FINAL REPORT OF
THE MARINE REVIEW COMMITTEE
TO THE CALIFORNIA COASTAL COMMISSION

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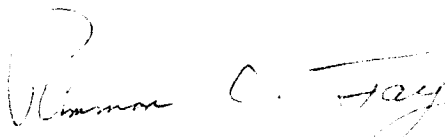
BY



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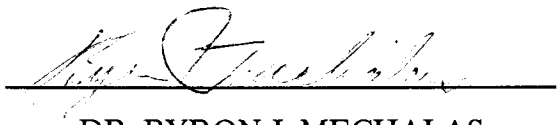

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August 1989

MATERIALS SUBMITTED TO THE CCC

Final MRC Report to the CCC (this document - MRC Doc. 89-02)

MRC Technical Reports to the CCC

Final Contractors' Reports to the MRC

Reviews of Contractors' Reports and Technical Reports

MRC data bases (11 mainframe tapes)

MRC data bases (on 5.25" floppy diskettes)

Guide to MRC data bases

MRC raw data files (13 mainframe tapes)

Final computer "dump" of MRC files and programs

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GUIDE TO THIS FINAL REPORT

Section I provides a summary of the entire report. Chapter 1 presents the Results and Recommendations; in doing so it summarizes Sections III-V (Chapters 6-20) of this report. Chapter 2 is essentially a summary of Section II (Chapters 3-5).

For those with time to read beyond Section I, Section II gives a fuller account of the background to the study. The results of each component of the study, and the means by which they were obtained, are presented in Section III (Chapters 6-17). Section IV (Chapter 18) presents those MRC results that bear on water quality regulations and, in response to provision B.1.b. of Coastal Permit No. 183-73, explains how decisions were reached on SONGS' compliance with these regulations. Section V (Chapters 19-20) provides the rationale for the recommendations made in light of the Results.

Annotation

The data presented in the MRC Final Report to the California Coastal Commission (MRC Doc. 89-02) have their sources in the *Technical Report*s and the *Interim Technical Reports* to the CCC. The identity of the source information is indicated in square brackets [ ].

Technical Reports

The Technical Report that is the source of a conclusion is referred to as TR, thus Section 2.1 in Technical Report A is abbreviated as [TR A: 2.1]. Information from Technical Reports is referred to by section. The fifteen Technical Reports prepared for the CCC are:

Technical Report A.	Sand Crabs	TR A
Technical Report B.	Anomalous sediments in the San Onofre kelp bed	TR B
Technical Report C.	Entrapment of juvenile and adult fish at SONGS	TR C
Technical Report D.	Adult-Equivalent loss	TR D
Technical Report E.	Metals and Radiation	TR E
Technical Report F.	Kelp Forest Invertebrates	TR F
Technical Report G.	Mysids	TR G
Technical Report H.	Mitigation	TR H
Technical Report I.	Soft Bottom Benthos	TR I
Technical Report J.	Kelp Bed Fish	TR J
Technical Report K.	Giant Kelp	TR K
Technical Report L.	Physical and Chemical Oceanography	TR L
Technical Report M.	Bight-wide effects on fish: Compensation	TR M
Technical Report N.	Integration of local depressions and increases in fish stocks with inplant losses	TR N
Technical Report O.	Water Quality Compliance	TR O

Interim Technical Reports

The Interim Technical Report that is the source of a conclusion is referred to as ITR, thus page 17 in Interim Technical Report 3 is abbreviated as [ITR 3: 17].

Information from Technical Reports is referred to by page, not section. The five Interim Technical Reports prepared for the CCC are:

1. Plant Description and Operating History	ITR 1
2. Sampling Design and Analytical Procedures (BACIP)	ITR 2
3. Midwater and Benthic Fish	ITR 3
4. Plankton	ITR 4
5. Fish Larvae and Eggs	ITR 5

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TABLE OF CONTENTS

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LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

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SECTION I.

