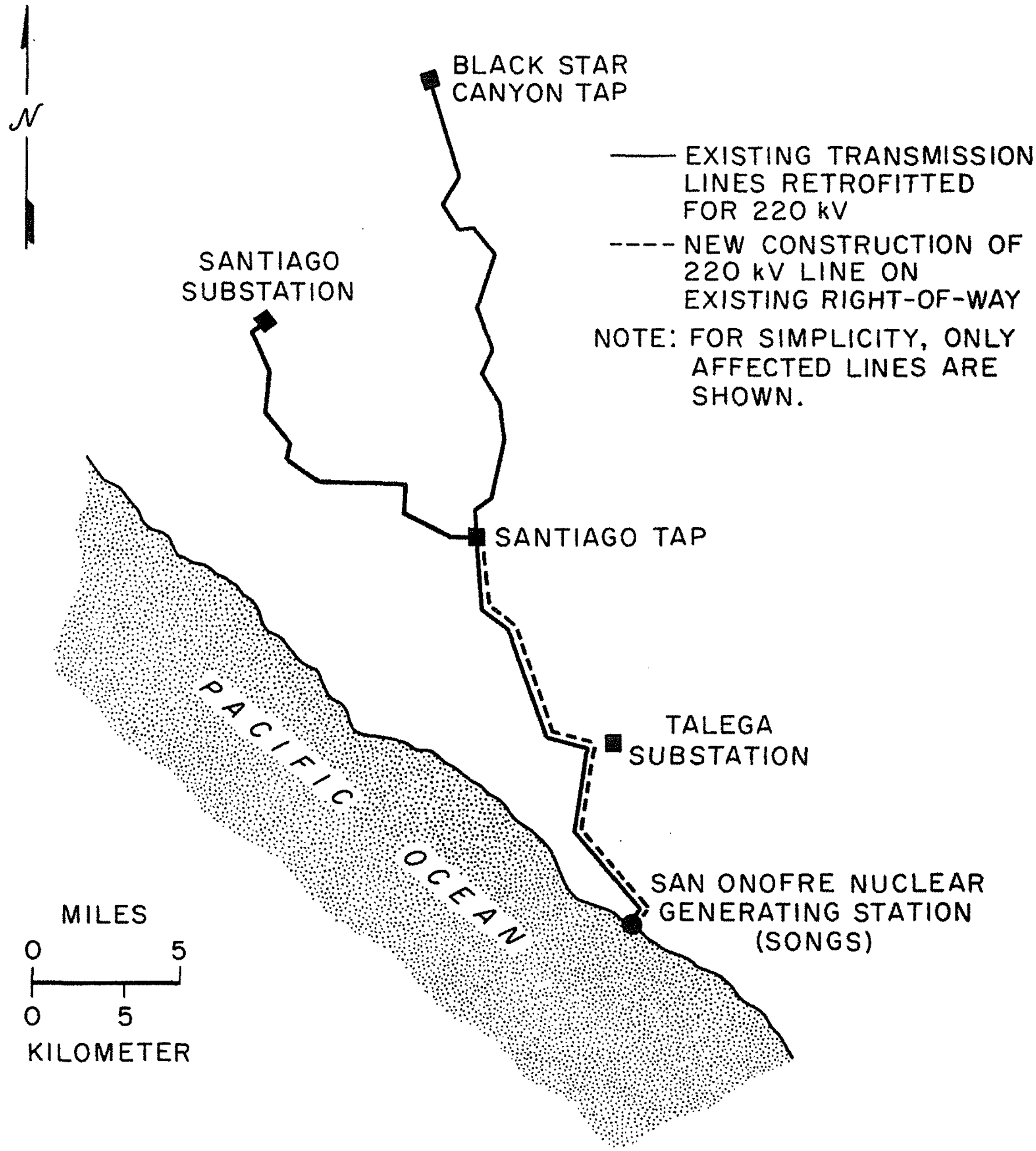

Fig. 3.7. Schematic diagram of proposed Southern California Edison Company transmission lines for SONGS 2 & 3.

3.2.5.1 SCE transmission lines

A double circuit 220-kV transmission line will be constructed between SONGS and Santiago Tap, an approximate distance of 24.3 km (15.1 miles) (Fig. 3.7). About 73 steel lattice towers (Fig. 3.10) will be required for this line, with an average span of about 335 m (1100 ft) between towers. The average tower height is estimated to be 39.6 m (130 ft). The new tower bases will require 2.44 ha (6.03 acres), and access road extensions are expected to require 1.32 ha (3.25 acres) of land (ER, Suppl. 2, Item 36). Additional transmission lines required by SCE that were not discussed in the FES-CP are those from SONGS to Santiago Tap, Santiago Tap to Santiago Substation, and Santiago Tap to Black Star Canyon Tap. These lines, totaling

ES-4079R

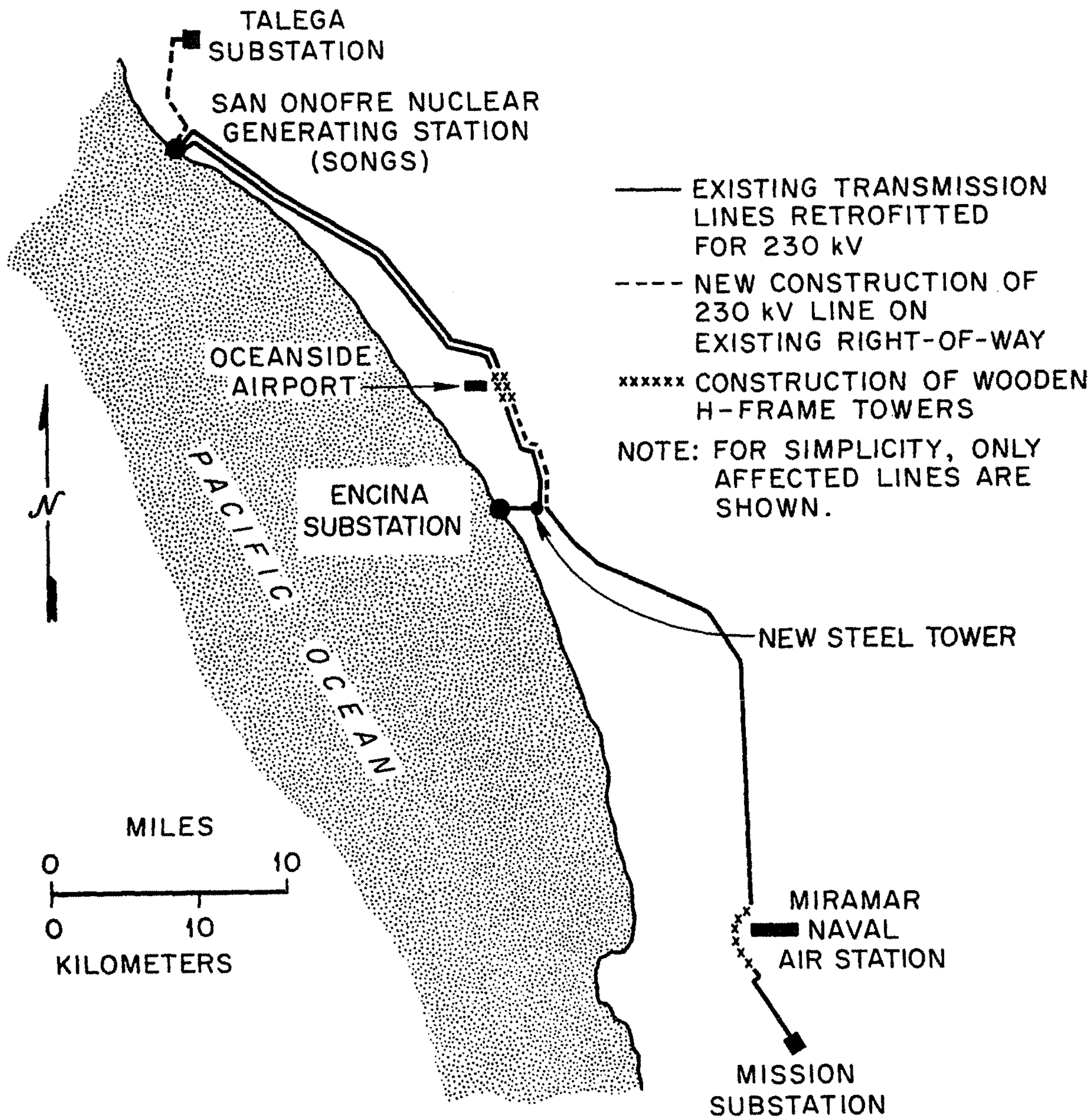

Fig. 3.8. Schematic diagram of proposed San Diego Gas and Electric Company transmission lines for SONGS 2 & 3.

71.7 km (44.2 miles) will be retrofitted to operate at 220 kV. Retrofitting will involve the replacement of existing conductors with larger ones (on existing towers) and the construction of four additional towers between Santiago Tap and Black Star Canyon Tap.[4] These towers are required to provide adequate ground clearance in some spans where the wire tension will have to be reduced from its present value (ER, Sect. 3.9.1.1). This additional construction is expected to require 0.13 ha (0.33 acres) of land for new tower bases and 0.52 ha (1.3 acres) for access road extensions (ER, Suppl. 2, Item 36).

The material storage yard for SCE transmission lines will be located about 1.6 km (1 mile) north of the San Onofre Nuclear Generating Station within Camp Pendleton Marine Base. The area involved will be about 2.2 ha (5.5 acres) and will not require any clearing or opening of new roads (ER, Suppl. 2, Item 30).

ES-4112

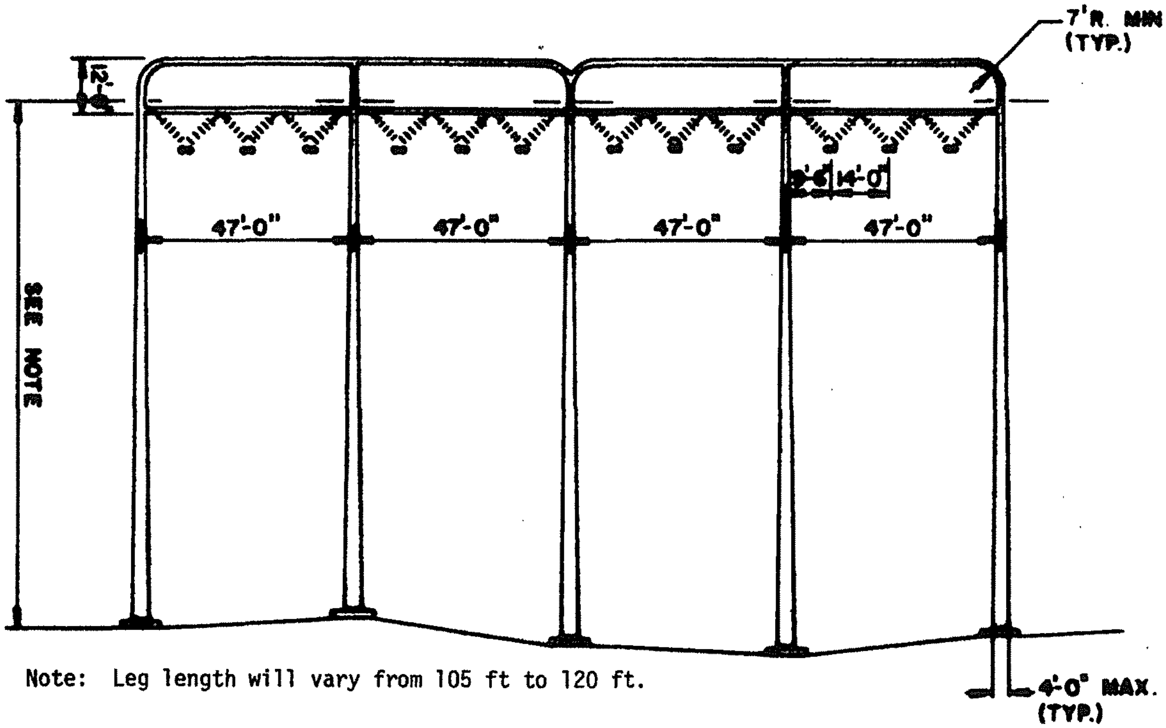

Fig. 3.9. Four-circuit steel horizontal portal structures used by Southern California Edison Company; San Diego Gas and Electric Company will use a similar structure with five circuits. Source: ER, Fig. 3.9-2.
(To convert ft to m, multiply by 0.3048.)