SUMMARY

Chapter 1

RESULTS AND RECOMMENDATIONS

Summary

Under the mandate of the Coastal Commission Permit 183-73, the Marine Review Committee (MRC) has studied the effects of San Onofre Nuclear Generating station (SONGS) on the marine environment since 1975. Our principal conclusions and recommendations are summarized below.

The plant kills large numbers of organisms in its intake cooling water, and sometimes moves turbid water into the San Onofre kelp bed (SOK).

The MRC has measured adverse effects on the kelp community in San Onofre kelp bed, including giant kelp, fish, and large benthic invertebrates. These effects, although local, are deemed substantial because kelp is a valuable and limited habitat.

The MRC calculates that there is a substantial impact on the standing stock of a number of midwater fish populations in the Southern California Bight. The reductions in standing stock are probably between one and ten percent. Because the effects can occur over large populations, we conclude they are substantial.

The MRC has also measured a reduction in the local abundance of some midwater fish populations. In addition, SONGS kills at least 20 tons of fish per year in its intake system.

The MRC analyzed a range of options for preventing, reducing, or mitigating these impacts, and presents two sets of options to the Commission. Option 1a is cooling towers; the majority of the MRC (Mechalas and Murdoch) recommends rejection of this option, Dr. Fay recommends its acceptance. Option 1b is moving the discharges; the MRC recommends against this option. The MRC recommends acceptance of option 2, which involves selection of one or a combination of four techniques: (1) reduction of flow of cooling water through SONGS or other SCE coastal power plants; (2) construction of a high-relief artificial reef designed to maximize fish production; and/or (3) restoration of a wetland. (4) Upgrading the existing systems at SONGS that are designed to exclude fish from the plant or to return them to the ocean. The MRC also recommends that the State Thermal Plan be amended to remove restrictions on the allowable across-the-condenser temperature rise for open coastal power plants, to facilitate reducing the flow of cooling water.

Other parts of the community that were studied and in which no substantial adverse effects were found are: the plankton, a range of animals associated with the sandy bottom, including invertebrates living in or on the soft sediments (these are called the "soft benthos"), certain mysids, bottom-dwelling fish, and intertidal sand crabs. The soft benthos, mysids and bottom-dwelling fish increased in abundance in the SONGS' area as a result of the plant's activities.[1]

The MRC concludes that SONGS is not in compliance with certain water quality regulations. The level of natural light at the bottom, downcoast from SONGS, was 6 - 16% lower than it would have been without SONGS. There were

[1] Dr. Fay disagrees with these conclusions.

significant reductions in local populations of midwater fish, and of kelp, fish and invertebrates in the San Onofre kelp bed. (Whether SONGS is in compliance with regulations for sediments will be determined by the results of an ongoing study.)

Some perspective on SONGS' effects on the marine environment may be useful. The impacts detected or inferred by the MRC, especially on the kelp community and on bight-wide fish populations, are substantial for the reasons given above. They should be prevented or mitigated. But they are not large-scale ecological disasters.[2] In particular, they are not on the scale of effects predicted during the 1973-74 Public Hearings, which were the stimulus for the creation of the Marine Review Committee. Key testimony at these hearings predicted that SONGS would create a large inshore ecological "desert." This has not occurred.

This chapter (a) summarizes the effects of San Onofre Nuclear Generating Station on the marine environment, (b) compares the MRC's results with the regulations of the National Pollutant Discharge Elimination System permits for the station, (c) explains the Committee's recommendations for prevention, reduction, and/or mitigation of effects, including monitoring of the effectiveness of mitigation measures, and (d) recommends future monitoring in relation to plant operation.

[2] Dr. Fay disagrees with this conclusion.

RESULTS

Physical Effects

The physical effects are discussed in detail in Chapter 6. SONGS Units 1, 2 and 3 take in a volume of water equivalent to 1 mile square and 14 feet deep each day. About 10 times this volume is quickly mixed with the discharged water. This plume is further diluted to about a 1% concentration about 2 miles downstream from the plant. The plume is pushed offshore by SONGS, and about 60% of the time is carried downcoast and through and over the San Onofre kelp bed (SOK) by the prevailing currents. This plume is often more turbid (contains more particles) than the ambient water. Make-up water, mainly from offshore, flows towards SONGS' diffusers, replacing the water entrained by the discharge jets.