3.2.5.2 SDG&E transmission lines

The only transmission line required by SDG&E that was not discussed in the FES-CP will run between SONGS and Mission Substation, a distance of 85 km (53 miles) (Fig. 3.8). This line will be installed by adding a 230 kV circuit to the vacant position on existing double circuit towers;[1] some of the existing towers will be replaced. A total of about 36 wooden H-frame towers (Fig. 3.11) will be constructed along a 1.6-km (1-mile) segment east of Oceanside Airport and a 6.8-km (4.2-mile) segment opposite Miramar Naval Air Station to accommodate FAA regulations.[1] About 9 km (5.6 miles) of existing 138 kV wood structures south of the Oceanside Airport will be replaced by approximately 32 double circuit steel lattice towers (Fig. 3.12). The construction of the new towers for this line will not require any additional land for tower bases or access roads (ER, Suppl. 2, Item 36). Subsequent to issuance to the FES-CP, additional information was supplied by the applicant regarding the line from SONGS to Encina Substation and SONGS to Talega Substation. The line from SONGS to Encina Substation, 40 km (25 miles), will be formed by adding a 230 kV circuit to the vacant position on existing double circuit towers.[1] In addition, approximately four wooden H-frame towers (Fig. 3.11) will be constructed along a 1-km (0.6 mile) segment east of Oceanside Airport to accommodate FAA regulations. To facilitate arrangement of the new conductors, a single steel tower will also be installed east of Encina Substation. All new structures will be constructed within existing rights-of-way and will not require any additional land for tower bases or access roads (ER, Suppl. 2, Item 36). The line from SONGS to Talega Substation traverses about 11.3 km (7 miles) and will require construction of about 32 steel lattice towers (Fig. 3.12). The new tower bases will require about 0.23 ha (0.58 acre), and access road extensions are expected to require 0.53 ha (1.3 acres) of land (ER, Suppl. 2, Item 36). Because SDG&E's original plan assumed that the Talega Substation would be constructed and in operation prior to completion of SONGS 2 & 3 (ER, Suppl. 2, Item 25), this facility was discussed in the FES-CP as if it were already in existence. Construction, however, was delayed. The proposed Talega Substation is expected to cover 2 ha (5 acres) of land; an additional 2 ha (5 acres) around the substation will also require grading.

The material storage yard for SDG&E transmission lines will be located in existing substations with the following exceptions: (1) fencing a level area of about 0.09 ha (0.23 acre) adjacent

ES-4113

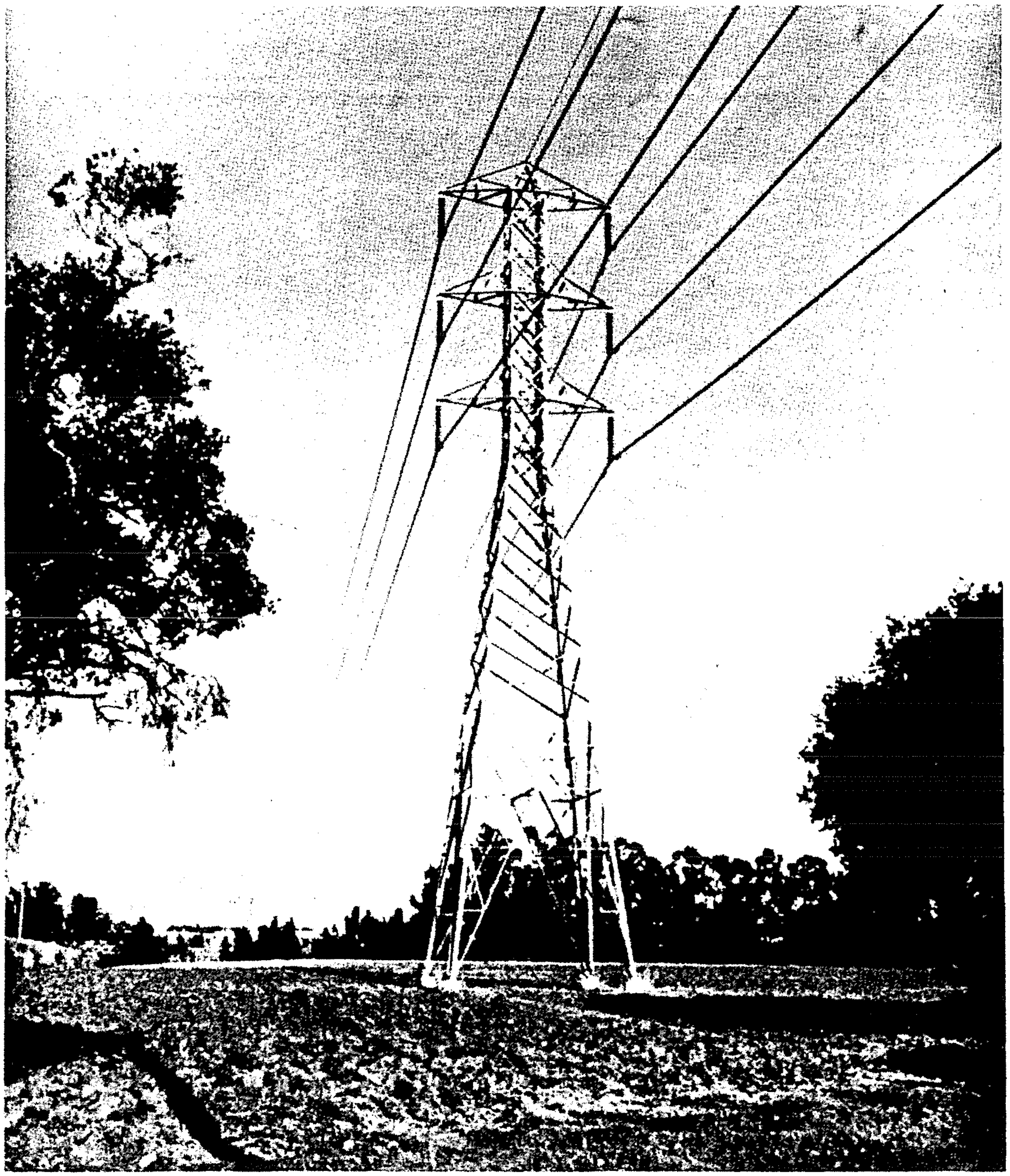

Fig. 3.10. Typical steel lattice tower design used by Southern California Edison Company. Source: ER, Fig. 3.9-3.

to the existing Pulgas Substation and (2) fencing a level area of about 0.09 ha (0.23 acre) adjacent to the Japanese Mesa Substation. No grading, clearing, or additional access roads are anticipated for this project (ER, Suppl. 2, Item 30).

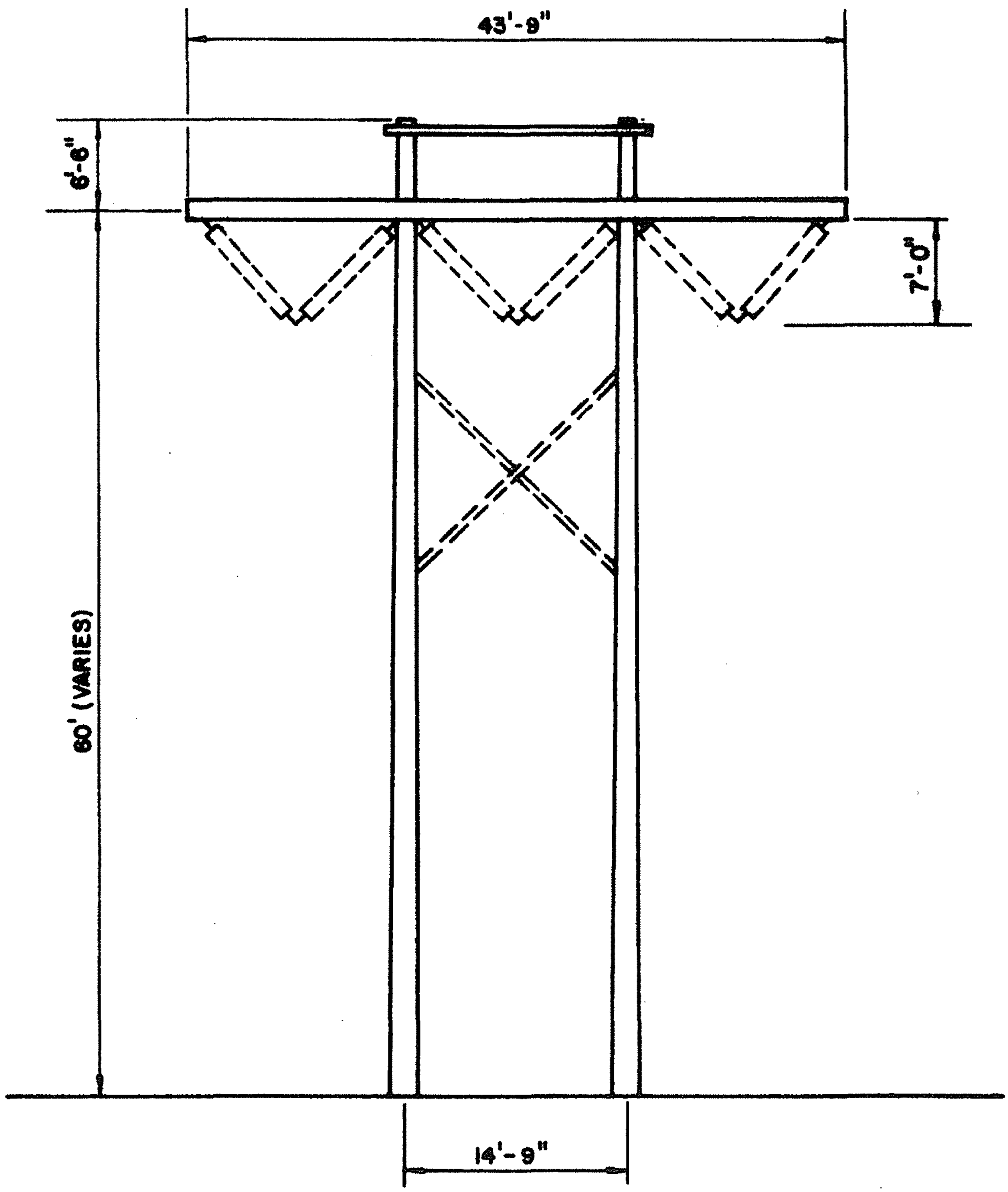

Fig. 3.11. Wooden H-frame tower used by San Diego Gas and Electric Company. Source: ER, Fig. 3.9-9.(To convert ft to m, multiply by 0.3048; to convert in. to mm, multiply by 25.4.)

3.2.6 Probable maximum flood berm

3.2.6.1 Description of structure and existing environment

Subsequent to issuance of the FES-CP the applicant was required to construct an earthern berm to protect the Station form the probable maximum flood (PMF). Construction of this structure

ES-4114

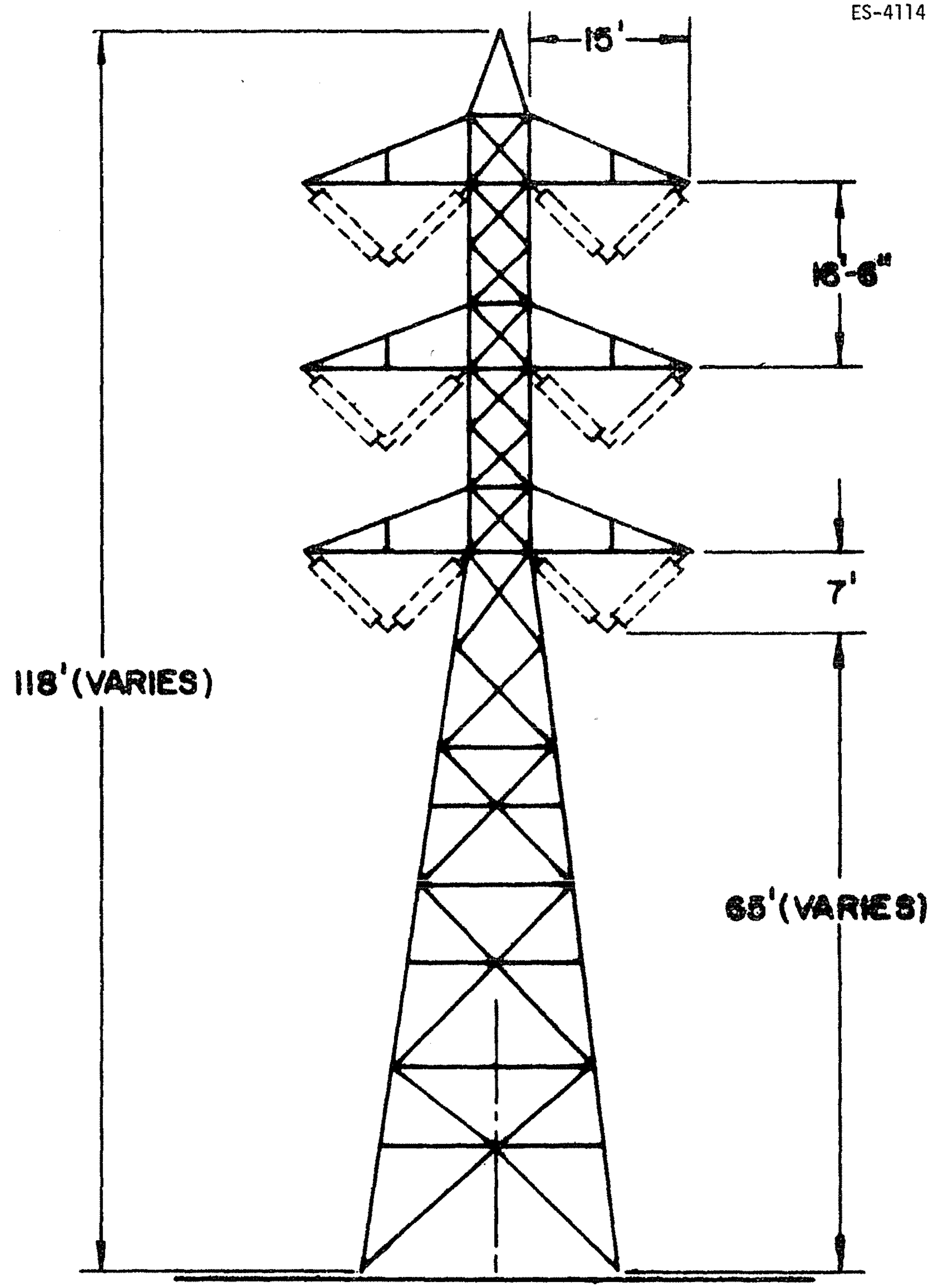

Fig. 3.12. Typical steel lattice tower design used by San Diego Gas and Electric Company. Source: ER, Fig. 3.9-8.(To change ft to m, multiply by 0.3048.)

and associated environmental impacts are presented by the applicant in a letter to the NRC[5] and in the applicant's final safety analysis report (FSAR).

The San Onofre site is located on a coastal plain at the base of the western foothills of the Santa Margarita Mountain Range. Elevation in this area rises sharply from sea level to a fairly level terrace formation 30 to 61 m (100 to 200 feet) above sea level. About 450 m (1500 feet) inland the foothills begin, rising with moderate slopes to an elevation of about 900 m (3000 ft) above sea level. Natural plant cover in the coastal plain typically consists of coastal chaparral and grassland, while in the foothills it is composed primarily of chaparral and open woodland.

There are no perennial streams in the general vicinity of the plant site. However, ephemeral streams and water courses do exist. The major streams are San Mateo Creek, located about 3.2 km (2 miles) to the northwest and San Onofre Creek located approximately 1.6 km (1 mile) to the northwest. The drainage divide separating San Mateo and San Onofre Creeks precludes the plant site from being influenced by San Mateo Creek. The applicant's results of the probable maximum flood (PMF) analysis concluded that the San Onofre Creek Basin exhibits no flooding potential to the site (FSAR, Sect. 2.4.2.2). Topographical features of the basin would contain the maximum flood stage and thereby preclude flooding of the site by this source. The foothill drainage basin, however, does contribute to the hydrologic factors influencing the plant site. The basin totals 2.2 km^2 (0.86 mi^2). There are no gaging stations located within the basin and, consequently, stream flow records are not available.

The entire watershed of the foothill drainage basin lies within the boundaries of the Marine Corps Base, Camp Pendleton. Elevation of the basin varies between 30 to 365 m (100 to 1200 feet) above sea level. Ground slope varies from 8 to 22%. Ground cover is moderate, consisting mainly of chaparral and grassland.

Water control structures at the foot of this basin consist of the 107- and 183-cm (42- and 72-in.) diameter concrete culverts under I-5. The capacity of these culverts is 5.1 and 14.7 m^3/sec (180 and 520 ft^3/sec), respectively. In addition to the two culverts, an earthern channel traverses the basin along the east side of I-5 diverting runoff to San Onofre Creek. The capacity of the channel is 52.4 m^3/sec (1850 ft^3/sec).

The applicant's analysis of the flooding potential of the foothill drainage area indicated that the plant site could be subjected to flooding during the occurrence of the PMF. In order to preclude flooding of the site by this source a diversion structure routes the surface runoff from the foothill drainage area to the San Onofre Creek Basin. This PMF structure will be an earthern berm, having an isoceles trapezoid cross section that is 2.4 m (8 feet) high and 12.8 m (42 feet) wide at its base, with 2:1 side slopes. The berm will parallel I-5 and will be 2.7 km (1.68 miles) long. The existing channel which parallels the proposed berm will be widened where necessary and will vary from 7.6 to 30.5 m (25 to 100 ft) in width. The berm will cover a portion of an existing road, El Camino Real Road, requiring the construction of a new road. The relocated road will run approximately parallel to and east of the proposed PMF berm.

Relocation of the road will require about 1.4 ha (3.5 acres) of land, the berm will cover approximately 3.5 ha (8.6 acres), and the channel (assuming a 30 m (96 ft) width) will require about 8.3 ha (20.6 acres) for a total land area requirement of 13.2 ha (32.7 acres). The existing channel and El Camino Real Road are included in this acreage.

A terrestrial biological survey of the site was conducted on October 25 and 31, 1977. Vegetation on the site is basically a southern coastal sage scrub community, being influenced by the coastal marine climatic conditions. However, nearly half of the site (northern portion) has been previously disturbed as evidenced by the presence of many non-native "weedy" species including saltbush (Atriplex semibaccata), Russian thistle (Salsola kali), mustard (Brassica geniculata) tree tobacco (Nicotiana glauca), and sow thistle (Sonchus oleraceus). Native species on this area include California sagebrush (Artemesia californica), California buckwheat (Eriogonum fascilculatum), and coyote brush (Baccharis pilularis). The southern half of the site is primarily vegetated with native species of the coastal sage scrub plant community including the native species listed above. The land on which the El Camino Real Road will be relocated contains many of the same species that occur at the berm site, but with a higher degree of cover.

Fauna surveys of the site and vicinity demonstrated that the majority of the species present were birds (24 species). Red-tailed hawks (Buteo jamaicensis) were prevalent in the vicinity using wooden posts, telephone and power poles as perches and a SCE lattice transmission tower for nesting. Although only 2 species of reptiles and 2 species of mammals were observed, others are likely to occur in the vicinity.

No threatened or endangered flora or fauna were observed on the proposed PMF Berm site, the area to be cut, or on the area where the El Camino Real Road is to be relocated.[5]

On November 14, 1977, an onsite inspection of the alignments of both the proposed berm and access road was conducted to determine the presence or absence of surficial paleontologic

values.[5] Although the survey did not result in locating any fossils, a review of the literature revealed that all sedimentary formations in the vicinity contain fossils. No localities in the immediate area have been placed on the National Registry of Natural Landmarks.

The site was surveyed for archaeological resources on December 8, 15, and 16, 1977 (ref. 5). The northern third of the berm was not surveyed because it had previously been studied; some portions of the berm also were not adequately surveyed because of dense vegetation.[5] In one area, eight pieces of marine shell were observed. The shells, however, were weathered and worn and gave the appearance of paleontological specimens, rather than archaeological remains.[5] An archaeological map and literature search revealed four recorded archaeological sites within 1.6 km (1 mile) of the proposed project, but none were located within the project area.[5]

3.2.6.2 Impacts of PMF berm

The berm will be built on top of an existing asphalt road. Consequently disruption of this area will have no significant biological impact. Widening the existing channel which parallels the proposed berm will require loss of about 8.5 ha (21 acres), and an additional 1.4 ha (3.5 acres) of habitat will be lost due to relocation of El Camino Real Road. Because these habitats do not represent unique communities, loss of this relatively small acreage should have no significant impact to biological resources of the area. To minimize the impact to raptors nesting in the vicinity the applicants will attempt to avoid construction activity during the period of March and April.[5]

The construction of the PMF berm might physically destroy fossils and/or relationships between fossils, or the environmental context of original deposition, that could provide significant paleontological data. In addition, the berm and new road may cover deposits containing significant paleontological data thereby making such data unreachable. To mitigate these potential impacts the applicants will conduct a paleontological survey prior to construction and monitor the excavation as it proceeds.[5] This will allow fossils to be salvaged as they are unearthed. Construction should be phased so that equipment could be shifted to other areas if fossils were located. Sufficient time should be allowed to uncover, record, and remove the fossils. If excavation were initiated in areas of highest paleontological potential, equipment could be moved to areas of low potential if paleontological values were encountered. This would provide a maximum amount of construction time and a maximum amount of time for paleontologic resource recovery.

Construction of the proposed PMF berm should not cause any direct or indirect adverse impact to known archaeological resources. However, the site would have been a favorable area for aboriginal habitation; i.e., an area of relatively flat topography with abundant fresh water and food resources.[5] The probability exists that buried resources may be in the area, especially where dense vegetation obscures the surface. Consequently, a trained archaeologist will monitor the construction activity and take appropriate conservation measures if necessary.[5]

No significant commitments of resources will result from construction and maintenance of the PMF Berm. The possibility exists that potential archaeological or palcontological resources would be destroyed during the excavation activity required for construction of the berm. However, if the proper mitigation measures are performed (monitoring, analysing, interpretating, preserving, and reporting), then these resources would not be irretrievable.

3.2.6.3 Floodplain management

The objective of Executive Order 11988, "Floodplain Management," is ". . . to avoid to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development whenever there is a practicable alternative." The Construction Permit was issued and the majority of construction completed prior to issuance of the Executive Order. Thus we conclude that no practicable alternative locations exist. The following is a discussion of floodplain conditions prior to construction of the plant and alterations made to these floodplains as a result of construction of San Onofre Units 2 and 3.

The San Onofre Units 2 and 3 are bounded on the east by Interstate Highway 5, the Atchison Topeka and Santa Fe Railroad and Highway 101. Interstate Highway 5 was constructed in 1968 prior to San Onofre Units 2 and 3. As part of the I-5 construction, a drainage channel designed for 100-year storm runoff was constructed parallel to and east of I-5. This channel intercepted tributary rainfall runoff from the foothills east of I-5 and transported it to the north away from the plant. The channel then merged with San Onofre Creek which in turn flowed to the Pacific Ocean.

The plant site which is bounded on the west by the Pacific Ocean was originally on a high coastal bench approximately 100 feet above sea level. Located at this elevation, the site was protected from severe flooding events and thus was not in the 100-year ocean floodplain.

The existing drainage channel which is west of and parallel to I-5, is being enlarged to contain floods and debris. The design capacity of the channel enlargement and extension is the Probable Maximum Flood, an event which is greater than the one-percent chance flood. The improvement will not induce higher flood stages.

The San Onofre plant grade is lower than the original coastal bench. However, construction of a seawall on the seaward side of the plant and east of the original bluff line provides protection from events larger than the one percent chance flood.

The plant, including the intake structure and seawall, is not built in the 100-year floodplain and will not be flooded by any 100-year flood levels. The intake crib and intake and discharge conduits are submerged on the ocean floor. The channel improvement east of Interstate Highway 5 will not increase flood levels. Therefore, the construction and operation of the San Onofre Unit 2 and 3 Nuclear Generating Station will comply with the intent of Executive Order 11988.

3.2.7 Emergency facilities

Emergency plans for San Onofre Units 2 and 3 call for an onsite Technical Support Center adjacent to the control room and an interim onsite Operational Support Center in the lunch room of the administration, warehouse, and shop building. Neither requires changes in the structural design or layout of the facility. An offsite Emergency Operations Facility is tentatively planned to be constructed on Japanese Mesa, east of Interstate 5, within the Camp Pendleton Reservation. This area was used for disposal of excavated material during construction. The structures must be designed to accommodate a minimum of 35 people.

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as Practicable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," May 5, 1975, and as amended Sept. 4, 1975, and Dec. 17, 1975, in Title 10, "Code of Federal Regulations," Part 50, Appendix I.