The major physical effects caused by SONGS' plume are as follows. (1) When the plume is turbid, it decreases the light reaching the ocean floor below it. On average, the light level at the bottom in SOK is about 16% lower than it would be in the absence of SONGS. (2) The turbid plume also increases the flow of particles close to the bottom, and increases the rate at which particles settle on the bottom. (3) The directions of currents near the plant are modified: upstream of the diffusers currents are diverted shoreward, while downstream currents are initially diverted offshore in the plume.

The turbid plume may be responsible for patches of anomalous sediment in SOK. These presently cover about 9 hectares (22 acres, 4.5%) of cobble bottom in

SOK. MRC is investigating this matter. The area covered by these patches has not increased since 1987, and has recently decreased.

The plant is a source of metals and radioactive nuclides. However, there is no evidence that SONGS releases enough metals to increase substantially their concentrations in the environment. The environment near SONGS is typically low in metals that might be released from SONGS. The activity levels of plant-related radioactive nuclides in local sediments and animal tissues are sometimes detectable, but are well below those associated with naturally-occurring radioactive nuclides. These results are presented in detail in Chapter 17.

Biological Effects

The effects reported here are based on many samples taken over at least four years; they therefore represent estimates of long-term effects.

Substantial impacts have been measured or inferred to occur in two components of the biota: fish, and organisms in San Onofre kelp bed. They arise, respectively, from two mechanisms. (1) Losses as a result of passage into or through the plant in the cooling water. (2) Changes in the physical environment in SOK as a result of the sometimes turbid plume.

SONGS' release of metals and radioactive nuclides does not lead to ecologically hazardous concentrations of these pollutants in the environment or the local biota. Metal concentrations are low and do not provide a reasonable explanation for the observed negative effects of SONGS on the biota. The same is

true for radioactive nuclides; internal radiation activity levels in local organisms are raised only slightly above the background level. See Chapter 17 for details.

1. Fish stocks in the southern California Bight (see Chapter 10)

This is the only finding of an adverse effect that is not based on direct observation of reduced abundances but instead is inferred from the assumed 100% mortality of fish eggs, larvae and juveniles taken into the plant in its cooling water.

For the most vulnerable fish species, MRC measured or estimated the amount by which mortality in Units 2 and 3 increases the bight-wide death rate of the immature stages. Simple models suggest that the increased death rate leads to a reduction in the Bight's standing stock of adult fish. It is not possible to estimate the reduction with any degree of precision. An estimate that lies in the middle of those possible, points to a loss of several hundred tons of mainly "fodder" fish (i.e., species that serve mainly as food for other fish species).

2. San Onofre Kelp Bed

Substantial impacts have been measured in three components of this community: giant kelp, kelp-bed fish, and large invertebrates living on the cobble bottom. Kelp beds are a particularly valuable and limited habitat.

2a. Giant Kelp (see Chapter 7)

Giant kelp is the key species in the bed, providing food and habitat for many other species. The Permit contains a condition, Condition C, stating that the diffusers "shall not be located within 1,900 feet of the area where the kelp bed to the south of the diffusers is likely to expand." In the Findings and Declarations, the Permit states that "Condition C will insure that the effects of Units 2 and 3 on the kelp beds are not substantial."

The area covered by moderate to high density kelp in SOK has been reduced on average by about 200 acres (80 hectares), or 60% below the abundance that would have occurred in the absence of SONGS. Increased turbidity created by SONGS' discharge plume is the cause. The MRC did not study organisms, such as some species of mysid shrimps, that are closely associated with kelp canopy, but it is a reasonable expectation that these species have also declined at SOK.