2. U.S. Nuclear Regulatory Commission, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)," NUREG-0017, April 1976.**

3. U.S. Nuclear Regulatory Commission, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," in Regulatory Guide 1.110, March 1976.**

4. Letter from Ira Thierer, Southern California Edison Co., to Dr. Knox Mellon, State Historic Preservation Officer, June 2, 1978.*

5. Letter from J. G. Haynes, Southern California Edison Co., to W. H. Regan, Jr., USNRC, undated, docketed on February 18, 1978.*

*Available for inspection and copying for a fee in the NRC Public Document Room, 1717 H St., N.W. Washington, DC 20555.

**Available from the NRC/GPO Sales Programs, Washington, DC 20555 and from the National Technical Information Service, Springfield, VA 22161.

4. STATUS OF SITE PREPARATION AND CONSTRUCTION

4.1 RESUME AND STATUS OF CONSTRUCTION

As of December 1980, the construction of SONGS Unit 2 was 97% complete, and SONGS Unit 3 was 68% complete. Figure 4.1 is a recent photograph of the site.

Impacts of construction have been identified in the FES-CP. The major terrestrial impact has been the excavation of about 16.4 ha (40.5 acres) of the San Onofre Bluffs, which resulted in the loss of a small amount of wildlife habitat. No rare or endangered animal species in the vicinity of the site have been or are expected to be adversely affected by construction activities.

The environmental impacts associated with changes in the routing of transmission lines subsequent to issuance of the FES-CP have been evaluated by the staff in its environmental impact appraisal regarding extension of the earliest and latest construction completion dates.

4.2 Offsite Emergency Operations Facility

An offsite Emergency Operations Facility is tentatively planned to be constructed on Japanese Mesa, east of Interstate 5, within the Camp Pendleton Reservation. This area was used for disposal of excavated material during construction. The structure must be designed to accommodate a minimum of 35 people. Construction of the Emergency Operations Facility on Japanese Mesa will not significantly disturb the area relative to previous disturbances.

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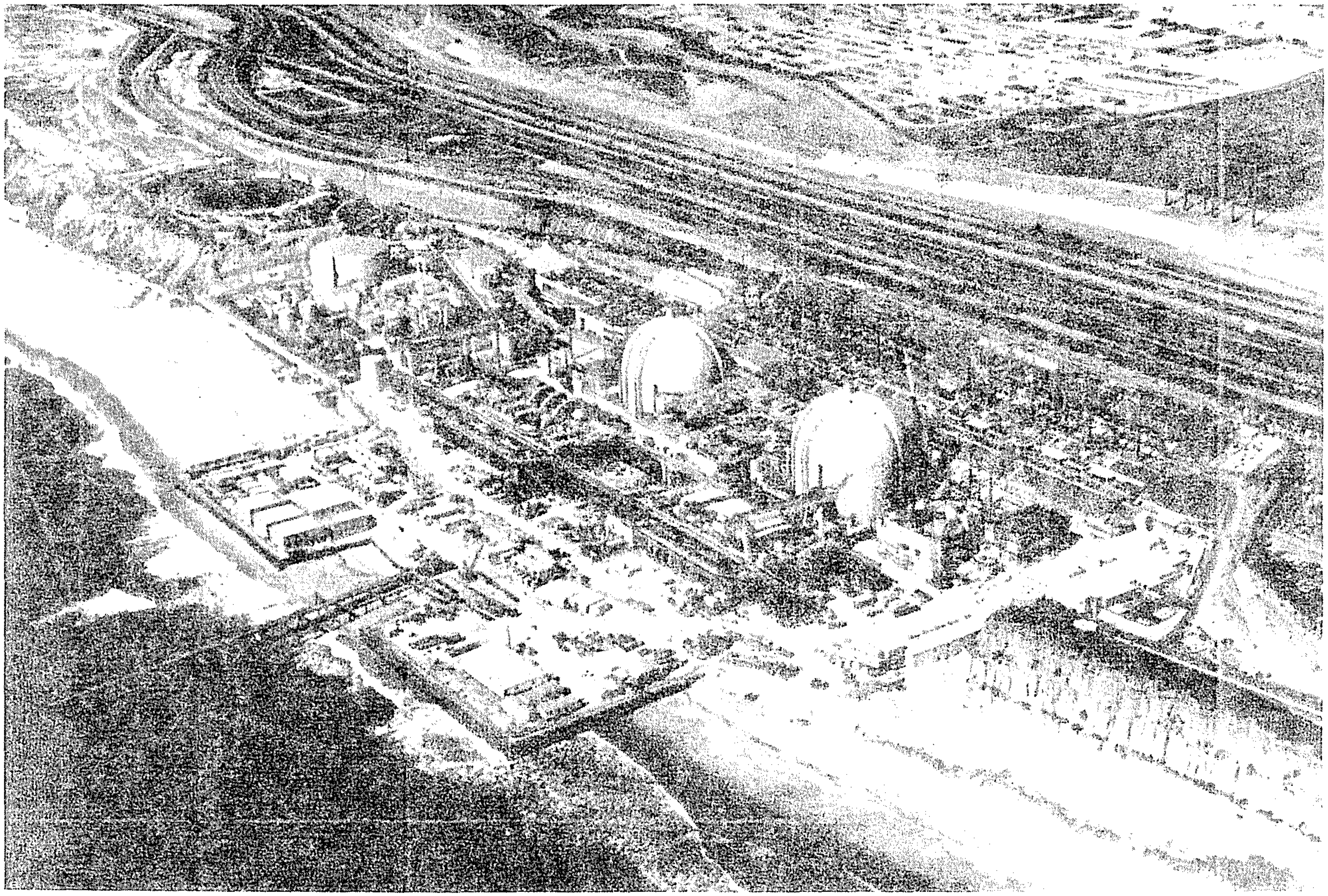

Fig. 4.1. Photograph of San Onofre Nuclear Generating Station taken in October 1980.

5. ENVIRONMENTAL EFFECTS OF STATION OPERATION

5.1 RESUME

The major design changes that have environmental effects involve the heat dissipation system. A more thorough analysis by the staff of the thermal plume is described in Sect. 5.3.1.2. The effects of the revised thermal-plume analysis on aquatic biota are discussed in Sect. 5.4.2.1. Changes in the effects of chemical effluents are discussed in Sects. 5.3.2 and 5.4.2.2. A revised discussion of radiological impacts is given in Sect. 5.5. Sect. 5.6 contains a revised assessment of the socioeconomic impacts.

5.2 IMPACTS ON LAND USE

Although the transmission line routes have been modified since the issuance of the construction permit (Sect. 3.2.5), the analysis of projected impacts as set forth in the FES-CP (Sect. 5.1) remains valid. All new transmission lines will be constructed on existing rights-of-way; a total of 5.2 ha (12.8 acres) of land will be required for access road extensions and for new tower bases.

The operation of SONGS 2 & 3 is not expected to affect any existing or proposed areas of the National Park System nor any existing or known potential sites to be listed as national landmarks.[1] In 1980, the applicant conducted a National Register assessment program of the 230 kV transmission right-of-way from San Onofre Nuclear Station to Black Star Canyon and Santiago Substation and to Encina and Mission Valley Substation and evaluated 41 previously identified archaeological sites. As a result of this effort, the NRC, in consultation with the State Historic Preservation officer, is seeking a determination of eligibility for inclusion in the National Register of Historic Places for 23 sites (see Appendix D, letter from Dr. Knox Mellon, State Historic Preservation officer, to D. C. Scaletti, USNRC, dated December 18, 1980). The staff agrees with the conclusions of the December 18, 1980, letter and will seek concurrence of determinations of effect from the Advisory Council on Historic Preservation.

5.3 IMPACTS ON WATER USE

5.3.1 Thermal discharges

5.3.1.1 Applicant's thermal analysis

The applicant retained the California Institute of Technology to perform a thermal analysis for the purpose of modifying the diffuser design in order to ensure compliance with state thermal standards. To accomplish this, a physical hydraulic model study was carried out at the W. M. Keck Laboratory of Hydraulics and Water Resources. The culmination of this effort was the diffuser design and configuration described in Section 3.2.2.

The physical model simulation was performed in a basin having horizontal dimensions of 11 m (36 ft) by 6 m (20 ft) which represents a prototype modeled region of about 8500 m (28,000 ft) by 4900 m (16,000 ft). The location and orientation of the Units 2 and 3 model intakes and diffusers within the basin are illustrated in Fig. 5.1. The bottom of the basin was filled with sand which was shaped to produce a simplified representation of the San Onofre bathymetry. The resulting bottom geometry was uniform in the longshore direction and varied as a composite of linear slopes in the offshore direction, as shown in Fig. 5.2. In order to satisfy scaling laws, the number of ports per laboratory diffuser was 16.

To perform simulations, the basin was filled with water at a constant temperature, then water at a temperature 16.67°C (30°F) higher was discharged through the diffusers. This excess temperature was required to maintain proper similitude and represents a 11.1°C (20°F) prototype excess temperature. Water was withdrawn from the basin through the intakes; however, this water was not recirculated. The model basin had the capability to simulate a variety of longshore current regimes, and among those investigated were no crossflow, crossflows of various amplitudes, reversing flows of various amplitudes, and special currents. The results of the simulations are summarized in the ER, Table 5.1-1. Among

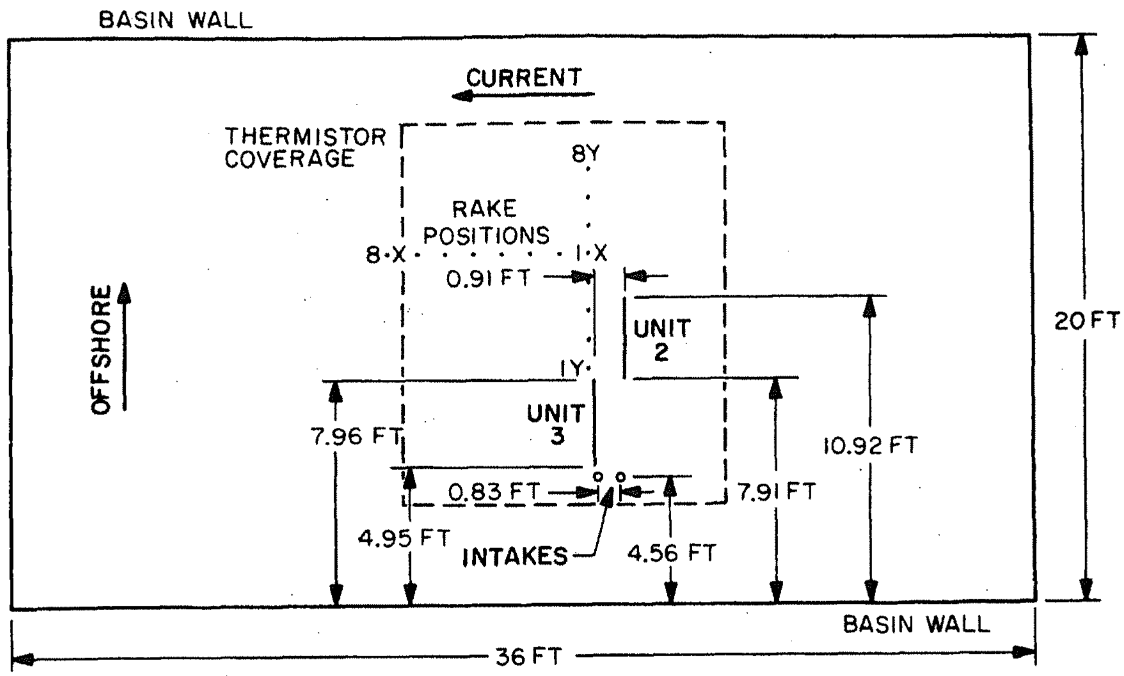

Fig. 5.1. Layout of basin used for the physical model study. Source: R. C. Y. Koh, N. H. Brooks, E. J. List, and E. J. Wolanski, *Hydraulic Modeling of Thermal Outfall Diffusers for the San Onofre Nuclear Power Plant*, W. M. Keck Laboratory of Hydraulics and Water Resources, California Institute of Technology, Report KH-R-30, January 1974, Fig. 6.1. (To change ft to m, multiply by 0.3048.)

these simulations, the worst case was that of zero crossflow. A plot of surface isotherms produced by the model for this case is given in Fig. 5.3. Further details of the physical-model study can be found in ref. 2. There are, however, certain physical conditions and mechanisms that could not be properly modeled in the laboratory. In an effort to account for this limitation on modeling, the modelers associated a probable temperature excess with each uncertainty. The total of these individual uncertainties was 0.83°C (1.5°F). It was therefore reasoned that state thermal standards should be met if the laboratory results satisfied these standards for 1.39°C (2.5°F), with the 0.83°C (1.5°F) margin of error, rather than 2.2°C (4.0°F).

It is evident from Fig. 5.3 that this case satisfies the state thermal standards. The applicant suggests that this is the worst case and, therefore, concludes that SONGS 2 and 3 will, under all conditions, comply with California State thermal standards.

The staff has reviewed the applicant's thermal analysis and believes that the physical model does not adequately represent certain hydrodynamic mechanisms and certain physical features of the prototype. The most significant of these is the duration of the physical model simulation. The staff believes that the physical model simulation, which yielded the result given in Fig. 5.3, has not reached thermal equilibrium. This is apparent in the applicant's results for surface excess temperature versus time given in Fig. 5.4. The upper curve represents the maximum surface temperature as a function of time anywhere in the basin, while the lower curve represents the maximum surface temperature as a function of time beyond 305 m (1000 ft) from the discharge point. The time scale for thermal equilibrium in the upper curve is a function of the time required for the heated water from the discharge to reach the surface and, therefore, should be relatively short. The staff has substantiated this by performing a least-squares curve fit on the data shown in the upper curve. The results show that the maximum surface excess temperature anywhere in the basin is increasing less than 0.028°C (0.05°F) per day. This is small compared with the standard deviation of the curve fit and, therefore, thermal equilibrium can justifiably be assumed. Beyond 305 m (1000 ft) from the discharge, the thermal equilibrium time scale will be a function of the rate of transport of heated water by densimetric effects and diffuser momentum away from the discharge point. This time scale should be longer than that for thermal equilibrium near the discharge. A similar curve fit performed on the lower plot reveals that the excess surface temperature beyond 305 m (1000 ft) from the discharge is increasing by approximately 0.16°C (0.29°F) per day. The staff believes that such a time-rate-of-change of temperature does not represent thermal equilibrium. Using a mathematic model, the staff has qualitatively reproduced the applicant's results. However, this mathematical simulation demonstrates that for increased

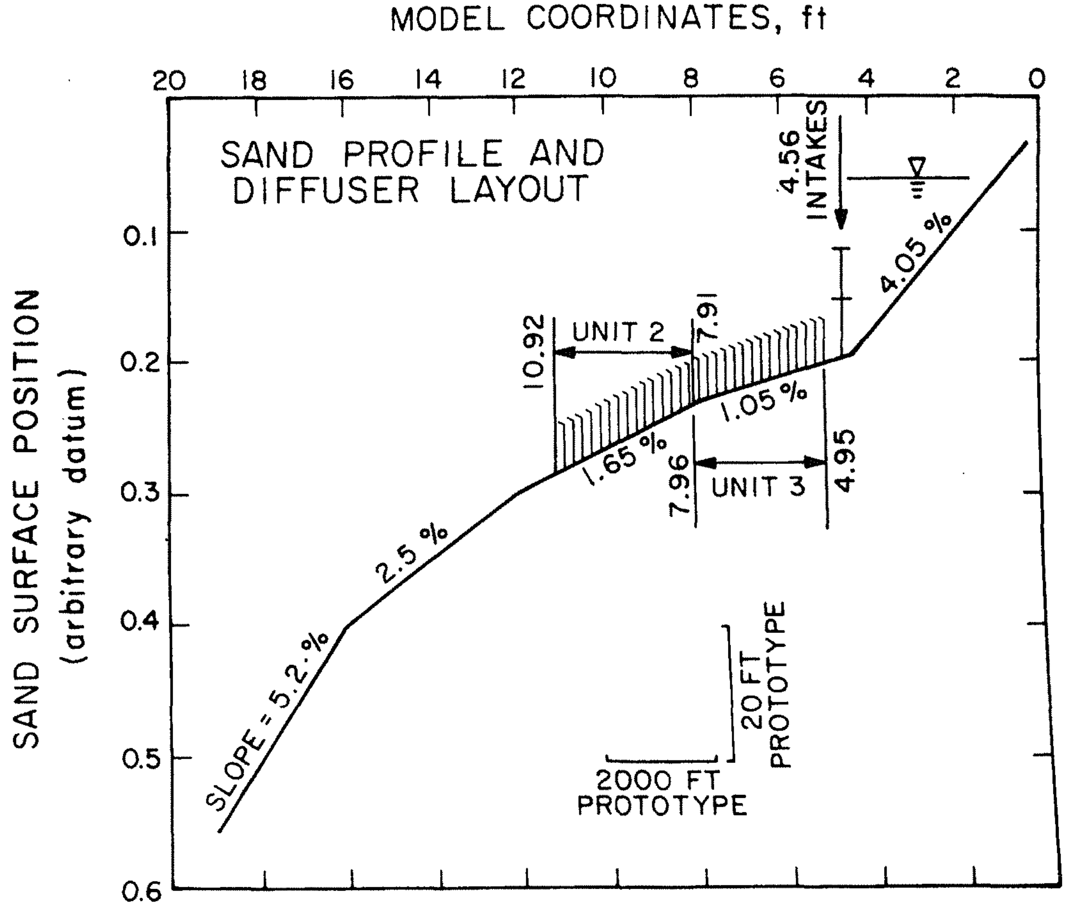

Fig. 5.2. Bottom profile used for the physical model study. Source: R. C. Y. Koh, N. H. Brooks, E. J. List, and E. J. Wolanski, "Hydraulic Modeling of Thermal Outfall Diffusers for the San Onofre Nuclear Power Plant," W. M. Keck Laboratory of Hydraulics and Water Resources, California Institute of Technology, Report KH-R-30, January 1974, Fig. 6.2. (To change ft to m, multiply by 0.3048)

duration of the simulation, there is a substantial increase in the predicted excess temperatures. In fact, for the conditions represented in Fig. 5.3, an increase in simulation time would likely have resulted in predicted excess temperatures that violate state thermal standards. However, such a prediction is unimportant because the particular simulation then represents conditions so unrealistic that the results become irrelevant.

Although the problem of underprediction is inherent in all the applicant's results, it is less significant for the realistic cases. For conditions more realistic than those in Fig. 5.3, the predicted excess temperatures are sufficiently low so that no violations of thermal standards would be expected as a result of increases of simulation duration in the physical model. This expectation is confirmed by the staff's mathematical model study.

5.3.1.2 Staff's thermal analysis

The staff has performed an independent thermal analysis for the proposed operation of the once-through cooling system. Depth-averaged numerical models from the Unified Transport Approach[3] were used to simulate plant-induced flows, natural flow, and water temperatures. Predictions have been made for conditions typical of mid-July, since this is the time of year when thermal impacts should be the most severe. The modeled region is a rectangle measuring approximately 24,000 m (80,000 ft) in the longshore direction and approximately 12,000 m (40,000 ft) in the offshore direction. This region with the numerical grid system superimposed is shown in Fig. 5.5.

ES-4570

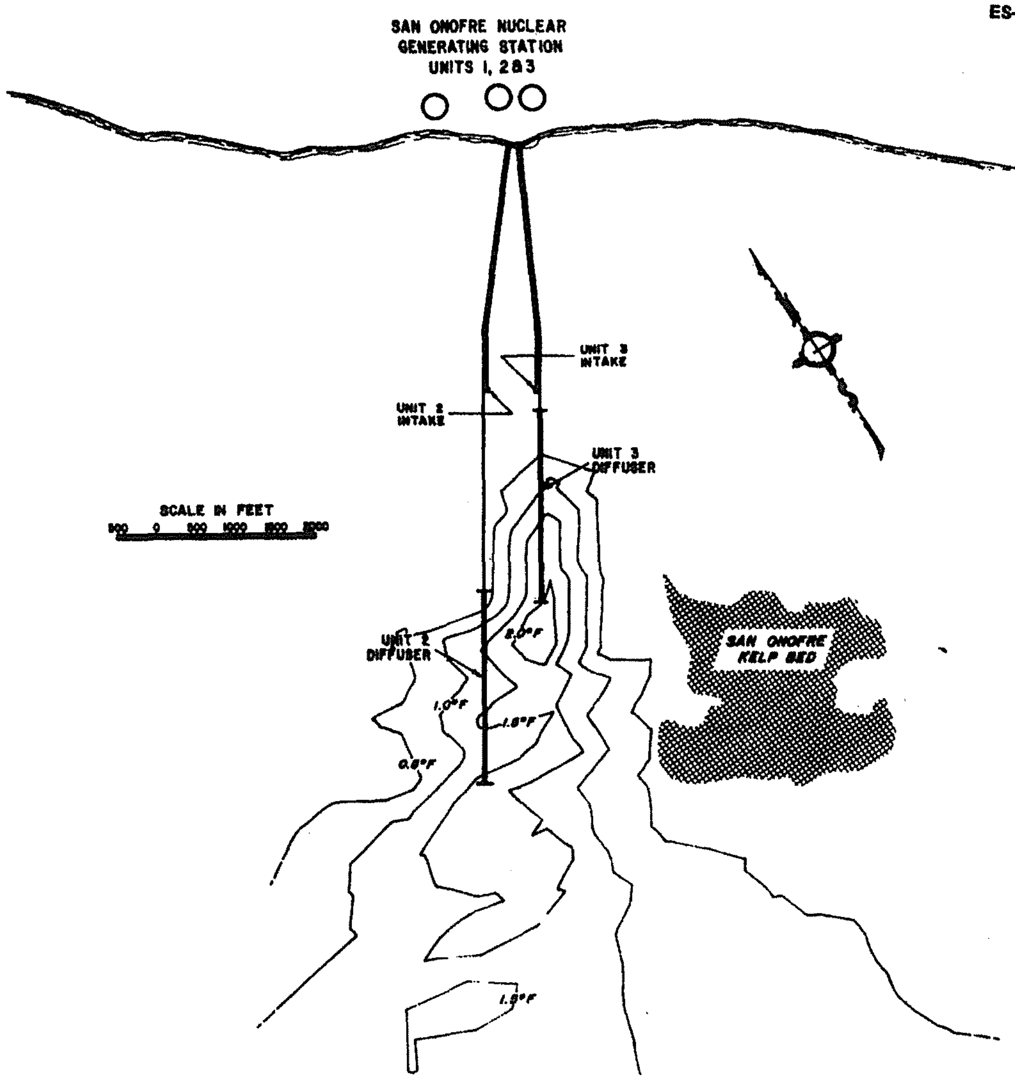

Fig. 5.3 Excess temperature at the surface predicted in the physical model study, for the case of no ambient flow. Source: ER Fig. 5.1-1. (To change ft to m, multiply by 0.3048; to change F° to C°, divide by 1.8.)

One numerical model was used to generate the induced flow from intakes and discharges from all three units. In this model, the intakes are represented as point sinks and the Unit 1 discharge is represented as a point source. The diffusers for Units 2 and 3 are each represented as a superposition of five jets. The hydrodynamics of each jet is modeled using a uniformly valid singular-perturbation theory, numerically corrected for bathymetry. The individual flows from the three intakes and discharges were summed to generate a total plant-induced flow field, as shown in Fig. 5.6.

A quasi-potential hydrodynamic model was used to generate the magnitude and direction of the natural currents and free surface displacement resulting from two tidal components and a net downcoast drift, at each grid element. The open-water boundary conditions were adjusted to produce flows which are consistent with observed data[4-7] from current meters and drogues. Three individual runs were executed, one for each of the two tidal harmonics (a 12.4 hr period and a 24.8 hr period), and a third to generate the drift current. These three flow components were combined, with the appropriate phase relationships, to produce a simulation of the natural flow field during mid-July conditions.

ES-4816

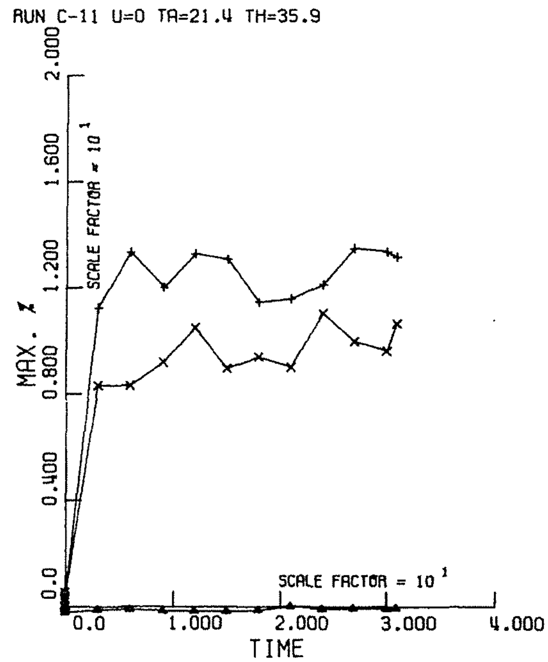

Fig. 5.4. *Summary of maximum temperature excesses (in percent of source temperature* excess) measured anywhere in basin (+), beyond 305 m (1000 ft) of diffusers (x), and ambient temperature (Δ) (Run C-11, u = 0.0 knot).