The estimated reduction of kelp, 80 hectares, is MRC's best estimate. However there is uncertainty as to the exact size of the loss since estimates of kelp abundance are subject to sampling "error," factors other than SONGS influence its abundance, and the amount lost varies through time. The loss might be as small as 40 hectares and, less probably, could be as high as 100 hectares. Nevertheless, 80 hectares is our best estimate and was derived using the assumptions that are most consistent with the available information.

2b. Kelp-bed Fish (see Chapter 8)

Fish living near the bottom in SOK (e.g., sheephead, barred sandbass and black surfperch) have been reduced by about 70% (roughly 200,000 fish weighing about 28 tons) below the abundance that would have occurred in the absence of SONGS. These losses were presumably caused largely by the reduction in kelp, but other changes in the kelp-bed habitat caused by SONGS also contributed. Again, there is uncertainty concerning the exact size of this loss, but 28 tons is the MRC's best estimate.

2c. Kelp-bed Invertebrates (see Chapter 9)

The abundances of 13 species of snails, and of the white sea urchin, were reduced substantially (30%-90%) below the levels that would have occurred in the absence of SONGS. These species were chosen for study, from over one hundred species of large benthic invertebrates that live on the cobble bottom in SOK, because they are common enough to be sampled accurately. It is reasonable to infer that the abundance of other less common species in this habitat, which were not sampled, also declined. The reduction is associated with the increase in turbidity caused by SONGS' plume, and hence with an increased flow of particles near the ocean floor. The particles may interfere with the feeding or other essential activities of these organisms. Patches of fine sediments on the cobble bottom at SOK have also played a part in reducing the abundance of these organisms.

3. Local Midwater Fish Populations (see Chapter 11)

The observed reductions in local fish populations represent a substantial, but local effect.

Each year, SONGS takes in 45 tons of fish and kills at least 21 tons. This estimate was made in a period of depressed fish abundance, and over the long term the amount killed will be about 56 tons per year.

In the midwater, the local abundance of queenfish has been reduced by between 30% and 70%, depending on the location, out to a distance of 2-3 km from SONGS, relative to the abundance expected in the absence of SONGS. A similar reduction occurred in white croaker, but over a smaller area. Several other species probably have experienced smaller reductions. Over 100 species of fish have been entrapped during the study. The reduction in white croaker and some of the reduction in queenfish can be explained by the loss of fish in SONGS' intakes, but it seems that some other factor (perhaps the local increase in turbidity caused by the plume, which might cause fish to leave the area) must also be operating.

Other Biological Effects

4. Local Benthic Fish Populations

The abundance of fish living on the bottom typically increased above the levels that would have occurred in the absence of SONGS, although a few less common species decreased. White croaker and queenfish increased by more than

100% 1.5 km downcoast of SONGS. Several other less common species also increased on the bottom.

5. Soft Benthos (see Chapter 14)

The abundances of small invertebrates (worms, crustacea, clams, etc.) that live in and on the sandy bottom near SONGS were in general increased above the levels that would have prevailed in the absence of SONGS. The increases were more prevalent in deeper (roughly 60-foot [18 meter]) water than in shallower (26-foot [8 meter]) water, and in the deeper water increases were seen in some organisms as far as 2 miles (3 km) downcoast from the diffusers. The increases are themselves increasing through time. SONGS has not changed the type of community present (e.g., the increase is not in "pollution-tolerant" species). Some decreases were seen in species in shallow water, out to almost 1 mile from the plant, but these decreases are disappearing with time.

6. Mysids (see Chapter 15)

Mysids are shrimp-like crustaceans, many of which stay near the bottom during the day, and move up in the water column at night. They were chosen to represent a larger group of crustacea that share this "semi-planktonic" habit. The MRC did not detect reductions in the abundance of these mysids; indeed, some species increased significantly in abundance above the level that would have occurred in SONGS' absence, and there was a general pattern of increases in this group. The increases were in species typical of the community and do not represent a change to a different and perhaps less-desirable set of species. The MRC did not