Water temperatures were computed using a depth-averaged thermal model. Inputs to this model were the calculated natural and plant-induced flows, along with meteorological parameters used for surface heat transfer calculations. The required meteorological variables are incoming solar radiation, cloud cover, air temperature, wind speed, and relative humidity. The incoming solar radiation is the mid-day value, which the code automatically adjusts for the time of day, from sunrise to sunset. The remaining parameters are taken to vary sinusoidally over one day and, therefore, require as input the daily average, the amplitude of the daily variation, and the time of maximum value. Typical values for these parameters during mid-July were used and are shown plotted as a function of time in Fig. 5.7.

This thermal model was first run without thermal output or flow from any of the units to produce a five-day simulation of ambient ocean temperatures. Subsequently, the calculation was repeated, with all three units operating at full capacity, to predict the total temperature field. These two results were then subtracted to generate excess temperature plots. Figures 5.8 through 5.15 show ambient flow and excess temperature plots at 6 hr intervals during the fifth day of the simulation at 2:00 am, 8:00 am, 2:00 pm, and 8:00 pm respectively. Isotherms are plotted in increments of 0.28°C (0.5°F) from 0.28°C (0.5°F) to 2.8°C (5.0°F). In general, the hottest spots occur directly above the discharge for each unit, with Unit 1 being consistently hotter than Unit 2 or 3. In addition, during the part of the tidal cycle when the natural flow is downcoast, there is a secondary warm spot approximately 3000 m (10,000 ft) downcoast of the discharges. This apparently is a result of the influence of the shape of the shoreline on the flow which, in turn, causes the plume from Units 2 and 3 to intersect the plume from Unit 1 at this point downcoast.

California thermal standards require that the 2.2°C (4°F) excess temperature isotherm never reach the shoreline or bottom, and that the 2.2°C (4°F) surface isotherm must be within 305 m (1000 ft) of the discharge point during at least one-half of the tidal cycle. Although the thermal model is depth averaged, it is still possible to address the state standards with the model results because the ambient crossflow has a destabilizing effect upon the discharge buoyancy. During portions of the tidal cycle, the ambient crossflow is of sufficient magnitude to dominate the stable stratification, resulting in mixing of the plume to the ocean bottom in the neighborhood of the diffuser. Recent work by Almquist[8] provides the basis for determination of conditions for vertical mixing. According to Almquist, the warm plume will mix to the bottom when the ratio of the ambient crossflow velocity to the cube root of the buoyancy flux per unit length of diffuser is greater than one. Figure 5.16 (a) is a plot of this stability parameter versus time for one tidal cycle based on the staff's ambient flow predictions. The shaded area shows the period during the tidal cycle when instability will occur and the water column will be vertically homogeneous.

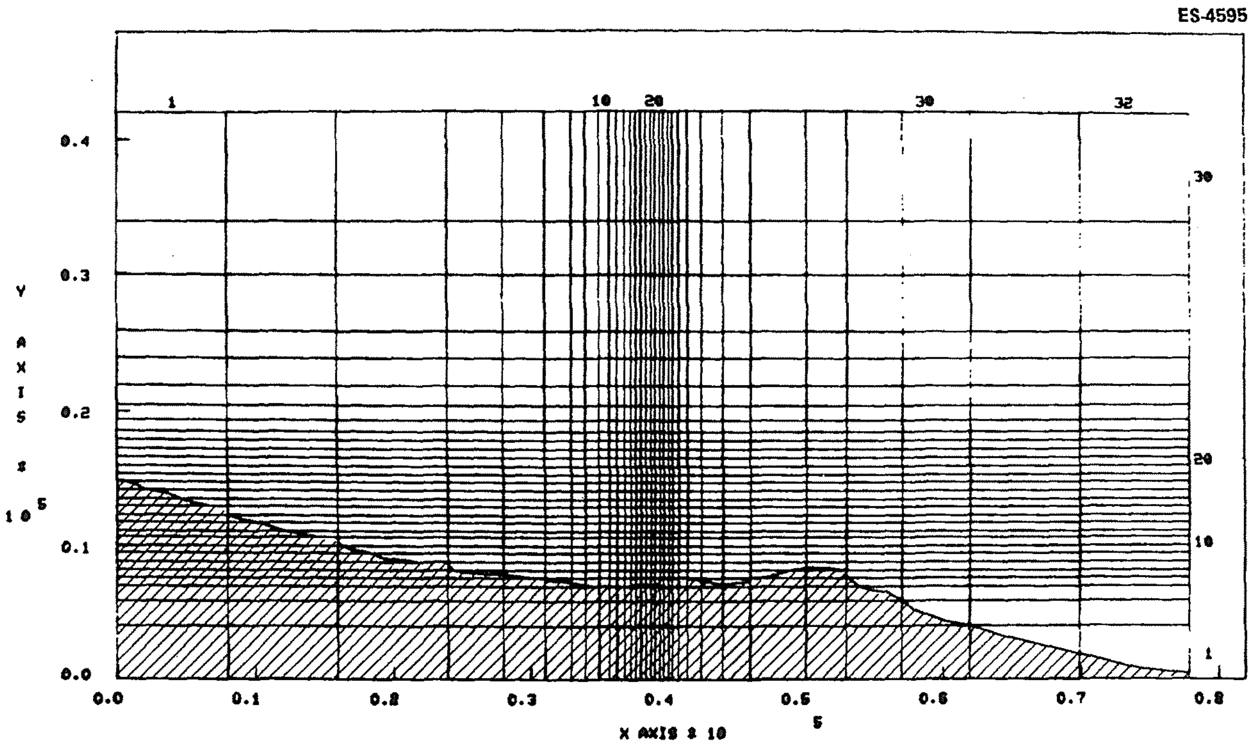

Fig. 5.5. Plot of region and grid system used for the mathematical model applications.

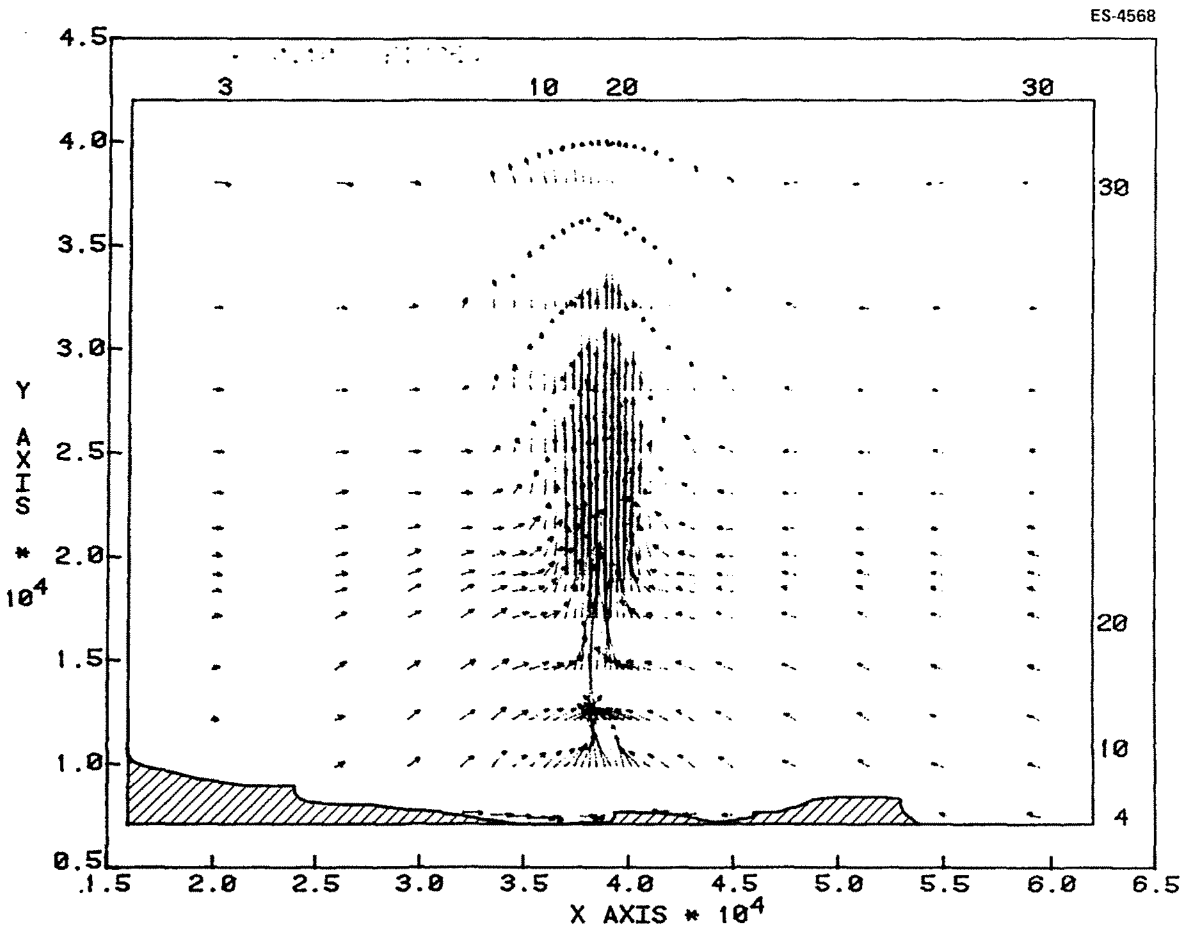

Fig. 5.6. Predicted, depth-averaged, plant-induced flow field for Units 1, 2, and 3.

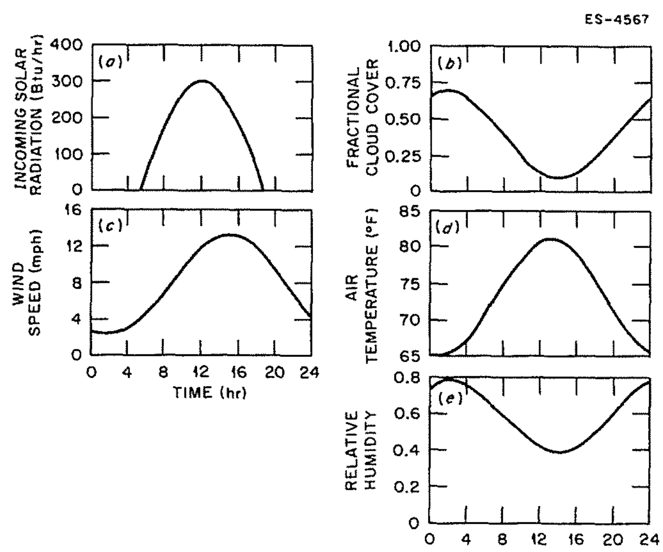

Fig. 5.7. Plots of meteorological variables as a function of time use in the thermal model. (To convert mi to km, multiply by 1.6; to convert °F to °C, subtract 32 and divide by 1.8.)

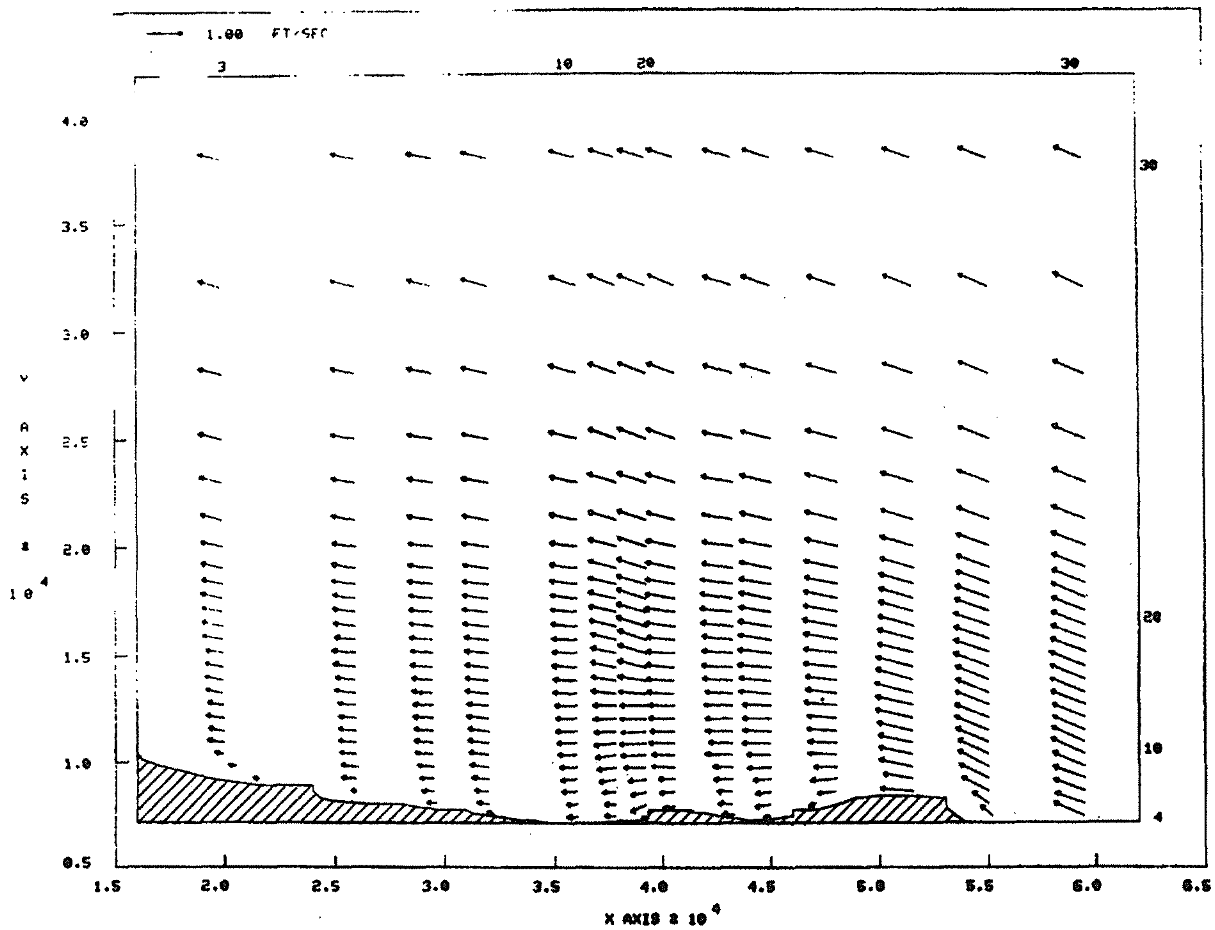

Fig. 5.8 Predicted natural flow field in the San Onofre region at 2:00 a.m. on the fifth day. (To change ft to m, multiply 0.3048; to change °F to °C, subtract 32 and divide by 1.8.)

Figure 5.16 (b) is a plot of the maximum excess temperature in the vicinity of the diffuser as a function of time for one tidal cycle. The shaded portion of this curve represents the period during the tidal cycle when the excess temperature is greater than or equal to 2.2°C (4.0°F) and the plume is vertically well mixed. In other words, the shaded area in this figure reflects the portion of the tidal cycle that will violate state thermal standards as applied to excess bottom temperature. It is clear from this figure that bottom excess temperatures greater than 2.2°C (4.0°F) are predicted to occur for two hours during the tidal cycle. Because, however, this prediction, based on a low ambient drift current, is conservative, excessive incremental bottom temperatures should not occur during each tidal cycle but rather during periods of worst case conditions.

With an assumed persistent drift, the data shown in Figs. 5.8 through 5.15 indicate that the constraints on the surface and shoreline excess temperature will be satisfied. The model is inadequate for addressing the issue of bottom temperature. However, at worst, the 2.2°C (4°F) excess temperature should only touch the bottom over a very limited area in the vicinity of the Unit 2 and 3 diffusers. On the basis of these results, the staff believes that violations of the state thermal standards are unlikely.

Heat treatment

Heat treatment will be necessary to control biological growth in the discharge conduits, intake conduits, and screenwells. Heat treatment consists of decreasing the flow rate through the heat-dissipation system while maintaining a constant waste-heat rejection rate. The result is an increased temperature rise across the condensers.

ES-4544

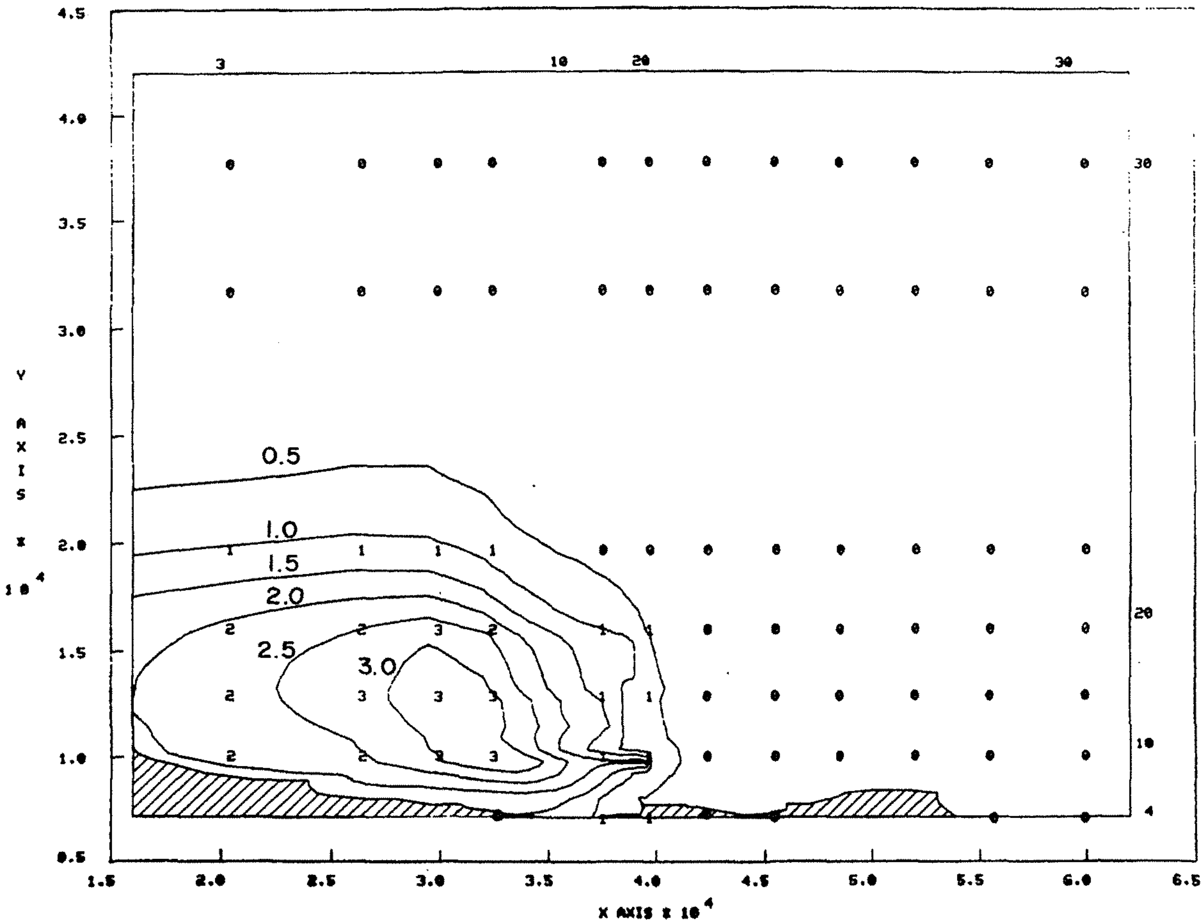

Fig. 5.9. Predicted excess temperatures in the San Onofre region at 2:00 a.m. on the fifth day. Isotherms are plotted in increments of 0.28°C (0.5°F) beginning with the 0.2°C (0.5°F) isotherm. (To change F° to C°, divide by 1.8.)

Discharge heat treatment will be required only when none of the following conditions are met:

1. discharge temperatures exceed 26.7°C (80°F) for a minimum of 1000 hrs,

2. discharge temperatures exceed 29.4°C (85°F) for 150 hrs, or

3. discharge temperatures exceed 32.2°C (90°F) for 31 hrs.

On the basis of these conditions it is expected that discharge heat treatment will be required only infrequently and usually during the winter. When discharge heat treatment is required, it will be performed at a discharge temperature of 40.6°C (105°F) for a duration of 1.1 hrs for Unit 2 and 0.9 hrs for Unit 3. During discharge heat treatment, discharge flow rates will be reduced and discharge temperatures will be increased. The discharge excess temperature will be the difference between the ambient water temperature and 40.6°C (105°F.) The reduction in the discharge flow rate will be proportional to the increase in the discharge excess temperature.

Although the exact nature of the thermal plume resulting from discharge heat treatment will be dependent upon the ambient conditions at the time of heat treatment, the thermal plume will be qualitatively similar to the plume resulting from normal operation as shown in Figs. 5.9, 5.11, 5.13, and 5.15. However, the flow is reduced and the temperature increased, so that the plume will be somewhat warmer and smaller in spatial extent than that from normal operation. The greatest plume temperatures will occur if Units 2 and 3 are heat treated simultaneously. A warmer plume will persist the longest when the heat treatment for these units are sequenced.

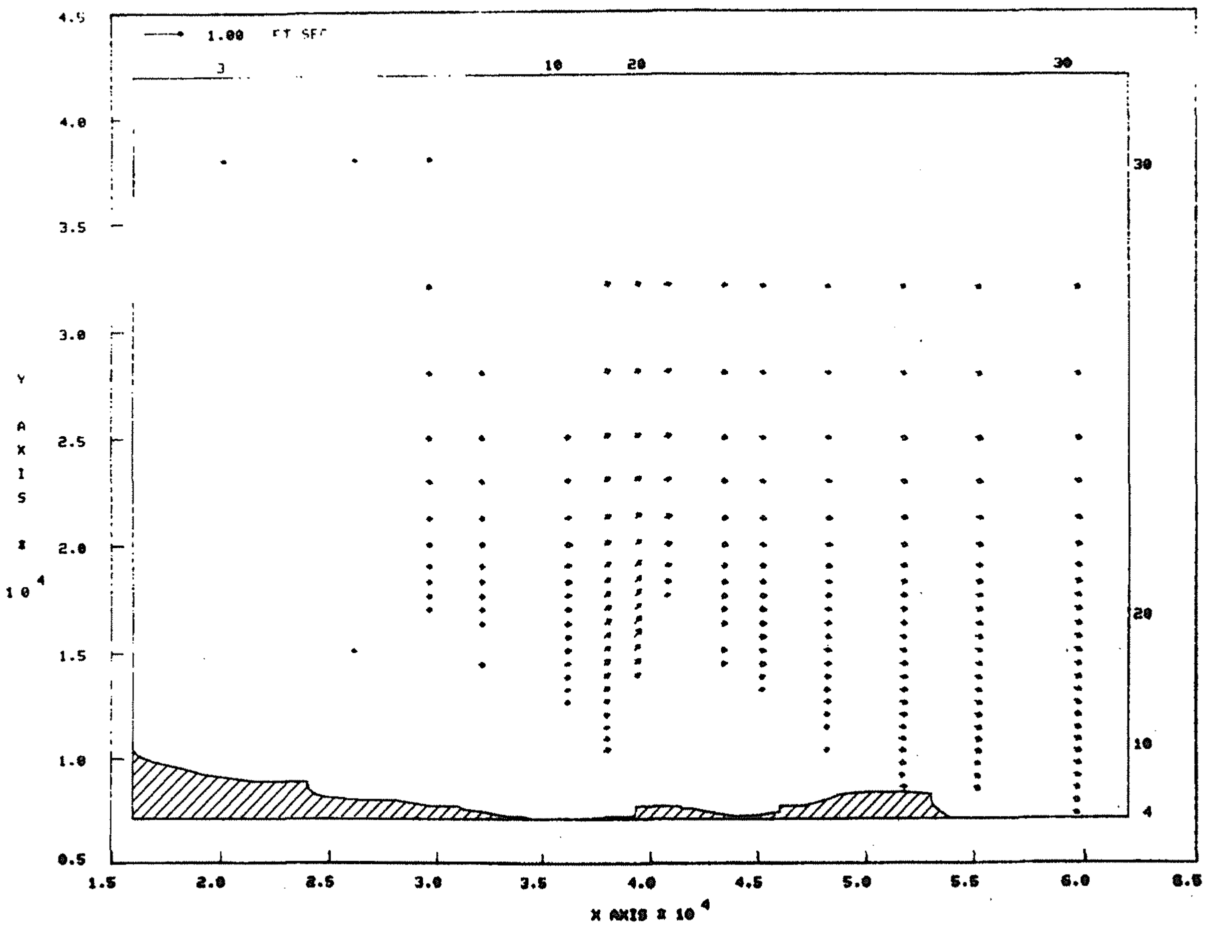

Fig. 5.10. Predicted natural flow field in the San Onofre region at 8:00 a.m. on the fifth day. (To change ft to m, multiply by 0.3048; to change F° to C°, divide by 1.8.)

During the summer months, discharge heat treatment should increase far-field plume temperatures by no more than 25% if both units are heat treated simultaneously (an unlikely event due to the increased probability of a reactor scram) and by no more than 15% if the units are heat treated sequentially. Plume temperatures at this extreme would persist for several hours, and plume temperatures would return to normal within several tidal cycles.

During the winter, the thermal plume should exhibit temperature distributions no greater that those predicted during the summer (Figs. 5.9, 5.11, 5.13, and 5.15). Excess temperatures during winter heat treatment will be greater than during the summer since a greater condenser temperature rise will be required to meet the design discharge temperature of 40.6°C (105°F). For an ambient water temperature of 10°C (50°F) (typical of winter) excess temperature at the San Onofre kelp bed would be approximately 4°C (7.2°F) if the Units 2 and 3 discharges are heat treated simultaneously and 2 to 3°C (3.6 to 4.8°F) if the discharges are heat treated sequentially.

Intake conduit and screenwell heat treatment will be performed by reducing the flow rate through the heat-dissipation system, thereby increasing the temperature rise across the condensers, and by reversing the flow direction so that ambient water is withdrawn through the diffuser and heated water is discharged from the velocity cap intake. The duration of this heat treatment will be 2.1 hr at an anticipated maximum temperature of 37.8°C (100°F). The plume produced by discharge through the velocity caps will resemble the thermal plume from Unit 1. Since this discharge does not induce the dilution produced by diffusers, the heat-treatment plume will be considerably hotter, though much smaller, than the plume resulting from normal plant operation. Plume temperatures will decrease approximately as the square of the distance from the intakes. Heat treatment on either the Unit 2 or the Unit 3 intake will have an indirect impact on the thermal plume of the unit operating normally. If, for example, the Unit 2 intake is heat treated while Unit 3 is operating normally, the Unit 2 heat treatment plume could be advected during certain times in the

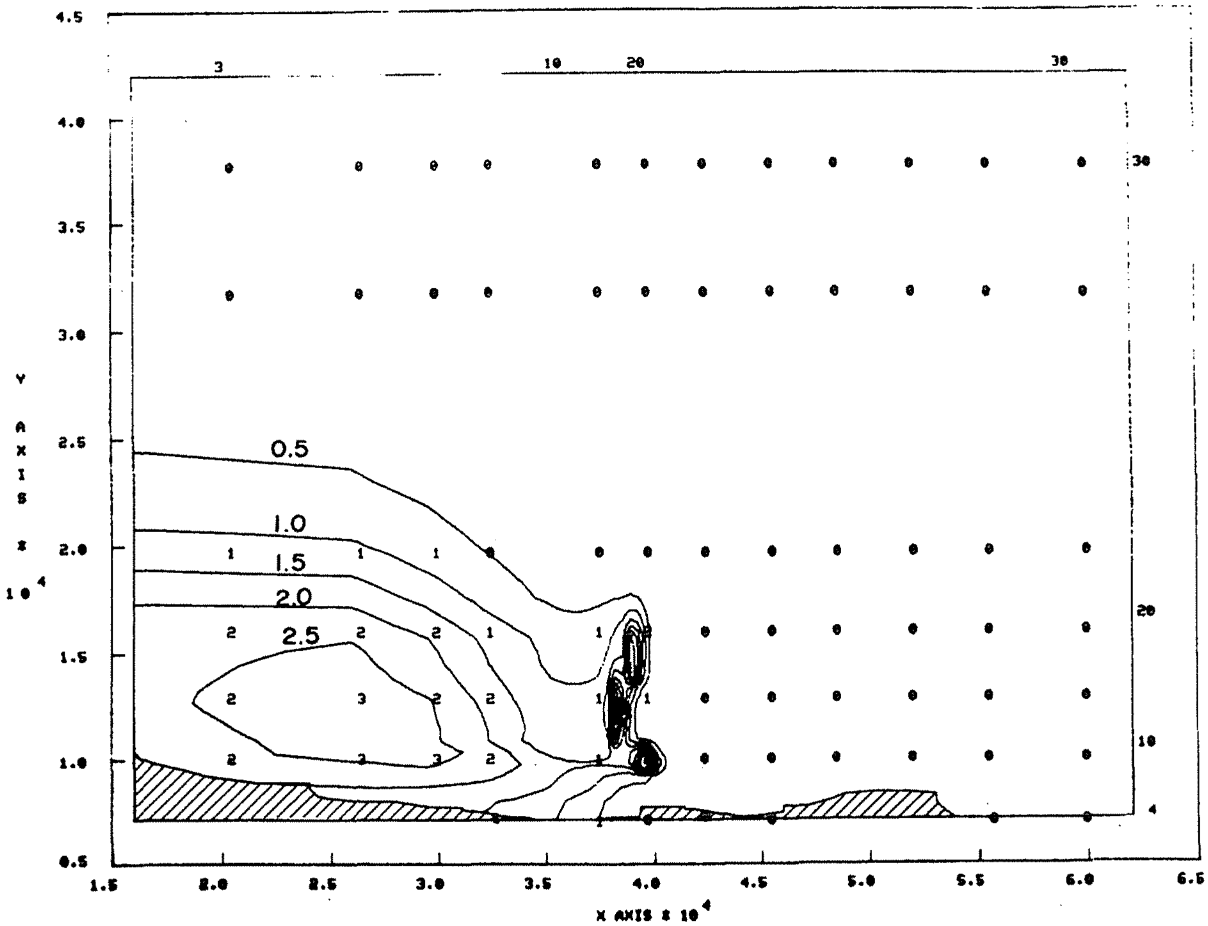

Fig. 5.11. Predicted excess temperatures in the San Onofre region at 8:00 a.m. on the fifth day. Iostherms are plotted in increments of 0.5°F beginning with the 0.5°F isotherm. (To change F° to C°, divide by 1.8.)

tidal cycle towards the Unit 3 intake. As a result, water at temperaures above the ambient could be drawn into the Unit 3 intake, resulting in a temperature rise in the Unit 3 discharge plume. Similarly, Unit 3 intake heat treatment could affect the plume from Unit 2. This recirculation phenomenon will be offset by virtue of the fact that only one unit will be discharging through the diffuser. Therefore, far-field diffuser plume temperatures will likely be less during intake heat treatment than during normal plant operations.

Both discharge and intake heat treatment will produce plumes showing temperatures greater than plume temperatures expected during normal operations. These increased temperatures will be greatest near the point of discharge, and will be of short duration returning to normal within several tidal cycles after completion of heat treatment.

Should it be determined that heat treatment results in significant excess temperatures at biologically sensitive areas, impacts could be mitigated by scheduling heat treatments during phases of the tidal cycle (such as periods when the tidal flow will transport the thermal plume away from areas of concern) that will minimize excess temperatures occurring in such areas.

5.3.2 Chemical discharges

The assessment of the effect of chemical discharges on water use contained in the FES-CP (5.2) is still, for the most part, valid. The discussion of the impacts of copper and nickel discharges has been altered by the change to titanium condenser tubes (3.2.4.1), and these discharges should not affect water use since the tubes no longer contain copper or nickel.

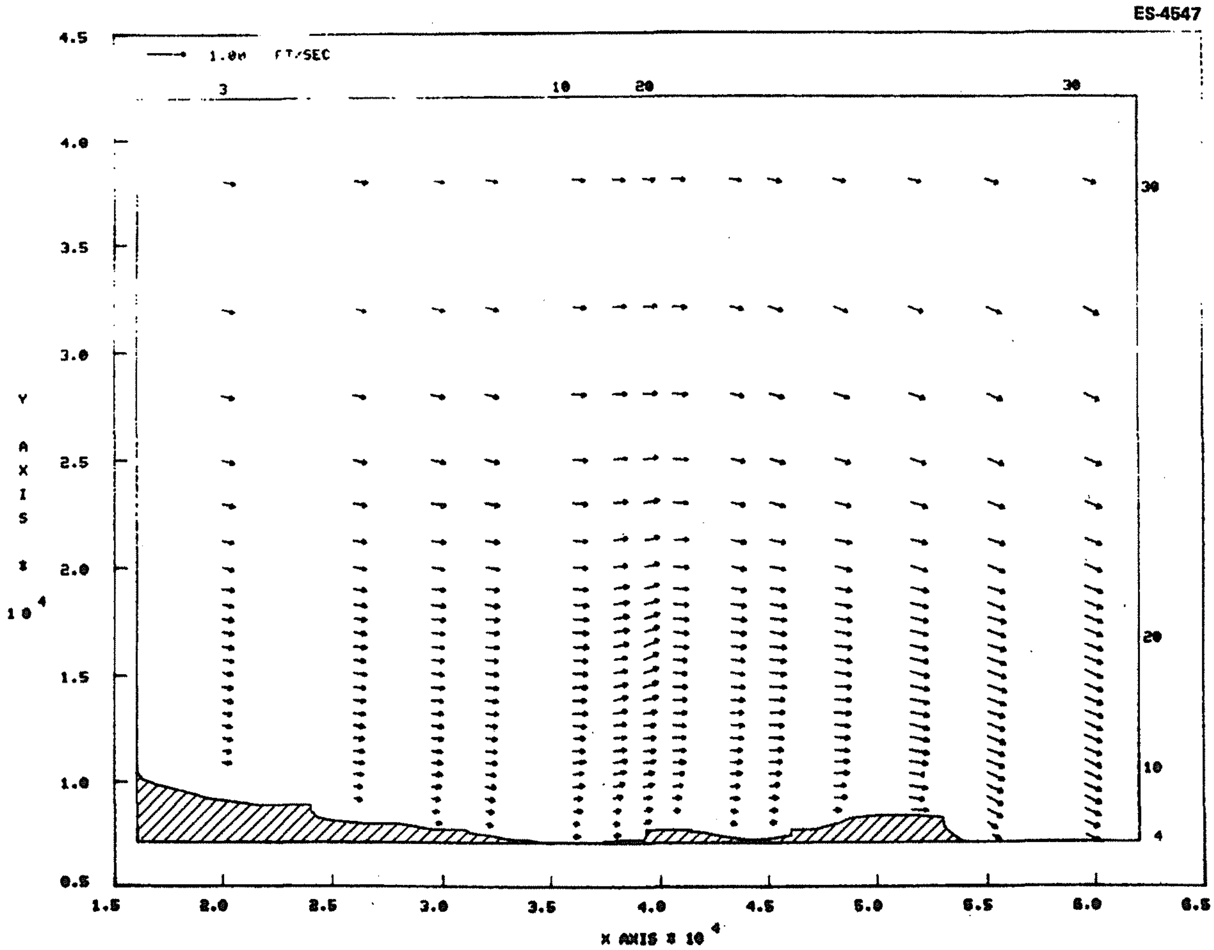

Fig. 5.12. Predicted natural flow field in the San Onofre region at 2:00 p.m. on the fifth day.

A National Pollutant Discharge Elimination System Permit for SONGS 2 & 3 was issued on June 4, 1976, by the California Regional Water Quality Control Board, San Diego Region. The chemical effluent limitations imposed by this permit are given in Sect. 3.2.4.1.

5.4 ENVIRONMENTAL IMPACTS

5.4.1 Terrestrial environment

Generally, operation of SONGS 2 and 3 and associated transmission lines should have no significant impact on the terrestrial ecological characteristics of the area. Although the transmission line routes have been modified since the issuance of the construction permit (3.2.5), the analysis of projected impacts as set forth in the FES-CP (5.3.1) remains the same. All new transmission lines will be constructed on existing rights-of-way; a total of 5.2 ha (12.8 acres) of land will be required for access road extensions and for new tower bases. The fire break which was bulldozed adjacent to the transmission line on Camp Pendleton Marine Base is expected to be maintained by periodic blading. Impacts associated with this operation should be minimal.

Other potential terrestrial impacts associated with operation of SONGS 2 and 3 which were not addressed in FES-CP are as follows. Some audible noise will be generated from the operation of the transmission lines. Noise levels, however, will be well within the urban evening levels accepted by the public (ER, Section 5.5.1). The transmission lines will be designed to minimize any affects on radio and television reception (ER, Section 5.5.1). Maintenance of the transmission lines (washing and repair work) requires that the access